A Survey on Enhanced Energy Efficient Routing Protocol of WSN for Internet of Things

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Abstract— Wireless Sensor Networks (WSNs) are a resource-constrained network class recognized as a major energy consumer. Wireless sensor technologies are used in many commercialized industrial automation processes and other real-world applications. The WSN protocol is well-suited to harsh situations where deployment is difficult or impossible, such as the battlefield, a toxic chemical plant, the cloud, fog computing, and the Internet of Things, but not in a high-temperature network infrastructure environment. WSNs have introduced various Energy-Efficient Routing Protocols based on network (NW) organization and protocols in recent years. Various WSN routing options for energy efficiency are explored in this work. The WSN Energy Efficient Routing Protocol is compared to other routing systems. We also compare and investigate better WSN routing algorithms for cloud computing, fog computing, and the Internet of Things.

Keywords- Cloud Computing, Energy Efficiency Routing Protocols, Energy Efficiency,Fog Computing, Internet of Things, Wireless Sensor Network.

1.INTRODUCTION

The Wireless Sensor Network (WSN) is widely used for environmental monitoring, traffic control, health care, as well as commercial and family needs. This NW form consists of self-organizing sensor nodes (SNs) that are fixed. SNs can add, process, and transfer raw data to the BS node, then sent to the Internet. The wireless transceiver, data storage, CPU, and power are all connected by a wireless SN. SN uses a practical energy routing approach to extend the life of WSN in a hostile environment or a place with low node energy [1]. WSN systems have sparked much interest in sectors like engineering and science, even though they're still a young field of research. As the Internet of Things (IoT) has progressed, the scope of a wireless mesh network (WMN) and wireless sensor network (WSN) research and development has expanded significantly. In an NW, data routing is a critical operation that consumes much energy. The amount of energy spent on determining if routing in NW is efficient, such as direction, node power, connection performance, traffic, and so on, can add up quickly. The Internet of Things [2], a popular technology today, allows for greater study and development of these components, such as networks, detectors, new protocols, and optimization methods. In IoT systems, networking is crucial, and boosting these NWs is critical to improving the systems' performance. The network gets more stable as its lifespan rises. This can be accomplished by improving the NW usage protocol, which allows network nodes to conserve energy. Sensor NWs are used in various data gathering applications to improve network performance, longevity, and capacity efficiency. The initial node's network lifespan is the amount of time it takes to run on battery power. The network's ability and lifetime are two significant goals [3]. Two of WSN's key concerns are energy efficiency and delivery time. LEACH (Reduced Energy Adaptive Clustering Hierarchy) routes have a low delivery interruption when compared to other hierarchical routing. In WSN implementation, LEACH is the most extensively utilized routing algorithm.

Extreme circumstances, such as increased mobility, congested traffic, and other factors affecting service quality, are now a reality. To help, new technology is necessary [4]. The LEACH protocol employs different access TDMA (Time Division Multiple Access) mechanisms to determine when data should be supplied. Data transmission costs more energy when the distance between the BS and the CHs is higher than the threshold distance. LEACH has been optimized to reduce energy consumption by installing MS and rendezvous nodes in the RN area [5].

Because of the steady operational states provided by IoT, a vast volume of data is growing exponentially. Such IoT devices generate a flood of data, disrupting expected data processing and analytics capabilities previously controlled faultlessly through the cloud. Fog computing design solves these disruptions by focusing on deploying micro clouds (fog nodes) on the edge of data sources with efficient cloud system complement characteristics. Extensive IoT data analytics using a fog computing framework is in the early stages of development and will necessitate substantial study to create more data and make more informed judgments [6].

Because of the continuous operational states given by IoT, a massive amount of data is being generated at an exponential rate. Such IoT devices generate a torrent of data, disturbing the cloud's expected data processing and analytics capabilities, which were previously flawlessly regulated. By focusing on deploying micro clouds (fog nodes) on the edge of data sources with effective cloud system complement properties, fog computing design eliminates these disturbances. Large-scale IoT data analytics employing a fog computing framework is still in its infancy, and additional research is needed to generate more data and make more educated decisions [6].

The remainder of the paper is laid out as follows: The second section gives an overview of RP and a taxonomy analysis. Section 3 discusses EERP, how to improve it in a WSN, and how to use IoT, Cloud Computing (CC), and Fog Computing(FC) in a WSN. In WSN, Section 4 gives a comparison based on their EERP and EEERP parameters. Section 4 delves into the context and ramifications of various routing protocols in emerging industries, including the Internet of Things, Fibre Channel, and Cloud Computing.

By providing for fast communication, dependable inspection, and job execution, WSNs have become a critical component of a wide range of applications, including environmental monitoring, military surveillance, and medical. WSNs are made up of a densely distributed network of sensor nodes that communicate wirelessly to deliver and receive environmental data. One or more sensors, a radio transmitter, a processor, and a power supply are all included in each sensor node. WSN development becomes a complex procedure due to the complexity of such systems. Several additional essential conditions must be met during creating a WSN, including the fundamental requirement of power consumption. As a result, several recent research has focused on WSNs. The authors explained what WSNs are and how they work.

The authors evaluated different sensor localization techniques and hierarchical taxonomy and their applicability in various contexts in their paper. They demonstrated new sensor localization algorithms and how they might be implemented in IoT infrastructure. The authors also presented a survey on sensor-free localization for the intelligent world in the same context. The authors looked at nine different WSN modeling methodologies. They demonstrated how each methodology describes the behavior of nodes and networks. They also demonstrated each approach's modeling tool. We present a study that gathers and examines existing data in this work, motivated by this idea.

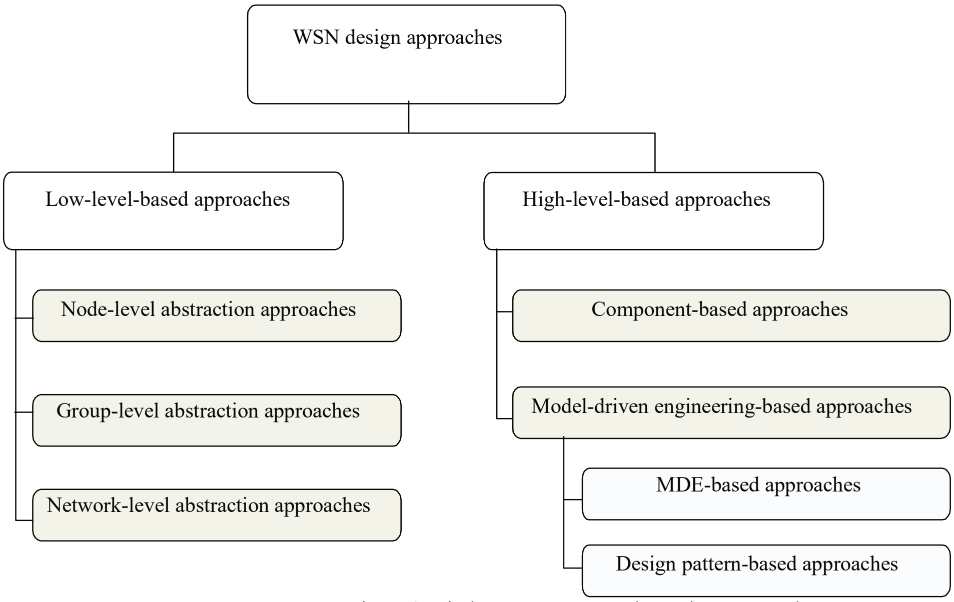

Figure 1:Wireless Sensor Network Design Approaches

Taxonomy

The transmission of data is the most energy-intensive body in WSNs. It necessitates the shortest possible transfer to a Base Station (BS), with all decision-making taking place at the node level. When the number of nodes and network size expands, scalability becomes even more crucial. The entire NW is divided into many virtual layers (clusters), and nodes in the same layer will have the same job. As the cluster's CH, some of the nodes are utilized to manage jobs between the nodes. Clustering decreases or aggregates network load by exploiting data correlation, resulting in increased energy efficiency. CHS collects and aggregates information from nodes before sending it to BS [10].

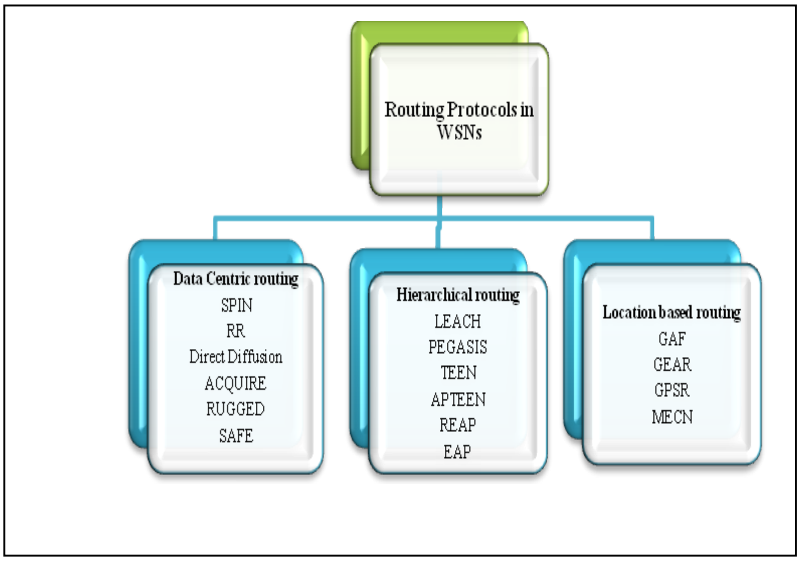

Figure 2.Routing Protocols.

Location-based Routing Protocols (LRPs), Hierarchical-based Routing Protocols (HRPs), and Flat-based Routing Protocols (FRPs) or Data Centric Routing Protocols are the three types of WSN Routing Protocols shown in Figure 2. (DRPs). Flat routing protocols assign all WS nodes equal functions and roles. Many nodes are assigned diverse roles and functions in hierarchical routing; however, in local routing, wireless sensor nodes are employed for data transfer[9].

Routing in the Internet of Things

Because nodes on the IoT network operate as hosts or routers, a path is required. For sensor networks and IoT applications, several routing algorithms have been proposed. Data flow from source to destination has an impact on transmission node electricity usage. The Internet of Things (IoT) has been a hot topic in wireless communication in recent years. Portable short-range transceivers are rapidly being developed for integration into a wide range of other devices and items, allowing for new sorts of interaction with things and people, as well as between them. IoT nodes are made up of sensor modules, processing modules, wireless connection modules, and control modules. There is no central control node in the network, and all nodes are in the same position. Grid nodes must react to complex position changes and find network routing in the lowest amount of time. A uniform IoT routing protocol standard has yet to emerge. Finding an appropriate IoT routing protocol is crucial. The overall routing, average end-to-end speed, and performance of various protocols were compared by changing the total number or percentage of nodes.

Routing Protocol in IoT Applications

WSNs are crucial to the Internet of Things' growth and expansion because they allow low-cost devices with limited capabilities to connect to the Internet and provide life-changing applications. One of the key standards that enable low-energy and lossy networks is IEEE standard 802.15.4, which serves as the backbone of WSNs such as the IoT component (LLNs). This standard specifies the physical and data-link layers of a network, as well as a low-cost operating framework. In recent years, the Internet of Things (IoT) has emerged as an exciting and promising paradigm for connecting more physical "things" to the Internet for various purposes. Though it has become a key enabler for various next-generation applications, it has also presented new issues for overburdened networks. The Internet of Things is already being developed in healthcare and smart settings, with many low-power sensors and actuators being added to improve our lives and deliver new public services. RPL is an LLN RP designed by the Internet Engineering Task Force (IETF) and standardized in RFC6550 in 2012. RPL received much interest, and several research papers were produced to analyze and enhance performance in various applications.

Table I: The IoT Security Requirements at a Higher Level

Internet of Things Layer	**The Requirements of Security**
The Application	• The Applications for Data Minimization • Policy Management & Privacy Protection • Authorization, Assurance, Authentication • Cryptography and Encryption for specialized applications
The Services support	• Cryptographic Data Storage • Protected Data Management & Handling (Search, Aggregation, Correlation, Computation) • Cloud Computing, Secure Computation, In-Network Data Processing, Data Aggregation
The Network layer	• Cross-domain Data Security Handling; • Cloud Interaction/ Secure Sensor • Security of Connectivity and Communication
The Sensor/ Smart object	• Data Format & Structures Access Control to Nodes Lightweight Encryption • Attestation & Trust Anchors

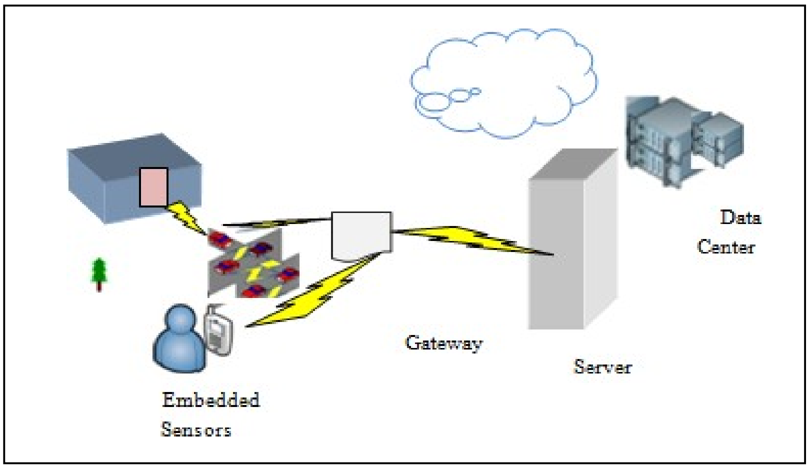

Figure 3.The Internet of Things in the Routing

Figure 3 shows how IoTs can be used in a variety of ways. IoTs are divided into three levels [30]. Many sensors are installed into Tier I to monitor objects and their surroundings. Level II is a node that collects data from built-in apps and serves it as a gateway. Traditional smartphone portals are superior apps to integrated sensors. Tier III includes servers or data centers that store and analyze data received from gateway nodes. Gateway nodes are used by servers or data centers to undertake complicated analysis by creating models.

Every day, the expanding popularity of WSNs puts this technology to use in today's modern environment. Because all things in the Internet of Things are connected, WSNs can be employed effectively. The capabilities of today's WSNs may allow for the completion of challenging tasks such as data fusion. SNs can be outfitted with a variety of components to suit a variety of applications. The main problem of WSNs is that they have limited power consumption, computation capabilities, and memory capacity. A fundamental difficulty in WSN protocols is increasing the life of sensor networks. There are numerous techniques to reduce energy consumption and extend the life of NW in WSNs. Many protocols like this will help WSNs live longer and better lives. These protocols transmit data to the sink node and convey data from the sink node to the cloud. These protocols are used to send data to the cloud and to relay information to the sink node. The concept of FC, on the other hand, is used in WSN routing protocols. Every round, cluster head(CH) picks are organized under

this protocol. By selecting nodes based on low energy cluster head(CH), helps to avoid the usage of heterogeneous energy. Optimizing the minimal distance between cluster head(CH) and FNs, choosing specific CHs for FN data, and lowering the total overhead of each FN could all assist extend the life of a network.
Older mobile phones have grown into contemporary, sophisticated Smartphones that can run a variety of apps and do a variety of functions. Mobile battery life is a big issue for smartphones, and it can be remedied by unloading and storing mobile cloud data to extend battery life. In a cloud context, securing important data against adversaries is difficult. The importance of communication protocols in the cloud environment cannot be overstated. Secure data transmission necessitates the use of a defined communication protocol.

The principles of cloud computing and the many routing techniques that have been employed to improve cloud network performance. The JSQ method provides the best outcomes in those methods, and a shorter path scheduling method provides a region route to reach. Multicast routing is used by optical NWs, while optimization methods are used by WSNs.

2.LITERATURE SURVEY

This section will go over the details of EERP (Energy Efficient Routing Protocol) in WSNs, and EEERP (Enhance Energy Efficient Routing Protocol) is another growing industry.

Zhibo Pang et al. produced hardware named inbox. To establish medical facilities. The Internet-of-Things (IoT)-based in-home healthcare services have a lot of potential in the business world. The issues associated with the integration of WSN and RFID technologies have been presented by Li Wang et al. One of the most difficult issues is the low communication efficiency caused by duplicate data. The proposed method employs a data cleaning algorithm to reduce duplicated data effectively.

Mihai T. Lazarescu showed the practical design and construction of a fully working WSN platform for various long-term environmental monitoring IoT applications.

Shancang Li et al. have devised a method for data sampling and acquisition in wireless sensor networks and the Internet of Things that uses compression sensing theory. In the Internet of Things, there is a smart grid.

Siyuan Chen proposed that there should be a limit or bound for obtaining data. To address this problem, the suggested method uses a wireless sensor network to collect data.

Liu and P. Zhang [2018] present a new load balancing (LB) technique for WSN data transmission called super-connection-based data drainage, which redistributes data traffic by leveraging supernodes' more robust hardware and better communication capacity**.** Because it differs from traditional passive late treatments, it is both a positive and an early intrusive method. The fundamental idea is to send data to people with low data traffic from extremely far locations on the Internet via a data traffic jump [13]. An estimation function is used to identify the best start and ending locations for super connections.

S. N. Mishra et al. [2018], the performance of a huge network's protocols is destroyed. To overcome this issue, the Scalable Survival Path Routing (SSPR) protocol has been proposed. The protocol uses a weight-based clustering strategy that considers the energy and node degree available in two parameters to determine node weight and then chooses the node with the highest weight as its cluster head(CH) simulation results to show that Scalable Survival Path Routing(SSPR) outperforms previous large network algorithms [17].

K. Manzoor et al. [2018] focused on the WSN protocol and ensuring stable node connectivity. A unique CH selection methodology has been introduced to increase the energy efficiency of TL- LEACH and Extended LEACH (ETL-LEACH). According to simulation results, ETL-LEACH considerably improves energy efficiency, node life, and communication delay (SRs). .

Z. Sun et al.[2019] Propose an energy-efficient Cross-layer Clustering Model (ECCM) for Mobile Intelligent FC. The proposed algorithm then uses a sensing-event-driven methodology based on cross-layer projection theory to project fog nodes onto the sensing layer, resulting in a strong virtual control node. After that, fog computation is employed to produce distributed clustering of event-field nodes using the fog layer's cluster-based RP control method. The second is effective data aggregation routing, which concentrates the fog nodes on a projectile. By replacing information in the sensor's bottom layer routing and balancing, it reduces the NW burden. Third, we use the Particles Swarm Optimization (PSO) methodology to optimize RP by selecting suitable node groups as cluster head(CH). NW's above energy may be effectively minimised and balanced, minimizing node weariness and extending network lifetime, with the exception of specific overhead competition. Finally, simulation results show that the routing structure is simple to construct and maintain, boosting the efficiency of the NW technique for data aggregation.

The Comparative Study

We present EERP in WSN based on its classifications and different parameters, as well as a comparison with EEERP based on protocols, applications, and their advantages and disadvantages Table II

Table II. The Energy Efficient Routing Protocols (EERP) Comparison

Routing protocols	**Classification**	**Mobility**	**Power Usage**	**Aggregation of data**	**Localization**	**Scalability**	**Query-based**
SPIN	Flat or Negotiation based	Yes	Limited	Yes	Yes	Limited	Yes
DD	Flat or Diffusion based	Limited	Limited	Yes	Yes	Limited	Yes
RR	Flat or Diffusion based	No	N/A	Yes	No	Good	Yes
COUGAR	Flat or Data-Centric	No	Limited	Yes	No	Limited	Yes
ACQUIRE	Flat or Data-Centric	Limited	N/A	Yes	No	Limited	Yes
LEACH	Hierarchical or Block based	Fixed BS	Maximum	Yes	Yes	Good	No
TEEN	Hierarchical or Block based	Fixed BS	Maximum	Yes	Yes	Good	No
PANEL	Hierarchical or Grid-based	Yes	Limited	No	Yes	Low	No

TTDD	Hierarchical or grid-based	Yes	Limited	No	No	Low	No
PEGASIS	Hierarchical or Chain based	Fixed BS	Maximum	No	Yes	Good	No
CCS	Hierarchical or Chain based	Fixed BS	Maximum	No	Yes	Good	No
GAF	Location-based or area partition	Limited	Limited	No	No	Good	No
GRID	Location-based or repartition	No	Limited	No	Yes	Good	Yes
GPSR	Location-based or OptimalPath	Limited	Limited	No	No	Limited	No
GEAR	Location-based or Optimal Path	Limited	Limited	No	No	Limited	No

Table III.Comparison Of Enhanced Energy Efficient Routing Protocol (EEERP) In WSN

Protocol	**Pros**	**Cons**	**Applications**
ELBSEP	It cuts down on transmission time.	The SNs will never communicate if the threshold values are not satisfied.	It is the best ideal for time-critical tasks.
Z-SEP	Low usage of energy.	Other complexity and long interruption.	This is suitable for both time-critical and non-critical applications.
SEP	It improves network longevity, stability, and performance.	It doesn't support nodes' multi-level heterogeneity.	This might be used for everything from machinery supervision to defect identification and diagnosis.
TAG	It reduces the quantity of data transmitted via sensor NW.	Overhead enhances.	This may be utilized for supervising machine
REEM	Fault-tolerant and reliable.	Due to many paths, overhead expenses and energy consumption may rise.	It can be used in situations where dependability and security are critical.

SAR	It maintains a number of routes to the goal.	The high cost of maintaining tables and the state for each SN.	It could be used in situations when QoS is a major issue.
SWE	It builds a hop spanning tree with the bare minimum of hops (MHST)	This is a composite protocol.	This might be used to keep an eye on a machine.
MWE	Reduce the energy path of every source a node within every network SN is set.	Greater overhead Less scalability more time.	It may be utilized to supervise machines.
SIO	It extends the lifetime of the NW	More Delay	It's possible to use it in the medical industry.
MIP	Useless energy.	More Delay	It was incorporated into large-scale NWs.
EESRA	Despite the increased NW size, EESRA will extend the network's life. EESRA reduces the load on CHs and selects CHs at random.	EESRA performance is reflected by average waste energy per round as well as energy consumption rate for all active SNs.	To develop a hybrid WSN MAC protocol, EESRA uses multi-hop transmissions and intra-cluster communication.

3.FUTURE CHALLENGES AND SCOPE

Future studies will concentrate on different routing options. Energy variance in LEACH, HUMS, and AERP is minimal compared to the RPs mentioned above, and CBCA is minor. While CBCA is comparable to other RPs, it is necessary to re-adjust the energy variance. Extending network life was also of major importance due to resource constraints in WSNs. Necessary research should be conducted to improve the life of wireless sensors Network.

The wireless sensor network is in charge of sensing and relaying data to the base station, which results in physical events. In a network of power limit sensors, routing is a key tool for tracking and data transfers. Initially, nodes can send and receive data through node-defined routes. If sensed data is accessible in some network segments.

4.CONCLUSION

A WSN comprises self-contained, geographically distributed sensors that can reliably monitor various military and civilian surroundings and send data to a central location via a network. RPs heavily influence the energy consumption of sensor networks. For this kind of network, and energy-efficient routing method is necessary. Thanks to the Internet of Things, we now have a growing number of energy-efficient protocols and algorithms to improve the system as a whole. Whether it's data routing in NW, optimizing the energy efficiency of NW nodes, extending the life of NW, or making NW smarter so that it can make its judgments based on previously obtained data, there's something for everyone, the possibilities are endless. Most SNs are used for data transfer to the base station because of their energy. As a result, they utilize their energy at a considerably faster rate. Extending network life was of significant importance in WSNs due to resource constraints. A proportionate study of EERPs was conducted.

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