International Journal of Education and Science Research
REVIEW
E-ISSN 2348-6457
Volume-3, Issue-2
April- 2016
www.ijesrr.org
Email- editor@ijesrr.org

MULTI-INTERFACE MULTI-CHANNEL ROUTING PROTOCOL WITH 2-LEVEL AGGREGATION FOR WIRELESS SENSOR NETWORKS

Garima Garg
Quantum School of Technology
Roorkee

Ritul Kumar, Sumit Kumar
Department of CSE/IT
Quantum School of Technology
Roorkee

ABSTRACT

Routing is a very serious problem in wireless sensor networks (WSN). Any routing protocol that is designed for WSN must provide reliability, energy-efficiency and should increase network lifetime. Here we proposed a two level data aggregation method in the presence of a Multi-interface Multi-Channel Routing Protocol (MMCR). Since the sensor nodes are always equipped with the radios which can operate on multiple non-interfering channels, where bandwidth availability on every channel, is used to find the appropriate channel for transmitting the data. The proposed protocol has used maximum energy of node as criteria for the routing that ensures reliability. The proposed protocol compared with popular hierarchical protocol, LEACH. All the simulation results shows that the proposed method outperforms over the existing approaches in terms of the evaluation metrics such as average energy consumption, packet delivery ratio, end-to-end delay and throughput.

1. INTRODUCTION

WSNs are specific sort of an ad hoc network system, in which the nodes are 'smart sensors'[2]. They are spatially circulated autonomous sensors that sense physical & environmental conditions, for e.g., temperature, weight, sound, etc., in present world systems are usually bi-directional, additionally empowering the control of the sensor action. The improvement of remote sensor systems was persuaded by the military applications, for e.g., front-line observation; today these systems are also utilized as the part of numerous mechanical and consumer applications[3], for e.g., checking of modern procedure and control, monitoring of machine etc.

Since sensor nodes may produce huge excess information, it is required to aggregate data packets from various nodes so that the quantity of transmissions is diminished. Information collection is used to bring together number of information from various sources with the help of aggregation functions, e.g., copy concealment, maxima, minima and normal. This system has been utilized to accomplish energy productivity [8]. Signal preparing techniques can be used for information conglomeration. For this situation, it is alluded to as information combination where a node is fit for delivering a more exact yield signal by utilizing few procedures, for example, shaft framing to join approaching flags and diminishing the noise in these signal.

The objective of remote sensor systems is to assemble data with high reliability quality and low energy[7]. Considering the extreme energy imperatives of sensor nodes, information accumulation and energy effective routing are fundamental for enhancing the energy productivity while keeping up packet conveyance proportion. Regularly, sensor nodes have radios that can deal with numerous non-covering channels. This requires the utilization of a multichannel routing protocol that would adjust the heap equitably on various channels utilizing a metric characterized by throughput, end-to-end delay and the energy usage [9]. We examine a proactive routing protocol called the Multi-interface Multi-channel Routing (MMCR) protocol that utilizations Multi-Point Relay (MPR)nodes[1] to forward information through the system, in this way lessening the measure of correspondence overhead.

2. MULTI-INTERFACE MULTI-CHANNEL ROUTING PROTOCOLS (MMCR)

A multi-interface multi-channel routing protocol (MMCR)[6] has been proposed in 2009. It chooses courses that upgrade data transfer ability while expanding energy effectiveness and minimizing the end-to-end delay. This is a proactive routing protocol that works autonomously on a specific plan for collector based channel task. The protocol uses the idea of Multi-Point Relays (MPRs). Subsequently, the routing intricacy decreases for the same system size when contrasted and other proactive routing protocols [5].

All in all, MMCR routing plan includes three occasional stages:

- choice of MPRs for every node
- choice of courses
- information exchange through the chose MPRs

Straightforward nearby show of HELLO messages is performed to find one and two-hop neighbors and their comparing costs. At that point the MPR nodes are chosen. This is trailed by course choice all inclusive for the entire system topology. At last, the information is sent through the chose ways. There are five sorts of control packets in MMCR

3. PROPOSED METHODOLOGY

Data aggregation is the method to aggregate the various nodes information so that quality of transmission is diminished. This method has been utilized to accomplish energy productivity and information move streamlining in various routing protocols.

In our proposed method we have performed two level of data aggregation which can be placed on the different sensor nodes. It begins from source node and continues till the packet reaches to destination. Here we are using two levels of aggregation, in which the first level are called as local aggregation. In our scheme data is generated by any particular node from the sensor readings which are then put inside a packet. Here nodes can decide to put two or more of the sensor data in a single packet; as a result there is reduction in the number of packets of data as all the information contained by different data packets is compressed into one data packet. This is the local aggregation or can be called as level-1 data aggregation method. This is a large-scale strategy of the data aggregation. Thus all the nodes of similar type will perform the same aggregation all over the network.

The level-2 data aggregation occurs with data packets of the locally aggregated data at each node in the direction of the BS. It means it happens at the intermediate node from the source node to BS.

4. THE ALGORITHM

Here we describe the proposed adaptive algorithm for two level data aggregation. The Level-1 data aggregation is always performed locally immediately after sensing a sensor data. However, the level-2 data aggregation is carried on the sensor data that come from the various nodes. Following is the algorithm for the level-1 and the level-2 data aggregation.

Level-1 Aggregation Algorithm

```
Step 1: Sensed data is required
{
 Step 2: If level-1 aggregation
        Then
 Step 3:   If event of interest
         Then
 Step 4:   packet is generated;

 Step 5:  and transmit the packet to the next hop
         Else
 Step 6: Store all the sensed data and perform
        Aggregation with all next readings
 Step 7:  End if
     Else
Step 8:  a packet is generated
     End if
 Step 9: transmit to next hop
} //end level-1
===================================
Level-2 Aggregation
Step 1: Packet must reach to next hop
{
Step 2: Store packet in the buffer
Step 3: If (packet priority = critical/important)
      then
Step 4: transmit packet to the next hop (no   aggregation)
     Else
 Step 5: Wait for T sec
 Step 6: If time reached
     then
 Step 7: Apply aggregation
 Step 8: forward aggregated packet to the next hop
    End if
    End if
Step 9: Repeat aggregation in the next hops till the packet reaches sink

} //end level-2
```

Firstly we consider the level-1 data aggregation. The sensor node is used to sense the data from the environment at frequent intervals of time. After reading the data, it examines for need of local aggregation (level-1) by the node. If the local aggregation is feasible, it stores sensor data and waits for the next readings of sensor before generating a packet. At the time of an event of interest, the packet is being generated instead of waiting for the local aggregation and is forwarded to the next node towards the next hop. Otherwise, it generates packet and transmits it to next hop. This is referred as level-1 aggregation.

In level-2 data aggregation, the node performs the collection of the packets in buffer. It examines for the priority of packets and appends it in the buffer as per the priority. If the packet is either critical or important, it is forwarded to the next hop towards the sink without doing any aggregation. In other words those packets are not being aggregated at all. In the time based mechanism, the system will wait for specific time period to insert packets into buffer. Then the node aggregates the packets from the head of the queue. It then forward the aggregated packet to the next hop and continue data aggregation till it reaches to sink, that will reduce the number of packets being transmitted in the network..

5. SIMULATION & RESULT

The simulations are carried out on the NS-2.35. The simulation parameter of the proposed studied is given below.

- Terrain dimensions: 2000 m x 2000 m
- Simulation time: 50 sec
- Number of nodes: 50, 100, 150 and 200
- Mobility model: Random Way Point
- Underlying MAC protocol: IEEE 802.11.
- Channel: Channel/Wireless Channel
- Propagation: Propagation/Two Ray Ground
- Network type: Phy/WirelessPhy
- Queue: Queue/ Drop Tail/Pri Queue
- Antenna: Antenna/Omni Antenna
- Topography 2000; # X dimension of the topography 2000; # Y dimension of the topography
- Queue length 500; # max packet in ifq

In the proposed work we used the traffic types CBR are:

- CBR 10 1 10000 512 1S
- CBR 5 1 10000 512 2S
- CBR 15 1 10000 512 1S

The routing protocols [4] in the WSNs have some more extra features over the ad hoc routing protocols. These features are relating to the source constraint in sensor networks and because of some requirement like as data aggregation and maximizing the lifetime of the networks. For that reason, according to the different aspect in our proposed protocol, we have evaluated our method in different classifications. The proposed protocol performance is compared with the LEACH protocol[10].

The following evaluation metrics were used to make complete our dissertation, all QoS parameter with brief information are given here.

- Throughput
- Average Energy Consumption
- Packet delivery ratio
- Average End to End Delay

5.1 Analysis

Here we consider initial four hops, namely 35, 32, 43 and 24. Nodes 35 sense the data and search the nearest hop having maximum energy after that select the 49 node as next hop for the transmission of data for performing two level data aggregation.

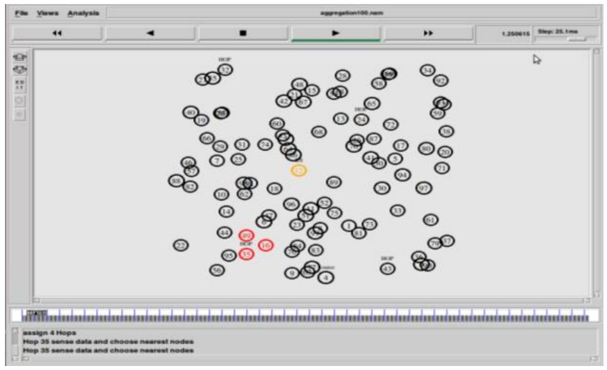

Figure 5.1 Initial phase of simulation with 100 nodes.

Nodes 49 sense the data and search the nearest hop having maximum energy and blue circle showing the bandwidth range for the transmission coverage.

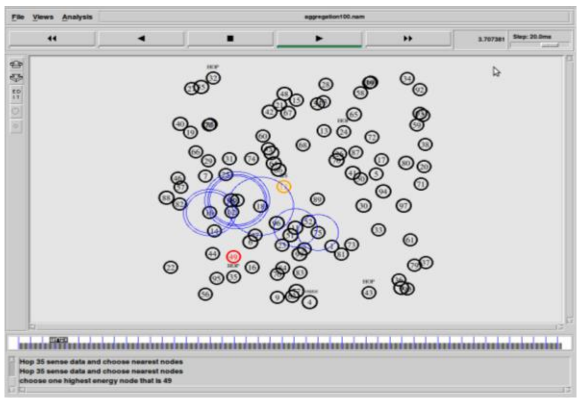

Figure 5.2 Sensing second hop in the simulation with 100 nodes.

Now Node 49 update its routing table with node 44, 14, 6, and 17 having maximum energy for transmission of data while performing 2-level aggregation.

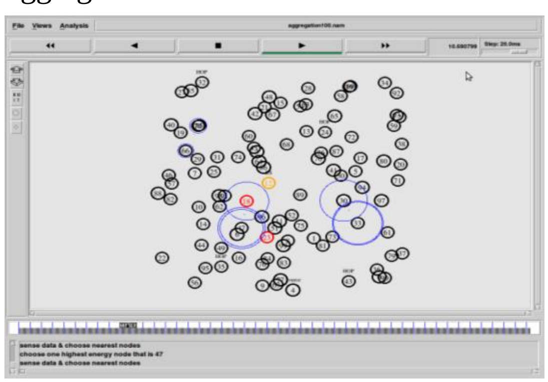

Figure 5.3 Snapshot showing selected hop for routing table.

Here Nodes 17 chooses the nearest node 23, 18 and compares the maximum energy between these two nodes.

Figure 5.4 Snapshot of showing neighbour node of node 17.

Node 18 has been chosen as the highest energy node. All the nodes perform 2-level aggregations so that data can be transferred to the sink also called as BS.

Figure 5.5 Snapshot of 2-level aggregation.

This process is followed by other hops till the simulation ends.

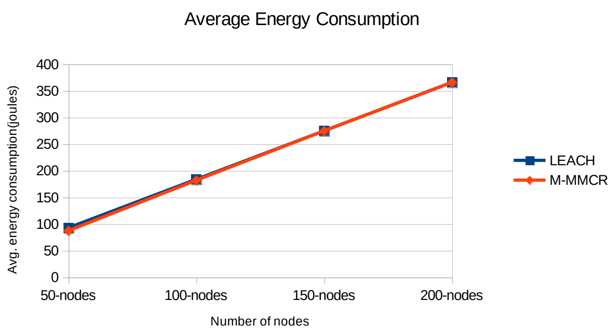

Figure 5.6 Shows all four hops are active to sense the data.

5.7 Average end to end delay

The end-to-end-delay is averaged over all existing data packets from sources to the destinations.

In this scenario, nodes are placed in a flat grid topology of size 2000m x 2000m. The number of nodes is varied as 50, 100, 150, and 200 with the value of average end to end delay from 0 to 0.9. Delay of proposed method M-MMCR protocol performs better up to 100 nodes and after that it increases up to the 0.85 as compared to LEACH protocol. At node 150 and 200 LEACH protocol perform better up to the 0.67. LEACH protocols have the entire node in the cluster form that's why it showing low performance till node 100 with the comparison of proposed method.

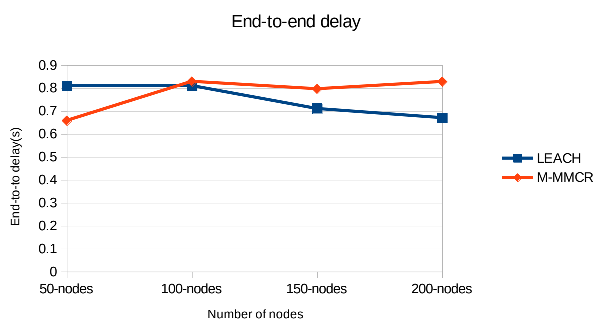

Figure 5.8 Average end to end delays.

6. AVERAGE ENERGY CONSUMPTION

The network energy consumption includes entire energy consumed at the time of data transmitting and receiving. The number of nodes is varied as 50, 100, 150, and 200 with average energy consumption up to 400 joules. Energy consumption of proposed M-MMCR protocol and Exiting LEACH protocol mostly perform same up to the 365 joules energy consumption.

7. THROUGHPUT

The number of nodes is varied as 50, 100, 150, and 200 with throughput up to 90kbps. Throughput of proposed M-MMCR protocol perform better all the 200 nodes up to 83kbps throughput and exiting LEACH protocol perform same as the proposed protocol up to 100 nodes after 100 nodes it perform 68kbps throughput up to the 200 nodes. So throughput of all the 200 nodes proposed protocol perform better of as compare to the exiting protocol.

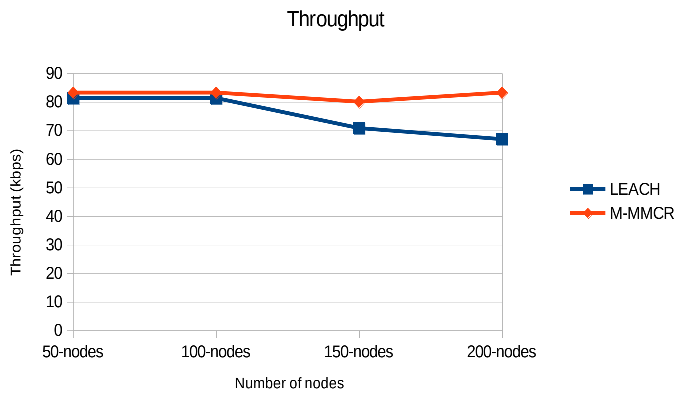

Figure 5.9 Throughputs versus number of nodes.

5.1.4 AVERAGE PACKET DELIVERY RATIO

Packet Delivery Ratio is the ratio of the number of data packets delivered to the BS to the number of packet generated by the source nodes. The number of nodes is varied as 50, 100, 150, and 200 with packet delivery ratio up to 90%. Packet delivery ratio of proposed M-MMCR protocol perform 80% up to the 100 nodes and 100 nodes to 200 nodes it perform better as compare to the exiting protocol up to the 82%. Exiting LEACH protocol performs better up to the 80 nodes. And after 80 nodes it decreases up to the 200 nodes 60%. So proposed protocol Packet delivery ratio of overall nodes perform better of as compare to the exiting protocol.

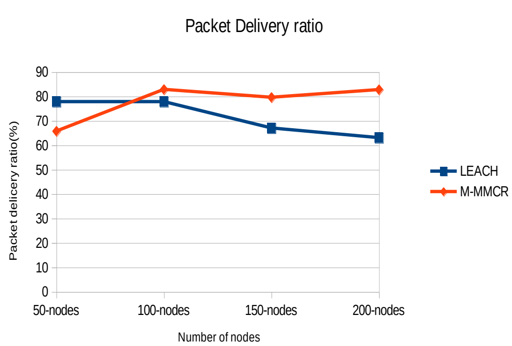

Figure 5.10 Packet delivery ratios versus number of nodes.

8. CONCLUSION

The goal of the proposed work in WSN is to collect the information having high reliability as well as low energy. Here we have considered various energy constraints of sensor nodes such as data aggregation and energy-efficient routing is vital for enhancing the energy efficiency at the same time maintaining the packet delivery ratio. Normally, sensor nodes have radios which can handle various non-overlapping channels. This necessitate use for a multichannel routing protocol which would stability the load regularly on the multiple channels with the help of metric defined by energy utilization throughput and average end to end delay .

The idea of data aggregation is to aggregate the various nodes information so that quality of transmission is diminished. This method has been utilized to accomplish energy productivity and information move streamlining in various routing protocols.

This dissertation shows the improvement over the existing protocol LEACH, this result is concluded with the help of the quality of services. As we can see the proposed method improves the network lifetime because the energy consumption and throughput are increased on the number of nodes.

The proposed work MMCR is used to select route that improved the bandwidth utilization whereas maximizing the energy efficiency and reducing the average end to end delay

9. FUTURE SCOPE

In the future, the following dissertation can be carried out to improve this work.

1. The improvement can be done by captivating mobility into concern.
2. Enhancing the reliability and fault-tolerance as future enhancement.
3. Make simulation comparison with various energy efficient protocols in NS-2.

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