A CONCISE STUDY OF WIRELESS SENSOR NETWORKS

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Abstract Wireless Sensor Network (WSN) comprise of independent sensors to check environmental or physical conditions and cooperate with each other using various techniques in the network to send data to main location called as sink. The sensor nodes in a WSN are restricted when talk is about resources like energy, computational speed, memory etc. The in-network processing in WSN like data aggregation, information fusion, computation and transmission activities require the sensors to use their energy efficiently in order to extend their effective network life time. This paper is an attempt to study the WSN under energy constraints by showing the extensions of LEACH protocol taking heterogeneous WSN. This goal will be achieved by studying the topology and using the residual energy of the sensor nodes for election mechanism.

Keywords: WSN, LEACH, Energy Efficient, Sensors.

1. Introduction

Wireless Sensor Network (WSN) consists of spatially distributed autonomous sensors to monitor physical or environmental conditions, such as temperature, sound, vibration, pressure, motion or pollutants and to cooperatively pass their data through the network to a main location. The more modern networks are bi-directional, enabling control over the activity of the sensors. The growth of wireless sensor networks was aggravated by armed forces applications such as battleground surveillance; these days such networks are also used in many manufacturing and end user application, such as engineering process monitoring and control, machine health monitoring, environment and habitat monitoring, healthcare applications, home automation, and traffic control. The WSN is built of nodes from a few to several hundreds or even thousands, where each node is connected to one (or sometimes several) sensors. Each such sensor network node has typically several parts: a radio transceiver with an internal antenna or connection to an external antenna, a micro-controller, an electronic circuit for interfacing with the sensors and an energy source, usually a battery or an embedded form of energy harvesting. A sensor node size may change but its generally small in size. The cost of sensor nodes is also likewise changeable, having range from hundreds of rupees to thousands, depending on the complexity of the any sensor node that is to be deployed. Size and cost constraints on sensor nodes result in corresponding constraints on resources such as energy, memory, computational speed and communications bandwidth. The WSN may have bus, mesh or star topology depending upon the scenario. Also, the propagation methods among the hops of the network can be by routing or by flooding.

Energy conservation in WSN is critical and has been addressed by substantial researchers. Usually energy management is pact with on five special levels:

• Well-organized scheduling between sleep and active nodes.

• Energy efficient routing, data aggregation and clustering.

• Proper management of transmission power to make sure an optimal exchange between energy consumption and connectivity.

• Data compression to lessen the amount of pointlessly transmitted data.

• Efficient channels access and packet re-transmission protocols on the Data Link Layer.

II. Architecture of WSN

WSN generally consists of a base station (or gateway) that can communicate with a number of wireless sensors via radio links. Data is collected at the wireless sensor node, compressed, and transmitted to the gateway directly or, if required, using other wireless sensor nodes to forward the data to the gateway. The transmitted data is then presented to the system by the gateway connection. The design of a layered architecture would normally consist of a base station and sensors scattered in the field. The layers of sensor nodes around the base station constitutes nodes that are in a single hop count to the base station, while nodes that are farther away can be multiple hop count to the BS depending on the size of the network, this is shown in Figure 1. One of the earliest protocols to complete the implementation of the layered architecture is the UNPF (Unified Network Protocol Framework) [1], designed 2 for multi-hop infrastructure network architecture. The UNPF protocol is unified in the sense that it combines three different protocol structures: the network organization, medium access control (MAC) and the routing protocol to achieve the objectives of a robust protocol.

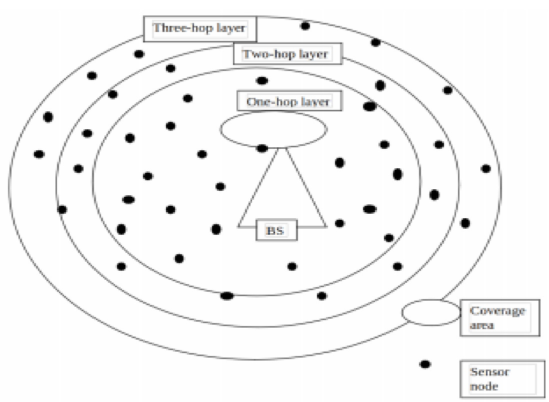

Figure 1: Layered topology of WSN

Characteristics of WSN Each SN has limited power, memory storage, data processing capacity and radio transmission range [4]. Generally, a WSN has the following characteristics:

Ad hoc Deployment SNs are spread randomly and hence they do not fit into any regular topology. Once distributed, they usually do not require any human intervention. Hence, the setup and maintenance of the network should be entirely independent and the network should be self-reconfigurable.

Dynamic Network Topology SNs may run out because of limited power or new nodes may be added to the network. Hence, the network connectivity changes with time, resulting in dynamically changing network topology.

Energy Constrained Operation An important bottleneck in the operation of SNs is the available energy. Sensors usually rely on their battery for power, which in many cases cannot be recharged or replaced. Hence, the available energy at the nodes should be considered as a major constraint while designing protocols as well as computational complexity and storage. For instance, it is desirable to give the user an option to trade off network lifetime for fault tolerance or accuracy of results.

Unattended Operation WSNs are usually spread in a hostile environment, and operating in unattended mode. SNs are spread randomly and hence they do not fit into any regular topology. Once distributed, they usually do not require any human intervention. Hence, the setup and maintenance of the network should be entirely independent and the network should be self-reconfigurable.

Infrastructure-less WSNs are primarily infrastructure-less. There is no central authority to monitor SNs. Therefore, all routing and maintenance algorithms need to be distributed. Sometimes this property becomes main drawback in operation of SN. Due to these property SNs needs to be self-organizing and self-maintaining.

Shared Bandwidth The radio channel in a WSN is broadcast in nature and is shared by all the nodes within its direct transmission range. So, a malicious node could easily obtain access to the data being transmitted in the network.

Large Scale of Deployment A WSN is a large-scale network, in which thousands of sensors are arbitrarily spread to track surrounding environment or monitor a particular object.

III. WSN PROTOCOLS

Several clustering schemes and algorithm such as LEACH, DEEC [2], have been proposed with varying objectives such as load balancing, fault tolerance, increased connectivity with reduced delay and network longevity. A balance of the above objectives can yield a more robust protocol. 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 [3] considered the reverse that is energy heterogeneity where the factors mentioned above is 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. A good protocol design should be able to scale well both in energy heterogeneous and homogeneous settings, meet the demands of different application scenarios and guarantee reliability.

LEACH PROTOCOL LEACH [4] stands for Low Energy Adaptive Clustering Hierarchy Protocol. W.R. Heinzeolman proposed this protocol, which is based on cluster structure and hierarchical technology. Hierarchical protocols are defined to reduce energy consumption by aggregating data and reducing transmission to the base station. LEACH is a Self-organizing, adaptive clustering protocol that uses randomization to distribute energy load evenly. LEACH is a TDMA based MAC protocol in which a network is divided into several clusters. CH collects the data locally from all its CMs and transmits the aggregated data either directly or via multi-hop transmission to the base station. LEACH protocol provides a concept of rounds and each round contains two phases cluster setup phase and steady phase. CH collects the data locally from all its CMs and transmits the aggregated data either directly or via multi-hop transmission to the base station. LEACH protocol provides a concept of rounds and each round contains two phases

M-LEACH Multi-hop LEACH [5] allows sensor nodes to use multi-hop communication within the cluster in order to increase the energy efficiency of the protocol. Multi-hop communication can be used both within the cluster and from cluster head to base station as well.

LEACH-C LEACH-centralized [6] is an attempt to distribute clusters throughout the entire sensor field. As a result of dispersing clusters throughout the network, LEACH-C protocol records better performance compared to LEACH. The base station receives information about residual node energy and node positions at the set-up phase of each round. With the received data, average residual energy for all nodes is calculated and all nodes with energy less than this average are excluded in selection of cluster heads.

LEACH-F LEACH with Fixed clusters (LEACH-F) is based on clusters that are formed once and then fixed. The Next Node position then rotates among the nodes within the cluster. The advantage with this is that, once the clusters are formed, there is no set-up overhead at the beginning of each round. To decide clusters, LEACH-F uses the same centralized cluster formation algorithm as LEACH-C. The fixed clusters in LEACH-F do not allow new nodes to be added to the system and do not adjust their behavior based on nodes dying. Furthermore, LEACH-F does not handle node mobility.

V-LEACH vice Cluster Head LEACH [7] overcomes the fact that once the cluster head dies, the entire cluster fails to send its data to the base station. It includes CH and a vice-CH which is the node that will become a CH of the cluster in case the CH dies.

E-LEACH Energy-LEACH protocol improves the CH selection procedure. It makes residual energy of node as the main metric which decides whether the nodes turn into CH or not after the first round. Same as LEACH protocol, ELEACH is divided into rounds, in the first round, every node has the same probability to turn into CH, that mean nodes are randomly selected as CHs, in the next rounds, the residual energy of each node is different after one round communication and taken into account for the selection of the CHs. That mean nodes have more energy will become a CHs rather than nodes with less energy**[8]**.

PEGASIS: Power-efficient gathering in sensor information systems proposed that sensor webs consisting of nodes with limited battery power and wireless communications are deployed to collect useful information from the field. Gathering sensed information in an energy efficient manner is critical to operate the sensor network for a long period of time. If each node transmits its sensed data directly to the base station then it will deplete its power quickly. PEGASIS (power-efficient gathering in sensor information systems), a near optimal chain-based protocol is an improvement over LEACH where each node communicates only with a close neighbor and takes turns transmitting to the base station, thus reducing the amount of energy spent per round. [9]

TEEN: A Routing Protocol for Enhanced Efficiency in Wireless Sensor Networks [10] said that Wireless sensor networks are expected to find wide applicability and increasing deployment in the near future on the basis of threshold. In this paper, the authors proposed a formal classification of sensor networks, based on their mode of functioning, as proactive and reactive networks. Reactive networks, as opposed to passive data collecting proactive networks, respond immediately to changes in the relevant parameters of interest. They also introduced a new energy efficient protocol, TEEN (Threshold sensitive Energy Efficient sensor Network protocol) for reactive networks and evaluating the performance of our protocol for a simple temperature sensing application.

SEP (Stable Election Protocol) [11] studied the impact of heterogeneity of nodes, in terms of their energy, in wireless sensor networks that are hierarchically clustered. In these networks some of the nodes become cluster heads, aggregate the data of their cluster members and transmit it to the sink. They assume that a percentage of the population of sensor nodes is equipped with additional energy resources—this is a source of heterogeneity which may result from the initial setting or as the operation of the network evolves. Classical clustering protocols assume that all the nodes are equipped with the same amount of energy and as a result, they cannot take full advantage of the presence of node heterogeneity. A very good protocol is proposed named SEP, a heterogeneous-aware protocol to prolong the time interval before the death of the first node (we refer to as *stability period*), which is crucial for many applications where the feedback from the sensor network must be reliable.SEP is based on weighted election probabilities of each node to become cluster head according to the remaining energy in each node.

EECS: an energy efficient clustering scheme in wireless sensor networks [12] proposed that data gathering is a common but critical operation in many applications of wireless sensor networks. Innovative techniques that improve energy efficiency to prolong the network lifetime are highly required. Clustering is an effective topology control approach in wireless sensor networks, which can increase network scalability and lifetime. In this paper, they proposed a novel clustering schema EECS for wireless sensor networks, which better suits the periodical data gathering applications. Their approach elects cluster heads with more residual energy through local radio communication while achieving well cluster head distribution; further more it introduces a novel method to balance the load among the cluster heads.

IV. APPLICATIONS OF WSN

WSN applications can be classified into two categories: monitoring and tracking. Monitoring applications comprise of various outdoor and indoor environmental checking and monitoring, inventory location, factory and process automation, health and wellness, power monitoring, and seismic and structural monitoring. Tracking applications include tracking of various objects, cars, vehicles and also living being like human. Though there are a lot of dissimilar applications, there is list of a few example applications that have been properly deployed and tested in the real environment. In all of applications, it is mandatory to maintain the integrity and the correct operation of the deployed network. Therefore, the security in WSNs becomes an important and a challenging design task.

- **Area Monitoring**
- **Greenhouse Monitoring**
- **Air Pollution Monitoring**
- **Forest Fires Detection**
- **Machine Health Monitoring**
- **Landslide Detection**
- **Water/Waste-Water Monitoring**
- **Health Applications**
- **Agriculture**
- **Structural Monitoring**

V. CONCLUSION:

Sensor Networks are emerging as great way to collect data related to environment specially which are remote only constraint after deployment is mainly energy. This review paper gives us idea about energy aware efficient clustering and routing concepts the battery and computation overhead will be reduced. A lot of proposed protocol is studied and their performance is reviewed. Either the network is clustered of not, each node release some amount of energy with each transmission. The energy reduction results the short network life. A lot of research had been done in this field considering to the different protocols with multilevel, heterogeneity, data compression. In a clustered network, the cluster selection is one of the major WSN protocol. In this literature we studied different approaches of cluster head selection based on distance, energy and other parameters.

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