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An Effective Model of the Neighbor Discovery and Energy Efficient Routing Method for Wireless Sensor Networks

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Abstract

The Wireless Sensor Networks (WSN) is one of most active research area over last decades. Due to the limited battery power and computation capacity of sensor nodes, it needs an effective routing protocol for WSN to increase the network lifetime. Basically, sensor nodes can be collected the application data and transmitted to the neighbor's node effectively. The Location Based Energy Aware Routing Protocol (LBER) is proposed in this paper. In LBER, a node select their neighbor node (Neighbor Discovery) using a beacon message and properly maintain the path for data transmission even a node failure. Furthermore, LBER consume a small amount of energy during node discovery, network activities and data transmission. In case of node failure, LBER protocol easy to handle the node breakdown problem. In the proposed work, LBER is compared with GPSR and LSR protocol, simulation results shows that LBER outperforms GPSR and LSR, which reduce the energy consumption, increase network lifetime and provide QOS of wsn.

Keywords: Energy Balance, Network Lifetime, Node Discovery, Routing Protocol, Self Organized, Wireless Sensor Network

1. Introduction

The Wireless Sensor Networks is a highly distributed wireless networks with tiny and light weight wireless nodes, which is deployed in large numbers for monitoring the application area or environment, system and industrial control[1]. The basic concept of WSN in each sensor node has limited battery power, communication capability, which is sufficient for the target application field[2]. In some applications of WSN, the sensor nodes are performed as an adhoc method[1]. After deployment of nodes in the application field they must be able to independently organize themselves into a wireless communication network. The sensor nodes are powered by small battery and also expected the network lifetime to long with minimum optimization of energy consumption[3,4]. In most of the critical applications, nodes are not able to replace or recharge the batteries of sensor nodes[6]. Hence, when we use effective routing protocol can increase the network lifetime by consuming a small amount of energy during data transmission.

Basically, the sensor nodes have been distributed in various applications to monitoring the target field such as military, remote region, disaster area[1-5], etc. In WSN, the nodes have a limited transmission range at the same time their computation, storage capacity and energy resources are so limited. Hence effective protocols in WSN are responsible for finds and maintain the routes inside the communication networks[8]. The protocol ensure for reliable transmission even in multi-hop

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count communication. Even a node is an idle mode, it may consume the energy, because, when a node is idle, (not receiving/transmitting) it listen and wait for data from their adjacent nodes[15,4]. This is one of the major reasons for energy wastage in WSN. Also, due to packet collision, packets are involved in collision and it must be retransmitted[16]. This is one of another reason for energy loss. Our goal is improve the lifetime of sensor networks, which is done by various routing mechanisms. For example, suitable (energy efficient) protocol minimize the energy consumption during network activities. Although, some amount of energy is consumed by sensor nodes even if nodes are idle. So power management methods are needed to switch off the nodes when nodes are not needed temporarily. In this paper, we propose a LBER (Location Based-Energy Aware Routing) Protocol for solve the above problems.

2. Related works

2.1 Greedy Perimeter Stateless Routing Protocol (GPSR)

Finding path is one of the challenging problems in wireless network[14], because these networks consist of numerous mobile nodes. Hence heavy traffic may be available from source to destination. Every data wants send through a series of intermediate forwarding nodes. The shortest path is one of another challenge problem, due to lack of energy in sensor nodes. Hence, this type of network needs an effective routing algorithm. GPSR protocol is one of the effective routing protocols for wireless networks[17]. It uses greedy forwarding technique to forward packets to stations that are progressively closer to the destination. It allows the building of networks and distributes the load on the network. The GPSR uses the Relative Neighborhood Graph (RNG) technique to find their immediate neighbors. After finding their neighbors, every node constructing the graph to find shortest path in which beaconing mechanism is necessary to find their neighbors. The beaconing mechanism sends the HELLO packets to discover the neighbors[15].

2.2 Link State Routing Protocol (LSR)

LSR is one of the famous protocols for WSN, which is performed by every forwarding node in the network. Here, every node constructs a routing map of the connectivity to the network. The routing map shows that, their neighbor nodes to find the shortest path to forward the packet. The LSR protocol uses the "Hello" message to find its neighbors[15]. A node (sender) can choose the Multipoint Relays (MPR) based on the one hop node that select the best routes to forward packet. Every two adjacent neighbors will exchange hello packets, which is serves as a keep alive function. In LSR protocol, each router builds its own Link State Packet (LSP)[18]. It consists of information such as neighbor ID, link type and bandwidth. After LSP created, they are forwarded out to neighbors after receiving. After received LSP the neighbor continues forward it via routing area. Also, routers use a database to construct a topology map of the network. The LSR protocol determines the shortest path by adding the cost and finding the lower cost. After determined the shortest path routes, these routes are enter into the routing table.

3. Network Model

In our work, consider the following properties of the network model:

- N sensor nodes are distributed randomly in the application field and one sink node deployed far away from the application area.
- Sensor nodes are static and energy constrained. After deployed, nodes will be operating till their energy is exhausted.
- All sensor nodes has their Unique Identifier (UID)
- Nodes are location aware. Every node is able to get their neighbor location using beacon message.
- Each node can exchange their energy level with sink node directly.
- Source nodes send IP address of the destination node to the neighbor node.

4. Location Based-energy Aware Routing Protocol (LBER)

After detailed analysis of various energy management techniques of WSN, we propose a novel energy efficient routing protocol known as Location Based Energy Aware Routing Protocol (LBER). The main goal of LBER are, all the sensor nodes wants find their neighbors nodes easily (Route Discovery) and properly maintained the route during the communication and reduce the power consumptions.

The operation of LBER is divided into following three phases.

- Route Discovery
- Route Maintained
- Energy Model

4.1 Route Discovery

The first step of the operation is neighbor discovery. Every nodes wants identifying their neighbors before data transmission. The neighbor of a node *A* is defined as one node is within the communication range of *A*. Hence, before the communication between any two nodes they wants establish a path. The source node starts are route discovery process by broadcasting HELLO packet, that means send RREQ (Route REQuest) message, which contains IP address of the destination node. After receives this RREQ request by intermediate node, it updates their routing tables with forward route and reverse route. Suppose a route to the destination node is not known, the intermediate nodes send the RREQ request back. After finds the new path to destination node the intermediate nodes generate the RREP (Route REPlay) message[15]. Now this message forwards to source node. After receives the RREP message by source node, it records the path to the destination node and send the packets to the destination node using the same path. If the RREP message is received by source node from more than one intermediate nodes, source node calculate the hop count and choose the lowest hop count as a new route for data transmission.

Figure 1. Architectural Model for LBER Protocol.

4.2 Route Maintenance

Due to node failure, a link (path) can get failure so intermediate nodes sends a RERR (Route ERRor) messages to source node. Every forward nodes detects any broken paths and send the RERR message to source node. Now, the source node generates a RREQ message and starts the path discovering process once again. If the path, not known packet may drop.

4.3 Energy Model

The link may happen when the intermediate nodes loss their energy. Due to this problem packet may drop. Hence, the source node generates a threshold (T) value for every intermediate nodes. The source nodes are monitoring the energy level of intermediate nodes. When the energy level get low than threshold value the source node choose the alternative path for communication.

5. Test and Analysis of the Result

In this section, we compare the performance of LBER protocol with GPSR and LSR protocols. This proposed work is performed using NS2. The sensor nodes are randomly and uniformly deployed in a given application area. The sensor nodes in the application areas, range from 10 to 100.

5.1 Number of Nodes with Total Energy

In this experiment, we used 100 nodes in the application area. Figure 2 shows that, the comparison between proposed LBER protocol with GPSR protocol.

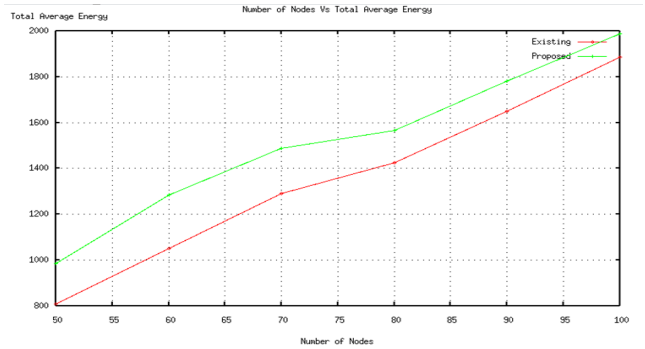

Figure 2. Number of nodes with Total energy.

We can find that LBER performs better than GPSR protocol. The GPSR protocol consumes more energy when nodes are increasing in the network. For LBER, each node finds their nearest neighbor with minimum energy and chose the shortest path for data transmission. So it saves more energy and leads to increase the network lifetime.

5.2 Number of Nodes with Packet Dropped

Here, we use 5 to 25 nodes in the field. Figure 3 shows that, the LBER protocol reduce the packet drop rate than GPSR protocol.

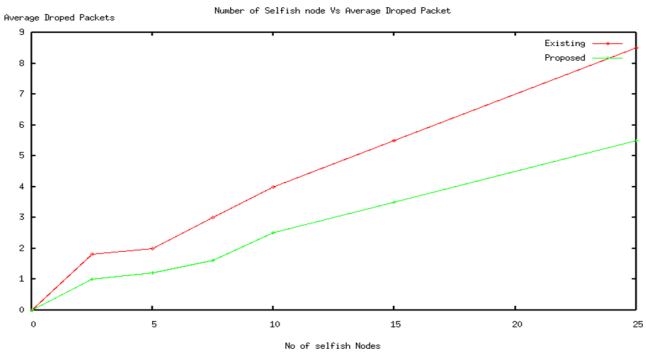

Figure 3. Number of nodes with Packet Dropped.

One reason for packet drop is path failure. The path failure may happen due to energy loss in nodes. But LBER protocol chose another shortest path before node get failure. For this reason LBER reduce packet drop rate.

5.3 Number of Attackers with Overhead

Figure 4 shows that, when we compare LBER protocol with LSR protocol, it reduces communication overhead while transferring the data between any two nodes.

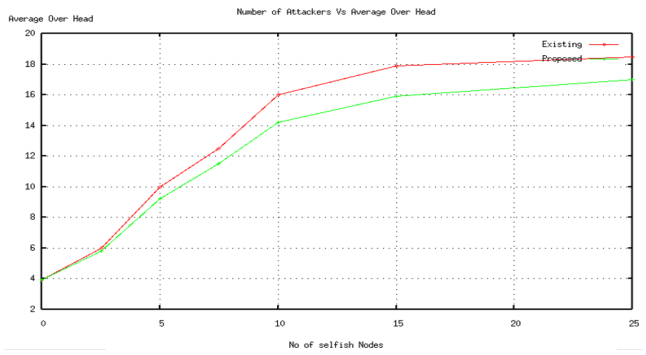

Figure 4. Number of attackers with overhead.

5.4 Simulation Time with Throughput

In this experiment, we use 10 to 25 nodes in the application field. Figure 5 shows that, when we increase the nodes in the network, packet delivery ratio also increases. LBER protocol reduces the communication overhead so that data will transfer between any two nodes without any interference. For this reason LBER protocol increases the throughput.

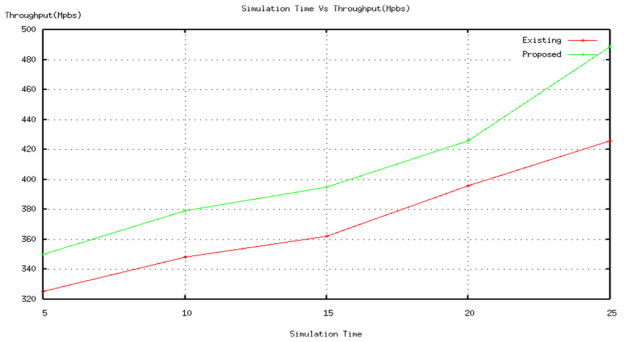

Figure 5. simulation time with throughput.

6. Conclusion

In this work, we introduce LBER protocol. This protocol has designed for easy to discover the neighbors (Node discovery) and increase network lifetime (Energy saving).

The simulation result shows that, LBER protocol outperforms GPSR and LSR protocol. Because LBER is a self organized protocol, it easy to discover the neighbors (Route Discovery), route maintenance works properly. Furthermore, it increases the packet throughput and reduces communication overhead. The main aim of this protocol is saving the energy during communication. LBER consumes a small amount of energy during node discovery and data transmission. In case of node failures, LBER protocol easy to handle the node breakdown problem and chose alternate shortest path compared with GPSR and LSR.

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