An Evaluation of Various Clustering and Routing Protocols in Wireless Sensor Networks

J. Joselin, V.S. Anita Sofia

Abstract: In the recent field of research the wireless sensor network plays an important role. Wireless sensor network is an important technology in this era. A Wireless Sensor Network (WSN) is a distributed network contains enormous sensor nodes with wide range of application. It transmits unlimited and enormous data like image, video, audio and data through end to end network. WSNs offer much solution to remote real time monitoring, recognition of physical occurrence and target tracking applications. This network growth is increasingly rapidly day by day and made the research field in difficult resurgence. The extended network lifetime, effective load balancing and scalability are essential for WSNs. The life time of the wireless network can be extended by the concept of clustering. Clustering is process of grouping the smaller localized networks in highly structured way. Diverse cluster technology available based on the network the clustering concept will be used. Efficient routing algorithm provide the way for efficient usage of bandwidth and reduce the delay in the network. This paper provides the survey of clustering and routing protocols to improve the efficiency in wireless technology in recent years.

Keywords: Wireless Technology, Sensor nodes, Dynamic Routing, Protocols and application, Clustering algorithm, LEACH, T EEN, ATEEN, HEED.

I. INTRODUCTION

Wireless Sensor Network is one of the growing concepts in the field of communication. There is lot of advanced technology found in this area but still there is scope of researchers to find the smart computing with efficient energy computation. WSN consists of large number of enormous nodes that together perform the operation of the wireless communication [integration journal of advanced research, ideas, and innovation in technology]. Wireless Sensor Networks covered a variety of applications from military to healthcare[1]. The development of the wireless sensor network was promoted by the surveillance battleground in military applications. But the availability of limited power source, usage of the energy should be highly considered resource for nodes in sensor networks. There are various research methodology has been proposed numerous ideas from diversify angles. Recent application lead to the development of micro sensor in wireless[5]. Each application have sensing unit, location and finding system, transceiver and processing unit which is used to process the sensed device in Fig 1.

The Wireless sensor network is a set of dynamically distributed sensor nodes to receive environmental parameters from various sources. The sources pass their data through the network to a base location called sink. The wireless sensor network sink collects the data from the various sources and pass it to the users through internet by any Private Virtual Network. A sensor may be two type homogenous and heterogeneous types of sensor nodes. A sensor has huge and diversified field of application from agriculture to home appliances control. Each sensor has unique characteristics and features; few sensors have reactors (react to events). The backlog of the sensor application is limited energy backup, and less bandwidth for communication but depending on the application the problem may vary other than low energy back is issue. Each sensor in a sensor network has three subsystems, these subsystems which sensors the environment, perform local computation on the sensed data [2]. The most important element in the wireless sensor network is a base station and sink node. The WSN made up of several hub, every hub associated with few sensors [3]. All Sensor node is coupled to a central place called a base station (BS), that is provides a connection link to world. There is high demand for the design and implementation in network scheme to prolong the energy activity. The energy efficient scheme consists of various strategy sleeps and wakes up, aggregation, overload reduction, single and multihop communication and transmission control. The design and communication of the sensor nodes plays important role. Hence clustering based routing algorithm is efficient for reliable communication with load balancing and fault tolerance. The clustering implements three elements cluster head, intermediate node to raise the activity in network and third cluster member or sensor node collects information from sensor node.

II. WIRELESS SENSOR NETWORK COMPONENTS

A Wireless Sensor Networks has several sensors all that called nodes and centralized place called Base Station. Sensor passes the information to the base station and it is consider as a small electronic device. Sensor is used to generate random information such as temperature, pressure, humidity, sound etc. A sensor consumes low energy hence it is a small device but it operates in high volume density and easily fix to the environmental sources. The components of sensor node allow the sensor to accomplish the task easily in efficient manner. The components are Controller, Transceiver device, Sensor/actuators, memory, and power supply.

2.1 Working principles in wireless sensor network

Wireless Sensor network consists of sensor nodes; it collects the environment data and send to base station. Base station act as a gateway between the

Figure 1: Architecture of the Sensor device

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WSN and outside world. Base station transmits the data to the network or other resources. The network manager displays the data for user analysis in manager node or user. The nodes have frequent patterns are event detection, function approximation and periodic measurement. The sensor nodes works beyond limitation of memory management, process management multitasking etc these are consider as inner level operation provided by an operating system. There are two types of WSN:

**Homogenous WSN:** In this all nodes are with same amount of initial energy.

**Heterogeneous WSN:** In this few nodes like primary nodes have higher compared to other nodes.

Wireless Sensor network has huge application areas but still many areas under research and development. The challenging area in the WSN is non rechargeable and limited energy resource and the areas are Adhoc implementation, Quality of Services, Maintaince of topology, fault tolerance and communication failure. The limitation of WSNs are very small storage capacity, posses modest processing power, and limited life time.

### III. CLUSTERING

The most critical process in wireless sensor network is clustering. Clustering in sensor nodes is a important order to solve issues like energy, scalability and sensor networks issues. All sensor applications cluster the sensor nodes to accomplish the scalability, reduced network traffic and robustness. Every cluster heads send out the aggregated data to the sink or base station. The advantage of clustering is the scalability in performance while expanding the network. Clustering provide numerous advantage to the sensor nodes. It avoids the failure and fault tolerance in transmitting network. Each cluster member communicates with every cluster head, and aggregate the collected data from the sensors in figure 2. The cluster head can also form another layer of cluster themselves before getting the sink. Each node in the WSN made up of four units: processing unit, sensor unit, energy unit and communication unit [6].

**Figure 2:** Sensor Nodes To The Cluster Board

#### 3.1 Components of cluster

The clustering algorithms can be separated on a variety of parameters. On the basis of Cluster Head replacement for a round it can be synchronous and asynchronous[4]. Each cluster has some important components which are used to transmit the collected data they are cluster member, cluster head, gateway node, intra-cluster link, cross-cluster link

#### 3.2 Types of clustering

There are different types of clustering which is used according to the weight of the communication. Each clustering method has process of gathering the small nodes such as Event to sink directed clustering, Load balanced clustering scheme, K-means algorithm, Low energy adaptive clustering, Hybrid energy efficient distributed clustering, Energy efficient hierarchical clustering and Weight based clustering protocols.

### IV. ROUTING IN WSNS

Routing is the challenging concept which differentiates the wireless sensor network from the mobile and other networks. The task of finding the routes in the WSN is a non trivial since the energy restriction and dynamic topology changes. There are many challenging factor in WSNs routing. Node deployment is most important factor affects the performance of routing. The energy consumption without losing accuracy is another factor it might lead to reroute of packets to regain the network. Data reporting model, fault tolerance, scalability, network dynamics transmission media, connectivity, coverage, data aggregation, and quality of service are other design issues faced in the routing protocol in WSNs. Routing protocols in wireless sensor network is a divergence topic which leads to many research process implementations. Routing protocols in WSNs can be divided into data centric based, hierarchical based and location based protocols. Depending on the network and application the routing protocols may vary. Routing Protocols is considered adaptive if certain system parameters can be controlled in order to adapt to the current network condition and available energy [10]. Datacenteric protocols are based on the query depending on the data of interest reduce the repeated transmission. Hierarchical protocols use the cluster method to reduce the transmission of data to save the energy. Third location based uses the position details or information to relay data transmission. In order to this routing protocols classify into three categories proactive, reactive and hybrid. Wireless Routing have four main categorization they are path establishment, network structure, protocol operation and initiator of communication in fig 3. Each of these allow the routing protocol in multiple environment work accomplishment.

**Figure 3:** Wireless Routing protocol

#### Data Centric -Protocols: the data is transmitted to the destination with minimum redundancy from every sensor node. This routing operates autonomously, the configuration is required. The protocols can perform sensor nodes selection and perform aggregation for energy consumption. Examples for this type protocols are energy aware routing, flooding and gossiping and sensor protocols for information.

#### Hierarchical based routing: when protocol need scalability and efficiency in communication hierarchical based routing will carried out also called as cluster based routing. Hierarchical scheme play a significant role in conserving the energy use in the
transmission of data. Energy consumed by the sensor node transferring the data from sensor nodes to the base station is the critical cause of energy reduction in sensor nodes [9]. This cluster based works under tow steps first select cluster and then routing. Examples for this protocol are Low Energy adaptive clustering hierarchy (LEACH) cluster head selection based on the residual energy and relative distance but it create unequal side if clusters and chances of low performance[11]. The optimal number of cluster head in LEACH is 0.05 times to the sum of number of nodes[8].

Threshold Sensitive Energy Efficient Sensor Network Protocol (TEEN)[13] it developed for the network which continuously sense the environment and transmit data soon as the sensed parameter exceed the user threshold[7]. Power efficient gathering in sensor information system (PEGASIS)[15], Threshhold-Sensitive Energy Efficient Sensor Network Protocol (TEEN)[15], Adaptive Threshhold Sensitive Energy Efficient Sensor Network Protocol (ATEEN)[17]and Hybrid, Energy-Efficient Distributed Clustering(HEED)[18]. Table 1 describes about various routing protocols.

### TABLE 1. Various Hierarchical Routing Clustering Protocol

| Clustering Protocol | Functionalities | Advantage | Disadvantage |
|---------------------|----------------|-----------|--------------|
| LEACH [13]          | It is hierarical protocol in which all nodes transfer data to cluster heads and then cluster heads aggregate and compress the data and forward it to the base station | • It reduce network traffic generated within the network  
• Increases lifetime of the network  
• Not necessary to define sensor nodes location of network  
• Dynamic clustering approach | • Sharing data among sensor nodes are not possible.  
• Cluster heads are not uniformly distributed in the cluster.  
• not suitable in large area coverage |
| PEGASIS[15]         | It is chain structure every chain has cluster heads.it distributes energy to all the sensor nodes uniformly | • Only one node transmit is enough to the base station instead of multiple nodes .  
• Increase lifetime of sensor node  
• It saves the battery  
• It increase the energy efficiency of the network | • Excessive delay is occurred on the chain  
• Single node header can become bottleneck on the chain |
| TEEN[15]            | Hybrid ,Hierarchical and data centric protocol is used It is grouping nearby sensor each led by cluster heads it uses LEACH’s strategy to form cluster first level cluster heads are formed away from the base station(BS) [16] | • Time critical data reaches the user immediately  
• A smaller value of the soft threshold gives a more accurate picture of the network  
• Variant soft threshold is used based on target application | • Sensor node may wait for their timeslot for transmission  
• Clusterhead always wait for data from node by keeping its transmission on |
| APTEEN[17]          | It is hybrid clustering based on routing protocol it allow sensor node to send their sensed data periodically and there any sudden change in the value of sensed attribute by reporting corresponding values to their cluster heads[16] | • It use proactive and reactive policies  
• It provide flexibility to change critical data values.  
• Energy consumption is controlled by time and threshold values | • Complexity and overhead is increased to forming multiple levels  
• Complexity is increased to implement threshold based on the function and time delaying |
| HEED[18]            | Periodically select cluster heads according to combination of two parameters the first parameter is residual energy and second parameter is inter cluster communication cost as a function of cluster density | • Breaking clustering processes within a content number of iteration  
• Producing well distributed cluster head and compact cluster  
• Save whole network lifetime  
• It operates correctly even when nodes are not synchronized | • Periodically cluster head rotation or election needs extra energy to reconstruct cluster |

**Localization Based Routing:** The nodes in the wireless sensor network are addressed by the location. The nodes are located by means of (Global Positioning System) GPS. The distance between nodes will be calculated to find the neighbor nodes. The examples for location based routing are Sequential Assignment Routing (SAR), Greedy other Adaptive Force Routing (GOAFR), Geographic adaptive fidelity (GAP), and Energy aware greedy routing (EAGR).

According to the protocol the routing can differentiated into Multipath, negotiation based, query based and network flow and QOs based. Each of these has unique transmission data properties, based on the network the selection of the protocol will be carried out. Apart from this heuristic schemes have goals in solving the clustering issues with optimal time[12].

### V. CONCLUSION

In this research we have highlighted the Wireless sensor network features, clustering and various concept of routing protocols. The protocols and routing methods need the
effecient data transmission with consuming energy. The clustering the provide the efficient transmission of data with minimum redundant and less energy. We have discussed about data centric hierarchy and location based routing protocols. With the use of the of the clustering in routing increases the efficiency in data transmission.

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