COMPARISON ON HIERARCHICAL ROUTING PROTOCOLS IN WSN

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ABSTRACT

Nowadays, wireless sensor networks are an emerging technology which plays a vital role in every field. Wireless sensor networks, as the spatially distributed networks consisted of a number of relatively simple, low-cost, low-power components interconnected mutually, provide quite wide application for different areas. Sensor networks works with the help of nodes which are battery driven. Since it loses its energy during transmission, the lifetime of the network is reduced. The main issue in the wireless sensor network is to enhance the network lifetime. Many researches are still going on to improve the time span of the sensor nodes. In this paper, a survey on different energy based routing protocols has been done.

KEYWORDS

Wireless sensor networks, Energy saving, routing protocols

I. INTRODUCTION

A WSN (Wireless Sensor Network) is a collection of nodes organized to form a network. Wireless Sensor Networks are made up of tiny sensors which are used for monitoring or sensing data [4]. Because of their small size, power supply is provided by a small battery, which, when deployed in a 'not-easily reachable' place, cannot be replaced or recharged frequently. The purpose of all these nodes is to monitor the required data and send them to a base station which may be in a remote place. Routing is an important technology in WSNs. The energy efficiency in the WSN is one of the very important critical issues.

1.1 Components of Sensor

The main components of the sensor network are (as shown in figure 1)

Sensing Unit

Sensor is used by wireless sensor nodes to capture data from their environment. They are hardware parts that produce a measurable result to a change in a physical condition like temperature or pressure. Sensors estimate physical data of the parameter to be monitored and have specific features such as precise, sensitivity etc.

Processing Unit

Each sensor node is a device which has a transceiver, a microcontroller, and a sensitive element. Usually sensor node is an independent device. Each sensor node in WSN measures some physical conditions, such as temperature, humidity, pressure, vibration, and converts them into digital data. Sensor node can also process and store evaluated data before transmission.

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Communication Unit

In WSNs communication is implemented through wireless transmission channel using low power transceivers of sensor nodes. It is responsible for exchanging message between the nodes.

Power Unit

Batteries are commonly used to power nodes in a WSN deployment but have a finite energy forecast. When the battery is depleted, a node cannot perform its function or participate in packet routing, which can isolate large areas of the network

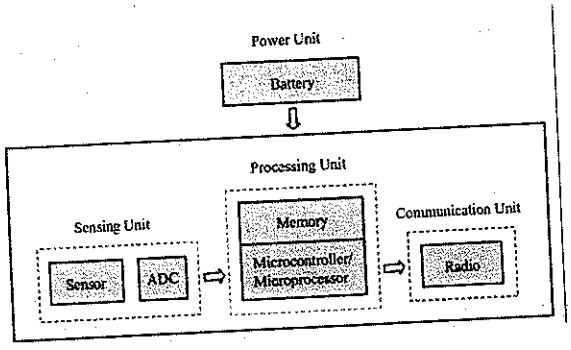

Figure 1: Components of Sensor [12]

II. Sensor Architecture

Figure 2 represents an example of a WSN. Each sensor node is a device which has a transceiver, a microcontroller, and a sensitive element. Sensor node is an independent device which measures some physical conditions. Network sink is a kind of a sensor node which aggregates useful data from other sensor nodes. As a rule, network sink has a stationary power source and is connected to a *server* which is processing data received from WSN. Such connection is implemented directly, if server and WSN are placed on the same object [3]. If it is necessary to provide a remote access to WSN, network sink also functions as a gate, and it is possible to interact with WSN through global network such as the Internet.[3]

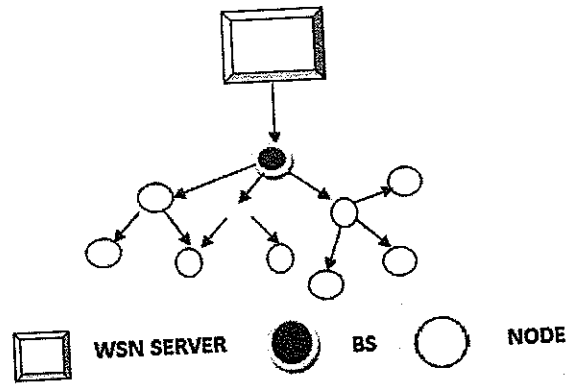

Figure 2: Example of a WSN

III. Energy

At the network layer, the intention is to find ways for energy efficient route setup and reliable relaying of data from the sensor nodes to the sink, in order to expand the lifetime of the network. The major differences between the wireless sensor network and the traditional wireless network sensors are very sensitive to energy consumption. A sensor network is composed with vast number of tiny sensors. Each sensor node is defined with specific parameters in terms of energy. With each communication over the network some energy is consumed [2]. The type of energy in the network can be of different types such as solar, electronic energy etc. This kind of network requires the effectiveness of each kind of operation in terms of energy. When more energy is consumed, the network lifetime is decreased.

IV. Issues in WSN

The major issues in the sensor networks are [8] :

- Energy Efficiency
- Limited storage and computation
- Low bandwidth and high error rates
- Errors are common

- Wireless communication
- Noisy measurements
- Node failure are expected

- Scalability to a large number of sensor nodes
- Survivability in harsh environments
- Experiments are time- and space-intensive

V. Routing Protocol

Generally, routing protocols on the basis of network structure are divided into three main classifications (as shown in figure 3)

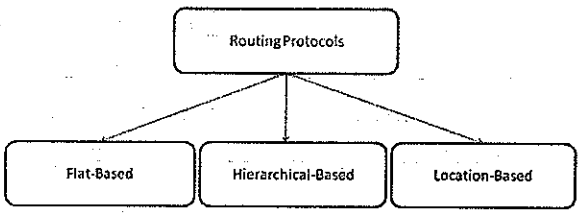

Figure 3: Classification of Routing Protocols

1. Flat Based

In flat based routing protocol all the nodes are treated equally and have the same functionality. Each node plays the same role in performing sensing task and all sensor nodes are peers [5].

Some of the existing Flat-Based Protocols are

1. Sensor Protocol for Information Negotiation (SPIN):
2. Directed Diffusion
3. Rumor Routing
4. Minimum Cost Forwarding Algorithm (MCFA)

2. Hierarchical Based

In Hierarchical Based routing protocol Sensor nodes are organized in to clusters, where the cluster members send their data to the sink. In this cluster based higher node are used for transmission and the lower node for sensing. This is two layer routing protocol which helps to increasing the life time of sensor nodes.

Some of the existing Hierarchical Based routing Protocols are

1. Low Energy Adaptive Clustering Hierarchy
2. Self Organizing Protocol
3. Virtual Grid Architecture
4. Hierarchical power-aware routing

3. Location based

In this routing protocol sensor nodes are addressed based on their location. Location is acquired by GPS (Global Positioning System) or via coordination among nodes.

Some of the existing Protocols are

1. Geographical Adaptive Fidelity
2. Self-Powered Ad-hoc Network

Specifically, hierarchical routing protocols consume less energy which helps to increase the network lifetime. In the following sessions some of the existing Hierarchical Based Routing Protocols are discussed.

5.1 LEACH PROTOCOL

LEACH (Low-Energy adaptive cluster Hierarchy): It is hierarchical protocol in which most nodes transmit to cluster heads. It consists of 2 phases

The Setup Phase:

In this phase, the clusters are organized and the cluster heads are selected. In every round, a stochastic algorithm is used by each node to check whether it will become a cluster head. (as shown in figure 4). If a node can be a cluster head once, it can't become a cluster head again for P rounds, where P is the percentage of these cluster heads. [1].

The Steady Phase:

In this phase, the data is broadcast to the base station. The duration of this phase is much longer than the duration of the above phase in order to decrease overhead.

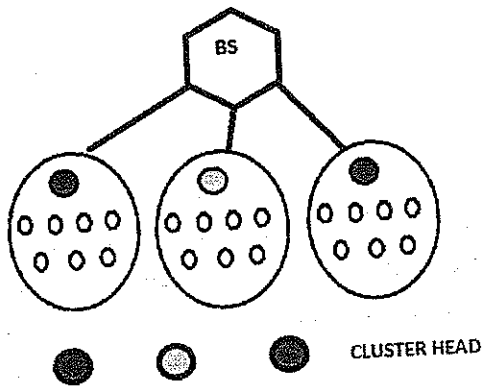

Figure 4: LEACH Protocol

ADVANTAGES

- It uses 2-tier hierarchy clustering architecture
- It uses distributed algorithm to arrange the sensor nodes into clusters.
- The cluster-head nodes generate TDMA schedules.
- Nodes transmit data during their allocated slots.
- The energy efficiency of the LEACH is mainly due to data collection.

DISADVANTAGES

- LEACH is a protocol that uses to decrease energy consumption in a wireless sensor network.
- However, LEACH uses Single-hop routing in which every sensor node transmits information directly to the cluster-head or the Sink.
- Therefore, it is not approved for networks that are delivered in large areas.

5.2 PEGASIS

PEGASIS (Power-Efficient Gathering in Sensor Information Systems) is based on the greedy chain-based power efficient algorithm. Every chain has only one cluster head. The main idea in PEGASIS is for each node to accept from and send to close neighbors and take turns being the leader for transmission to the BS. This approach will spread the energy load evenly among the sensor nodes in the network [6]. In "PEGASIS" each node transfers solely with a detailed neighbor to direct and acquire information. It receipts turns communication to the BS, so make less the amount of energy consumed per round. (as shown in figure 6).

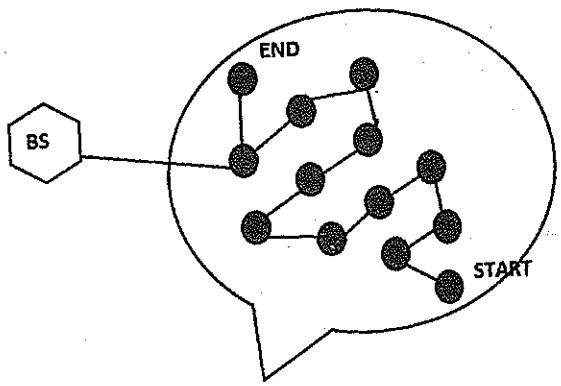

Figure 6: PEGASIS Protocol

ADVANTAGES

- Reduce distance nodes must transmit.
- Decrease number of leaders that transmit to BS.
- Minimize broadcasting overhead.
- Reduce the number or messages leader needs to receive.
- Distribute work more equally among all nodes.
- The Base Station is fixed at long distances from the sensor nodes.
- The sensor nodes are alike and energy constrained with consistent energy.
- No mobility of sensor nodes. [10]

DISADVANTAGES

- In PEGASIS sensor nodes usually or probably die early.
- Moreover, long-range communication directly from the node to the sink will breed an excessive amount of energy consumption.
- The communication manner suffers from excessive delays caused by the one or single chain for distant nodes and a high probability for any node to become a bottleneck.

5.3 TEEN

TEEN (Threshold Sensitive Energy Efficient Sensor Network Protocol) is a threshold impressionable Energy Efficient sensor Network protocol. It is a reactive protocol in which the nodes react unexpectedly to instant and drastic changes in the value of a sensed attribute. Teen Functioning at every cluster change time, the cluster-head broadcasts to its members[9]. The sensors within a cluster report their sensed data to their CH. The CH sends 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. TEEN uses a data-centric method with hierarchical approach. [10]

ADVANTAGES

- Adapted for time critical data sensing applications.
- Time critical data reaches the user almost instantaneously.
- Soft threshold can be varied, depending on the criticality of the sensed attribute and the target application.
- A smaller value of the soft threshold gives a more precise picture of the network, at the expense of increased energy consumption. Thus, the user can control the trade-off between energy efficiency and accuracy.
- At every cluster change time, the attributes are broadcast afresh and so, the user can change them as required [7].

DISADVANTAGES

- If the thresholds are not reached, the user will not get any data from the network at all and will not come to know even if all the nodes die.

5.4 APTEEN

APTEEN (Adaptive Threshold TEEN): This protocol is a modification of TEEN aiming to capture time-critical events and regular data collections together. The network architecture is same as TEEN. While forming clusters, the cluster heads circulate attributes, the threshold values, and therefore the transmission schedule to any or all nodes [11]. Cluster heads are also responsible for data aggregation so as to reduce the size of data transmitted and the energy consumed. (as shown in Figure 6).

ADVANTAGES

- Captures both periodic data collection and reacting to time-critical events
- Outperform LEACH in terms of energy dissipation and total lifetime of the network APTEEN supports queries:
- Historical –Examine past data values
- One-Time –Take a snapshot of the current network view
- Persistent monitor an event for interval of time.

DISADVANTAGES

- The main drawback of this scheme is the additional complexity required to implement the threshold functions and the count time [12].

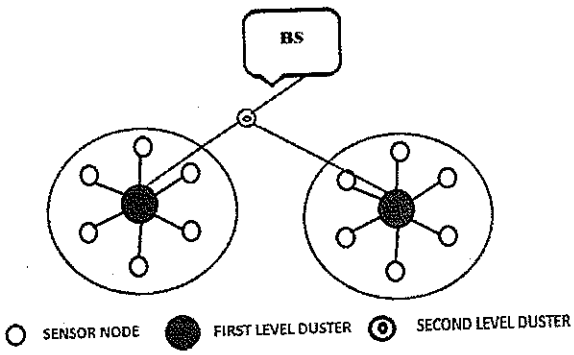

Figure 7:APTEEN Protocol

The routing protocols state in the above sections is developed for different applications. The comparison of the protocols is shown in the below Table 1.

Table 1: Comparison among Different hierarchical Based Routing Protocols

Routing Protocols	LEACH	PEGASIS	TEEN	APTEEN
Categorization	Hierarchical	Hierarchical	Cluster Based	Hierarchical
Data transfer Model	Cluster head	Chains based	Active threshold	Active threshold
Data Fusion	Good	Good	Good	Good
Power Consumption	Very High	Very High	High	High
Scalability	Good	Good	Good	Good
N/W Life Time	Very good	Very good	Very good	Very good
QoS	Bad	Bad	Bad	Bad

VI. CONCLUSION

In wireless sensor networks, the energy conservation of nodes plays an important role in designing any protocol for implementation. In this paper, analyses of the protocol have been done. Based on this survey, further study would investigate on the best routing protocols to improve the energy efficiency.

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