Network Reliable Routing Protocol for Event-Driven Wireless Sensor Network

Anchal Rana
M.Tech. (C.S.E.),
Uttarakhand Technical University
Dehradun, India

Anshika Garg
Asstt. Professor, Deptt. of C.S.E
Dehradun Institute of Technology,
Dehradun, India

Sandeep K. Chaurasiya
Asstt. Professor, Deptt. of C.S.E
Dehradun Institute of Technology,
Dehradun, India

ABSTRACT
Wireless Sensor Networks is a collection of various densely deployed sensor nodes which is implemented in a variety of applications such as Home, Medical, Military, Security Surveillance and Combat Field Reconnaissance etc. An event-driven wireless sensor networks (EWSNs) is a type of wireless sensor network in which the desired information is disseminated to the sink more reliably. Another important function of EWSN is the accurate event detection so that the probability of false alarm becomes low. Likewise WSN, sensor nodes in EWSNs are also energy constrained thereby designing energy-efficient algorithm becomes an important factor for extending the life span of the event-driven wireless sensor network. In EWSNs, clustering is used for efficient use of constrained resources for energy saving. This paper provides a novel Network Reliable Routing Protocol for EWSNs. This protocol provides better data aggregation by using clustering at initial and reliable data dissemination by using multipath routing method which makes the network fault tolerant. Network Reliable Routing Protocol setup a routing path from source to sink. It also minimizes unnecessary activation of nodes during data dissemination process. Performance results show that Network Reliable Routing Protocol handles more events than already exists ESDC and also achieves the energy efficiency objective.

Keywords: Wireless sensor networks, Clustering, Cluster head (CH), Event-Driven wireless sensor networks and Multipath routing.

1. INTRODUCTION
An Event-Driven Wireless Sensor Network is a special type of wireless sensor network [1], in which nodes are densely deployed in a particular terrain to sense the occurrence of events known as point of interest (PoIs). The main function of EWSNs is to accurate detection of the PoI and transmits the appropriate sensed data to the sink or base station reliably. In EWSNs, the sensed data is typically generated and transmitted to the sink only when an event is occur or a particular PoI is detected [2][3]. When an event is detected in a particular terrain the aggregated data or information sensed by the nodes is delivered to the sink. So that clustering mechanism enable the sensor nodes to collect and aggregate data at the node known as cluster head (CH), which avoid the redundancy of data in EWSNs. Most of the functionalities done by cluster head, so clustering removes some overheads such as energy consumption, collision avoidance, packet generation, redundancy of data etc. Hence clustering increase the lifespan of a network and also increase the scalability of EWSNs.

The main challenges in formation of energy-efficient clusters are the design criteria to select the cluster-heads, maintenance of them and integration of clustering approach with other mechanism in the network such as coverage, data correlation and routing. In event driven wireless network accurate event detection and reliable data transportation to the end-user is very important, so that now days many of the researchers focus their attention on event detection and reliable data dissemination algorithms [4][5]. Some of these studies offer pre-event clustering and routing solutions, while others present coverage aware, energy-efficient clustering mechanisms[6]-[10].Now a days many of the solution exists for the energy efficient clustering Some of these are pre-event clustering [6][7][8] while others provides coverage efficiency[4][9][10].. The main common drawback of these algorithms is that they build clusters before the occurrence of an event in the field or follow the pre-event clustering approach and form clusters in the entire field [4]. So that they have lots of overhead in terms of processing. The event-driven clustering (EDC) protocols exploit only the energy model of the sensors and select the cluster-heads according to the maximum residual energy [12]. Another energy-efficient clustering algorithm that provides reliable data deliver is ESDC. 'Alper Berketli and Ozgur B. Akan', presents Event-to-Sink Directed Clustering approach which is used to continuously form the cluster in the direction of sink. However, this scheme achieves the energy efficient clustering in WSN, but unnecessarily activates the neighbor nodes. Network Reliable Routing Protocol provides a reliable path from, source to sink.

This paper introduce a Network Reliable Routing Protocol for EWSNs that provide energy efficient clustering by making the cluster only when an event is trigger and transmitted the data to the sink by using efficient multipath routing method. The rest of the paper is catalogued as follows: Section II provides the proposed work including its model. Section III provides the performance analysis and finally, section IV concludes this paper, and section V present the Future Work.

2. PROPOSED SCHEME
[4] Despite the infinite scopes of event-driven wireless sensor networks, they are limited by the node battery lifetime. Once they are deployed, the network can keep operating while the battery power is limited. This is critical point to be considered as it is almost impossible to replace the node battery once deployed over an inaccessible area. Such constraints combined with a typical deployment of large number of sensor nodes, have posed many challenges to the design and management of sensor networks and necessitate energy-awareness at all layers of networking protocol stack. This means that in all aspects, the algorithm must be designed to be

extremely energy-efficient, accurately detect event and deliver data reliably while improving the quality-of-service. This section provides the working model of the Network Reliable Routing Protocol for Event-Driven Wireless Sensor Networks followed by the description. Network Reliable Routing Protocol provides reliable data delivery from event area to the sink. This protocol also prolongs the network life span by employing efficient clustering method. In this protocol the cluster-head is selected only for the aggregation of data after that the concept of relay node is used for the transmission of required information which makes the system fault tolerant.

2.1 Network Reliable Routing Protocol Model

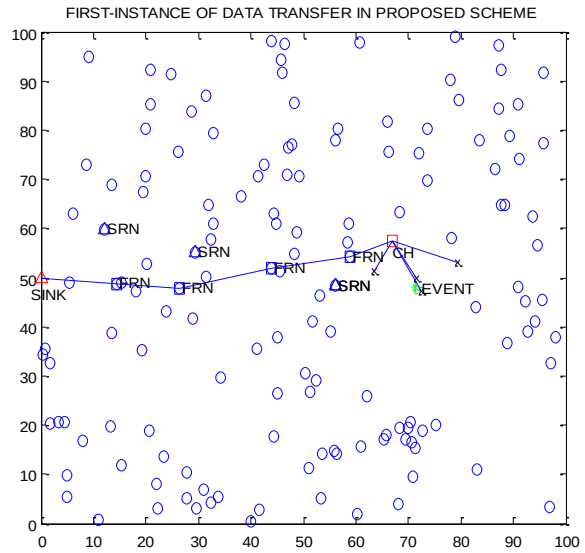

Fig 1: Data Dissemination from source to sink

Like ESDC algorithm [4], Network Reliable Routing Protocol made the clusters when and where required or when an event is trigger. The detailed description of the Network Reliable Routing Protocol is as follows:

At the start of n/w operation, nodes communicate with the base station and get their respective location. At the initialization phase, every node exchanges a beacon message. With every other node within its communication range (Rc) to discover its neighbors. The beacon message contains the following tuple such as:

- Residual energy of node. (Ei)
- Coordinates of the node (xi, yi),
- Communication/Transmission Range (Rci)
- Sensing Range (Rsi)
- Flag that indicate event occurrence (D ε 0,1)
- Weight of the node (wi)

When an event is triggered, nodes sense the event broadcast the following message in their transmission or communication range:

$$< Ei, (xi, yi), Rci, Rsi, D = 1 >$$

Nodes those receive such message's computes its weight to being a cluster head:

$$wi = c1/dsink + c2/dievent + c3ninf + c4Ei$$

Here, $dsink$ is the distance from the sink or base station, $dievent$ is the distance from the event location, $ninf$ is the no. of information received by the node, and $Ei$is the residual energy of the particular node.The node which has the highest value of weight (wi) become the cluster head. c1, c2, c3, c4 are constants. To calculate the distance from the event area, nodes that receive the message sent by the sensor nodes that sense the event calculate the Event location through the coordinates of the nodes that detect the event. Now cluster head aggregate the information received by the sensing nodes.

For reliable data delivery, Network Reliable Routing Protocol follows the multipath routing method so that every node will provision two Relay nodes FRN and SRN. Initially cluster head node is treated as a first node FN=CH. This protocol also follows the concept of acknowledgement for making routing fault tolerance.

If a FN has FRN (First Relay Node) and SRN (Second Relay Node) it'll ask both of its Relay nodes whether they can forward the data. If its Relay nodes, acknowledged with 'yes', FN will prefer FRN and forward its data packet to FRN.(if FRN is not available, packet will forward to SRN). The header of the data packet carries the following information:

1. Location of the previous node.
2. Transmission Range of the previous node.

Otherwise if FN has neither FRN nor SRN, FN will initiate a search and choose its FRN and SRN and will do accordingly. The value of FRN and SRN is calculated by the following formula:

$$FRN(i) = Ere(i) + \frac{1}{d(i, sink)} * cos\alpha i$$

$$FRN(j) = Ere(j) + \frac{1}{d(j, sink)} * cos\alpha j$$

This process is continuing until the desired information is transmitted to the sink.

3. PERFORMANCE EVALUATION

The main drawback of the energy efficient clustering algorithms [6]-[12] is that they design the clusters the occurrence of the events in the network that is they follows the pre-event clustering formation approach. This process increases the energy consumption and overhead in terms of processing. An example of such types of algorithm is HEED [11], LEACH [13] etc. Even though, the ESDC approach build the clusters when and where required. In our analysis, we evaluate and compare the performance of the Network Reliable Routing Protocol with the ESDC algorithm in terms of average energy consumption per node and total network energy consumption. Therefore, handling of number of events in Network Reliable Routing Protocol is more than the ESDC algorithm.

The performance of Network Reliable Routing Protocol is evaluated by using the Mat lab 12, with the parameters defined in TABLE 1.

Table 1: Simulation Parameters

Parameters	Values
No. of Nodes	100
Field	$100 \times 100\ m2$
Transmit Power	100Mw
Sensing Range	10m
Initial Node Energy	1J
Beacon Message Length	44 Bytes

3.1 Average Energy Consumption

The energy gain of Proposed Scheme (Network Reliable Routing Protocol) compared to ESDC clustering is shown in Figure no.2. Here, ESDC consume higher energy than Proposed Scheme. This is mainly because Network Reliable Routing Protocol does not unnecessarily active the node in the entire network, it forms clusters only within the event region and further follows the two relay nodes concept. Note also that the energy saving achieved by ESDC further increases with the number of reporting nodes. Approx. 673 events have been reported to the sink via ESDC Scheme, whereas approx.2685 events have been reported to the sink via Proposed Scheme.

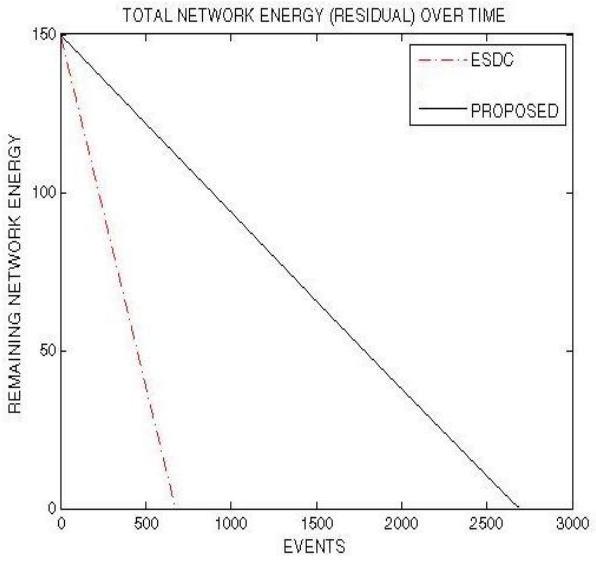

Fig 2: Total Energy Consumption of Network

3.2 Per Node Energy Consumption

Figure no. 3 shows that per node energy consumption after the occurrence of a particular event in proposed scheme is less than the ESDC scheme.

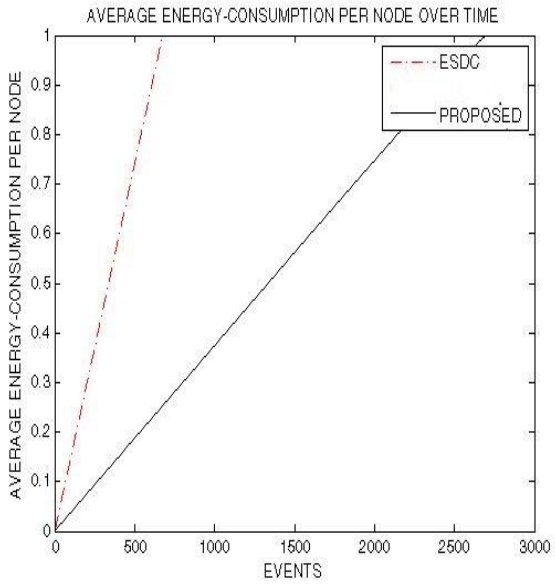

Fig 3: Per Node Energy Consumption

4. CONCLUSION

The Network Reliable Routing protocol achieves energy-efficient clustering and reliable data forwarding in EWSN. Unlike the existing Event- to- Sink Directed clustering protocol solutions in the literature, Network Reliable Routing Protocol of EWSN requires to form cluster only at the initial step for data aggregation purpose and maintain two relay nodes for data forwarding, in the direction of data flow from event location to the sink. Performance results show that the Network Reliable Routing Protocol has the following advantages:

- As per quantitative result, Network Reliable Routing Protocol for EWSN proves to be better performance than ESDC.
- In Network Reliable Routing Protocol occurrence of no. of events are more than as compared to the ESDC.
- Energy consumption is less in Network Reliable Routing Protocol as compared to the ESDC.

5. FUTURE WORK

In near future further gain can be achieved in terms of network life time. Accurate data detection can be implemented for improving the Network Reliable Routing Protocol.

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