A Comparative Analysis of the Various Techniques for Energy Conversation through Clustering and Energy Aware Routing in WSN

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Abstract **-**Applications of sensor networks have become an emergent technology, which can monitor a specific area and collect eco-friendly data around a place. In recent years, low power wireless communication and the availability of cheap and small micro sensor nodes lead to enhanced improvements ofwireless sensor network applications in real society. A sensor is an autonomous device for monitoring physical as well as environmental conditions. Main contest in the field of WSN is energy conservation through route optimization. In this paper we analyzed the various techniques used by the different researchers for efficient energy conservation through the clustering as well as energy aware routing. Both of techniques work on various parameters and have some limitation as well.

Keywords **-** *WSN, Energy conservation, Route optimization, Clustering, Energy aware routing*

I. INTRODUCTION

Wireless Sensor Networks (WSNs) is an indispensible part of our life due to its monitoring and security aspects. Wide range of applications makes its significant for us.WSN consists of a number of sensor devices that work together with each other to accomplish a common task (e.g. environment monitoring, object tracking, etc.) and report the collected data through wireless interface to a center node (sink node). The areas of applications of WSNs vary from civil, military, environmental tohealthcare. Examples of applications include target tracking in battlefields, civil structure monitoring, forest fire detection,habitat monitoring, and factory maintenance [1].

A wireless sensor network (WSN) is a distributed sensing technology that can be used to monitor physical phenomenon and can be easily deployed [2]. Sensor devices are equipped with a tiny microprocessor, a small battery, a radio transceiver, and a set of transducers that used to acquire information that reflect the changes in the surrounding environment of the sensor node [1].

Sensor networks can be divided in two classes, in event-driven networks, data is sent whenever an event occurs and in continuous dissemination networks, every node periodically sends data to the sink [2].Deployment and topology of sensor network depends upon the application. Deployment and topology defines the overall network structure that includes number and distribution of nodes, their transmission range, distance between neighbors, type of routing paths, type of communication etc [3].

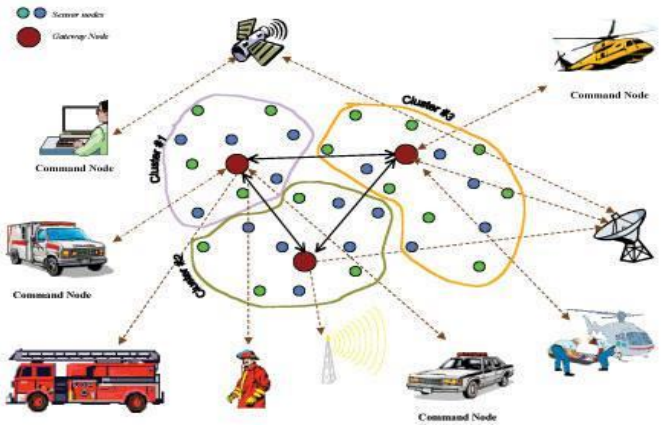

Fig. 1.1 Wireless Sensor Network

A. IMPORTANT FACTORS FOR AN EFFICIENT SENSOR NETWORK DESIGN

- Energy conservation is very important for sensor networks. But the major problem of reducing sensor node's energy consumption has not been solved perfectly. If all sensor nodes transmit packets directly to the base station, the furthest nodes from the base station will die early. On the other hand, while transmitting packets through multiple hops, sensors closest to the base station tend to die early, leaving some network areas completely unmonitored and causing network partitions called holes. In order to maximize the WSNs lifetime, it is essential to prolong each individual sensor node's lifetime by

minimizing transmission energy consumption, and sending packets via paths that can avoid sensor nodes with low energy and thus minimizing the total transmission power. To overcome the problem of energy - constraint in WSNs, Different researchers have been working on different aspects such as power-aware MAC protocol, topology control, transmission power control, etc [2].

- Energy Consumption: Power Consumption deals with the distribution of energy among all the nodes throughout the networkQuality of Service (QoS): It depends upon high routing efficiency under multi hop transmission circumstances. Focus on both the energy consumption and routing efficiency [4].

B. VARIOUS TECHNIQUES FOR ENERGY CONSERVATION

- Clustering Technique
- Energy Aware Routing Technique

(i) CLUSTERING TECHNIQUE

In the first techniqueclustering is used to save the energy consumption. In clustering process, sensors nodes are organized into distinct groups, called clusters and each cluster has a coordinator referred as cluster head (CH) and remaining nodes within a cluster act as cluster members (CMs). Each sensor node must belong to one and only one cluster. Sensor nodes send their sensed data to their corresponding CHs. CHs then aggregate them and send it to a remote base station called sink using single hop or multi-hop communication [5].

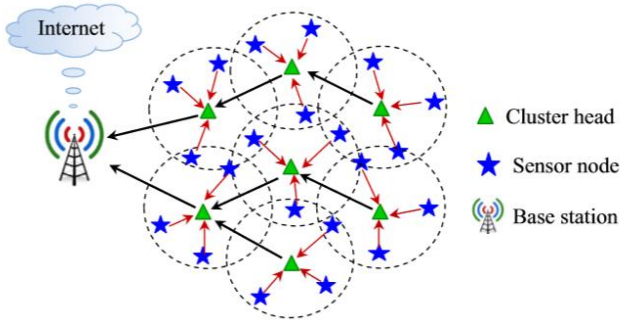

Fig.1.A wireless sensor network model based on cluster [6]

Each sensor node in the network consumes power, not only in sensing data, but also for processing the data and transmitting/receiving these processed information for further routing. Therefore, the power consumption at each stage is as low as possible. Secondly, the network lifetime has to be kept at its maximum [7].

Sukhkirandeep Kaur and Roohie Naaz Mir [3] introduced a new clustering approach for WSN that includes load balancing and improves energy efficiency by precise selection of CH's. Analysis and simulation results demonstrate the effectiveness of the proposed approach.Tarachand Amgoth and Prasanta K. Jana [5] introduced energy aware routing algorithm for cluster based WSNs. The algorithm is based on a smart strategy of cluster head (CH) choice, remaining energy of the CHs and the distance between clusters, for cluster formation. To help data routing, a directed virtual backbone of CHs is constructed which is rooted at the sink. The proposed algorithm is also demonstrated to balance energy consumption of the CHs during data routing process. Verified that the algorithm achieves regular message and linear time complication.

Pratyay Kuila and Prasanta K. Jana [6] classified Linear/ Nonlinear Programming (LP/NLP) formulations of these problems pursued by two proposed algorithms based on particle swarm optimization (PSO). The routing algorithm is expanded with multi-purpose fitness function and an effective particle encoding system. The clustering algorithm is proposed by considering energy conservation of the nodes through load balancing. The algorithms tested and verified in terms of network life, energy consumption, dead sensor nodes, and delivery of total data packets to the base station. Chengfa Li et al. [9] developed an Energy Efficient Unequal Clustering (EEUC) method for periodical records collecting in wireless sensor networks. It divides the nodes into clusters of uneven size, and clusters nearer to the base station have small size as compare to the cluster far away from the base station. Therefore, cluster heads closer to the base station can maintain some energy for the inter-cluster data transferring. Presented an energy-conscious multiple hops routing protocol for the inter-cluster communication.

(ii) ENERGY AWARE ROUTING TECHNIQUE

Routing is a serious issue in WSN due to the computational as well as resources constraints. These constraints prohibit the deployment of traditional routing protocols. Any routing protocol designed for use in WSN should be reliable, energy-efficient and should increase the lifetime of the network. Therefore, a routing protocol designed for these networks should definitely be such that the power consumption at each stage is as low as possible and the network lifetime has to be kept at its maximum.

Jalel Ben et. al [1] presented Energy Efficient and Quality of service, multipath routing protocol (EQSR) which optimized the network lifetime by balancing energy consumption among several nodes, with the attention of service segregation to give permission to delay important traffic to reach the sink node with in an acceptable delay, reduces the end to end delay

through distributing the traffic across multiple paths, and enhances the throughput by introducing data repetition. EQSR uses the residual energy, available buffer size of node and Signal-to-Noise Ratio (SNR) to forecast the best next hop by means of paths construction phase. R. Vidhyapriya and P.T. Vanathi [2]presented a reactive routing protocol called energy aware routing that is intended to provide a reliable transmission environment with low energy consumption. This protocol efficiently utilizes both the energy available in the node and quality of the link to identify the best possible route to the destination.

Piyush Charan et. al [4] compared two analytical models which demonstrate and forecast the QoS in terms of throughput, average end-to-end delay, jitter, and energy consumption. Different network models are grid based and cluster-based. Both are simulated using QualNet v 6.1 Simulator.Sudip Misra and P. Dias Thomasinous [7] provided a simple, energy-efficient, least time routing protocol with one-level data aggregation that makes sure improved life time for the network. The protocol was evaluated with well known ad hoc and sensor network routing protocols. It was examined that the proposed protocol performed well in throughput, average energy utilization, latency and average network life time. The new proposed protocol uses node energy and absolute time as the constraint for routing, this ensures trustworthiness and congestion prevention.

Shashidhar Rao Gandham et al. [8] presented the deployment of multiple mobile base stations to extend the lifetime of the sensor network. Moreover, lifetime of the sensor network divides into equal slots of time known as rounds. Base stations are repositioned at the beginning of a round. Proposed technique utilizes an integer linear program to decide new positions for the base stations and a flows-based routing protocol to make sure power efficient routing throughout each round. Dionisis Kandris et al. [10] proposed PEMuR, a unique dual proposal for efficient video communication, which aims at both high QoS attainment and energy saving. PEMuR proposes the collective use of an intelligent video package scheduling algorithm with an energy conscious hierarchical routing protocol. The accepted routing protocol enables the choice of the most energy efficient routing paths, controls the network load according to the energy remains of the nodes and avoids useless data communications through the projected use of an energy threshold. In this way, an outstanding level of energy efficiency is obtained. The proposed packet scheduling algorithm facilitates the decline of the video communication rate with the minimal possible raise of distortion.

II. TABLE OF ANALYSIS

Reference No.	Author	Year	Technique	Advantages	Disadvantages
8	Shashidhar Rao Gandham, Ravi Prakash,Milind Dawande and S. Venkatesan	2003	Multiple Base Stations	• Effectively either reduced or retained the hop count of each sensor node in the network. • Effectively reduces the energy consumption per message delivered. • To increase the lifetime of a sensor network,	• It is difficult to determine the total number of base stations. • Selection of next base station. • Increased overheads in the selection of next base station.
9	Chengfa Li, Mao Ye, Guihai Chen, Jie Wu	2005	Energy Efficient Unequal Clustering (EEUC) mechanism	• Study the cluster head characteristics of the unequal clustering algorithm • Investigate how EEUC balances the energy consumption of the cluster heads and thus prolongs the network lifetime • Calculate each node's energy consumption from data transmission and aggregation per round	• It is difficult to determine the optimal value of certain parameters according to network scale
3	Sukhkirandeep Kaur Roohie Naaz Mir	2016	load balancing and improves energy efficiency by precise selection of CH's	• Variable cluster sizes are formed in the network. • More number of CH provides efficient results • Cluster far from sink node has more number of nodes while cluster near sink node has very few nodes which prevents the problem of energy drainage of nodes near sink node.	• In this approach precise assignment of nodes are presented in a cluster. • This network is considered for stationary nodes.
7	Sudip Misra, P. Dias Thomasinous	2010	A simple, least-time, energy-efficient routing protocol with one-level data aggregation that	• Proposed protocol was compared with routing protocols, AODV, DSR, DSDV, DD and MCF. • Proposed protocol outperformed in throughput, latency, average energy	• It is suitable only for simple and small network. • More work is to be done on security, reliability and fault tolerance.

			ensures increased life time for the network.	consumption and average network lifetime.	
4	Piyush Charan1, Tahsin Usmani1, Rajeev Paulus2, Syed Hasan Saeed1	2016	Two analytical models which demonstrate and predict the QoS in terms of throughput, jitter, average end-to-end delay and energy consumption.	• Compared the various parameters like energy consumption, average end to end delay and throughput for star and grid network topology	• When packets per second increases then the network throughput decreases • The average end-to-end delay increases in both star and grid based network situations.
5	Tarachand Amgoth, Prasanta K. Jana	2014	An energy aware routing algorithm for wireless sensor networks called ERA. The algorithm consists of clustering and routing phases.	• Ensure that all the CHs should take part in data routing process and at the same time their relaying load is balanced with respect their residual energy • Comparisons have been made by considering two scenarios of node deployment random and grid	• Did not consider the dynamic scenario and fault tolerant aspects of the sensor network
6	Pratyay Kuilan, Prasanta K. Jana	2014	Linear and Nonlinear Programming of routing and clustering problems proposed two algorithms for the same based on particle swarm optimization	• Algorithms have been tested with several scenarios of WSNs by varying number of sensor nodes and gateways. • The results have shown that the algorithms perform better in terms of energy consumption, network life, number of inactive sensor nodes, number of hops and the total data packets transmission.	
10	Dionisis Kandris, Michail Tsagkaropoulos, Ilias Politis, Anthony Tzes, Stavros Kotsopoulos	2011	PEMuR, a novel dual scheme for efficient video communication, which aims at both energy saving and high QoS attainment with the combined use of an energy aware hierarchical routing protocol and an intelligent video packet scheduling algorithm	• outstanding level of energy efficiency is achieved • Not only proposes an energy efficient route selection policy but also manages the network load according to the energy residues of the nodes and prevents useless data transmissions.	• It may work with the limited available channels so there is a need of scalability
1	Jalel Ben, Othman, Bashir Yahya	2010	Energy Efficient and QoS aware multipath routing protocol (abbreviated shortly as EQSR) that maximizes the network lifetime through balancing energy consumption across multiple nodes	• Decreases the end to end delay by spreading out the traffic through multiple paths • Increases the throughput through data redundancy • EQSR uses the residual energy, node available buffer size and Signal-to-Noise Ratio(SNR) to predict the best next hop through the paths construction phase	• Further analysis required to study the impact of the buffer size, network size and path length on the performance metrics
2	R. Vidhyapriya and P.T. Vanathi	2007	A reactive routing protocol called energy aware routing that is intended to provide a reliable transmission environment with low energy consumption.	• Efficiently utilizes both the energy available in the node and quality of the link to identify the best possible route to the destination.	• More research is to be required enhance the packets delivery ratio and to decrease the average delay

III. SUMMARY OF THE VARIOUS TECHNIQUES

The most demanding research topic in WSN is the energy conversation because energy is the most crucial part of it. Therefore, designing energy saving routing algorithm is one of the most focused research area. Many routing solutions specifically designed for WSNs have been proposed. Some of the techniques are based upon clustering and others are based upon energy aware routing techniques.

Energy efficient clustering and routing are two well known optimization problems which have been studied widely to extend lifetime of wireless sensor networks (WSNs) [6]. Different routing techniques are negotiation based, multi-path based, QoS based, and query based. Many of the researchers work on the following Performance metric such as load balancing, Reliability, fault tolerance, data aggregation, average end to end delay, packet delivery ratio and average energy consumption. Comparison between star and grid network topology on the basis of following parameters energy consumption, average end to end delay and throughput is made [4]. An ideal routing protocol for WSN should be simple, less computation, efficient in power consumption and enhance the network lifetime [7]. Multiple base stations can be employed and periodically change their locations to extend the lifetime of a sensor network, it effectively reduces the energy consumption [8].

In the clustering techniques total area is divided into the number of cluster each having the cluster head, which is selected under certain criteria and parameters i.e. topology, cluster distribution, cluster count. Square grid topology is taken and new clustering approach with load distribution is implemented depending upon the application to be used, ideal number of nodes acting as cluster head can be found [3]. Energy consumption of the CHs is significantly balanced and the lifetime of the network is improved. It is based on the derivation of efficient particle encoding scheme and fitness function for routing and clustering separately [9].

IV. CONCLUSION

In the current scenario sensors are used by almost all the fields for the security and safety purpose. In WSN battery has the limited capacity so there is a need of energy conservation that can be achieved by energy aware routing or clustering. Both of the techniques are discussed and analyzed. Clustering effectively reduces the energy consumption and increase the lifetime of a sensor network but it is difficult to determine the total number of base stations and to select the next base station. More work is to be done on assignment of nodes in a cluster and suitability in the dynamic environment. Energy aware routing ensuresto identify the best possible route to the destination. It performs better in terms of network life, outstanding level of energy efficiency, number of hops and the total data packets transmission. Scalability is required to improve the performance.

V. REFERENCES

[1] Jalel Ben, Bashir and Othman, “Energy efficient and QoS based routing protocol for wireless sensor networks”, J. Parallel Distrib. Comput. 70(2010)849–857

[2] R. Vidhyapriya and P.T. Vanathi, “Energy Aware Routing for Wireless Sensor Networks”, IEEE - ICSCN2007, MIT Campus, Anna University, Chennai, India. Feb. 22-24, 2007. Pp.545-550.

[3] Sukhkirandeep Kaur and Roohie Naaz Mir, “Energy Efficiency Optimization in Wireless Sensor Network Using Proposed Load Balancing Approach”, International Journal of Computer Networks and Applications (IJCNA) Volume 3, Issue 5, September – October (2016)

[4] Piyush Charan, Rajeev Paulus, Tahsin Usmani, and Syed Hasan Saeed, “Performance Evaluation of AODV Protocol for Energy Consumption and QoS in IEEE 802.15.4 Based Wireless Sensor Network Using QualNet Simulator”, Scientific Research Publishing, Wireless Sensor Network, 2016, 8, 166-175

[5] Tarachand Amgoth and Prasanta K. Jana, "Energy-Aware Routing Algorithm for Wireless Sensor Networks", Journal of Computer and Electrical Engineering, Vol. 41(C), pp. 357-367, 2014

[6] Pratyay Kuila and Prasanta K. Jana, "Energy Efficient Clustering and Routing Algorithms for Wireless Sensor Networks: Particle Swarm Optimization Approach”, Application of Artificial Intelligence Engineering, Vol. 33, pp. 127-140, 2014

[7] Sudip Misra and P. Dias Thomasinous, "A simple, Least-Time, and EnergyEfficient Routing Protocol with One-Level Data Aggregation for Wireless Sensor Networks”, Journal of System and Software, Vol. 83(5),pp. 852-860, 2010

[8] Shashidhar Rao Gandham, Milind Dawande, Ravi Prakash and S. Venkatesa, "Energy Efficient Schemes for Wireless Sensor Networks with Multiple Mobile Base Stations”, In the proceedings of IEEE Conference on Telecommunication Vol. 1, pp. 377-381, 2003

[9] Chengfa Li, Mao Ye, Guihai Chen and Jie Wu, “An Energy-Efficient Unequal Clustering Mechanism for Wireless Sensor Networks”, 2005 IEEE

[10] Dionisis Kandris, Michail Tsagkaropoulos, Politis, Stavros Kotsopoulos and Anthony, "Energy Efficient and Perceived QoS Aware Video Routing over Wireless Multimedia Sensor Networks", Journal of Adhoc Network, Vol. 91(4), pp. 591-607, 2011