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Review on Routing Protocols for Wireless Sensor Networks

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ABSTRACT: Rapid advances in the areas of sensor design, information technologies and wireless networks have paved the way for the proliferation of wireless sensor networks. These networks have the potential to interface the physical world with the virtual world on an unprecedented scale and provide practical usefulness in developing a large number of applications, including the protection of civil infrastructures, habitat monitoring, precision agriculture, toxic gas detection, supply chain management and health care. Mainly wireless sensor networks with thousands of sensor nodes, it will gather the information from the unattended location and transmit the collected data to the particular user depending on the application.

KEYWORDS: WSN, Deployment, Protocol.

I.INTRODUCTION

Wireless sensor networks refers to a group of spatially dispersed and dedicated sensor for monitoring and recording physical conditions of the environment and organizing the data at a central location. WSN is a wireless that consist of base stations and numbers of nodes or wireless sensors. These networks are used to monitor physical or environmental conditions like sound, treasure, temperature and co-operatively pass data through the network to the main location.

Applications of terrestrial wireless sensor networks:

* Military and national security applications

* Environmental monitoring

*Medical applications

*Industrial applications

*Smart buildings

*Transportation & Logistics

*Precision agriculture & Animal tracking

Characteristics of WSN:

*The consumption of power limits for nodes with batteries

*Capacity to handle node failures

*Mobility of nodes

*Large scale of distribution

*Capacity to ensure strict environmental conditions

In this paper we are doing a survey on different types of routing protocols in WSN.

II.NODE DEPLOYMENT

Node deployment in WSNs is application dependent and affects the performance of the routing protocol. The deployment is either deterministic (manual) or self-organizing (random). In deterministic situations, the sensors are manually placed and data is routed through pre-determined paths. Whereas in self-organizing systems, the sensor

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nodes are scattered randomly creating an infrastructure in an ad hoc manner. The position of the sink or the cluster-head is very crucial in terms of energy efficiency and performance. When the distribution of nodes is not uniform, optimal clustering becomes a necessity to enable energy efficient network operation. In some applications like battle field and wildlife monitoring, sensor nodes are randomly deployed like being dropped from an airplane.

III. ROUTING PROTOCOLS FOR WSN

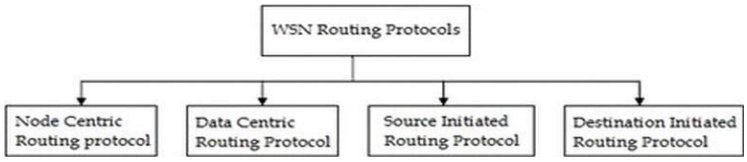
Several types of routing challenges involved in wireless sensor networks. Some of important challenges are mentioned below:

It is almost difficult to allocate a universal identifiers scheme for a big quantity of sensor nodes. So, wireless sensor motes are not proficient of using classical IP-based protocols.

The flow of detected data is compulsory from a number of sources to a specific base station. But this is not occurred in typical communication networks.

The created data traffic has significant redundancy in most of cases. Because many sensing nodes can generate same data while sensing. So, it is essential to exploit such redundancy by the routing protocols and utilize the available bandwidth and energy as efficiently as possible.

Moreover wireless nodes are firmly restricted in relations of transmission energy, bandwidth, capacity and storage and on-board energy. In an unstructured mode the sensor nodes are randomly distributed within the target area that is dropped from a fixed plane.The preplanned or structured mode considers optimal placement, grid placement and 2D,3Dplacement models.



The complexity of a routing protocol may affect the performance of the entire wireless network. The reason behind is that we have inadequate hardware competences and we also face extreme energy limitations in wireless sensor networks.
The design of routing protocols in underwater environment is the complicated task because in underwater environment, the static topology is not valid due to continuous movement of water. The design of dynamic topology is the best solution in underwater environment

IV. CLASSIFICATION OF ROUTING PROTOCOLS

The routing protocols define how nodes will communicate with each other and how the information will be disseminated through the network. There are many ways to classify the routing protocols of WSN. The basic classification of routing protocols.

4.1. **Node centric:**

In node centric protocols the destination node is specified with some numeric identifiers and this is not expected type of communication in Wireless sensor networks. E.g. Low energy adaptive clustering hierarchy(LEACH).

LEACH is a routing protocol that organizes the cluster such that the energy is equally divided in all the sensor nodes in the network. In LEACH protocol several clusters are produced of sensor nodes and one node defined as cluster head and act as routing node for all the other nodes in the cluster.

As in routing protocols the cluster head is selected before the whole communication starts and the communication fails if there is any problem occurs in the cluster head and there is much chances that the battery dies earlier as compare to the other nodes in cluster as the fix cluster head is working his duties of routing for the whole cluster.

Advantages of LEACH protocol:

It contains many advantages like it does not need any control information, it saves energy, it is completely distributed.

Disadvantages of LEACH protocol:

It contains many disadvantages like it cluster had dies then cluster become useless, clusters are divided randomly

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etc.

4.2. **PEGASIS (Power-Efficient Gathering in Sensor Information Systems):**

PEGASIS is considered an optimization of the LEACH algorithm [17]. 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. The chain is constructed with a greedy algorithm. 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. For a network running PEGASIS, it is required to form a chain that contains all nodes. The chain construction starts with the farthest node from the base station. By using a greedy algorithm, it chooses the second farthest node as its neighbor. Then the third farthest node is chosen as the second farthest nodes other neighbor. This process is repeated until the closest node to the base station is chosen as the other end of the chain. When some node dies, this chain will be reconstructed. PEGASIS gathers data round by round. In each round, the end of one side of the chain starts these round transmissions by sending data to its neighbor on the chain. Then, the neighbor fuses received data with its local data, and sends the result to its other neighbor on the chain. This process is repeated until the data reach the leader. So does the other side to the leader of the chain. After the leader received data from its both sides, it fuses those data with its own data, and sends them to the base station.

Features of PEGASIS:

1. It forms chains using greedy approach instead of forming a cluster.

2. In the local gathering, the distances that most of the nodes transmit are much less compared to transmitting to a cluster-head in LEACH.

3. The amount of data for the leader to receive is much less compared to a cluster-head in LEACH.

4. PEGASIS introduces excessive delay for distant node on the chain.

4.3. **Threshold Sensitive Energy Efficient Sensor Network Protocol (TEEN):**

TEEN is a hierarchical clustering protocol [18], 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. TEEN is a clustering communication protocol that targets a reactive network and enables CHs to impose a constraint on when the sensor should report their sensed data. Hard threshold is the minimum possible value of an attribute, beyond which a sensor should turn its transmitter ON to report its sensed data to its CH. Thus, the hard threshold allows the nodes to transmit only when the sensed attribute is in the range of interest, thus reducing the number of transmissions significantly. Once a node senses a value at or beyond the hard threshold, it transmits data only when the value of that attribute changes by an amount equal to or greater than the soft threshold, which indicates a small change in the value of the sensed attribute and triggers a sensor to turn ON its transmitter and send its sensed data to the CH. As a consequence, soft threshold will further reduce the number of transmissions for sensed data if there is little or no change in the value of sensed attribute. Thus, the sensors will send only sensed data that are of interest to the end user based on the hard threshold value and the change with respect to the previously reported data, thus yielding more energy savings. One can adjust both hard and soft threshold values in order to control the number of packet transmissions. However, both values of hard and soft thresholds have an impact on TEEN. These values should set very carefully to keep the sensors responsive by reporting sensed data to the sink.

Advantages of TEEN:

1. It is useful for the applications where the users can control a trade-off between energy efficiency, data accuracy, and response time dynamically.

2. TEEN makes use of a data-centric method with hierarchical approach.

3. It is suitable for time critical sensing applications.

4. Since message transmission consumes more energy than data sensing, so the energy consumption in this scheme is less in comparison with the proactive networks.

Disadvantages of TEEN:

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TEEN is not suitable for sensing applications where periodic reports are needed since the user may not get any data at all if the thresholds are not reached.

4.4. **Adaptive Periodic Threshold Sensitive Energy Efficient Sensor Network Protocol (APTEEN):**

APTEEN IS improvement to TEEN in order to overcome its limitations and shortcomings. It mainly focuses on the capturing periodic data collections (LEACH) as well as reacting to time-critical events (TEEN). Thus, APTEEN is a hybrid clustering-based routing protocol that allows the sensor to send their sensed data periodically and react to any sudden change in the value of the sensed attribute by reporting the corresponding values to their CHs. The architecture of APTEEN is same as in TEEN, which uses the concept hierarchical clustering for energy efficient communication between source sensors and the sink. APTEEN guarantees lower energy dissipation and a helps in ensuring a larger number of sensors alive. When the base station forms the clusters, the CHs broadcast the attributes, the hard and soft threshold values, and TDMA transmission schedule to all nodes, and a maximum time interval between two successive reports sent to a sensor, called count time (TC). CHs also perform data aggregation inorder to save energy.

APTEEN supports three different query types namely:

1. Historical query, to analyze past data values.
2. One-time query, to take a snapshot view of the network.
3. Persistent queries, to monitor an event for a period of time.

APTEEN has following advantages:

1. Guarantees lower energy dissipation.
2. It ensures that a larger number of sensors are alive.
3. Simulation of APTEEN has shown it to outperform LEACH.

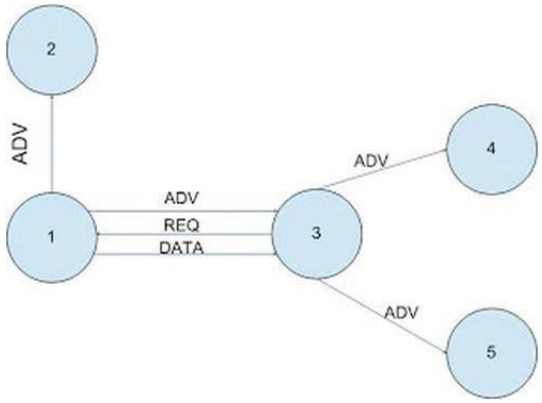
Disadvantages of APTEEN are as follows:

1. The overhead and complexity of forming clusters in multiple levels.
2. Implementing threshold-based functions.
3. Dealing with attribute-based naming of queries.

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

The SPIN family of protocols uses data negotiation and resource-adaptive algorithms. 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:

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



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Advantages of SPIN:

1. In SPIN, topological changes are localized since each node needs to know only its single-hop neighbours.
2. SPIN gives a factor of 3.5 less than flooding in terms of energy dissipation.
3. Meta-data negotiation almost halves the redundant data.

Disadvantages of SPIN:

1. SPINs data advertisement mechanism cannot ensure permanently the delivery of data. For instance, if the nodes that are interested in the data are far away from the source node and the nodes between source and destination are not interested in that data, such data will not be delivered to the destination at all.

2. SPIN is not a good choice for applications such as intrusion detection, which require reliable delivery of data packets over regular intervals.

4.6. **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. Furthermore, the sensors are aware of their residual energy as well as the locations and residual energy of each of their neighbours. GEAR uses energy aware mechanism that is based on geographical information to select sensors to forward a packet towards its destination region. Then, GEAR uses a recursive geographic forwarding algorithm to spread widely the packet inside the target region.

4.7. **Geographic Adaptive Fidelity (GAF):**

GAF is an energy-aware routing protocol which has been mainly proposed for MANETs, but can also be used for WSNs because it deals with energy conservation. The design of GAF is based on an energy model that considers energy consumption due to the reception and transmission of packets as well as idle (or listening) time, when the radio of a sensor is to detect the presence of incoming packets. GAF is based on mechanism of turning off unnecessary sensors while keeping a constant level of routing fidelity (or uninterrupted connectivity between communicating sensors).It has three types of states in GAF a)Discovery state, b) Active state and c) Sleeping state. The ranking of sensors is based on their residual energy levels. Thus, a sensor with a higher rank will be able to handle routing within their corresponding grids. For example, a sensor in the active state has a higher rank than a sensor in the discovery state. A sensor with longer expected lifetime has a higher rank.

4.8. **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. 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 sink. In order to identify the optimum gradient, positive and negative reinforcements are used. This algorithm works with two types of gradients: exploratory and data gradients. Exploratory gradients are intended for route set-up and repair whereas data gradients are used for sending real data.

4.9. **Rumor routing:**

Rumor routing is a variation of directed diffusion which attempts to combine characteristics of event flooding (classic flooding) and query flooding (directed diffusion).The key idea is to route the queries to the than flooding the entire network to get the information about the occurring events. In order to flood events through the network, the rumor routing algorithm employs long-lived packets, called agents. In this scheme, each node maintains a list of neighbours and an event table. When a node detects an event, it adds such event to its event table, and generates an agent. Agent travels the network in order to propagate information about local events to distant nodes. When a sink generates a query for an event, the nodes that know the route, may

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respond to the query by inspecting its event table. Hence, there is no need to flood the whole network, which reduces the communication cost. Rumor routing maintains only one path between source and destination as opposed to directed diffusion where data can be routed through multiple paths at low rate.

PROTOCOLS	MOBILITY	NETWORK LIFETIME	SCALABILITY	RESOURCE AWARENESS	RESOURCE AWARENESS	CLASSIFICATION
LEACH	Fixed BS	Maximum	Very Good	Good	YES	Clustering
TEEN	Fixed BS	Maximum	Very Good	Good	Yes	Reactive/ Clustering
APTEEN	Fixed BS	Maximum	Very Good	Good	Yes	Hybrid
PEGASIS	Fixed BS	Maximum	Very Good	Good	Yes	Reactive/ Clustering
SPIN	Supported	Limited	Good	Limited	Yes	Proactive/ Flat
DD	Limited	Limited	Good	Limited	Yes	Proactive/ Flat
RR	Very Limited	Not Supported	Very Good	Good	Yes	Hybrid/Flat
GEAR	Limited	Limited	Good	Limited	Yes	Location
GAF	Limited	Limited	Good	Limited	Yes	Location

V.CONCLUSION

wireless sensor networks are designed for sensing the different types of environmental conditions. so, designing an efficient routing protocols for sensor networks is necessary. routing protocols in wsn's is still an area of research as sensor nodes are finding new applications with time. in our work, first we have gone through the survey of types of protocols under wsn. in this document we have discussed 9 routing protocols leach, teen, apteen, pegasis, spin,dd ,rr ,gear & gaf.

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