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A Wireless Sensor Networks Routing Protocols Survey for Energy Efficiency Techniques

Nisha Saini
M.Tech Student (CSE)
CGC Gharuan, India

Aashima Singla
Assistant Professor (CSE)
Chandigarh University, Gharuan, India

Abstract- Wireless Sensor Networks are combination multi-sensor networks and are often deployed in hostile environments, which make such networks highly vulnerable and increase the risk of attacks against this type of network. WSNs are clusters of large number of sensor networks with different hardware abilities and functions. A parameter which is one of the main points of concern in the design of wireless sensor networks is its work-life efficiency, directly affected by the power unit capacity, powering the network. A wireless network consists of hundreds to thousands of sensors with sensing, computing, and wireless communications abilities. Routing protocols are designed in such a ways to reduce the time needed for maintenance and location of the routes in the network. In this paper we intend to discuss some of the major routing protocols for wireless sensor networks. For each protocol, we will review the made-up of protocols, analyse each design, and overview several representing protocols also comparison of security, performance and efficiencies will be done.

Keywords— Optimization, Sensor networks, Data-centric routing. Energy-Efficient Routing, wireless sensor networks, hierarchical routing protocol, routing protocol

I. INTRODUCTION

The tremendous development in the electronics technology lead the way to development of micro-electronics thus enabling production of small chips and micro devices. A Wireless Sensor Network consists of a collection of some sensing stuffs usually called sensors of low-power multi-functioning sensor nodes, operating in an unattended environment, with limited computational and sensing capabilities. WSNs have lot of applications in military, health and other industrial sectors. Because of the characteristics of WSNs, sensor nodes are usually characterized by limited power, low bandwidth, memory size and limited energy [1.1306]. The sensing unit usually consists of one or more sensors and analog to digital converters (ADCs). Sensor nodes sense or measure physical data of the area to be monitored. The continual analog signal sensed by the sensors is digitized by an analog-to-digital converter and sent to the processing unit. The processing unit usually consists of a microcontroller or microprocessor with memory, which provides intelligent control to the sensor node. The communication unit consists of a short-range radio for performing data transmission and reception over a radio channel [2]. In contrast to traditional sensors, sensor networks offer a flexible proposition in terms of the ease of deployment and multiple functionalities. In classical sensors, the placement of the nodes in the network topology need to be pre-determined carefully [1]. In addition, the nodes in a wireless sensor network are also capable of performing other functions such as data processing and routing, whereas in traditional sensor networks special nodes with computational capabilities have to be installed separately to achieve such functionalities.

For taking full efficiency out of these features of wireless sensor nodes, we need to account for certain constraints associated with them.WSN routing approaches are compelled to find out routes that ultimately result in prolonged network life time, rather than focusing on routes with shortest distance, minimum delay or maximum bandwidth [201]. Many factors are to be focused upon for designing the networks of which the most noticed is, reduction in the consumption of power is a key requirement in the design of sensor network protocols and algorithms [1] and other requirements such as fault tolerance, scalability, production costs, and reliability. Since the sensor nodes are equipped with small, often irreplaceable, batteries with limited power capacity, it is essential that the network be energy efficient in order to maximize the life span of the network [16,17]. It is necessary that the designer takes these factors into account when designing protocols and algorithms for wireless sensor networks [16].

Therefore, a vast form of research work has been conducted on routing data in WSN where the main focus has been on reducing energy consumption and maintaining a highly power efficient network routing also called Energy Efficient Routing (EER) [4].

II. ROUTING IN WSN

A. Study Area

Routing protocols are designed in such a wayas to reduce the time needed for maintenance and location of the routes in the network. WSNs have especially designed protocols like routing, power management, and data dissemination protocols [2]. In general, routing in WSNs can be divided into flat-based routing, location-based routing and hierarchical-

based routing, depending on the network structure [20] [5] [8] [21]. In Flat-based protocols utilize the information is directed to the desired regions rather than the whole. In order to save energy Hierarchical cluster heads can average and reduce the information unlike flat and location based routing [23] [24]. Hierarchical routing is an efficient way to lower energy consumption within a cluster, performing data aggregation and fusion in order to decrease the number of transmitted messages to the BS. So as to achieve better network throughput under high load the reduction of channel contention is done which results in higher energy efficiency.

A number of different routing protocols have been developed for the WSN. Due to its limitations in the processing power and limited battery power so the routing protocols for the wired networks cannot be used in such conditions. There are three categories proposed protocols:

1) Direct approach :

The simple flooding type routing protocols comes under the direct approach. Though it is simple in its implementation, it is not an energy efficient protocol for the sensor networks

2) Location based routing :

The routing of data to the nodes is done on the basis of geographic location of the nodes (i.e.) nodes are identified by their location only. The location information of each node is obtained by the low power GPS receivers embedded in the nodes.

3) Attribute based routing or data centric routing :

The basic view which separates the sensor network from the other wireless networks is the difference between the address of the node and the content of the node. In the above "Location based routing" strategy the entire sensor nodes in the particular region are viewed as the system rather than as the separate nodes. This is how the lead sensor [16] network takes routing decisions based on data held by the nodes in the network rather than its destination address or geographic location.

B. Key Management in Hierarchy Networks:

Many key management approaches are based on a normal flat structure. There are still some approaches that utilize a hierarchical structure in order to ease the difficulties by balancing the traffic among a BS, CHs, and sensors are the three parts of networks that have different resources. The WSNs mostly use the symmetric key schemes because these schemes requires less computation time than other schemes. On the basis of key distribution, key discovery and key establishment in the schemes, symmetric [8] schemes are divided into six categories: entity based schemes, pure probabilistic-based schemes, polynomial-based key pre-distribution schemes, matrix-based key pre-distribution schemes, tree-based key.

In asymmetric key management schemes, RSA and Elliptic Curve Cryptography (ECC) [23] are two major public key techniques. Public key technology is widely used in the security of Internet. On the other hand, some researchers believe that these techniques are too heavy-weight for sensor networks because of requirement constraints. Whereas in Hybrid schemes, several research groups proposed the hybrid key establishment schemes for WSNs. The motivation is to exploit the difference among the BS, the CH and the sensor, and place the cryptographic burden on the BS [23] or the sensors whose have sources in abundance.BS has much more computational power and other resources than Sensors that have limited computational power and energy resources. The high computational cost on the sensors of the hybrid key establishment schemes can be reduced by placing them on the BS side

II. SECURITY MECHANISMS IN WSNs

1. LEAP

LEAP (Localized Encryption and Authentication Protocol), is a basic example of deterministic key management scheme. LEAP establishes four types of keys that must be stored in each sensor to ease the overhead of key management and to provide secure communications in WSNs.

Hybrid Cryptography Schemes: use both asymmetric-key and symmetric-key cryptographs.

One-way Hash Schemes: is used in many approaches that come from one-way hash function technique to ease key management.

2) LEACH

LEACH stands for Low-Energy Adaptive Clustering Hierarchy and LEACH was one of the first hierarchical protocols. The need of network protocol such as LEACH is due to the fact that a node in the network is no longer useful when its battery dies. The LEACH protocol, the sensor nodes will be organizing themselves into [5] local clusters, with one of the nodes acting as the cluster head.

Leach utilizes the randomized rotation of cluster heads to evenly distribute the energy load among the sensors in the network. This randomized approach is done in order to not drain the battery of a single node. The cluster heads are responsible for collecting data from their clusters, but also to aggregate the collected data for reducing the amount of messages to be sent to the BS, which results in less energy dissipation, to enhance the network life time. The sensor nodes [8] elect themselves to

be CHs at any given time. To find out whether a node elevates to cluster head is made dynamically at a time interval. The elevation decision is to be made [2] by each node independent of other nodes hence it minimizes overhead in cluster head establishment. To come to conclusion a function of the percentage of optimal cluster heads in a network which are predetermined on the basis of the time a given node has been a cluster head in the past.

3) TL-LEACH

Two-Level Hierarchy [24] LEACH (TL-LEACH) is an addition to the LEACH algorithm. There are two levels of cluster heads instead of a single. Here, the primary cluster head in each cluster communicates with the secondary, and the corresponding secondary cluster communicates with their sub-cluster nodes. Data from source node to link is communicated in the following steps:

1) Secondary nodes [24]: The data is collected from their respective clusters and at this level Data fusion can be performed.
2) Primary nodes [24]: The data is collected from their respective secondary clusters and at primary cluster head level Data-fusion can also be implemented. The structure of TLLEACH being in two levels helps to reduce the number of nodes that are to be transmitted to the base station and it effectively reduces the total energy usage.

4) TEEN

Threshold sensitive Energy Efficient sensor Network protocol (TEEN), is a hybrid of hierarchical clustering and data-centric protocols designed for time-critical [4] applications. It is a responsive protocol to sudden changes of some of the attributes observed in the WSN (e.g. temperature). The algorithm first goes through cluster formation. The CHs then broadcast two thresholds to the nodes in their clusters named hard and soft thresholds for the sensed attribute:

Hard Threshold (HT): This is a threshold value for the sensed [26] attribute. It is the absolute value of the attribute beyond which, the node sensing this value must switch on its transmitter and report to its cluster head.

Soft Threshold (ST): This is a small change in the value of the sensed attribute which triggers the node to switch on its transmitter and transmit. It stimulates the node to switch on its transmitter and report the sensed data. A node [20, 26] will report data only when the sensed value is beyond the HT or the change in the value is greater than the ST. TEEN cannot be applied for sensor networks where as periodic sensor readings should be delivered to the Sink, since the values of the attributes may not reach the threshold at all. There are some wasted time-slots in TEEN protocol and there is always a possibility that the sink may not be able to distinguish dead nodes from alive ones. Another limitation of the protocol is that the message propagation is accomplished by CHs only. If CHs are not in each other's transmission radius, the messages will be lost.

5) APTEEN

The Adaptive Threshold sensitive Energy Efficient sensor Network protocol (APTEEN) is an extension to TEEN and aims at both capturing periodic data collections and reacting to time critical events. It has same architecture [25] like TEEN. When the base station forms the clusters, the cluster heads broadcast the attributes, the threshold values, and the transmission schedule to all nodes. In order to save energy Cluster heads also perform data aggregation. APTEEN supports three different query types:

1. Historical, to analyze past data values;
2. One-time, to take a snapshot view of the network;
3. Persistent to monitor an event for a period of time.

6) EECS

An Energy Efficient Clustering Scheme (EECS) is a clustering algorithm in which cluster head helps in elevation to cluster head. This involves broadcasting [15, 27] their residual energy to neighbouring candidates. If a given node does not find a node with more residual energy, it becomes a cluster head. Cluster formation is different than that of LEACH. Clusters of LEACH are formed with the help of the minimum distance of nodes to their corresponding cluster head. EECS extends this algorithm by dynamic sizing of clusters based on cluster distance from [5] the base station. This results in an algorithm that solves the problem that clusters at a greater range from the base station requires more energy for transmission than those that are closer. This way it improves the energy distribution throughout the network, giving better resource usage and extended network life time. EECS is a LEACH-like [15] clustering scheme, where the network is partitioned into a set of clusters with one cluster head in each cluster. The link between cluster head and BS is direct (single-hop) communication. In the network deployment phase, the BS broadcasts a "hello" message to all the nodes at a certain power level. By this way each node can compute the approximate distance to the BS based on the received signal strength. The proper power level to communicate with the BS is selected. Also this distance is used to balance the load among cluster heads. In cluster head election phase, well distributed cluster heads are elected with a little control overhead. In the phase of cluster formation, a novel weighted function is introduced to form load balanced clusters.

7) HEED

Hybrid Energy-Efficient Distributed Clustering (or HEED) is an algorithm that exhibits multi-hop clustering for sensor networks that are wireless, the main criteria is to achieve a clustering [4] that is effecient by proper selection of cluster heads based on the physical distance between nodes. The aims of HEED are to:

• Distribute energy consumption to prolong network [28] lifetime;
• Minimization of energy during the cluster head selection phase;
• Minimize the control overhead of the network.

The most important aspect of HEED [24] is the method of cluster head selection. Cluster heads are determined based on two important parameters:

1) The residual energy of each node is chosen in the initial set of cluster heads depending on the probability. This is the most commonly used parameter in other clustering schemes.

2) Intra-Cluster Communication Cost is used by nodes to select which cluster is to be joined. This is especially useful if a given node falls within the range of more than one cluster head. In HEED is important to identify the ranges of a node is in terms of its power levels as a given node will have multiple discrete transmission power levels. The power level used by a node for intra-cluster announcements and during clustering is referred to as cluster power level. Low cluster power levels promote an increase in spatial [19] reuse while high cluster power levels are required for inter cluster communication as they span two or more cluster areas.

To select a cluster, a node will communicate with the cluster head that yields the lowest intra-cluster communication cost. The intra-cluster communication cost is measured using the Average Minimum Reachability Power (AMRP) measurement. The AMRP [24] is the average of all minimum power levels required for each node within a cluster range R to communicate effectively with the cluster head. AMRP of a node becomes a measure of the expected intra-cluster communication energy if this node is elevated to cluster head. Using AMRP as a second parameter in cluster head selection is more efficient than a node selecting the nearest cluster head.

III. CONCLUSION

Though the protocol like LEAP, LEACH, TL - LEACH, HEED, EECS, APTEEN, TEEN are proved to be energy efficient than its previous models the main pitfalls in these protocols are that nodes are assumed to be static and stationary. The main goal of a routing protocol design is to provide energy efficiency and extend network lifetime. In this paper, we take an initial step to overview the proposed multipath routing protocols in WSNs. We classify multipath routing protocols mainly based on whether the proposed routing protocol creates multiple path infrastructure or not.

REFERENCES

[1] *A Survey on Energy Efficient Protocols for Wireless Sensor Networks*, B.Baranidharan, B.Shanthi, International Journal of Computer Applications (0975 - 8887).

[2] *Energy Efficient Routing in Wireless Sensor Networks Through Balanced Clustering,Stefanos* A. Nikolidakis, Dionisis Kandris, Dimitrios D. Vergados, Christos Douligeris

[3] *An Advanced Survey on Secure Energy-Efficient Hierarchical Routing Protocols in Wireless Sensor Networks*, Abdoulaye Diop, Yue Qi, Qin Wang and Shariq Hussain

[4] *A Survey of Hierarchical Routing Protocols in Wireless Sensor Network* , Md. Atiqur Rahman, Shahed Anwar, Md. Ileas Pramanik, Md. Ferdous Rahman

[5] *A Survey of Hierarchical Routing Protocols in Wireless Sensor Network* , Ankita Joshi , Lakshmi Priya.M

[6] *Energy-Efficient Routing Schemes for Wireless Sensor Networks*, Maleq Khan, Gopal Panduranga, Bharat Bhargava

[7] *A Centralized Energy-Efficient Routing Protocol for Wireless Sensor Networks,* S IVA D. MURUGANATHAN, DANIEL C. F. MA, ROLLY I. BHASIN, AND ABRAHAM O. FAPOJUWO, UNIVERSITY OF CALGARY

[8] *Routing in Wireless Sensor Networks,* Hannes Frey, Stefan R ührup, and Ivan Stojmenović

[9] *Energy Optimization Routing Techniques In Wireless Sensor Networks,* G. Nivetha , International Journal of Advanced Research in Computer Science and Software Engineering

[10] I.F. Akyildiz, W. Su, Y. Sankarasubramaniam, and E. Cayirci, "*A Surveyon Sensor Networks*," IEEE Communications Magazine, vol. 40, no. 8,pp. 102-114, Aug 2002.

[11] W. Heinzelman, A. Chandrakasan, and H. Balakrishnan, *Energy Efficient Communication Protocols for Wireless Sensor Networks* In Proceedings of the 33rd Annual Hawaii International Conference on System Sciences (HICSS), 3005±3014, Big Island, Hawaii, USA, January 2000.

[12] V. Loscri, G. Morabito, and S. Marano, *A Two-Level Hierarchy for Low-Energy Adaptive Clustering Hierarchy,* DEIS Department, University of Calabria.

[13] A. Manjeshwar and D. P. Agrawal, *TEEN: A Protocol for Enhanced Efficiency in Wireless Sensor Network* 1st international Workshop on Parallel and Distributed Computing Issues in Wireless Networks and Mobile Computing, 2001, p.189.

[14] A. Manjeshwar and D. P. Agrawal, *APTEEN: A Hybrid Protocol for Efficient Routing and Comprehensive Information Retrieval in Wireless Sensor Networks*, 2nd International Workshop on Parallel and Distributed Computing Issues in Wireless Networks and Mobile Computing, 2002, 195-202.

[15] M.Ye, C.Li, G.Chen and J.Wu, *EECS:An Energy Efficient Clustering Scheme in Wireless Sensor Networks*, National Laboratory of Novel Softaware Technology,Nanjing University, China.

[16] I. F. Akyildiz et al., "*Wireless Sensor Networks: A Survey,*" Elsevier Sci. B. V. Comp. Networks, vol. 38, no. 4, Mar. 2002, pp. 393-422

[17] W. B. Heinzelman, A. P. Chandrakasan, and H. Balakrishnan, "*An Application-Specific Protocol Architecture for Wireless Microsensor Networks,*" IEEE Trans. Wireless Commun., vol. 1, no. 4, Oct. 2002, pp. 660-70.

[19] W. R. Heinzelman, A. P. Chandrakasan, and H. Balakrishnan, "*Energy-Efficient Communication Protocol for Wireless Microsensor Networks,*" Proc. 33rd Hawaii Int'l. Conf. Sys. Sci., Jan. 2000.

[18] P. Minet, "*Energy efficient routing*", in Ad Hoc and Sensor Wireless Networks: Architectures: Algorithms and Protocols, Bentham Science,2009.

[20] Jamal N. Al-Karaki, Ahmed E. Kamal," *Routing Techniques in Wireless Sensor Networks: A Survey*", IEEE Wireless Communications, Vol 11, pp.6-28, December 2004

[21] Debnath Bhattacharyya 1, Tai-Hoon Kim and Subhajit Pal," *A Comparative Study of Wireless Sensor Networks and Their Routing Protocols*", in International. Journal of Sensors ,pp.10506-10523,2010

[22] A. Abbasi, M. Younis, "*A survey on clustering algorithms for wireless sensor networks,* "in Elsevier Computer Networks Computer Communications, vol. 30, pp. 2826-2841, October 2007.

[23] W. Heinzelman, A. Chandrakasan and H. Balakrishnan, "*Energy-Efficient Communication Protocol for Wireless Mi-crosensor Networks,*" Proceedings of the 33rd Hawaii International Conference on System Sciences (HICSS '00),January 2000.

[24] *A Survey on Clustering Techniques For Wireless Sensor Networks* Rudranath Mitra, Diya Nandy, International Journal of Research in Computer Science eISSN 2249-8265 Volume 2 Issue 4 (2012) pp. 51-57

[25] *A Review on Hierarchial Clustering Based Routing For Wireless Sensor Networks,* V.Chandrasekaran, Dr.A.Shanmugam

[26] *A Survey on Hierarchical Routing Protocols in Wireless Sensor Networks* Sheenam Malhotra, Mehakpreet Kaur, International Journal of P2P Network Trends and Technology (IJPTT) - Volume3 Issue4- May 2013 ISSN: 2249-2615 http://www.ijpttjournal.org Page 255

[27] *An Energy Efficient Clustering Schemein Wireless Sensor Networks,* Mao YE, Chengfa LI, Guihai CHEN, and Jie WU

[28] O. Younis, S. Fahmy, "*HEED: A Hybrid,Energy- Efficient, Distributed clustering approach for Ad Hoc sensor networks*", IEEE Transactions on Mobile Computing 3 (4) (2004) 366-379.

