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Survey on Data-Centric protocols of WSN

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ABSTRACT

Wireless sensor network led to many new protocols where energy awareness is vital consideration. This paper surveys on data centric protocols for sensor network

Keywords: Sensor Network, Data centric protocols, routing protocols

1. INTRODUCTION

Wireless sensor network (WSN) refers to a group of spatially dispersed and dedicated sensors for monitoring and recording the physical conditions of the environment and also for organizing the collected data at a central location. WSNs measure environmental conditions like temperature, sound, pollution levels, humidity, wind speed and direction, pressure, etc. A WSN consists of anywhere from a few hundreds to thousands of sensor nodes. The sensor node equipment includes a radio transceiver along with an antenna, a microcontroller, an interfacing electronic circuit, and an energy source, usually a battery.

Routing in sensor network is very challenging due to several characteristics that distinguish them from wireless adhoc networks. Number of sensor network can be several orders of magnitude higher than the node in adhoc network. Sensor network are densely deployed as well as prone to failure. Topology of sensor network changes very frequently and use broadcast communication paradigm where as adhoc use point to point communication. Sensor network are limited in power computational capacities and memory as well as it does not have global identification (ID) because of large amount of overhead and large number of sensors. [1]

2. APPLICATION OF SENSOR NETWORK

The most important application areas of sensor networks include

a) **Military application:** some examples of possible utilizations of WSNs for military applications are Position and movement control of troops and vehicles, target detection, non-human combat-area monitoring as well as landmine removal or building exploration.

b) **Intelligent housing***:* WSNs permit that houses can be equipped with movement, light and temperature sensors, microphones used for voice activation and pressure sensors in chairs are also examples of WSN utilization in building automation. Thus, air temperature, natural and artificial lighting and other components can be tuned according to specific user needs.

c) **Machine surveillance and preventive maintenance**: It can be performed by Embed sensing/control functions into places where no cable has gone before e.g., tire pressure monitoring.

d) **Precision agriculture:** Irrigation control and precise pesticide application are possible with the help of WSN utilization on farmlands.

e) **Medicine and health care** : It can be utilized in Post-operative/ intensive care or Long-term surveillance of chronically ill patients or the elderly .[15]

3. ARCHITECTURE SENSOR NETWORK

The communication architecture of the sensor networks is shown in Figure 1 [2]

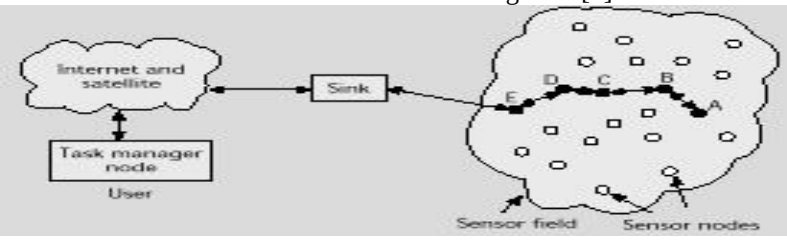

Figure 1 Sensor nodes scattered in a sensor field.

In sensor field sensor nodes are scattered and deployed. The nodes in these networks manage amongst themselves to produce simply accessible and high-quality information about the physical environment. Every sensor node in these networks operates alone with no central point of control and communicates using infrared devices or radios. Each of these scattered sensor nodes has the capabilities to accumulate data and route data back to the sink. A sink may be a long-range radio, capable of connecting the sensor network to existing long-haul communications infrastructure. The sink may also be a mobile node acting as an information sink, or any other entity required to take out information from the sensor network [3]. Data are routed back to the sink by a multi-hop infrastructure less architecture through the sink as shown in Figure 1. The sink may communicate with the satellite. The design of the sensor network is influenced by many factors, including fault tolerance, scalability, production costs, hardware constraints, transmission media and power consumption[2][3]

4. DATA CENTRIC PROTOCOLS

Data Centric routing is used to control the redundancy of data , it happens because sensor node does not have global identification number which specify them uniquely, so data is transmitted to each node with significant redundancy. In data centric routing, the sink request for data by sending the query so the nearest sensor node transmits the data selected understand from the query. The property of data is specified by attribute based naming.

4.1 Flooding and gossiping

These are two mechanisms to transmit the data without using routing algorithms and topology maintenance

Flooding: Sensor node transmits the data to its entire neighbors till the packet reach the destination [14]. Its advantage is easy to implement. Following are some of the limitations associated with Flooding.

- **Implosion:** It is caused by duplicated messages sent to same neighbor node, In Fig 2 [1][8], Node A starts by flooding its data to all of its neighbors. D gets two same copies of data eventually, which is not necessary.

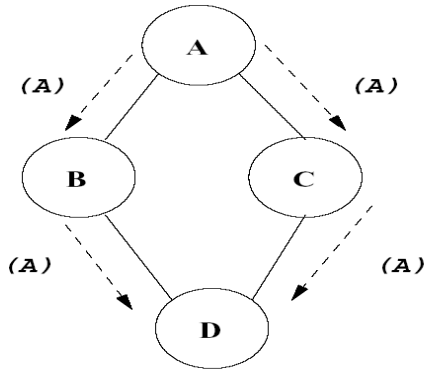

Figure 2. The implosion problem.

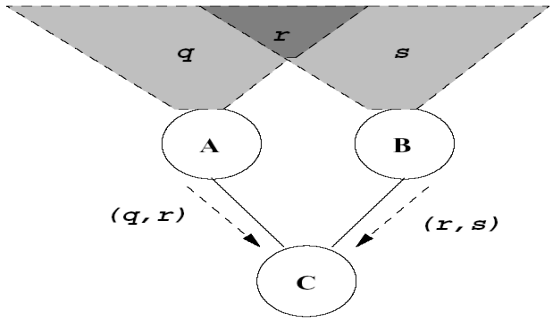

Figure 3. The overlap problem.

- **Overlap problem:** The same event may be sensed by more than one node due to overlapping regions of coverage. This results in their neighbors receiving duplicate reports of the same event. In Fig 3[1][8]Two sensors cover an overlapping geographic region and C gets same copy of data from these node.
- **Resource blindness:** The flooding protocol does not consider the available energy at the nodes and results in many redundant transmissions. Hence, it reduces the network lifetime.

a) **Gossiping:**

In Gossiping packet is send to the randomly selected neighbor which selects another random neighbor to forward the data and so on. Its advantage is that it avoid implosion .However this cause delay in propagation of data among nodes.[1][8]

4.2 Sensor protocols for information via negotiation

- The key feature of SPIN [8] is advertisement mechanism, in this mechanism Meta data is exchanged among sensors. Each node on receiving new data advertise to its neighbors then interested neighbors (one who do not have data) retrieve the data by sending request message[1].
- Here Three types of messages are used,(Fig 4 [1][8]):

ADV message: This allow sensor node to advertise particular Meta data
REQ message: Request specific data.
DATA message: carry actual data.

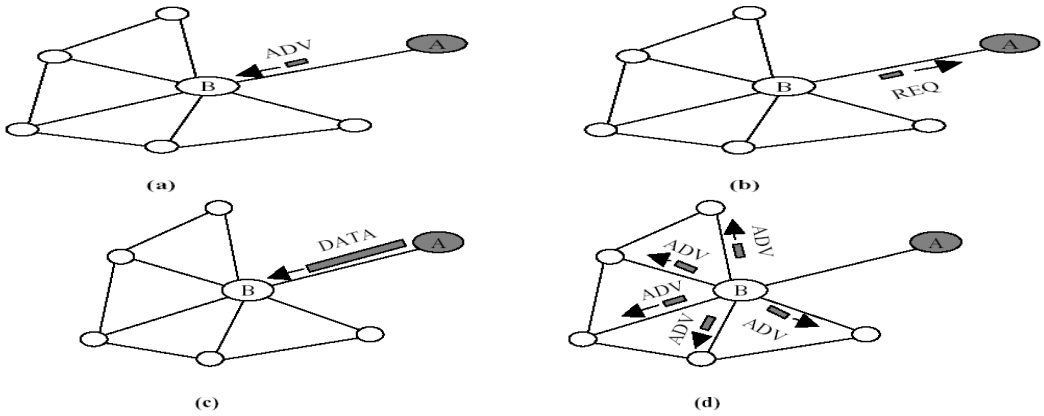

Figure 4 SPIN protocol. (a)Node A starts by advertising its data to node B. (b) Node B responds by sending a request to node A. (c)After receiving the requested data , (d) node B then sends out advertisements to its neighbors , who in turn send requests back to B (e–f).

Advantage of SPIN:

- Node need to know only its single Hop neighbors,
- It overcome resource blindness
- No redundant information passing thus achieving lot of energy efficiency

Problem is that SPIN doesn't guarantee the delivery of data i.e. if the destination node is far away from source node and between nodes are not interested in data then data will not be delivered to destination node.

4.3 Directed Diffusion

- Its key features are named attribute value pairs and path reinforcement.[4][5]
- In this data is transmitted by using naming scheme for data.
- Direct diffusion use the attribute value pairs for the data and on demand basis queries the sensor using those pairs. Query is created using list of attribute value pairs such as name of objects .interval, duration, geographical area etc.
- Figure 5[1][4] summarize the data diffusion protocols, When a node known as a sink node wants Information about a particular attribute, it broadcasts interest messages to its neighbors. These interest messages are flooding through the network and are added to each node's interest cache. Each interest record in this cache has one or more gradients which correspond to neighbor nodes that transmitted the interest. The gradient also stores the rate at which data is desired, the duration of the interest, and a timestamp. When a node generates data that matches an interest in its cache, it sends the data back to the source along the gradients. Intuitively, the data is drawn to the sink through the gradients. The sink node may reinforce the shortest path (i.e., the one with the fastest response) by sending an interest with a higher data rate along that path. Intermediate nodes propagate the reinforcement by examining a local cache of recently sent data messages. The data cache also prevents loops in data delivery. Slower data paths may be sent negative reinforcement, i.e. interest messages with a slow data rate to save network bandwidth. If a sink wants to continue receiving data it must periodically reinforce the path to update the timestamp and duration in the gradients.[6]

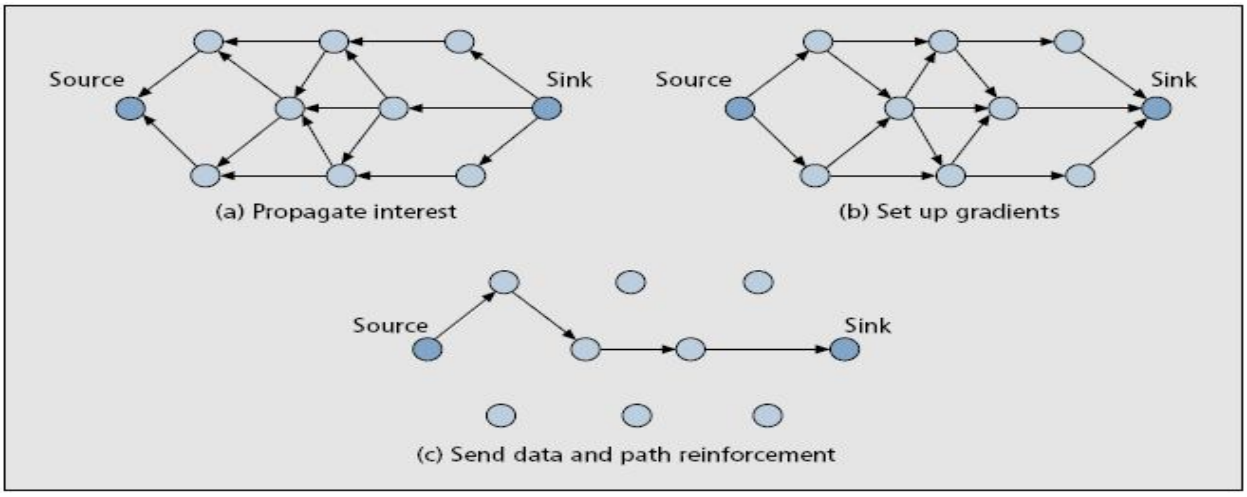

Figure 5 Directed Diffusion protocol phases.

- Directed diffusion differs from SPIN in two aspects.
  - Query method
  - Communication method
- Directed diffusion may not be applied to applications (e.g., environmental monitoring)
- Matching data to queries might require some extra overhead.

4.4 Energy-aware routing

- Shah and Rabaey [12] proposed to use a set of sub-optimal paths to enhance the lifetime of the network. These paths are selected by means of a probability function, which depends on the energy consumption of each path.
- Multiple paths are used with a certain probability so that the whole network lifetime get enhance and energy of nodes don't get depleted.
- There are 3 phases in the protocol:

1) **Setup phase:** Localized flooding occurs to find the routes and create the routing tables. This helps in calculating total energy cost in each node.
2) **Data communication phase**: Each node forwards the packet by randomly choosing a node from its forwarding table using the probabilities.
3) **Route maintenance phase:** Local flooding is performed uncommonly to keep all the paths active.

- The described approach is similar to Directed Diffusion in the way potential paths from data sources to the sink are discovered. In Directed Diffusion, data is sent through multiple paths, one of them being reinforced to send at higher rates. On the other hand, Shah and Rabaey select a Single path haphazardly from the multiple alternatives in order to save energy. Therefore, when compared to Directed Diffusion, it provides an overall improvement of 21.5% energy saving and a 44% increase in network lifetime. This complicate the route setup as compare to direct

4.5 Rumor routing

- It is Agent-based path creation algorithm
- It is another variation of direct diffusion.
- This routing is between query flooding and event flooding.
- It route the query to the node one who has observed the event to occur rather than flooding to entire network as shown in Fig 6[16]
- Rumor routing use long lived packet known as agent, created at random by nodes, and agent will die after visit k hops.
- If number of events is small and then number of queries is large[9]

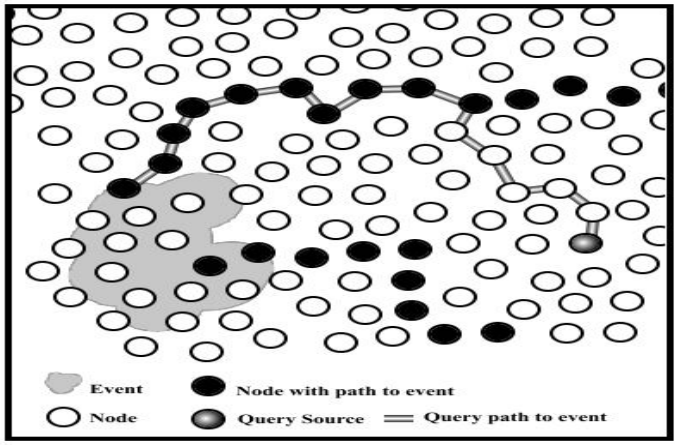

Figure 6. Rumour Routing Network

- Agent travel in the network to inform the distant nodes about local events
- When a node generates a query about event, the node which knows the route respond to the query by referring its event table.
- Advantage:

a) It maintains only one path between source and destination.
b) It provides energy saving over flooding
c) Easily handle node failure.

- Problem: This routing performs magnificently only when numbers of events are small.

4.6 CADR

- Constrained anisotropic diffusion routing (CADR) is a protocol query sensors and route data in a network in order to maximize the information gain, while minimizing the latency and bandwidth. This is achieved by activating only the sensors that are close to a particular event and dynamically adjusting data routes.
- In CADR, each node evaluates an information/cost objective and routes data based on the local information/cost gradient and end-user requirements. The information utility measure is modeled using standard estimation theory.
- CADR diffuses queries by using a set of information criteria to select which sensors to get the data, simulation results confirmed that it is more energy efficient than Directed Diffusion where queries are diffused in an isotropic fashion, reaching nearest neighbors first.[1][11]

4.7 COUGAR

The main idea is to use declarative queries in order to abstract query processing from the network layer functions such as selection of relevant sensors etc. and utilize in-network data Aggregation to save energy. The abstraction is supported through a new query layer between the network and application layers[1][7]

4.8 ACQUIRE

ACtive QUery forwarding In sensoR nEtworks (ACQUIRE) is mechanism for querying sensor nodes. This approach is well-suited for complex queries which consist of several sub queries [1]. The querying mechanism works as follows: the query is forwarded by the sink and each node receiving the query, tries to respond to some extent by using its pre-cached data and forward it to another sensor. If the pre-cached information is not up-to-date, the nodes gather information from its neighbors within a look-ahead of the hops. Once the query is being resolved completely, it is sent back through either the reverse or shortest-path to the sink.[7][13]

5. CONCLUSION

Various data centric routing algorithm and protocols have been proposed in wireless sensor networks. When selecting a WSN routing protocol, some other standards also need to be considered such as complexity, energy usage, quality of service features. Due to specific application based requirements, an all-purpose routing protocol does not exist.

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