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SURVEY ARTICLE

A Survey on Energy Efficient Clustering Protocols for Wireless Sensor Network

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Abstract -Wireless sensor networks are an attractive field of researchers for several applications like industrial automation and environmental monitoring and military surveillances.Energy scarcity is a major issue on sensor networks. To meet out the requirement at various power management protocols are proposed by several researchers. Different cluster-based schemes are discussed as a solution for this problem. In this paper, analysis of the present-day classification and general grouping of clustering schemes are studied. It furthermore surveys different energy efficient clustering algorithms with QoS service enhancements.It also analyzes these clustering algorithms based on metrics such as energy efficiency, cluster stability, location awareness, node mobility and QoS support.

Keywords-Sensor network, clustering, QoS, Lifetime, Energy efficiency

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Introduction

Wireless Sensor Network (WSN) is future machinery, which has a wide range of purpose, including infrastructure protection and industrial sensing. This kind of network, usually consists of a huge number of nodes that bring them together to form a network. The most imperative consideration for a wireless sensor network is power consumption. Though the applications of WSN are extremely ample and attractive, the WSN will not be adopted in most of these applications if batteries are to be changed constantly. Therefore, when the sensor node is designed, power consumption must be minimized. There are a number of strategies that can be used to reduce the average supply current of the radio, and hence the power consumption.

The problem related to the energy consumption is attempted by many methods like, providing an improved clustering algorithm, routing algorithm, data aggregation, optimizing the transmitter and receiver power, reducing data size, local data processing, etc. Among these, many of the problems could be solved by choosing an energy efficient clustering algorithm.

Wireless sensor network is a power consuming system, since nodes perform with restricted power a battery which decreases its lifetime. Once deployed, the small sensor nodes are usually inaccessible to the user, and thus replacement of the energy source is not feasible. Hence, one of the most important issues that need to be enhanced in order to improve the life span of the network is energy efficiency. To overcome this demerit much research has been done to improve the lifetime of WSN. To improve the lifetime of sensor network clustering mechanism plays an important role. The work classified into three parts as follows

1. QoS enhanced clustering algorithms
2. Energy efficient clustering algorithms with optimization techniques
3. Cluster based routing protocols

QoS enhanced clustering algorithms

Abraham O. Fapojuwo and Alejandra Cano-Tinoco et al analyzed that a Quality of service enhanced Base station Controlled Dynamic Clustering Protocol (QBCDCP), suitable for the support of video and imaging traffic over resource constrained wireless sensor nodes. The protocol achieves energy efficiency through a rotating head clustering approach and delegation of energy-intensive tasks to a single high-power base station, while providing quality of service (QoS) support by including delay and bandwidth parameters in the route selection process. A Time Division Multiple Access (TDMA) scheme is used for intra- and inters cluster communication, providing bandwidth reservation. Performance of QBCDCP is evaluated in terms of energy consumption and end-to-end image delay via analytical and discrete-event simulation techniques. The main contribution of this paper is the proposal and performance that provides support for real-time traffic while maintaining energy efficiency. [1]

M Sheik Dawood et al.[2] Analysed energy efficient QoS enhanced clustering protocol in Base station controlled dynamic clustering protocol. Well-organized an energy routing protocol is extremely vital technique in wireless sensor networks since sensor nodes are exceedingly energy based. In this paper, a Weighted Clustering Algorithm (WCA) is used in QoS Enhanced Base Station Controlled Dynamic Clustering Protocol (QBCDCP) which considers the ideal degree, transmission power, battery power and mobility of a mobile node. The proposed protocol performs better comparable with standard LEACH and standard base station controlled dynamic clustering protocol.

Sensors usually have concerns regarding coverage, energy, processing power and memory, etc., achieving Quality of Service is hard in sensor networks. Therefore the authors proposed a protocol to deal with such issues of sensors and to maximize the Quality of Service. Firstly the two tier Heterogeneous Sensor Network's approach is used to route the data. Second, the sensors are partitioned into clusters to increase the network coverage and to reduce transportation costs and energy utilization. Voronoi clustering and Tabu search meta-heuristics have been used for making such clusters. An Improved Tree Routing technique applies to two-tier Heterogeneous Sensor Networks to route the data through cluster heads. This approach has largely increased the performance of sensor networks. It also enhances the QOS parameters like delay and throughput. [14]

A wireless sensor network requires a certain delay and bandwidth which pose more challenges in the design of routing protocols. The algorithm that is used for packet routing in such applications should be able to establish a tradeoff between end to end delay parameter and energy consumption. In this paper, a new multipath routing algorithm for real time applications is proposed. In which QoS enhanced routing is achieved through QEMPAR. It reduces end to end delay and network lifetime, improved using the proposed approach. [15]

As the issue of Quality of Service (QoS) provisioning in WSN networks has been acquiring increasing importance, particularly in view of the domains of application of these networks .Mansoor-uz-Zafar Dawood et al.[10] studied the routing protocols specifically designed by considering QoS and energy efficiency as the main parameters. It proposed Energy aware Quality of

Service (QoS) based routing protocol to reduce the congestion of the network and increases the energy efficiency and lifetime. It also enhances the QOS parameters like energy efficiency and throughput.

A novel energy-efficient routing mechanism to ensure bounded delay of the data delivery in sensor networks is proposed by akkaya and Younis [7] Energy-aware multi-hop data paths, consider for transmitting a sensor event. End-to-end delay bound is achieved through the use of a Weighted Fair Queuing (WFQ) based packet scheduling technique in each sensor node. In this paper, the approach pursues multi-hop packet relaying to minimize transmission energy and provide soft real-time guarantees for data delivery.

Energy efficient clustering algorithms with optimization techniques

Indranil Gupta et al. [3] Analyzed a fuzzy logic based clustering approach to cluster-head election.It's based on three descriptors energy, concentration and centrality of sensor nodes. The energy consumption can be reduced by allowing only some nodes to communicate with the base station. These nodes called cluster-heads collect the data sent by each node in that cluster compressing it and then transmitting the aggregated data to the base station. Appropriate cluster-head selection can significantly reduce energy consumption and enhance the lifetime of the WSN.

Ali Norouzi et al. [6] Analyzed the optimization method to improve the lifetime of Wireless Sensor Networks (WSNs). To transmit aggregated data to the Base Station (BS), logical nodes called Cluster Heads (CHs) are required to relay data from the sensing nodes located on the ground in the high altitude station. The Genetic Algorithm (GA) as a dynamic technique to find optimum states of sensor nodes. By using genetic optimization technique, intelligent clustering architecture is achieved to improve the lifetime of WSN.

Moslem Afrashteh Mehr et al. [13] proposed a clustering algorithm for WSN. It is the one of the representative approaches to prolong the lifetime of sensor nodes. In this paper, authors experiment a dynamic clustering algorithm using the genetic optimization technique. This algorithm takes dissimilar parameters into consideration to increase the network lifetime. These parameters are residual energy, required energy to send a message to the sink node, and number of cluster heads.

Cluster based routing protocols

Authors Proposed a Clustering technique for prolonging the lifetime of a wireless sensor network. It used to mitigate the hot spot problem. It groups the nodes into clusters of unequal sizes. Cluster heads closer to the base station have smaller cluster sizes than those farther from the base station, thus they can preserve some energy for the inter-cluster data forwarding. A greedy geographic and energy-aware routing protocol is designed for the inter-cluster communication, which considers the tradeoff between the energy cost of relay paths and the residual energy of relay nodes. [4]Guihai Chen et al .

Bagger Zaire et al. [5] analyzed a novel Cluster Based Routing Protocol (CBRP) for heterogeneous sensor . CBRP achieves a good performance in terms of lifetime by balancing the energy load among all the nodes. In this protocol Cluster the network by using the spanning tree routing method to handle the heterogeneous energy capacities.

Stefanos et al. [8] Analyze a new protocol called Equalized Cluster Head Election Routing Protocol (ECHERP), which pursues energy conservation through balanced clustering and using the Gaussian elimination algorithm, the proposed algorithm calculates the combinations of nodes that can be chosen as cluster heads in order to extend the network lifetime. ECHERP protocol selects a random node or the node with the higher energy at a particular time instance as the new cluster head. It furthermore considers the current and the estimated future residual energy of the nodes, the number of rounds that can be clustered heads, in order to maximize the network lifetime. Simulation result shows that the proposed protocol outperforms standard clustering protocols.

Golam Rashed et al. Analyses the energy efficient routing protocol called Weighted Election Protocol. Longer stability period is achieved when nodes having higher values of extra energy during its heterogeneous behavior. A standard LEACH algorithm is used to determine cluster and cluster heads in WEP.[9]

The cluster heads which form a dominating set in the network decide the topology and are responsible for its stability. In this paper, the authors proposed a Medium access control (MAC) protocol using On-Demand Weighted Clustering Algorithm. Performance of WCA is studied in terms of the number of cluster heads, reaffiliation frequency and dominant set up dates. It takes the parameters such as ideal degree, transmission power, and mobility and battery power of a mobile node to electing a cluster head. It furthermore improves the network lifetime. Mainak Chatterjee et al.[11].

Chuan-Ming Liu and Chuan-Hsiu Lee et al[12] had given a cluster-based architecture to achieve energy efficiency in wireless sensor networks. . In this paper authors consider the cluster-based protocol for data-gathering and two different algorithms for mobility and cluster head selection. Two efficient distributed algorithms for cluster-head election in terms of energy consumption are provided. Two mobility models, Random Walk Mobility model and Random Direction Mobility model, are considered in this paper for node mobility. These algorithms determine the cluster-heads by counting and location based mechanism.

Table 1-Energy efficient clustering protocols

	Protocol	**Paper description**	**Cluster Head selection Algorithm**	**Performance/ QoS parameters**
1.	QBSCDP	QBCDCP protocol achieves energy efficiency through a rotating head Clustering approach	Cluster setup algorithm and Cluster balancing algorithm	Delay and bandwidth
2.	WCA for QBCDCP	WCA implemented in QBCDCP for mobile wireless sensor network.	Weighted Clustering Algorithm (WCA)	Transmission power, battery power
3.	CH election using FUZZY	. Energy efficient clustering algorithm for wireless sensor network	LEACH algorithm Cluster head election based on Energy, and centrality	Energy consumption
4.	UCP	Mitigates the hot spot problem Unequal Cluster-based Routing (UCR) protocol	Greedy lookup Algorithm	Energy consumption
5.	CBRP	Cluster Based Routing Protocol (CBRP).	Spanning tree routing algorithm	Energy consumption
6.	FELBP	Intelligent energy efficient clustering algorithm	Genetic Algorithm	Energy consumption and distance
7.	WFQ	Energy-efficient paths for real-time data that is subject to end-to-end delay requirements	Weighted Fair Queuing (WFQ)	Delay ,Bandwidth And Energy efficiency
8.	ECHERP	Energy Efficient Routing in Wireless Sensor Networks Through Balanced Clustering	Gaussian elimination algorithm	Energy consumption and Lifetime
9.	WEP	Energy efficient clustering protocol for Heterogeneous Wireless Sensor Network	LEACH protocol	Energy consumption and ,Node lifetime

10.	EAQBRP	To reduce the congestion of the network and increases the energy efficiency. Handling QoS routing traffic in sensor network	Sequential Assignment Routing (SAR)algorithm	Energy efficiency, Throughput Cost, transmission energy and error rate
11.	ODWCA	Performance of WCA in terms of the number of cluster heads, *affiliation*, *frequency* and dominant set up dates. WSN	On-demand Weighted Clustering Algorithm	Energy consumption
12.	DAEECHS	Cluster-based protocol for data-gathering for Mobile WSN	Cluster head Election by Counting (ACE-C),Cluster-head Election by Location (ACE-L)	Energy consumption
13.	EECA	A proposed algorithm based on a genetic optimization algorithm.	Dynamic Clustering Algorithm	Energy consumption, Lifetime
14.	QBHCDTT	QoS enhanced Clustering algorithm for HWSN	Tabu search and Voronoi-clustering algorithm	Throughput
15.	QEMPAR	QEMPAR- Energy efficient routing algorithm to increase the network lifetime WSN	QoS and Energy Aware Multipath Routing Algorithm	Throughput and End to end delay

Conclusion

This survey study the range of clustering protocols developed for wireless sensor networks. It furthermore analyzes the role of clustering protocol to enhance the performance of WSN. It also analyzes the importance of QoS enhanced energy efficient clustering protocols to extend the lifetime of WSN.

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