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A Qualitative Comparison of Various Routing Protocols in WSN

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ABSTRACT

Wireless Sensor Network (WSN) consists of a large number of small nodes with the capabilities of sensing various types of physical and environmental conditions, data processing, and wireless communication. In Wireless Sensor Network(WSN) the sensor nodes collects the data from its surrounding and transmit the gathered data to a particular user, the transmission of gathered data by sensor nodes depends on the application that is used. The nodes have limited processing power, limited transmission range and storage capabilities as well as limited energy capabilities. In this paper we discuss the routing protocols of wireless sensor network and also discuss the classification and comparison of routing protocols. The architecture of routing protocols categories in three main category Hierarchical, Location-Based and data centric protocols according to some important factors and will summarize in the way these protocols operates. Finally, we will provide a comparative study on these various protocols.

Keywords: Wireless Sensor Network, Routing Protocols, Location-based Routing, Data Centric.

I. INTRODUCTION

Wireless Sensor Network(WSN) consist of hundred to thousand low power sensor nodes, they are deployed in field, have capability to gather data and send to base station for taking decision about specific region for specific purpose. Basic component of wireless sensor node is sensor, processer, radio transceiver, power unit. Sensors are responsible to sense the deployed region for capturing the data. Processer received data form storage unit process it and transmit to nearest neighbor which may be node are base station. Radio transceiver has the ability to transmit and received data form neighbors nodes

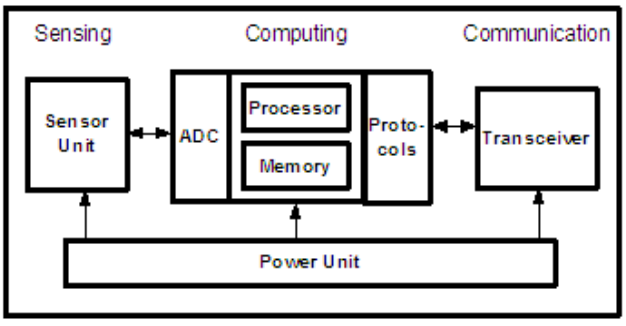

Figure 1: Components of a Sensor Node

Power unit is responsible for managing energy consumption of the node. These various components of a node are shown in Figure 1 above.

II. METHODS AND MATERIAL

A. Wireless Sensor Network Protocols

Wireless Sensor Network (WSN) has a wide range of applications to industry, science, transportation, civil infrastructure and security and many other fields, such as some forests are very dangerous where human approach fails, so from that areas we collect our desired information using wireless sensor application. In this paper we stud the routing protocol of wireless sensor network and we categorize the routing protocols in three basic categories on the basis of network structures. This paper organized as follows. In the first phase we discussed about the hierarchical protocols, second phase is about location based and third phase describes data centric protocols.

Routing Protocols in WSN

Wireless sensor network routing protocols are different from traditional routing protocol [1-8]. On

the basis of network structure routing protocols are classified in many different categories, like data centric, hierarchical and location-based protocols and also compared the routing protocols.

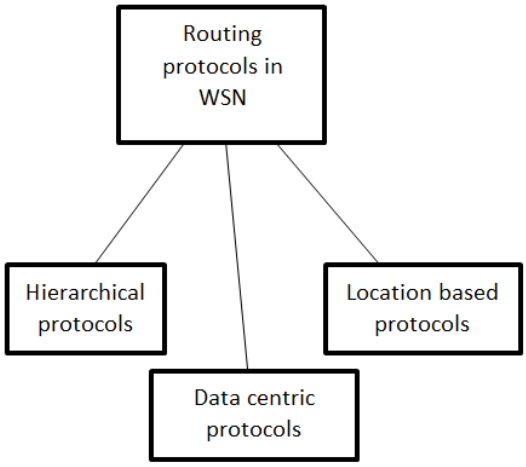

Figure 2: classification of WSN Protocols

A. Hierarchical protocols In this paper different hierarchical based routing protocols described. Which is (LEACH, TEEN, APTEEN, PEGASIS) energy efficient and maintain the energy of sensor node. A hierarchical approach network is divides in to cluster and cluster head. Cluster node captures the data and sends the data to cluster head. Cluster head received the data from cluster aggregate the data and send to base station. In hierarchical based routing protocols data send form one node to another node and cover large distance. This approach moves the data faster to base station. Representative protocols of hierarchical routing are is following:

1) LEACH
2) 2)TEEN
3) APTEEN
4) PEGASIS

1) **LEACH:** Low Energy Adaptive Clustering Hierarchy (LEACH) is most popular hierarchical routing protocols for sensor network. Leach performs data fusion to compress the data when data send to from cluster to base station. In this why leach is most popular protocol to reduce the energy consumption and enhance the lifetime of the node. Leach protocol divide the total operation in two phase. One is setup phase and other is steady state phase. In set-up phase cluster head is selected for each cluster. Cluster head is selected from sensor nodes at the time of certain probability. The cluster head is selected random number between 0 and 1.the node become cluster head for the current round if the number is less than the threshold,

$$T(n)=\begin{bmatrix}\dfrac{P}{1-P*\left(r \bmod (1/P)\right)} & \text{if } n\in G\\ 0 & \text{otherwise}\end{bmatrix}$$

Where p is desired percentage of cluster head, r current round, G are those node which is not selected cluster head in 1/p round.

In steady state phase cluster head send the data to leader node. Leader node compress, aggregate the data and send to base station.

2) **TEEN:** Threshold energy efficient network (teen) protocol a hierarchical clustering protocol. The sensor network based on hierarchical grouping cluster nodes from clusters and this process goes on second level until base station is reached. In this type of protocol cluster head send two types of data to neighbor's nodes. One is hard threshold and other is soft threshold. The node transmits the data if one of the following conditions satisfies:

a) Sense value > hard threshold
b) Sense value ~ hard threshold >= soft threshold

If hard threshold satisfy that condition if sensed value is greater than hard threshold. This means the node send those data which are interested and reduce the number of transmission. In soft threshold any small change in the sense value transmits the data to forward.

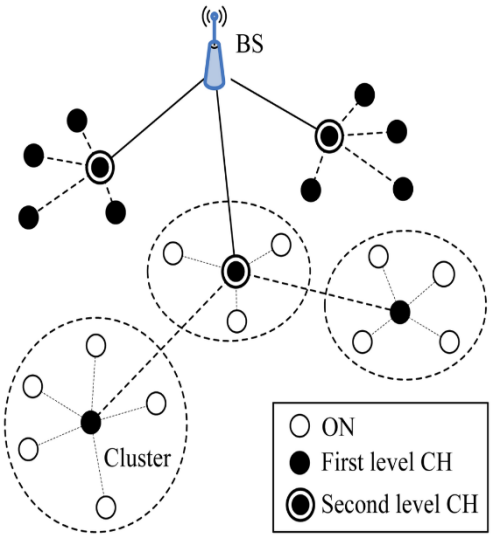

Figure 3: Architecture of TEEN protocol

3) **APTEEN:** Adaptive threshold energy efficient network protocol (APTEEN) is improve version of teen protocol which capturing both periodic data collections and reacting to time critical event. The architecture of APTEEN is same like TEEN.APTEEN support different type query.
   - Historical analysis of past data values.
   - Snapshot of the current network view.
   - Monitoring of an event for a period of time.

4) **PEGASIS:** Power Efficient Gathering in Sensor Information System (PEGASIS), which is chain based power efficient algorithm. In PEGASIS only one node chose to transmit data to base station other nodes capture the data and send the data to neighbor node. PEGASIS chain of sensor node every sensor node transmit data to neighbor node and received data for neighbor node. For example:

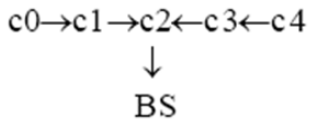

Figure 4 : Architecture of PEGASIS

In the above example C0 send data to C1. Node C1 combine the data of C0 and own data then transmit to leader node.C2 is leader node which send token to C4, node C4 transmit data to C3. C3 combine the data of C4 with its own data and transmit to leader node. Node C2 wait for neighbor node data if received the data form neighbor node then combine the data and send only one message to base station [9-28].

B. Location Based Protocol:

In sensor networks the information about the location of nodes are very necessary. By means of their location the sensor nodes are located in Location Based Protocol.

The energy estimate can consumed by all the routing protocol to calculate the distance between two particular nodes. Location protocol can increase the lifetime of network. In Location Based routing protocol the position of sensor nodes are estimated to route data in the network. Location Based routing protocol needs some location for the sensor node these location can be obtained from GPS (Global Positioning System) signals, Received Radio signals etc.

GEAR is an example of Location Based routing protocol.

i. Geographic and Energy-Aware Routing (GEAR): GEAR is an energy efficient routing protocol. This protocol is used to find the location of sensor node in the network. Localization hardware just like GPS, GIS etc. are fitted in nodes through this the nodes will know about their current position, their energy as well as they will know about their neighbors. It uses energy aware methods geographical information for sending the packets towards its destination. At that point GEAR use recursive geographic forwarding to spread the packets inside the target region.

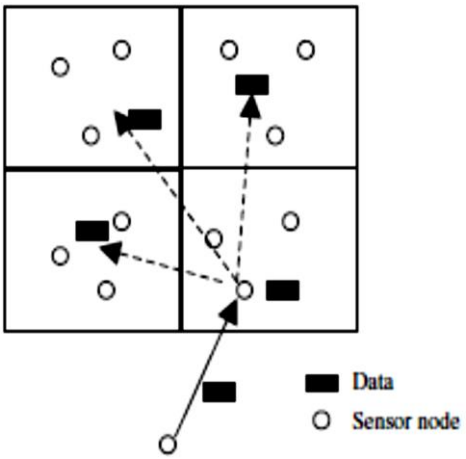

Figure 5: Operation of GEAR Protocol

ii. Geographic Adaptive Fidelity (GAF):

It is an energy aware routing protocol. Initially GAF was proposed for MANETS and mobile ad hoc networks. But later it can also applied to sensor networks. GAF is a location based routing protocol. In GAF nodes use location information through any system just like GPS, GIS and received radio signal etc. to locate itself with its nearest neighbors.

Nodes consume energy while transmitting data i.e. at sending time as well as at the receiving time. In idle state some amount of energy is used but it is less in comparison to the active state.

- **From Discovery to Active state transition:**

For finding the equivalent nodes each node exchange discovery messages. Nodes belongs to the same grid

are equivalent. Discovery messages contains information about the nodes i.e. node id, grid id, node state and energy level [29-40]. After predefined time Td the nodes enters into the active state if it doesn't receive any other discovery message.

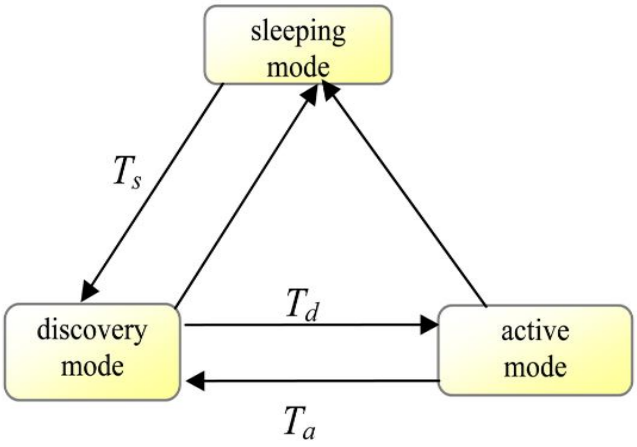

Figure 6: State Operational Model

- **From Discovery to Sleeping state transition:**

In this state if node receives any other discovery message from another node which have higher energy level than a node that is enter to the sleep state. At one time only one node will be in active state the remaining will be in sleep state. In order to keep the routing fidelity, the sleeping neighbors will adjust their sleeping time (Ts). If the active node expires then another sleeping node become active.

- **From Active to Sleeping state transition:**

Active time show that at what time a node will be in active state. After active time (Ta), another node which have higher energy from the rest of nodes in the grid become active and the current one will go to sleep state.

- **From Sleeping to Discovery state transition:**

Before wake up a node has to complete its sleep time and then enter to discovery state. If the node have higher energy then it will enter to active state otherwise re-enter into sleep state.

- **From Active to Discovery state transition:**

When a node enters to the discovery phase after a predefined time (Td) and rebroadcast the discovery message for time td. If it receives a message from another node having higher residual energy then it enter into sleep state else re-enter into active state.

1) Trajectory Based Forwarding:

It is a method to forward packets in a dense ad hoc network that makes it possible to route a packet over a predefined path. The source specify the trajectory in a packet but doesn't explicitly the path on the hop-by-hop basis. Based on the location information of its neighbor a forwarding sensor makes a greedy decision to determine the next hop that is the closest to the trajectory fixed by the source sensor.

2) Minimum Energy Communication Network (MECN) and Small-MECN:

Minimum Energy Communication Network (MECN) is a Location-Based protocol. This protocol is used for achieving minimum energy for randomly deployed ad hoc networks. Which attempt to set up and maintain a minimum energy network with mobile sensors. This protocol has two phases.

- In the first phase the protocol takes the position of a two dimensional plane and constructs a sparse graph which is also called an enclosure graph. It consist of all the enclosures of each transmit node in the graph. Enclose graph contains globally optimal links in terms of energy consumptions.

- The second phase finds optimal links on the enclosure graph. It uses distributed shortest path algorithm with power consumption as a cost metric.
- Small Minimum Energy Communication Network (SMECN):This protocol is used to improve MECN. In this protocol minimal graph is regarded as with its minimum energy property. In this protocol every sensor discovers its immediate neighbors by broadcasting a discovery message using some initial power that is updated incrementally.

C. Data centric protocol

In sensor network the data centric protocol is different from traditional in carrying data .data centric protocol is query-based i-e the sink send queries to certain region and wait for the required sensing data in the sensor located region. Data is being requested through

queries. Naming data is essential to specify properties of data based on attributes .the most important thing it reduce redundancy in data transmission. The base station sends queries to the specific sensor region and waits for the information about that filed transmitting by the nodes. Thus is very efficient in term of energy consumption .in data centric protocol the sensor themselves are less important than their own data centric protocol is divided into many categories.

1. SPIN

(Sensor Protocol for Information via Negotiation):-it was design to improve classic flooding protocol. The plan behind spin is to name the data using high level descriptor or Meta data. Meta data are changed between sensors before transmission via a technique of data advertisement. In spin all information is broadcasted to each node in the network user can easily query to any node and can get the information very soon [41-44].

2. Directed Diffusion

It develop after spin .it is a data dissemination and aggregation protocol an application aware protocol in which sensor node generate data and name it by attribute value paired. The operation is shown below

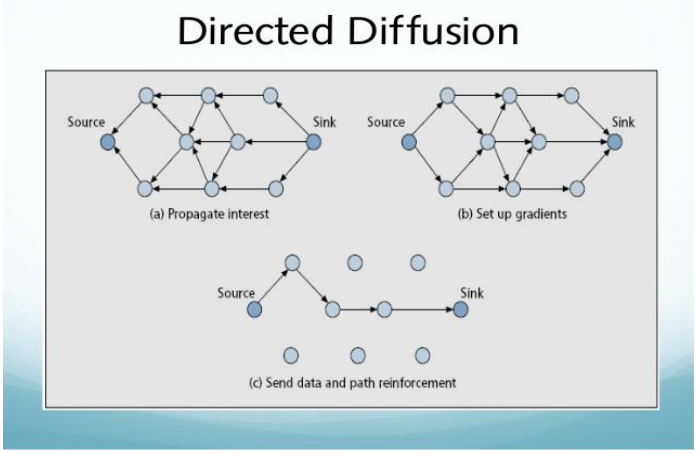

Figure 7: Directed Diffusion Operation

III. RESULTS AND DISCUSSION

Comparison of Various Routing Protocols

Comparison of Various Routing Protocols

Routing protocol	Data aggregation	Power usage	Scalability	Query based	Data delivery model
LEACH	Yes	High	Good	No	Cluster Head
TEEN	Yes	High	Good	No	Active Threshold
APTEEN	Yes	High	Good	No	Active Threshold
PEGASIS	No	maximum	Good	No	Chain Based
GEAR	No	Limited	Limited	No	Demand Driven
GAF	No	Limited	Good	No	Virtual Grid
SPIN	Yes	Limited	Limited	Yes	Event Driven
DD	Yes	Limited	Limited	yes	Demand Driven

IV.CONCLUSION

In recent year, wireless sensor network is the most interesting field for the researcher to contribute the main aim of the routing protocol to improve lifetime of sensor node for the purpose to improve network lifetime. This paper is about the classification of routing protocols into three main categories. Such as, data centric, hierarchical and location based. In hierarchical node are divide in cluster and cluster head. In data centric protocol, all data come from the nodes to gateway. Then gateway send the data to base station, in this way gateway is more overloading. In location-based protocols, need the information of node to calculate the distance between two nodes to estimate energy consumption.

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