Routing in Wireless Sensor Network

Satish Kumar[1]
[1]Department of Electronics &Communication Engineering,.
Ganga Institute of Technology and Management,
Kablana, Jhajjar, Haryana, India

Abstract **--Wireless sensor networks are appealing to researchers due to their wide range of application potential in areas such as target detection and tracking, environmental monitoring, industrial process monitoring, and tactical systems. Routing in sensor networks has attracted a lot of attention in the recent years and introduced unique challenges compared to traditional data routing in wired networks. In this paper, we have summarized various routing protocols in wireless sensor network like TEEN, APTEEN etc.**

Keywords**:** ***WSN, TEEN, APTEEN, PEGASIS, LEACH, SPIN and GEAR.***

I. INTRODUCTION

Wireless Sensor Network Wireless sensor networks (WSNs) is an emerging technology[1], which has a wide spread of potential applications, including environment monitoring, battle field surveillances, climate control in buildings, nuclear, chemical and biological attack detection, home automation, smart spaces, medicine-systems and robotic exploration etc. WSN consists of group of sensors linked by wireless medium and performs sensing tasks. The WSN observes the physical world, process the data, decides based on the observations and takes appropriate actions. The WSN has hundreds or thousands of sensor nodes. These sensors communicate with each other or to an external base station (BS). When a sensor node detects an event, it records the event and routes it to the base station for further processing.

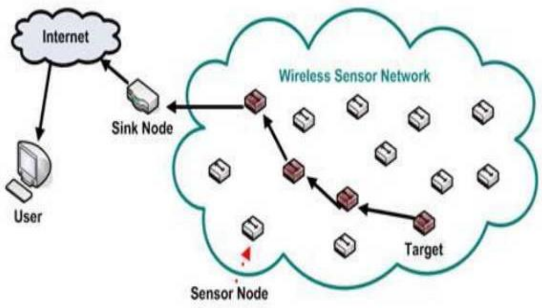

Figure 1 Architecture of Wireless Sensor Network

The routing protocol faces challenges in selecting a best relay node within the communication range.

The sensed data should be routed towards the base station in an energy efficient way. The sensor nodes in the same communication range may sense the same value. So, the relay node aggregates the data and forwards towards the base station to achieve high efficiency. Therefore, hierarchical structure with resource limited ensor nodes Wireless sensor networks have limited energy resources, So WSNs operations must be energy efficient in order to maximize the network lifetime [1]. However, designing an efficient routing protocol for WSNs is a great challenge due to the limitations in the resources of the WSNs such as the limitation of the power source, computation capability and memory size [3].

- Cluster Based Routing Protocol
- Non-Cluster Based Routing Protocol

A. *Cluster Based Routing Protocol*

It is divided into four parts that are PEGASIS, TEEN,

APTEEN, LEACH which can be explained below.

1) Pegasis [4]:

PEGASIS (Power-Efficient Gathering in Sensor Information Systems), which is near optimal for this

data gathering application in sensor networks. The key idea in PEGASIS is to form a chain among the sensor nodes so that each node will receive from and transmit to a close neighbor. Gathered data moves from node to node, get fused and eventually a designated node transmits to the BS. Nodes take turns transmitting to the BS so that the average energy spent by each node per round is reduced. Building a chain to minimize the total length is similar to the traveling salesman problem, which is known to be intractable. However, with the radio communication energy parameters, a simple chain built with a greedy approach performs quite well. The PEGASIS protocol achieves between 100 to 300% improvement when 1%, 20%, 50% and 100% of nodes node die compared to the LEACH protocol.

The main idea in PEGASIS is for each node to receive from and transmit to close neighbors and take turns being the leader for transmission to the BS. This approach will distribute the energy load evenly among the sensor nodes in the network. We initially place the nodes randomly in the play field, and therefore, the i-th node is at a random location. Thenodes will be organized to form a chain, which can either be accomplished by the sensor nodes themselves using a greedy algorithm starting from some node. Alternatively, the BS can compute this chain and broadcast it to all the sensor nodes.

2) Threshold sensitive Energy Efficient

sensor Network protocol (TEEN)

TEEN is a hierarchical clustering protocol [5], which groups different sensor nodes into clusters with each having a cluster-head(CH).The job of the sensors within a cluster is to send their sensed data to their respective CH. The CH now sends the aggregated data to higher level CH until the data reaches the sink. Thus, the sensor network architecture in TEEN is based on a hierarchical grouping where closer nodes form clusters and this process goes on the second level until the BS (sink) is reached.

- Important Features

The main features of this scheme are as follows [6]:

1) Time critical data reaches the user almost instantaneously. So, this scheme is eminently suited for time critical data sensing applications.
2) Message transmission consumes much more energy than data sensing. So, even though the nodes sense continuously, the energy consumption in this scheme can potentially be much less than in the proactive network, because data transmission is done less
3) frequently.
4) The soft threshold can be varied, depending on the criticality of the sensed attribute and the target application.
5) A smaller value of the soft threshold gives a more accurate picture of the network, at the expense of increased energy consumption. Thus, the user can control the trade-off between energy efficiency and accuracy.
6) At every cluster change time, the attributes are broadcast afresh and so, the user can change them as required.

· **Drawback**

The main drawback of this scheme is that, if the thresholds are not reached, the nodes will never communicate; the user will not get any data from the network at all and will not come to know even if all the nodes die. Thus, this scheme is not well suited for applications where the user needs to get data on a regular basis. Another possible problem with this scheme is that a practical implementation would have to ensure that there are no collisions in the cluster.

3) Adaptive Periodic Threshold-sensitive Energy Efficient Sensor Network Protocol (APTEEN) [7]

In APTEEN once the CHs are decided, in each

cluster period, the cluster head first broadcasts the

following parameters:

- Attributes(A): This is a set of physical parameters which the user is interested in obtaining data about.
- Thresholds: This parameter consists of a hard threshold (HT) and a soft threshold (ST). beyond which a node can be triggered to transmit data.
- Schedule: This is a TDMA schedule similar to the one used in [9], assigning a slot to each node.
- Count Time (TC): It is the maximum time period between two successive reports sent by a node.
- Important Features

The main features of our scheme are:

1. By sending periodic data, it gives the user a complete picture of the network. It also responds immediately to drastic changes, thus making it responsive to time critical situations. Thus, It combines both proactive and reactive policies.

2. It offers a flexibility of allowing the user to set the time interval (TC) and the threshold values for the attributes.

3. Energy consumption can be controlled by the count time and the threshold values.

4. The hybrid network can emulate a proactive network or a reactive network, by suitably setting the count time and the threshold values.

- Drawback

The main drawback of this scheme is the additional complexity required to implement the threshold functions and the count time. However, this is a reasonable trade-off and provides additional flexibility and versatility.

4) Leach Protocol

LEACH Protocol is a typical representative of hierarchical routing protocols. It is self adaptive and self-organized. LEACH protocol uses round as unit, each round is made up of cluster set-up stage and steady-state stage, for the purpose of reducing unnecessary energy costs, the steady-state stage must

be much longer than the set-up stage **[9]**. The main goal of this protocol is to increase the sensor nodes lifetime. Initially the LEACH protocol includes distributed cluster formation. LEACH protocol uses randomization and selects a few sensor nodes as cluster heads. They are rotated to evenly distribute the energy load among the sensor in the network.

In some conventional clustering algorithms, a particular cluster head will be chosen and fix throughout the system lifetime and so they die quickly. They also make an ending to the useful lifetime of all the nodes belonging to that cluster.

But here in LEACH randomized rotation of high energy cluster head position is performed so that it rotates among various sensors in order to not drain the battery of a single sensor.

II. NON-CLUSTER BASED ROUTING PROTOCOL

It is divided into three parts that are SPIN,

GEAR, DD which can be explained below.

A. Sensor Protocols for Information via Negotiation (SPIN):

The SPIN family of protocols uses data negotiation and resource-adaptive algorithms [5]. SPIN efficiently disseminates information among sensors in an energy constrained wireless sensor network. This enables a user to query any node and get the required information immediately. Nodes running a SPIN communication protocol name their data using high-level data descriptors, called meta-data. They use meta-data negotiations to eliminate the transmission of redundant data throughout the network. These protocols work in a time-driven approach and distribute the information all over the network, even if a user does not request any data. There are three messages defined in SPIN to

exchange data between nodes. These are:

- ADV message to allow a sensor to advertise a particular meta-data.
- REQ message to request the specific data and
- DATA message that carry the actual data.

The SPIN protocols [11] disseminate information

with low latency and conserve energy at the same

time. Our results highlight the advantages of using

meta-data to name data and negotiate data

transmissions.

There are two protocols in the SPIN family [11]:

SPIN-l (or SPIN-PP) and SPIN-2 (or SPIN-EC). SPIN-PP uses negotiation to solve the implosion and overlap problems. It reduces energy consumption by a factor of 3.6 compared to flooding, while disseminating data almost as quickly as theoretically possible. SPIN-EC, which additionally incorporates a threshold-based resource-awareness mechanism in addition to negotiation, disseminates 1.4 times more data per unit energy than flooding and in fact comes very close to the ideal amount of data that can be disseminated per unit energy

B. Geographic and Energy-Aware Routing (GEAR)

GEAR is an energy-efficient routing protocol which has been proposed for routing queries to target regions in a sensor field. In GEAR, the sensors are supposed to have localization hardware equipped with it, for example, a GPS unit or a localization system so that they can know their current positions [5]. Furthermore, the sensors are aware of their residual energy as well as the locations and residual energy of each of their neighbors. GEAR uses energy aware mechanism that is based on geographical information to select sensors to forward a packet towards its destination region.

The process of forwarding a packet to all the nodes in

the target region consists of two phases [11]:

1)Forwarding the packets towards the target region:

GEAR uses a geographical and energy aware neighbor selection heuristic to route the packet towards the target region. There are two cases to consider:

(a) When a closer neighbor to the destination exists: GEAR picks a next-hop node among all neighbors that are closer to the destination.

(b) When all neighbors are further away: In this case, there is a hole. GEAR picks a next-hop node that minimizes some cost value of this neighbor.

2) Forwarding the packets within the region:

If the packet has reached the region, it can be diffused in that region by either recursive geographic forwarding or restricted flooding. Restricted flooding is good when the sensors are not densely deployed. In case of high density of sensors, recursive geographic flooding is used which is more energy efficient than restricted flooding. In that case, the region is divided into four sub regions and four copies of the packets are created. This

Splitting and forwarding process continues until the regions are left where there is only one node.

C) Directed Diffusion (DD)

Directed Diffusion is a data-centric paradigm. Data generated by sensor nodes is named by attribute value pairs. A node that demands the data generates a request where an interest is specified according to the attribute-value based scheme defined by the application. The sink usually injects an interest in the network for each application task [11]. The nodes update an internal interest cache with the interest messages received. The nodes also keep a data cache where the recent data messages are stored.

This structure helps on determining the data rate. On

receiving this message, the nodes establish a reply link to the originator of the interest. This link is called gradient and it is characterized by the data rate, duration and expiration time. Additionally, the node activates its sensors to collect the intended data. The reception of an interest message makes the node establish multiple gradients (or first hop in a route) to the sinks.

III. CONCLUSION

Wireless sensor networks consist of small nodes with sensing, computation, and wireless communications capabilities. Many routing, power management, and data dissemination protocols have been specifically designed for WSNs where energy awareness is an essential design issue. Routing protocols in WSNs might differ depending on the application and network architecture. This paper surveys recent routing protocols for sensor networks and presents a classification for the various approaches pursued.

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