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EEDS: ENERGY- EFFICIENT AND DELAY-SENSITIVE MECHANISM FOR IMPROVING NETWORK LIFESPAN WITH WBAN

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ABSTRACT-
With implications in intelligent modes of transportation, automation in homes, agriculture, and self-driving cars, wireless networks of sensors, or WSNs, have risen in importance in the context of the Internet of Things (IoT). The entire communication system between nodes that sense and the sink represents an important concern in terms of energy and system lifespan because device nodes are restricted by battery power. It looks like the nodes near the analysis sink remain involved in data transfer. In addition to this, nodes that are situated closer to the sink absorb energy far more rapidly than nodes that are away from it. Sink accessibility can solve the earlier issue. RPL has been created to regulate node mobility in wireless networks utilizing a shortage of energy. One of the suggested initiatives is to determine the RPL protocol's effectiveness with a randomized and stationary sink node. The paper outlines how RPL performance could possibly be boosted going into the future and conveys the results of present rules determined by a variety of routing standards. Two distinct situations with 25 and 50 nodes are looked at for comparison. Networking simulator 2.35 has been utilized for simulation. Two unique scenarios: random sink node and static sink node—are further categorized into two environments. The system gets evaluated utilizing the following metrics such as average efficiency, packet delivery number, average E2E delay, as well as usage of energy. Simulations suggest that implementing a movable sink promotes system performance as the whole.
KEYWORDS: Intelligent Transportation Systems, Wireless Sensor Networks, Routing Protocol for Low Power and Lossy Network, Internet of Things.

1.INTRODUCTION-

1.1. Wireless Sensor Networks:
Nowadays, innovation is evolving at an alarming rate, keeping our lives ever more automated and secure. A prime instance of an innovation that has increased in importance in everyday life is WSN. As the title suggests, it is an instance of wire-free system that includes dispersed self-monitoring equipment that utilize sensors in order to maintain an eye on atmospheric and physical state.

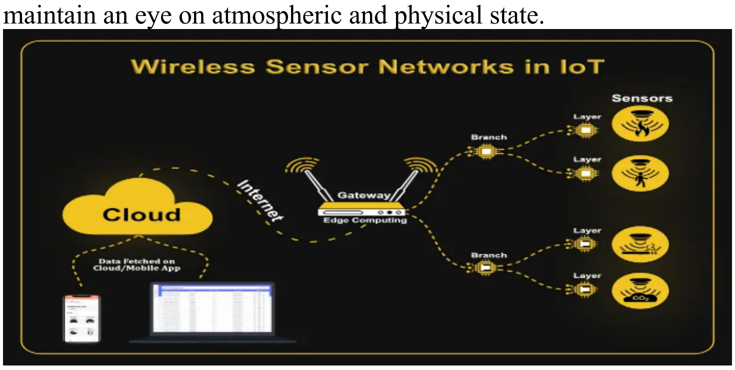

Fig. 1. Wireless Sensor Networks [2]

Regular environments, like houses, businesses, as well as towns, often include Wireless Sensor Networks (WSNs) [11]. Functional locations focus on the acquired truths from the real world. Dedicated divisions which ensure recognition, process, along with future abilities for viewing widespread sites include WSNs [5].

1.2. Internet of Things:

Tangible things or activities comprise the Internet of Things (IoT). With the goal of improving capability through sharing evidence among producers, managers and several other tactics, this system incorporates software, electronic devices, and sensors. Cloud computing knowledge and movable devices are combined to enhance the capabilities of movable devices. Increasing capacity for processing and storing is one advantage of interfacing mobile devices with cloud computing. In order to learn about the full distribution, allowable communication, on-demand use, along with best sharing with various home resources and abilities, the commercial uses of IoT and Cloud Workout are taken into account. By linking IoT and cloud, there's an opportunity to boost the application of current information that is obtainable in cloud environments. Cloud-based storage for IoT requests may be obtained through this combination [19].

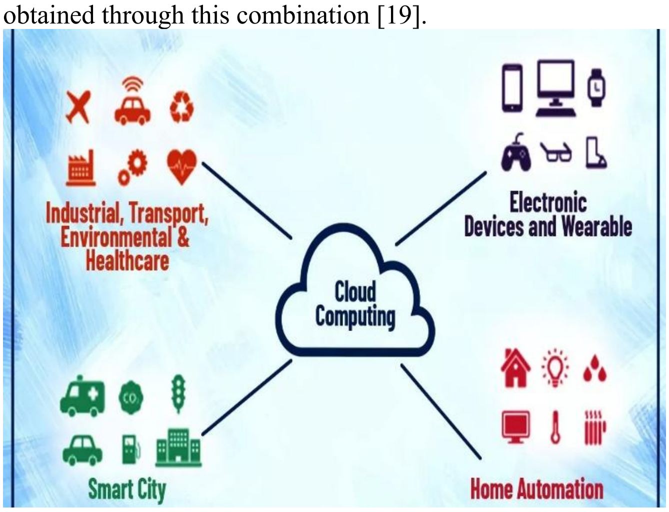

Fig.2. IoT & Cloud Computing Integration

1.3. A Low Power or Lossy Net Routing Protocol:

RPL has been actively discussed as a way to support sensor node routing. Typically, a backbone of in-between nodes is deployed, which is likely to be permanent. For the static backbone network, RPL uses a graded routing approach. Movement is characterized by a particularly dynamic topography and frequent disruptions from surrounding nodes. Because of the dynamic geography, packets absorbed by a mobile node are forwarded to boundaries (parents) even after the mobile node has moved out of range of those people [12]. Uneven load distribution in the RPL system causes bottlenecks, energy holes, premature node demise, and poor network performance. If the impacted nodes are a single hop away from the sink or root, such issues will cause significant disruption to the RPL network. As a result, effective load equalization strategies must be created to prevent these issues [13]. Because the energy of the burdened chosen parent node can drain abundantly faster than that of other people, a piece of the network is also separated due to load imbalance. The deterioration of that stressed parent node's battery could have a negative impact on network consistency. This is a serious disadvantage that is open to the public [12]. The effects of load imbalance include early node death, energy depletion, and buffer occupancy. As a result, load equalization algorithms were developed to address these concerns, and the RPL network's node and network life times were increased [14].

It has been projected by Cisco that 500 billion machines will be online by 2030. The general architecture of the Internet of Things comprises the application, transport, and sensor layers. Collecting data is mostly the domain of the sensor layer. Several computer technologies for obtaining valuable information from enormous amounts of data are made available by the application layer. This layer acts as a connection between different devices with internet connectivity and end people. The transport layer facilitates internet connectivity [1]. Smart manufacturing, agriculture, autonomous automobiles (Intelligent Transportation System), and smart health are just a few of the industries that use IoT technologies [2].

The rapid advances in the Internet of Things (IoT) enabled the establishment of wireless sensor networks. A crucial component of the sensor layer of the Internet of Things (IoT) architecture are wireless sensor networks (WSNs). To make it possible to gather information via wireless networks, a typical WSN is built up of a network consisting of separate sensor nodes which are dispersed over several locations. A sink node gathers the data that is transferred by the nodes and decides to employ it locally or distributes it to another network [3]. Sensor nodes implemented in various WSN application areas face limited resources with regard to storage, computation efficiency, node energy, and power profile [4].

The fact that sensors frequently have limited energy, the long-term reliability of WSNs is an important issue to take into consideration before implementing in the real world. Because it's possible to advance all of the data that is provided by the intermediate nodes, the nodes nearest to the sinks have a shorter service life. [5] Anyone can deploy a fixed sink node (generally at the core of the WSN) or a moving sink node in various regions. Nodes that act as relaying nodes or routers and are set up near a static sink are believed to expire faster than nodes that have been located far from the sink [6]. The connection distance among the sensor and sink nodes regulates how much energy gets utilized during communication.

Each of the sensor nodes transmits data to the nearest static sink, which can help shorten the distance between devices [7]. The remedy for balancing node loss of energy and routing interest appears to be sink mobility. The mobile node that sinks finds the anchor hubs because it searches for them based on variables including separation, communication range, as well as energy. This idea improves to a longer lifetime for the network due to this anchor node doesn't have to transmit information of other nodes [8]. Throughput, coverage, and reliability of data, along with security are all facilitated by the employment of a mobile sink [9].

The next section is the layout of the remaining portions of this work. The research that is currently done in this field is reviewed in the subsequent part. Section 3 presents the suggested work. The efficiency of both random and stable sinks is assessed in Section 4. Thus finishes the paper in Section 5.

2. RELATED WORK-

Table 1. Summary of RPL enhancements

Author	Year	Approach	Findings
Jamal Toutouh	2012	optimising the routing protocol's values for parameters using a problem of optimization.	In terms of the efficacy of the optimization strategies employed, SA surpasses the other examined meta heuristic methods but dealing the given optimization problem.
David Carels	2015	A fresh strategy for handling down-track updates.	End-to-end delayed and ratio of packet delivery enhanced by up to 40%, based on the circumstances at hand.
Belghachi Mohamed	2015	The RPL protocol's subsequent hop choosing mechanism utilizes two routing metrics such as the broadcast time and the remaining power.	RPL's energy competence has risen due to evidence of sensor access, energy, and delay-mindful routing methods.
H. Santhi	2016	For multi-hop wireless communications, a new efficient routing structure that offers higher throughput and reduced end-to-end latency was developed.	In contrast to offering simple and accurate routes, this improved Associativity Based Routing protocol delivers more efficient and ideal paths from the source to the destination.
Meer M. Khan	2016	A sink-to-sink synchronization system.	Higher outputs and an extended lifespan are obtained by the system by splitting the load among sink nodes.
Weisheng Tang	2016	CA-RPL, an RPL-based compound routing the metric system, is used to avoid congestion.	The median amount of time delay is 30% less with CA-RPL compared to the initial RPL. The packet loss percentage declines by 20% when the inter-packet time is short.
Patrick Olivier Kamgueu	2018	It looks at recent RPL studies and highlights significant attempts to improve it, particularly in the fields of portability, safety, and topology streamlining.	It looks at recent RPL studies and highlights significant attempts to improve it, particularly in the fields of portability, safety, and topology streamlining.

Table 2. Research Gaps

Author Name	Methodology	Research Gap
Hyung-Sin Kim, 2015	(QU-RPL) is a queue deployment-based RPL which significantly improves packet transfer efficiency and end-to-end delay.	Due to population growth, packet losses are frequent in high traffic. Routing parent selection is an important load balancing issue for RPL.
Rahul Sharma, 2015	Two objective functions were used. To examine the performance of RPL in various radio models, we used 1) Expected Transmission Count, 2) Objective Function Zero).	A flood of overlay packets created to transmit again messages that have been diminished in the network serves as what causes congestion. Power consumption increased as a consequence of channel management and data packet buffer.
Amol Dhumane, 2015	Assess how the actual Internet of Things routing standard, Low Power and Lossy Network (RPL), performs above it.	More usual routing rules continually refresh their routing record. It is impossible to routinely bring RPL up to date via this method.
Fatma Somaa, 2017	a Bayesian methodology for precisely predicting sensor hub rate distributions. To aid with RPL adaptability, create the Mobility-based Braided Multi-way RPL (MBM-RPL).	A distinctive path towards the sink via each DODAG hub constituted the basis of each arrangement that had been put forth for giving flexibility through RPL. It looked like any of these strategies used an additional path in case the primary one failed.
M.Qasem, 2017	To even out the network's traffic load, a new RPL statistics has been established.	The parental element in RPL may be assigned to several children if they choose it as their preferred parent. Because their energy reserves run out much more quickly compared to those of other parental nodes, the overused preferred parents will eventually develop into breakable nodes.
Hossein Fotouhi, 2017	Three variables were taken into account when developing the system's components: window size, hysteresis margin of error, and stability monitor.	These standards have several problems even though the goal is to eliminate problems with mobility. i) The size of the window must encompass the entire amount of packets requested to measure the average acquired signal strength. This ought to be regarded as a search trouble because it may not be appropriate in most circumstances. ii) Calculating the hysteresis margin creates another toughness, necessitating the determination of a threshold for the beginning and end of the hand-off. iii) iii) Even small modifications to the threshold may hamper performance when assessing stability. iv) There are several explanations why position upgrades are costly. Every position change consumes node energy and raises the prospect of a packet failure at the medium access control layer. Direction-finding effectiveness is hampered by packet collisions, leading to in origin data packet loss due to diminished accuracy in recognizing the precise local topology. A dropped packet can be transmitted again, however doing so will result in greater end-to-end latency.

Hanane Lamaazi, 2018	Three scenarios are used for evaluating an RPL implementation: movement designs, multiple sinks, and network scalability.	Not each RPL activity estimate can be utilized by every one of them in every scenario.
Vidushi Vashishth, 2019	An optimization method for protecting the energy of IOT devices can be implemented through the use of clustering, head cluster selection, and less power-expensive path calculation for optimum routing.	In the networked environment, only a handful of nodes participate fully in the creation and transmission of information. By waiting for disturbances or specific incidents to occur, the other nodes in the network lose

3. ENERGY AND TIME EFFICIENCY NETWORK MODEL-

Based on the linked research, numerous techniques or factors can be utilized to improve the network's performance in general. Hence, among these characteristics, network latency and life frequency are essential. The sole objectives of our effort are to reduce latency and improve network life. A region has been surveyed by N different types of sensors. Although a static sink node is employed at the network's hub, a moving sink node is free for movement around the entire wireless sensor network. All sensor nodes as well as both sinks possess the same set the communication radius for data transfer.

Table 3. Research Gaps

No.	Name	Values
1	Sensor Nodes Count	25, 50
2	MAC type	Mac/802_11
3	Routing Protocol	RPL
4	Initial Energy	100j
5	Idle Power	675e-6
6	Receiving Power	6.75e-6
7	Transmission Power	10.75e-5
8	Sleep Power	2.5e-8

3.1. Energy Efficiency Network Model:

Power consumption during network installation and operation depends on the nature of the information load carried by the heterogeneity system, as shown by practical encounters utilizing wireless mixed networks and cellular networks. Considering constant power consumption and optimal conditions for data flow, a BS's Pci (average power consumption) is as follows:

$$\mathrm{Pc}_i = \mathrm{N}_{\sec} N_{ant}\left(A_i P_{tx} + \mathrm{B}_j + \mathrm{P}_{BHi}\right) \tag{3.1}$$

Nant is the amount of antennas per sector and Nsec is the quantity of sectors for a certain base station. Pci is the median of the total energy generated by all the base stations, however Ptx is the power that is transmitted for each base station. The coefficient Ai indicates the portion of the Pci that corresponds directly to the mean power transferred from a base station, while the coefficient Bi represents the total amount of power used without regard to this average sent power. These are important characteristics that describe base station power consumption data. PBHi is used to determine the electrical consumption that occurs during transmission.
The entire quantity of information sent dividing by the whole amount consumed is known as energy efficiency, or EE. The term for EE is as follows:

$$EE = \frac{Overall\ data\ rate}{Total\ power\ consumed} = \frac{RT}{PCT} \tag{3.2}$$

RT is data rate,

$$Rn = \sum_{(k=1)}^{K} r^k n \tag{3.3}$$

Where, K aggregates to the total sub channels assumed for n users. The whole data ratio for totally users can be written as:

$$Rt = \sum_{(n=1)}^{N} Rn \tag{3.4}$$

Data assumed to each user can be labeled as a function of received power:-

$$\mathrm{Rn} = BWnlog2(1+\frac{Prxn}{In}) \tag{3.5}$$

Therefore, for an individual base station in a heterogeneous network, the total information rate change for all users may be characterized as:

$$\mathrm{Rt} = \eta \sum_{n=1}^{N} \mathrm{Nrb} log2(1+\frac{Prxn}{In}) \tag{3.6}$$

The η normally equals 1 (correction factor). From here the EE of a specific base station with consumed power Pc can then be written as:

$$\mathrm{EEi} = \frac{Rt,i}{Pc,i} \tag{3.7}$$

The above equation gives us the required energy efficiency of a station.

3.2. Time Efficiency Network Model:

The efficacy of a specific heterogeneous network in a specific area can be evaluated using the EE paradigm previously mentioned. The most effectively utilized heterogeneous network area must be chosen from a number of sites. We have to figure out the efficacy over a given time period with the aim to accomplish this. Time effectiveness can be calculated as follows, assuming that THET is the time required for all information transfer throughout a heterogeneous network:

$$\mathrm{Te} = \frac{EEhet}{T\,het} \tag{3.8}$$

T_e is then measured in bits per joule per second. The origins can be traced back to the assumption that two stations have some EE. One macro station, numerous sub-macro stations, and numerous pico stations make up BSs. Both the data rate and the power consumption for each station must be calculated. A heterogeneous network with a single macro base station, M micro base stations, and P pico base stations has the following energy efficiency:

$$EEhet = \frac{Rmacro + \sum_{(M=1)}^{M} Rmicro + \sum_{(P=1)}^{P} Rpico}{Pmacro + \sum_{(M=1)}^{M} Pmicro + \sum_{(P=1)}^{P} Ppico} \tag{3.9}$$

EE_{HET} signifies the energy effectiveness of the entire diverse system. And if we have the T_{HET}, we can compute the time competence for the similar as follows:

$$Te = \frac{\dfrac{Rmacro + \sum_{(M=1)}^{M} Rmicro + \sum_{(P=1)}^{P} Rpico}{Pmacro + \sum_{(M=1)}^{M} Pmicro + \sum_{(P=1)}^{P} Ppico}}{T(HETEROGENEOUS)} \tag{3.10}$$

Area energy efficiency (AEE), which is defined as the bit/Joule/unit area, can also be used to compute area time efficiency. You can write the AEE for a certain base station as:

(3.11)

Where EEi and ABS signifies the EE in bit/Joule

The Area Time Efficiency can be found in a similar manner (ATE). Bit/joule/second/unit area is used to describe its unit. A heterogeneous network area's ATE can be expressed as:

$$ATEi = \frac{Te,i}{ABs,i} \tag{3.12}$$

4.RESULT & ANALYSIS-

WSN effectiveness is measured using strategies such as packet distribution percentage terms, throughput, end-to-end delay, and energy consumption. The routing algorithm for a power-efficient and lossy network (RPL) is used to build two alternative situations within the Network simulator with varying amounts of units (25 and 50) and keeping both the static and moveable sink.

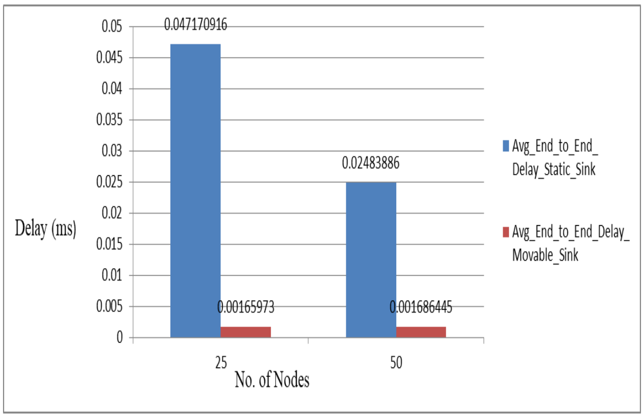

Fig. 3. Average End to End Delay

RPL's average end-to-end delay for 25 nodes using a stationary sink nodes equals 0.004717 ms, where as the average end-to-end delayed for RPL with a moveable sink unit is 0.00165 ms, as shown in Figure 3. Utilizing a stationary sink node, RPL's average end-to-end latency over fifty nodes equals 0.002483 ms, while using a movable sink node offers an average end-to-end delay of 0.001686 ms.

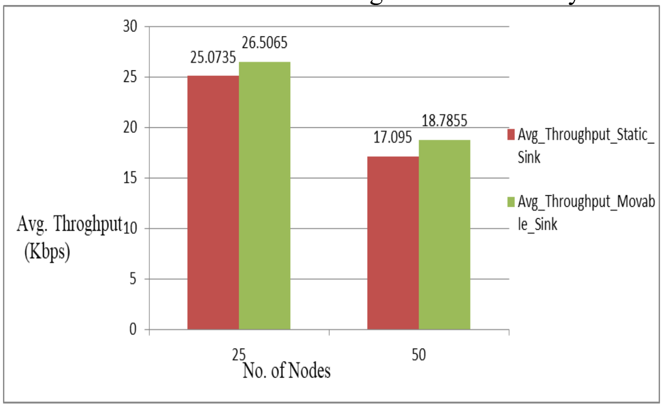

Fig. 4. Throughput

In accordance with Figure 4, the throughput of RPL utilizing a static sink node equals 25.0735 kbps for 25 nodes, 26.5065 kbps for RPL using a movable sink node, and 17.095 kbps for RPL with a static sink node and 18.7855 kbps for 50 nodes respectively.

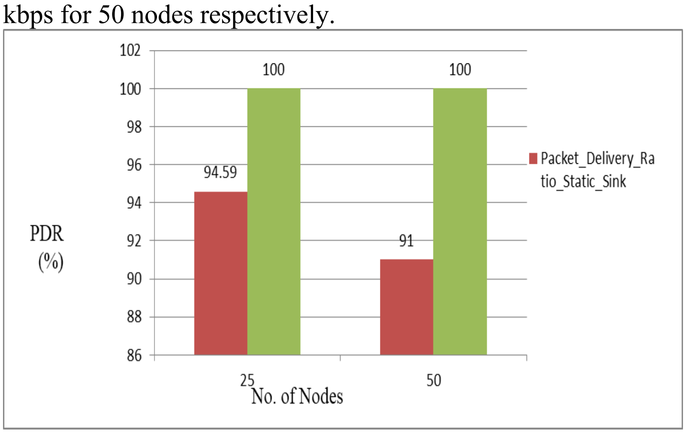

Fig. 5. Packet Delivery Ratio

Figure 5 demonstrates that for 25 nodes, the Packet Transfer Ratio through RPL is 100.00 percent for moving sink nodes and 94.59 percent for static sink nodes. Using RPL, the proportion of packets delivered for a network of 50 nodes gets 91.00% when the node that is sinking is static and 100.00% when the sink node is moving forward.

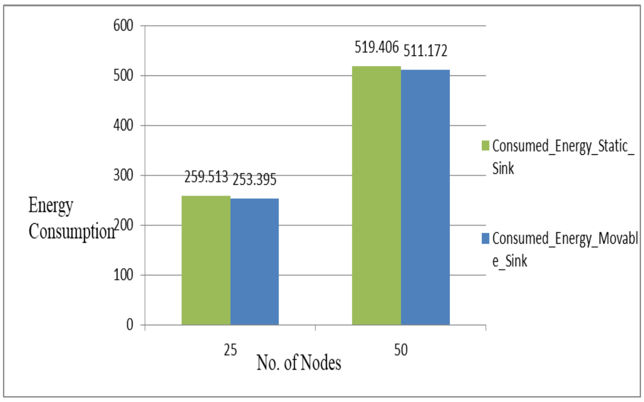

Fig. 6. Consumed Energy

RPL using a static sink node occupies 259.513 (J) and RPL with a mobile sink node occupies 253.395 (J) in 25 nodes, while RPL using a static sink node uses 519.406 (J) and RPL using a mobile sink node uses 511.172 (J) in 50 nodes, as shown in Figure 6.

5. CONCLUSION & FUTURE SCOPE-

WSNs (wireless sensor networks) may be employed to detect and aggregate data about people, weather, as well as disasters. Saving energy is the key concern for these (wireless sensor networks). While deployed nodes are often expensive to repair and have a short battery capacity, saving energy is essential. When WSNs go live in poor conditions with little human activity and nodes that cannot be manually removed or changed, strategies for minimizing electricity usage must be used to maintain network lifetime. When wireless nodes have limitations involving low power, insufficient energy, along with restricted resources, emphasis must be taken while constructing a mobile management plan. The simulation outcomes indicated that a mobile sink enhanced the network's lifespan, packet delivery proportion, throughput, and end-to-end delay. Present investigations can be improved by including more movable sinks and network data such as delays and routing overheads.

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