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A Bidirectional Data Centric Routing Protocol To Improve The Energy Efficiency In Wireless Sensor Networks

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Abstract

Wireless sensor network (WSN) is made up of spatially distributed autonomous sensors to monitor physical or environmental conditions and cooperatively pass their data through the network to a main location. Wireless sensor network are data centric and depend on battery power. In WSN the main area of concentration is in energy consumption. But in a network, consumption of energy is mainly due to the routing of data. Protocols like CLASSICAL FLOODING, GOSSIPING, SPIN (Sensor Protocol for Information via Negotiation) and DD (Directed Diffusion) try to reduce the consumption drastically. But these undergo a drawback of data redundancy, resource blindness and packet loss. To overcome this disadvantage , we present a novel protocol called BIDIRECTIONAL DATA CENTRIC protocol which uses a meta data descriptor, data aggregation and the data is send in the shortest path based on source and sink interest thereby making it bidirectional . On performing simulation of BIDIRECTIONAL DATA CENTRIC protocol, the graph results prove that BIDIRECTIONAL DATA CENTRIC protocol has higher percentage in disseminating data at a fixed energy level.

Keywords: WSN, routing protocols, SPIN, Directed Diffusion, BIDIRECTIONAL DATA CENTRIC PROTOCOL..

Introduction

Sensor networks[2] consist of a large number of small sensor devices that have the capability to take various measurements of their environment. For instance, such measurements can include acoustic, magnetic, and video information. Each of these devices is equipped with a small processor and wireless communication antenna and is powered by a battery making it very resource constrained. These sensors are typically scattered around a sensing field to collect information about their surroundings.

WSNs can be deployed in unpleasant, inaccessible or hazardous Environments which are impractical with traditional wired networks such as in the bearings of

motors or the inside of whirring motors. In addition to this, the collaborative nature of WSNs brings about flexibility, self-organization, self-configuration, inherent intelligent-processing capability, and enables rapid deployment. In[5] order to meet the requirements of different types of applications, it is important to process the collected information from the surrounding environment and relay them appropriately to the destination. So, these are the vital considerations in any routing protocol.

The wide ranges of applications that can be deployed on top of WSN make it difficult to develop a single routing protocol. [1][7] The design of the routing protocol is strictly dependent on the nature of the application requirements. Current trend of research in this area also focuses on routing algorithms designed for achieving better performance and longer network lifetime. Traditional routing protocols are address-centric. Here packets are routed based on unique IP addresses and data payload remains unchanged during the data delivery process. But this type of addressing scheme is not suitable for WSN, because it is hard to globally identify the sensor nodes in the network. Again due to energy and storage constraints of sensor nodes, redundant data are processed before their transmission. Moreover, local data are aggregated and it is also possible to add new data at different levels of hop. As WSNs are qualitatively different from traditional network, they need a different routing approach for their data to route. Data-centric routing is one of them. Since most WSNs are application specific it is relatively advantageous to concentrate on data content rather that address. In data- centric routing scheme, data are

retrieved through querying. Querying the data is based on some of their attributes values. In this type of routing protocol, advertisement or interest for data is propagated throughout the network. There are two popular approaches in this context. These are SPIN family of negotiation protocol and Directed Diffusion.

In this paper, we introduce BIDIRECTIONAL ROUTING PROTOCOL, protocol to transmit information to sink node when there is a drastic change in the sensed and also when the sink request for particular data using Meta data. In this proposed protocol, total number of packet transmissions is less and use of Meta data memory. Therefore a significant amount of total energy can be saved. BIDIRECTIONAL DATACENTRIC ROUTING protocol is implemented using C++ programming language and evaluated using Network Simulator 2.

The rest of the paper is organized as follows. Section II surveys related works. Section III gives the system models and presents the problem statement. The proposed BIDIRECTIONAL DATACENRIC ROUTING protocol is described in section IV. Performance analysis of BIDIRECTIONAL DATA CENTRIC ROUTING PROTOCOL and comparison with SPIN and Directed Diffusion protocol is discussed in section V. Finally, in section VI we conclude the paper with a direction for future work.

Related Work

WSN routing protocols are classified into three categories: flat routing protocols, hierarchical routing protocols and location based routing protocols. Generally the flat routing protocols are simple, robust and well suited for small and mid-scale networks. It requires less power consumption because there is neither hierarchy nor additional power consumption for managing the clusters. While hierarchical routing protocols are complex and well suited for large scale networks. In location-based routing protocols, sensor nodes are communicated by means of their locations. The distance between neighbouring nodes can be calculated on the basis of incoming signal strengths. This section of the paper concentrates on the comparison of two sensor network routing protocols Directed Diffusion (DD) and SPIN protocols.

Directed Diffusion

Directed Diffusion protocol [3], is a data-centric and application aware paradigm in the sense that all data generated by sensor nodes is named by attribute value pairs. It is a query based protocol, where sink sends queries to the sensors in an on-demand fashion by disseminating an interest. It consists of three stages: interest propagation, gradient setup and data delivery along reinforced path.

Interest Propagation : When sink node wants some information from source nodes it sends out its query to its neighbour sensor nodes. The corresponding query is carried by interest packet. The sensor node receives the interest packet can temporarily store the packet and search for all of the matching target data as shown in figure1 (a).

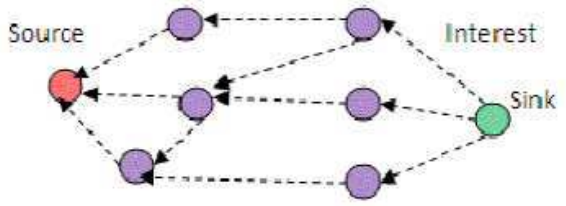


Figure 1(a): interest propagation.

Initial Gradient Setup: Using Gradient in DD, the data propagation direction with minimum cost principle. Propagation of interest packets setup the gradient in the network for delivering data to the sink. Gradient is a reply link to a neighbour node from which the interest was received as shown in figure 1(b).

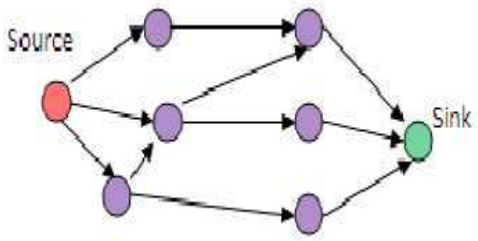


Figure 1(b): Initial Gradient Setup.

Data Delivery

In data propagation phase, source node sends data packets to sink node to the initial setup gradient direction. Sink sends a reinforced packet to the neighbour node which is the first one receiving the target data. The neighbour node which receives the reinforced packet can also reinforce and select the neighbour node which can receive the new data first. Consequently, a path with maximum gradient is formed, so that in future received data packets can transmitted along best reinforced path. Finally the source will send the required data, in selected path as shown in figure 1(c).

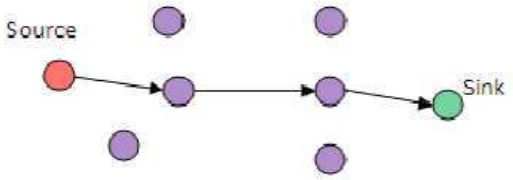


Figure 1(c): Data Delivery.

SPIN (Sensor Protocol For Information via Negotiation)

SPIN[9] is a negotiation-based information dissemination protocol suitable for WSN. It is based on the concept of metadata. Meta-data is a description of data which in database, it can be used to describe table. In SPIN sensors use metadata to concisely and completely describe the data collected SPIN is a data- centric routing protocol. It fits under event driven data delivery model in which the nodes sense data and disseminate the data throughout the network by means of negotiation. SPIN nodes use three types of messages for communication:

- ADV- When a node has new data to share; it can advertise this using ADV message containing Metadata.
- REQ- Node sends an REQ when it needs to receive actual data.
- DATA- DATA message contains actual sensor data.

System Model and Problem Statement.

A. System model

In our research the wireless sensor network consists of various sensor nodes scarcely distributed. The network structure is layer based each node has the capacity to sense multiple types of data. And data are transmitted in the form of Meta data. Here both the base station and nodes have the capacity to transmit data.

B. Problem statement

Disadvantages of SPIN protocol

- The source node on receiving the data sends ADV message to all neighbouring nodes, this results in unwanted computation.
- The node does not reply to ADV message if the sensor node dies out.
- SPIN: selective transmission is not supported in the existing SPIN protocols.
- Data advertisement method of SPIN protocol does not guarantee data delivery.

Disadvantages of DIRECTED DIFFUSION protocol

- Directed Diffusion cannot be applied to all sensor network applications since it is based on a query- driven data delivery model.
- The applications that require continuous data delivery to the sink will not work efficiently with a query- driven on demand data model.
- The naming schemes used in Directed Diffusion are application dependent and each time should be defined a priori.
- The matching process for data and queries might require some extra overhead at the sensors.

Bidirectional data Cenric Routing

The novel protocol conserves energy by becoming active only when changes occur in the network, broad casting data id provides guaranteed data delivery. When there is a need for continuous it sends data without waiting for sink to send its interest. It uses two way hand shake protocol thereby using less energy comparing to the existing protocols. The sink sends interest in the shortest path there by conserving energy.

This protocol is mainly developed to work in the environment where multiple data are used as in gas sensors in coal mines, costal sensors for sensing flood as well as depth monitoring etc., initially all the nodes are in sleep state and becomes active upon sensing the changes in the environment. Then the node sends the interest to all the neighbour nodes. Once the node has received and registered the interest it checks in the task descriptor and compares the corresponding value and aggregates the value and updates the value. Whenever the value reaches the threshold value it sends the data to the base station in the shortest path. If the base station needs for a value in a particular region it sends the interest to all nodes in the region and the data is sent back to the base station.

Algorithm

Step 1: N sensor nodes are uniformly distributed in a target area.

Step 2: Initially all nodes are in inactive mode in order to conserve energy.

Step 3: nodes wake up from inactive mode to active mode upon sensing changes in the Environment.

Step 4: each data sensed by a node has a unique data kind id, node id, value and broad cast it to the neighbor node.

Step 5: upon receiving the interest from the neighbor node it checks for the data kind id and compares the value. If value > current value & value > threshold value, sends data packet to base station in the shortest path. & go to step 9.

Step 6: Else if value> current value & value < threshold, updates the current value

Step 7: Else discard the value.

End if.

Step 8: if base station request for data, send all data kind id and current value of the node. in the shortest path.

Step 9: Check whether the data has reached the base station, If yes broad cast the data id to all the nodes.(in order to avoid redundancy) Else go to step 4

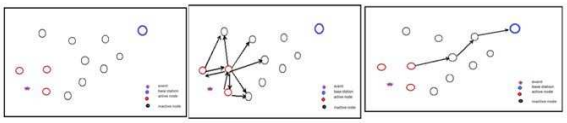


Figure 2: Network initiated by the event of BIDIRECTIONAL DATA CENTRIC routing protocol (a): Network activation. (b): Interest propagation(c): data propagation after aggregation.

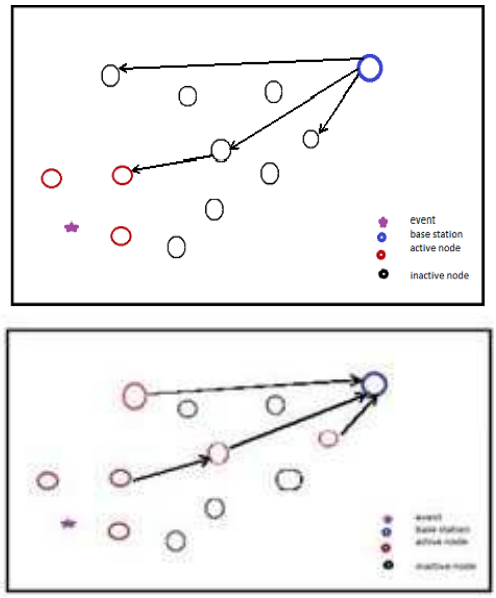
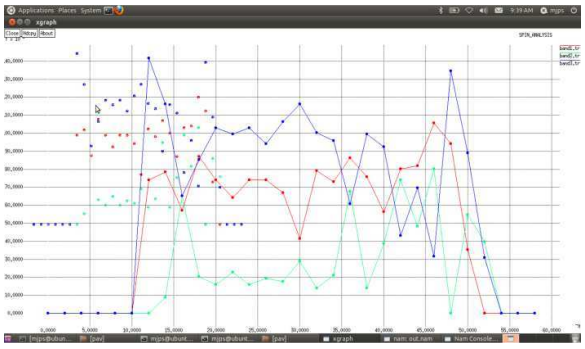


Figure 3: base station initiationof the network by BIDIRECTIONAL DATA CENTRIC ROUTING PROTOCOL (a):base station propagates interest (b): data propagation after reciving interst and making nodes active.

Key advantages:

•Data redundancy is eradicated.
•Overcomes resource blindness.

Performance Analysis



The main experiment is actually measure the energy of the network. When a node receives and transmit a data packet, the total energy will decrease gradually.

The first node dies in 120 and 150 iteration for SPIN and DD respectively whereas the node dies only after 230 iterations in BIDIRECTIONAL data centric routing protocol.and the banwidth consumption is 3 times lesser than the DD and 2.5 times lesser than the SPIN protocol. The bandwidth and the life time of nodes increases compared to the protocols DD and SPIN

Conclusion.

In this paper, we have proposed a BIDIRECTIONAL DATACENTRIC routing protocol using Meta data descriptor for WSN. Here the data is sent whenever there is a drastic change in the data sensed or only when the base station request for data. We have compared its performance with existing SPIN and Directed Diffusion protocol. But one major problem is that security of messages.

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