EFFICIENT CLUSTERING HIERARCHY BASED ROUTING ALGORITHM FOR IMPROVING NETWORK LIFETIME IN WIRELESS SENSOR NETWORK

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ABSTRACT

In wireless networks, interference between nodes is an important factor which affects the performance of communications. In this paper, we propose an Interference Avoidance Routing Protocol (IARP) that chooses a route with fewer collisions and show that the new routing algorithm is stable. The idea is to collect the busyness information about nodes, and use this to determine the next hop based on the backpressure routing algorithm. From the simulation results, we observe that IARP can achieve better performance in terms of network delay than the pure backpressure routing protocol. Simulations show that E2R2 can achieve much reductions in energy dissipation compared with conventional routing protocols. In addition, E2R2 is able to distribute energy dissipation evenly throughout the sensors, doubling the useful system lifetime for the networks we simulated.

Keywords: Interference Avoidance Routing Protocol (IARP), Energy Efficient and Reliable Routing (E2R2), Software Defined Network (SDN), Wireless Sensor Network (WSN), Modified LEACH (MLEACH),

I. INTRODUCTION

Routing in Wireless Sensor Networks (SDN) is a challenging task and quite a few results have been reported so far regarding this issue. Routing has also been studied with respect to specific system model of such wireless sensor network systems. Wireless sensor networks are severely constrained in terms of resource, and the topology of such networks remains highly dynamic. For the successful and efficient deployment as well as operation of the wireless sensor network, the protocols and various algorithms are to be application specific. That is why, with new and sophisticated applications of SDN emerging every day, there is a demand for design of novel protocols and algorithms to handle such applications.

Energy efficient routing in a typical SDN with static sensor nodes deployed randomly over a geographic region has been yet an active area of research. And when mobility is introduced to the sensor nodes the problem of routing becomes even more complex.

Mobility to the sensor nodes may be introduced in two possible ways: First, the sensor nodes are attached to some moving objects and second the sensor nodes are motion enabled by its own electro mechanical sub systems (i.e., mobilize) which is again battery power driven component attached to the sensor nodes. Sensor nodes are severely energy constrained and all the tasks like sensing, data processing, communication including both transmission and reception of signals etc are to be carried out by utilizing the available limited energy.

Moreover mobility of the sensor nodes due to the introduction of mobilize unit as mentioned above also consumes energy and mobility introduces more dynamics to the topology of the SDN. The protocols and algorithms are various reasons of the successful operation of the SDN are essential to be energy efficient and also smart. In this chapter, author addresses the most important network layer issue called routing for a mobile wireless sensor network in which mobility gets introduced into the sensor nodes. A dense sensor network is considered in which the sensor nodes are deployed densely. Author presents a novel cluster based routing protocol for such a wireless sensor network system. The proposed protocol is based on the following observations: First, at a sensor node it is highly desirable to have optimum utilization of limited available energy and therefore, most of the network management tasks are to be diverted towards the Base Station as the Base Station is highly resourceful whereas sensor nodes are tiny and severely resource constrained.

Second, in a densely deployed wireless sensor network there is a possibility that more than one sensor nodes may sense same data leading to redundancy and therefore, some sensor nodes may be kept in sleep mode int mobile is a challenging problem due to the following characteristics of such networks: a) highly dynamic topology due to node mobility, node failure and new node addition, b) limited battery power, limited bandwidth and also limited onboard memory and processing capability of the sensor nodes, c) less reliable nature of noisy wireless links.

Existing routing protocols do not consider mobility in sensor nodes as well as in the Base Station and therefore, these are not directly applicable to a mobile SDN. In this chapter, a novel routing protocol called Energy Efficient and Reliable Routing (E2 R2) protocol for mobile wireless sensor network is proposed which is a hierarchical one. The major goal is to achieve energy efficiency and providing connectivity to the nodes so that packets can move through suitable routes in spite of mobility of the nodes which shall eventually lead to link failure. The proposed protocol puts best effort to ensure an acceptable throughput at the Base Station.

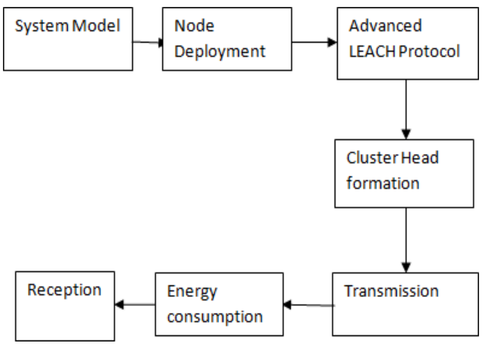

Fig 1. Block Diagram

The protocol minimizes storage requirements at the node level and majority of the computing burden is shifted to the Base Station since the Base Station is a resourceful node. The clusters are formed by the Base Station and each cluster contains two Deputy Cluster Head (DCH) nodes and one Cluster Head (CH) node. This arrangement is to reduce the workload in the single CH node. The mobility and connectivity is managed by the DCH nodes.

Here it introduces the notion of cluster head panel which is a set of suitable nodes for the roles of Cluster Head as well as Deputy Cluster Head. This is prepared at the time of system setup and is valid for the longest duration possible. Another important property of E2 R2 is scheduling of nodes for active or dormant state. In the proposed protocol the CH nodes do not communicate directly to the Base Station. Rather several alternate multi-hop paths from a Cluster Head node to the Base Station are maintained and these paths are used alternately.

The notion of spanning tree is used here. In the event of the link failure, effort has been made to minimize the recovery time by offering an alternate path to the suffered nodes. The rest of this chapter is organized as follows: section states the problem undertaken formally followed by section which describes the related work to the problem of energy efficient and reliable routing in SDN. Section describes the proposed protocol in detail followed by section in which the simulation results and analysis are reported. Finally, in section the work is concluded mentioning the future scope of the work.

II LITERATURE SURVEY

Aji Setiabudi et al[2] had proposed the concept of Vanet Mobilism by simulation explains about the GPSR and ZRP routing protocol in Vanet environment. Vijay Kumari et al[9] proposed MLEACH protocol and found that by this performance can be improved in compared to LEACH protocol. Ravi Kishore Kodali et al[11] proposed the energy efficient protocol and shown that MLEACH is giving better result in compared to the LEACH and further can be improved. Saranya et al[16] proposed the explosion and spiralmethod and show the work of KNN method in the work. Reshma I Tandel et al[15] proposed the data dusion work in LEACH protocol and shown that LEACH is the better for data fusion and transfer and can be done in the secure form in wireless sensor network domain. Mohammed Abu Zahad et al[8] proposed the MSIEE protocol and to eliminate the energy hole problem and to improve the result further in Wireless Sensor Network. Juan Luo et al[10] proposed ENS_OR algorithm for minimizing energy consumption and improving network lifetime in 1-D queue network in WSN.

III METHODOLOGY

1. EXISTING SYSTEM:

LEACH is a type of self-organizing, adaptive clustering protocol which uses randomization to distribute the energy load evenly among the sensors in the field of network. In LEACH protocol, the nodes organize themselves into local clusters, with one node acting as the local base station or cluster-head. If the cluster heads here were chosen a priori and fixed throughout the system lifetime, same as in the conventional clustering algorithms then it is easy to see that those unlucky sensors chosen to be cluster-heads would die quickly and leads to the ending of the useful lifetime of all nodes belonging to those clusters.

Thus LEACH here includes randomized rotation of the high-energy cluster-head position such that it rotates among the various sensors in order to not drain out the battery of a single sensor node. In addition, here LEACH also performs local data fusion to “compress” the amount of data which being sent from the clusters to the base station, further reducing the energy dissipation and enhancing the system lifetime. Sensors here elect themselves to be local cluster-heads at any given time with a certain probability. These cluster head nodes broadcast their status to the other sensor node in the network.

The base station is far away in the scenario where we are examining, which is a high energy transmission. However, since there are only a few cluster-heads, that only affects a small number of nodes.

A. DISADVANTAGES OF EXISTING SYSTEM:

• Existing routing protocols reported do not consider the mobility in sensor nodes and in the BS, and therefore, these are not directly applicable to a mobile SDN.

• None of the existing protocols can able to achieve all the following goals at the same time:

• Guaranteeing reliability in an energy-efficient manner in the presence of node and BS mobility.

• Managing mobility of the nodes and maintaining connectivity through the alternate paths in network.

• Minimizing the message overhead and overcoming the problem of less reliable wireless links.

2. PROPOSED SYSTEM:

• In this paper, a novel routing protocol, which is called Energy-Efficient and Reliable Routing protocol for mobile wireless sensor network (E2R2), is being proposed. Here our major goal is to achieve energy efficiency and to provide a better connectivity to the nodes.

• The mobility of the nodes is considered while routing decisions are made. The objective behind such type of routing is that the data packets need to move through suitable routes in spite of node mobility and in presence of subsequent link failures.

Self Organization Phase: After the deployment of the sensor nodes the first phase that starts is the self organization phase. During this phase the clusters are formed and cluster head set, current Cluster Head, Deputy Cluster Head are selected by the Base Station. The Base Station collects the location information from each of the sensor nodes before the formal routes are established by the routing protocol. The sensor nodes transmit this location information towards the Base Station by broadcast and forwarding mechanism.

Based on the velocity of a sensor node the Base Station can prepare a rough estimate of the zone in which the sensor node is going to be in the next time interval. The value of the next time interval can be set manually depending on the type of the application and this value is critical as most of the computations e.g., cluster setup validity period, medium access slot etc are dependent particularly on the next time interval. Using this information the Base Station can compute the topology. Once the Base Station creates the sensor field map, it generally forms the clusters. Cluster Head nodes are uniformly distributed over the entire sensor field.

After formation of the clusters the Base Station identifies a set of suitable nodes i.e., cluster head panel from within each cluster which can take role of Cluster Head node and Deputy Cluster Head node. This selection is based on cumulative credit point earned from the three parameters namely residual energy level of the node, degree of the node (i.e., the number of neighbours) and mobility level of the node (high, moderate, low).

The threshold value can be set manually at the time of implementation and also depending on the application of the SDN under consideration and the normalization function. The node with highest credit point is selected as the current Cluster Head. The next two nodes in the list with second and third highest credit point respectively are selected as Deputy Cluster Heads for the same cluster.

Role of Cluster Head node: The Cluster Head node is responsible for gathering sensory data from the cluster members, aggregate those and forward to the Base Station either directly or in a multi-hop fashion according to the communication pattern distributed by the Base Station.

Role of Deputy Cluster Head node: The Deputy Cluster Head nodes keep monitoring the sensor nodes' mobility pattern.

Deputy Cluster Head nodes are also called cluster management nodes as they take a major responsibility of collecting current location information from the cluster members and communicating it to the Base Station. Based on this information the Base Station computes the actual current topology and previously what the Base Station had is an estimate only. Moreover in the event of the immediate link or node failure in the route of the CH towards the Base Station, the Cluster Head may seek aid of one of the Deputy Cluster Head nodes to forward the data towards the Base Station. CH-BS network creation: Since the location information of each of the CH node is available with the BS, the BS computes different alternate multi-hop routes for each of the CH node.

Alternate DCH-BS network creations: Similar to the CH-BS network creation process the BS also creates the DCH-BS networks. In this situation, only the DCH nodes in the sensor field are considered. Alternate routes are also created for the DCH and also switched intelligently by the BS. Use of the cluster head panel: The cluster head panel is selected initially and remains valid till the end of Cycle Length or till the re-clustering is initiated. If the current Cluster Head (CH) loses connectivity with most of its cluster members due to which throughput at the Base Station degrades, the Cluster Head may be asked to relinquish the charge of cluster headship. Even a Cluster Head node may drain out its energy beyond a threshold and becomes useless; in this situation also a new Cluster Head is necessary. Under such circumstances the Base Station may give the charge of headship either to one of the two Deputy Cluster Head (DCH) nodes or to a node from within the cluster head panel. This saves lot of cost and time involved in the process of selecting Cluster Head.

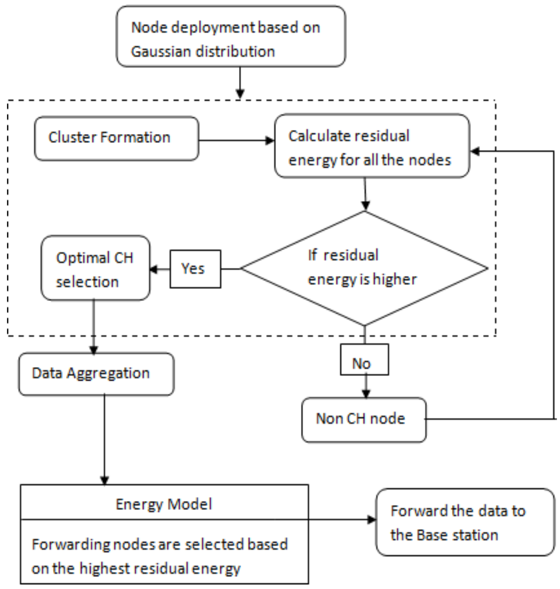

Fig 2.Proposed work flow diagram

A. ADVANTAGES OF PROPOSED SYSTEM:

- We consider the mobility of the sensor nodes and the BS while routing decisions are made.
- The notion of deputy cluster head (DCH) is used, which increases the lifetime of the network.
- The notion of cluster head (CH) panel is being used, which also increases the lifetime of the network.
- The notion of feedback by the BS regarding data delivery in it is considered.
- The protocol here ensures the reliability in terms of data delivery at the BS.
- We adapt a probability-based mathematical model that can be used for identifying the most suitable path for data forwarding.

B. SYSTEM ARCHITECTURE:

MODULES:

- System Construction Module
- Self-Organization Phase

- Current Cluster Setup Cycle Length
- Performance Evaluation

MODULES DESCRIPTION:

i. System Construction Module:

After the deployment of the sensor nodes, here the BS creates groups of different sensor nodes in order to form the clusters. Each cluster contains a CH node and two DCH nodes. The BS selects a set of suitable sensor nodes from each cluster, that can act as a CH or DCH at the later stage. This set of nodes is also called CH panel.

- The cluster members that is, the sensor nodes, forward data to the respective CH node. The CH nodes do the data aggregation to remove the redundancy and then forward the aggregated data towards the BS. The DCH nodes here do several cluster management tasks that include mobility monitoring also.
- They also remain ready to act as an intermediate hop in the presence of faults in some CH nodes. Therefore, the DCH nodes are also called cluster management nodes. The CH nodes do not transmit data directly to the BS, unless it is the nearest one to the BS.

ii. Self- Organization Phase:

- After random deployment of the sensor nodes in the sensor field, the self-organization phase starts. It is the first phase of the protocol. During this phase, the clusters are formed. The CH set, the current CH, and the two DCH nodes are selected by the BS. Initially, the BS collects the current location information from each of the sensor nodes and then forms a sensor field map. The value of the next time interval can be set manually depending on the type of the application, and this value is critical because most of the computations, e.g., cluster setup validity period and medium access slot, are dependent on the next time interval. Using this information, the BS can compute the topology of the sensor network. Once the BS creates the sensor field map, it forms the clusters.

iii. Current Cluster Setup Cycle Length:

- An important and critical issue is how long a particular cluster setup will remain valid. Depending on the initial energy level of the sensor nodes and the kind of application, the optimal time duration is fixed. This optimal time duration is called as cycle length, and the current cluster setup remains valid until the end of the cycle length.
- Due to mobility of the nodes, severe link failures may occur, and nodes may die out due to depletion of energy, which may together cause network partition. In such situations, current cluster validity time, i.e., cycle length, may become outdated, and re- clustering may get initiated by the BS before expiry of the cycle length.

iv. Performance Evaluation:

The following metrics are used to understand the performance of our routing approach:

Average Communication Energy: It is the average of the total energy spent due to communication in the network over a particular time period and with respect to a specific data rate. If E is the total energy spent due to communication and N is the total number of nodes in the system, then E/N (i.e., energy per node) is the average communication energy. A protocol with lower average communication energy is desirable.

$$\text{Average energy} = E/N$$

Throughput: It is the ratio between the actual numbers of packets transmitted by the nodes in the system to the numbers of successfully delivered packets at the BS. It reflects the percentage of packets lost during transmission. A protocol with higher throughput is desirable.

$$\text{Throughput} = \frac{\text{Total number of received packets at destination x packet size}}{\text{Total simulation time}}$$

Lifetime: It is the time taken since the start of the network (during the simulation) for the first node to die. A protocol with larger lifetime is desirable.

Node Death Rate: It is a measure with regard to the number of nodes that died over a time period since the start of the simulation.

Delay: It is being calculated here for the delay period of the node from source to destination for both the parameters.

$$\text{AverageDelay} = \frac{\sum(\text{Packet Arrival Time} - \text{SendTime})}{\text{Number of Packets Received}}$$

Packet Delivery Ratio: It is ratio of the number of delivered data packet to destination.

$$\text{PDR} = \frac{\sum \text{Number of Packets Received}}{\text{Number of Packets Sent}}$$

IV. RESULTS AND ANALYSIS:

i)**Cluster head formation:** Below it is showing the cluster head formation.

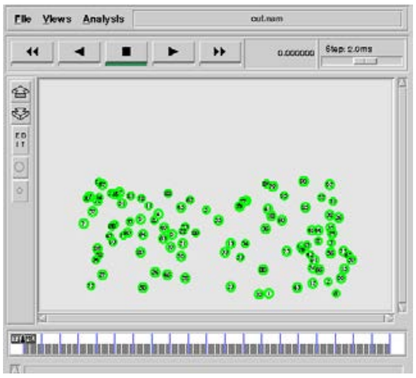

Fig 3. Cluster head formation

ii)**Node sensor creation**: Below it is showing the node sensor formation.

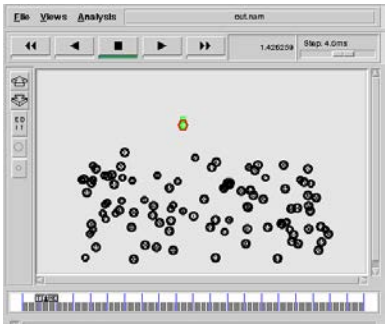

Fig 4. Node sensor creation

iii)**Base station formation:** Below it is showing base station formation.

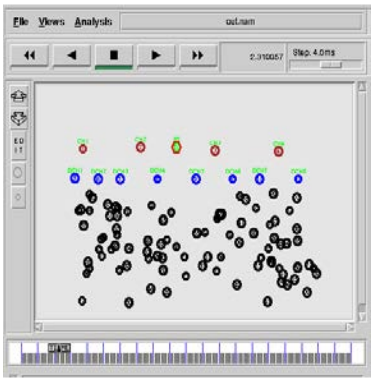

Fig 5. Base station formation

iv)**Throughput :** Below it is showing the variation of both the protocols and is showing that which is giving better result and here we got that MLEACH is giving better result in compared to LEACH protocol.

Table 1. Value for both parameters

Nodes	Throughput (LEACH)
80	259.89
100	204.03
120	406.06
150	172.30
180	90.21
200	239.99
230	168.62
260	272.73
300	153.42
330	146.02
360	257.88
400	310.75

Nodes	Throughput (MLEACH)
80	468.38
100	263.62
120	660.90
150	181.77
180	1261.65
200	403.74
230	579.01
260	272.73
300	297.72
330	195.64
360	297.88
400	405.93

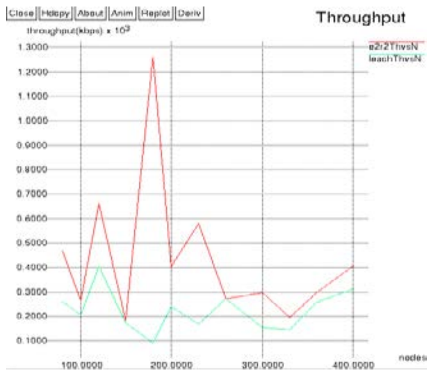

Fig 6. Throughput

v)**Energy:** Below it is showing the range for both the parameters and by this it shows that the value for that of MLEACH is better than LEACH in terms of energy.

Table 2 . Value for both parameters

Nodes	Energy (joules)	Nodes	Energy (Joules)
80	72.735	80	63.563
100	98.236	100	92.533
120	125.008	120	123.49
150	224.766	150	109.84
180	202.534	180	68.438
200	102.255	200	95.95
230	125.999	230	125.405
260	192.405	260	127.03
300	80.33	300	59.808
330	148.00	330	107.582
360	138.824	360	91.551
400	108.541	400	97.145

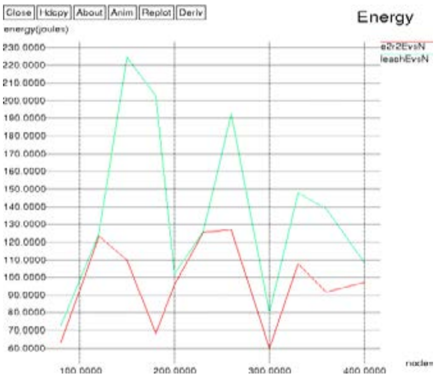

Fig 7. Energy

vi)**Packet delivery ratio:** Below graph is showing that variation of the values for both the parameters and it shows that PDR for MLEACH is better than that of LEACH here in the proposed work.

Table 3.Value for PDR for both parameters

Time (m sec)	PDR (LEACH)
0	95.776
2	95.485
4	69.952
6	66.156
8	66.789
10	86.727
12	90.293
14	91.776
16	92.485
18	79.951
20	76.156

Time (m sec)	PDR (MLEACH)
0	110.03
2	523.23
4	59.49
6	178.26
8	239.10
10	279.52
12	364.72
14	99.03
16	503.23
18	57.49
20	158.26

Fig 8. Packet Delivery Ratio

vii)**Delay:** Here below in the graph it shows that variation of the delay value for both the LEACH and MLEACH protocols and it shows that here the reult is better for MLEACH in compared to the LEACH.

Table 4. Values for both parameters

Time (m sec)	Delay (LEACH)
0	110.03
2	523.23
4	59.49
6	178.26
8	239.10
10	279.52
12	364.72
14	99.03
16	503.23
18	57.49
20	158.26
22	219.10
24	259.52
26	344.72
28	99.03
30	483.23

Time (m sec)	Delay (MLEACH)
0	95.78
2	95.48
4	69.95
6	66.16
8	66.79
10	86.73
12	90.29
14	91.78
16	92.48
18	79.95
20	76.16
22	76.78
24	84.73
26	89.99
28	95.78
30	95.48

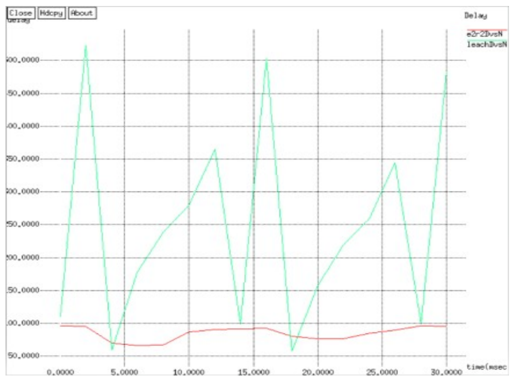

Fig 9. Delay

V. CONCLUSION AND FUTURE WORKS:

This protocol proposes an energy efficient and reliable routing protocol for dense and mobile wireless sensor networks. The proposed protocol (E2 R2) is a hierarchical and cluster based one in which each cluster contains one Cluster Head node and the Cluster Head is assisted by two Deputy Cluster Head nodes which are also called as the cluster management nodes. The performance evaluation of the proposed protocol is analyzed through simulations. Here also compares the performance of the proposed protocol with MLEACH in terms of lifetime and throughput. The proposed protocol outperforms MLEACH in terms of lifetime and throughput. Such a routing protocol is useful for a dense wireless sensor network when the sensor nodes as well as the Base Station are mobile. This work can be extended to improve the throughput parameter even in the high data rate situation where the sensor nodes generate data at a very high constant rate.

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