Stable Election Leach Protocol – A Review

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Abstract

This paper presents a survey on different protocols of wireless sensor network. Increasing the network lifetime is a major issue in sensor network. The network lifetime is the time till the last node of the network is alive. Even some protocols like SEP or extended SEP put their more focus on the round when the first node dies. First node dead round states the stable time of sensor network. The overall objective of this work is to evaluate the performance of LEACH, E-LEACH, SEP and Extended SEP.

Index terms: LEACH, E-LEACH, SEP, Extended SEP, Network Lifetime, Stable period.

1. INTRODUCTION

Wireless communication technologies [1] – [18] continue to grow in diverse areas to provide new opportunities for networking and services. One fast-moving area is wireless sensor networks (WSN). With the advances in micro-electro mechanical systems, sensor devices can be built as very small lightweight wireless nodes. WSN are highly distributed networks of such kind of sensor nodes, and have been deployed in large numbers to monitor the environment or production systems. There is a growing need for the nodes to handle more complex functions in data acquisition and processing, and energy saving solutions remains a major requirement for these battery-powered sensor nodes.

Three major functions are performed by sensor; the data processor that performs local computations on the data sensed; and the communicator that performs information exchange between neighboring nodes. Each sensor is usually limited in their energy, processing power and sensing ability. However, networks of these sensors give rise to a robust, reliable and accurate network. The sensors can collaborate and cooperate among each other, elect leaders or heads, gather their data and then transmits a more results from the sensing. Lots of studies on WSN have been carried out in laboratories. WSN systems are increasingly demanding with new applications in various areas wireless sensor networks are consisted of thousands of small sensors that span a large geographical region. These sensors are able to communicate with each other to collaboratively detect objects, collect information and transmit messages. However, as sensors are usually small in size, they have many physical limitations such as battery, computational power and memory. Because of those limitations, energy-efficient techniques are main research challenges in wireless sensor networks.

A number of techniques have been proposed to solve these challenges. LEACH (Low-Energy Adaptive Clustering Hierarchy) is one of the famous techniques in wireless sensor networks. This is a cluster-based protocol that utilizes randomized rotation of local cluster base stations (cluster-heads) to evenly distribute the energy load among the sensors in the network. This technique can reduce a number of transmissions in clusters. However, the intense data flow can be harmful, especially in wireless sensor networks, since congestions and collisions may be occurred. Traditional server/client-based techniques like a LEACH cannot utilize autonomous-repair and scalability and so on. And also it gives too much burden on base-station. Wireless Sensor Networks (WSNs) are networks of light-weight sensors that are battery powered used majorly for monitoring purposes. The advances in micro-electromechanical technologies have made the improving of such sensors a possibility.

Recently, WSNs have been heavily researched by several organizations and by the military where we can enhance some of the applications in battle surveillance and other security devices. However, while WSNs are increasingly equipped to handle some of these complex functions, in-network

processing such as data aggregation, information fusion, computation and transmission activities requires these sensors to use their energy efficiently in order to extend their network life time. Sensor nodes are prone to energy drainage and failure, and their battery source might be irreplaceable, instead new sensors are deployed. This can negatively impact the stability and performance of the network system if the extra energy is not properly utilized. LEACH protocol and the likes assume a near to perfect system; an energy homogeneous system where a node is not likely to fail due to uneven terrain, failure in connectivity and packet dropping.

But more recent protocols like SEP is considered the reverse that is energy heterogeneity where the factors mentioned above are a possibility, which is more applicable to real life scenario for WSN. Thus, energy heterogeneity should therefore be one of the key factors to be considered when designing a protocol that is robust for WSN. The goal is to present a modified protocol design that is more robust and can ensure longer network life-time while taking other performance measures into consideration. Sensor network should be adaptive and sensitive to the dynamic environment where they are deployed. Since nodes are battery-powered and communications are radio-based, nodes are more susceptible to failures. The information collected by individual node should be aggregated to give more accurate and reliable results. Sensor network should be reliable and be able to provide relevant data through information gathering techniques. The hardware design should incorporate methods to conserve energy using low powered processors and the system software should use minimal power as possible. A sensor network algorithm should be distributed and self-organizing, since WSN is infrastructure-less. The security of the network should also be considered. Scalability is another important factor to be considered when designing a topology for WSN.

1.1 GENERAL ARCHITECTURE

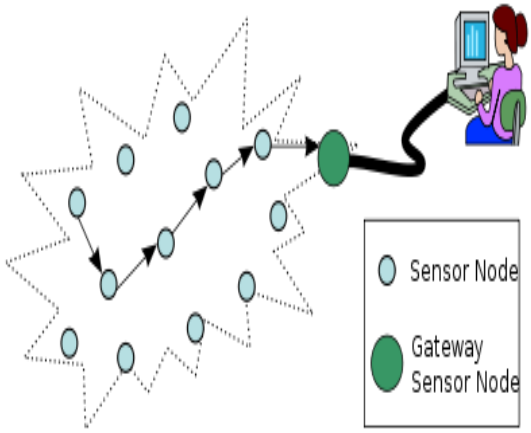

Fig.1 Communication in a Sensor network

Routing or Data Transmission in Clusters:

From routing perspective, clustering allows to split data transmission into intra-cluster (within a cluster) and inter cluster (between cluster heads and every cluster head and the sink) communication.

a) Intra-cluster Routing:

Most of the earlier works on clustering assume direct (one hop) communication between member nodes and their respective cluster heads. All the member nodes are at most two hops away from each other (Figure 2(a)). One-hop clusters makes selection and propagation of cluster heads easy, however, multi-hop intra-cluster connectivity is sometimes required for large radio ranges.

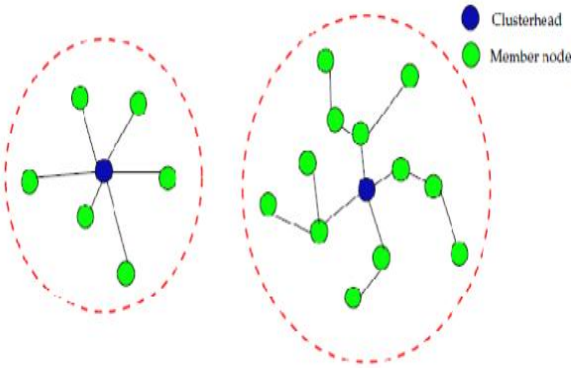

Fig.2(a)Intra-Cluster Communication

b) Inter-cluster Routing:

Earlier cluster-based routing protocols such as LEACH (Energy-efficient communication protocol for wireless sensor networks, 2000) assume that the cluster heads have long communication ranges

allowing direct connection (single hop) between every cluster head and the sink.

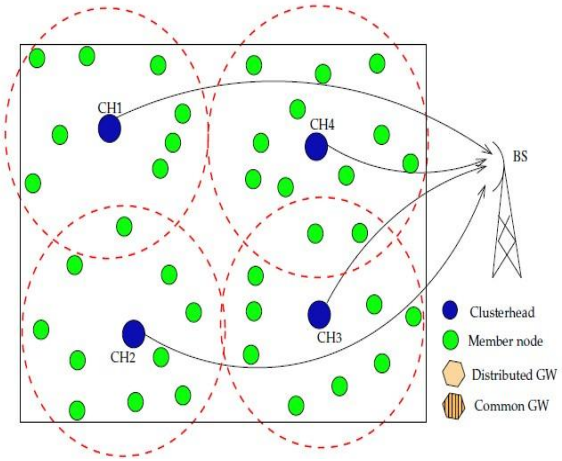

Fig.2(b)One-Hop towards sink

2. LITERATURE SURVEY

Guisheng Yin et al. [2008] [1] Since the nodes of wireless sensor networks are in the condition of a highly-limited and un replenishable energy resource such as battery power, computation, and storage space, the energy efficiency is the most important key point of the network routing designing. Haosong Gou et al. [2010] [2] Wireless sensor networks (WSNs) have been considered as a promising method for reliably monitoring both civil and military environments under hazardous or dangerous conditions. Due to such environments, the power supplies for sensors in the network are not usually rechargeable or replaceable. Therefore, the energy efficiency is critical for the lifetime and cost of WSN. Numerous mechanisms have been proposed to reduce the impact of communication protocols on the overall energy dissipation of WSN. The low-energy adaptive clustering hierarchy (LEACH) and another improved centralized LEACH deploys randomized rotation of cluster-heads to evenly distribute the energy load among all sensors in a WSN.

Heikki Karvonen et al. [2004] [3] has studied the effect of coding on the energy consumption in wireless embedded networks. An analytical model of the radio energy consumption is developed to study how different DC balanced codes affect the energy consumption for the one-hop case. A Rayleigh fading channel is assumed, the analysis is extended to include multihop scenarios in order to study the tradcoff between coding overhead and energy consumption. Hongjoong Sinet al. [2008] [3] adopted biologically inspired approaches for wireless sensor networks. Agent operates automatically with their behavior policies as a gene. Agent aggregates other agents to reduce communication and gives high priority to nodes that have enough energy to communicate. Agent behavior policies are optimized by genetic operation at the base station. Simulation results show that our proposed framework increases the lifetime of each node. Each agent selects a next-hop node with neighbor information and behavior policies.

Huu Nghia Le et al. [2012] [5] has proposed a distributed, energy efficient algorithm for collecting data from all sensor nodes with minimum latency called Delay-minimized Energy-efficient Data Aggregation algorithm (DEDA). The DEDA algorithm minimizes data aggregation latency by building a delay-efficient network structure. At the same time, it also considers the distances between network nodes for saving sensor transmission power and network energy. Energy consumption is also well balanced between sensors to achieve an acceptable network lifetime.

Linlin Wang et al. [2010] [6] Wireless sensor network is composed of hundreds of sensor nodes involving in limited energy, efficient and low-energy consuming routing algorithm is the crucial problem to the routing design. Ma Chaw Mon Thein et al. [2010] [7] Recent advances in wireless sensor networks have led to many new protocols specifically designed for sensor networks where energy awareness is an essential consideration. Clustering is a key routing technique used to reduce energy consumption. Clustering sensors into groups, so that sensors communicate information only to cluster heads and then the cluster-heads communicate the aggregated information to the base station, saves energy and thus prolonging network lifetime.

Meenakshi Sharma et al. [2012] [8] Routing protocols like EEE LEACH, LEACH and Direct Transmission protocol (DTx) in Wireless Sensor Network (WSN) and a comparison study of these protocols based on some performance matrices. Addition to this an attempt is done to calculate their

transmission time and throughput. To calculate these, MATLAB environment is used. Finally, on the basis of the obtained results from the simulation, the above mentioned three protocols are compared. M M Islam et al. [2012] [9] has presented algorithm considers the sensor nodes are static and randomly distributed in the heterogeneous network, the coordinates of the sink and the dimensions of the sensor field are known.

Reetika Munjal et al. [2012] [10] has studied that the main problem with the LEACH lies in the random selection of cluster heads. There exists a probability that cluster heads formed are unbalanced and may remain in one part of network making some part of network unreachable. Here our main purpose is to select a cluster head depending upon its current energy level and distance from the sink node. This increases the energy efficiency and hence network lifetime. Rupesh Mehta et al. [2012] [11] has discussed that the LEACH (Low Energy Adaptive Clustering Hierarchy) protocol randomly selects a few nodes as cluster heads based on a probability model. The probabilistic approach leads to the formation of unequally sized clusters which leads to imbalance in energy consumption across the network and thereby reduces the efficiency and network lifetime.

Shuo Shi et al. [2012] [12] has discussed that the largest energy consumption for a single cluster head in the next round will be estimated, and all nodes with residual energy larger than the calculated consumption will be taken to a new round of simulated annealing to find a better solution. Thus, loss of the cluster head for each round can be minimized, and the WSN lifetime can be extended ultimately. Smaragdakis et al. [2004] [13] has proposed SEP (Stable Election Protocol) so every sensor node in a heterogeneous two-level hierarchical network independently elects itself as a cluster head based on its initial energy relative to that of other nodes.

Thu Ngo Quynh et al. [2012] [14] Wireless Sensor Network (WSN) is a promising approach for a variety of applications. Because of limitation of energy resource, memory space and processing capability of sensor nodes, it is very difficult to implement IP-based routing protocols in WSN. Recently, many research focus on developing special routing protocols for WSNs with the main design criteria: energy efficiency, load balance and reliability. Vivek Katiyar et al. [2011] [15] As the use of wireless sensor networks (WSNs) has grown enormously in the past few decades, the need of scalable &energy efficient routing and data aggregation protocol for large scale deployments has also risen. LEACH is a hierarchical clustering protocol that provides an elegant solution for such protocols.

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Yuhua Liu et al. [2009] [16] has discussed that the non cluster-heads choose optimal cluster-head, they consider comprehensive nodes' residual energy and distance to base-station, then compare their performance, the simulation results show that the new strategy of cluster-heads election achieve great advance in sensor and networks' life-time. Zach Shelby et al. [2005] [17] has provided an analytical model for the study of energy consumption in multihop wireless embedded and sensor networks where nodes are extremely power constrained. Low power optimization techniques developed for conventional ad hoc networks are not sufficient as they do not properly address particular features of embedded and sensor networks. It is not enough to reduce overall energy consumption, it is also important to maximize the lifetime of the entire network, that is, maintain full network connectivity for as long as possible.

Zhi-feng Duan et al. [2009] [18] A Mobile Wireless Sensor Network consisting of a large amount of tiny sensors with low-power can be an effective tool for gathering data in a variety of environments. The data collected by each sensor is transmitted to a single processing center that uses all data to determine characteristics of the environment. Sensors deployed in all kinds of areas on a large scale can move with wind and water.

Conclusion

The literature review on LEACH, E-LEACH, SEP and Extended SEP has been conducted in this paper. By conducting the detail study it is found that the Extended SEP protocol is quite better than other protocol. Extended SEP is more useful

than other not only because of its high stable period and maximum lifetime also it categorize nodes among normal, intermediate and advance. The survey has shown that still some research is required in WSN. Because we can optimize the cluster head selection methods by considering the energy at run time. In near future we will propose a new Improved SEP protocol which increase the stable period as well as entire lifetime of the WSN.

7. REFERENCES

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