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Investigation And Analysis Of New Energy Efficient Routing Method For WSN

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Abstract

In the wireless networks like WSN, MANET, every data communication is overheard by every other node in the same zone, and hence this is one of major reason of the nodes energy consumption. This is just unnecessary wastage of nodes energy. But the routing protocol like DSR (Dynamic Source Routing) protocol collect their routing information's through such overhearing, they would suffer if they are used in combination with 802.11 PSM. Wireless sensor networks are made up of number of tiny mobile nodes which are having the capability of computation, sensing and wireless network communication. The energy efficiency of every node is one of the important issues in such kind's networks under considerations. Thus for this networks, sensor nodes life time is basically depends on use of routing protocols for routing operations in WSN. There are various routing protocols are proposed by the different researchers which are considered as efficient on the basis of performance of network lifetime and energy scavenging. There are different methods which are introduced for the WSN routing protocols such as flat routing protocols, clustering routing protocols, hierarchical routing protocols etc. In this project, our studies basically are focusing on the investigation and analysis of hierarchical routing protocol (H-Pro) and flat routing protocol. We carried out the detailed study of (H-Pro) protocol, its architecture, and design considerations. We are performing the investigation over the performance analysis two kinds of routing protocol of sensor networks such as (H-Pro) (hierarchical routing protocol), PEGASIS (flat routing protocol). Here the performance of this new protocol is evaluated on the basis of throughput and energy consumption.

1. Introduction

Recently, there are number of advances are done in the wireless technology like MEMS, wireless network communications, digital electronics which are allowing for the development of the less power, lower cost, complex, and multi functional tiny network nodes of wireless sensor networks. Those tiny sensor nodes are communicating without any kind of restriction over the short distances.

There are various filed into which such sensor nodes are extensively used like battlefield, target tracking, military, detection of objective, civil aviation, monitoring of environment etc uses the WSNs. Each sensor node in the WSN doing the task of detecting the specific events monitoring, and also it is responsible for gathering the complete data in order to return the data to the specific base station (BS) which is also called as sink node. The most important part while designing of sensor nodes needs to consider is the batter energy; this limits the overall performance and lifetime of the wireless sensor networks. And hence the various routing protocols are designed for wireless sensor networks only to enhance the sensor networks lifetime. The position of the network topology and classical sensor is defined fixed according to the *Qiangfeng Jiang, et al. and Al-Karaki, et al.* Whereas, the sensor nodes that are present in the routing path basically depleting their battery energy very quickly only because of fixed paths use in order transfer the data which is sensed by the network back to base station. The sensor network communication is depends on technology of MANET (mobile ad hoc network). If sensor nodes in the sensor network will not able to communicate with the base station directly, then intermediate sensor nodes will used for the data forwarding [1] [2].

Thus, as there intermediate sensor nodes are used for the forwarding the packets to the destination node directly, but this intermediate sensor nodes are consuming the more power of battery and rapidly. Thus in orders to overcome this drawback, various routing protocols have been proposed which are basically multihop only to forward the packets through the other sensor nodes to the sink node. Flat based routing, cluster based routing and Hierarchical based routing etc are three kinds of major categories for wireless sensor network protocols those are used for communication. However flat routing protocols as well as cluster based routing protocols are having

the performance issues and also the network lifetime is minimized due the more energy consumptions as compare to the hierarchical based routing protocols for WSN [3].

In this research studies we are discussing and investigating the H-Pro protocol for the wireless sensor networks and analyse their performance metrics in terms of throughput, delay, network nodes energy consumption, network lifetime as compared to one of existing protocols.

2. Literature Review of WSN Routing Protocols

As we discussed in the above section, there are many routing protocols which are proposed for the routing mechanisms for the wireless sensor networks in order to establish the energy efficient as well as stable routes. Following figure 1 is showing the different types of protocols for routing in wireless sensor networks according to the operation of protocol and network structure. There are two major categories into which the WSNs routing are divided as showing in figure: first approach is by networking structure like location based hierarchical based and flat based routing protocols; whereas other approach according to operation of protocol like query based, negotiation based, coherent based or the QoS based approaches. In this section, we will describe the existing all the protocol which are used for the routing in the wireless sensor networks. Apart from this our main area of concern is the hierarchical based routing protocols, those all are presented in following subsections [3].

Initially the researcher *[Heinzelman, et al]* presented the hierarchical based clustering algorithm for the sensor networks which are called as the low energy adaptive clustering hierarchy (LEACH) algorithm. In short, LEACH routing protocols is cluster based protocol which is applied for the randomized rotation of cluster heads in order distribute the energy load.

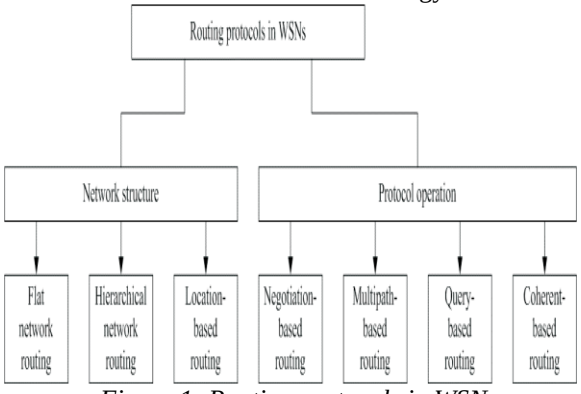

Figure 1: Routing protocols in WSNs.

The LEACH functionality organized in the various rounds which are made up of steady state phase and set up phase. The overall network is differentiated into the various networks clusters during the phase of set up, every cluster with randomly chosen cluster head among the sensor nodes in the cluster. In case of steady-state phase, cluster heads are collecting the data from the sensor nodes inside their respective clusters, and also fusing data before the forwarding of them to sink node directly [4]. Finally we can say that, this protocol is providing the sensor networks with multiple important features like localized coordination, clustering based and cluster heads randomized rotation. LEACH provides sensor networks with many good features, such as clustering-based, localized coordination and randomized rotation of cluster-heads, however most of the energy is consumed over the cluster heads whenever directly forwarding data packets to destination node [5].

The enhanced LEACH protocol is then presented by the research [*Lindsey et al.*]. The protocol called PEGASIS (*Power Efficient Gathering in Sensor Information Systems)*, considered as every node having the location information related to the every other node in the network. Thus, the PEGASIS chain is easily constructed with the help of greedy algorithm on the basis of LEACH. Every mobile node is transmitting to and receiving from only one of its neighbours. During every round, nodes taking the turns in order to be leader over the chain path to send aggregated data to destination node or sink. For locating the nearer neighbour sensor node in the PEGASIS, every node is adopting the overall strength of signal in order to measure the distance among all the neighbour sensor nodes [6].

But, global information about the overall network is addressed by every sensor node which is not at all easily obtained. As the sensor network is generating the more data for end users in order to process it, sensor network needs to do data aggregation. PEDAP (*Power Efficient Data Gathering and Aggregation in Wireless Sensor Networks)*, this kind of protocol is basically based on the concept of minimum spanning tree. These protocols consider that sink node knowing the all sensor nodes locations, and such routing information is then calculated by the prim's algorithm with sink node as the root. The lifetime of the last sensor node is prolonging by the PEDAP in system while providing the very good lifetime for first node. On the other hand, PEDAP has power aware version which is providing the near optimal first node lifetime while decreasing the last node lifetime slightly. In addition to this, sensed data is transmitted by sensor nodes to sink nodes through the routing path that is constructed earlier in order to provide the system of minimum energy consuming. Intermediate sensor nodes are consuming the more energy quickly [7].

In case of HAR means *Hierarchy-Based Anycast Routing Protocol*, the hierarchical tree is

constructed by sending packets such as CREQ, CAPAC, PREQ, and CACP etc. for discovering every sensor nodes in turn child nodes. Periodic updates as well as flooding both are prevented by the HAR, however this needs to reconstruct tree when the sensor nodes fails or new sensor nodes are added. The major disadvantage of HAR protocol is that too many packets are sent and received in overall network and hence expending the more energy.

3. Routing Algorithm under Investigation

This section presents the hierarchical routing algorithm for efficient energy consumption is discussed along with its implementation design.
The system environment example shows in Fig 2. Under in sensing field sensor nodes divided randomly. Under in interesting area considered network is defining a small number of sink nodes & some wireless sensor nodes. The sensor nodes are put on to be lifetimes & fixed there, and set priori of identifier of sensor nodes. And also, these have limited processing power, storage and energy, when the sink nodes have powerful resources to perform any tasks or communicate with the sensor nodes.
When nodes are deployed, they rest at their sensing tasks locations. Its receive massage from other nodes. Sink node starts with hop value *"0"*, when other sensor nodes are *"_"*. H-PRO is a hierarchical routing protocol that can be cut energy consumption & prolong the lifetime in sensor networks.

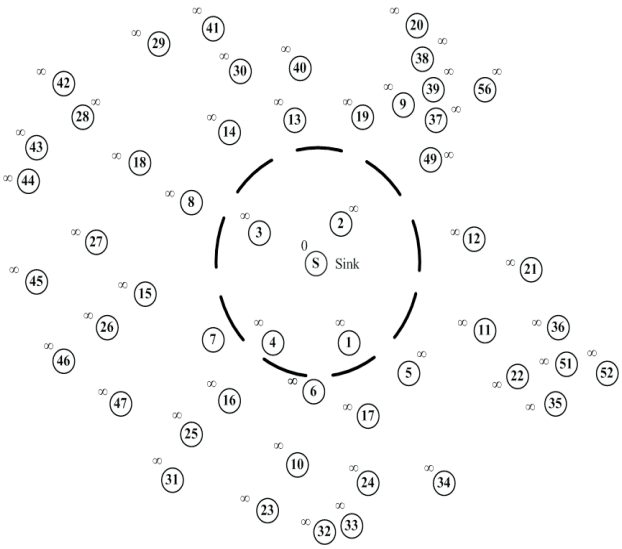

Figure 2: Example of sensor network environment.

It replies with a perfect route from the source node to the sink quickly, and prepare balance energy of nodes from routes path and. Leach-cell perfect intermediate nodes to aggregate all packets under a short period and transmit only one aggregated packet to the following node.
For hierarchical tree architecture H-PRO is base, in which the sink nodes do as root nodes. It must be member of the architecture, i.e., an internal or leaf node, to convey with the sink node. Proposed protocol has two phases; *Layer Construction Phase (LCP)* and *Data Dissemination Phase (DDP)*

3.1 Layer Construction Phase (LCP)

Shows in Figure 3, sensor node (1) define the *Packet_Type* of a received packet (which may come from other nodes). If L is the value of *Packet_Type* field, then it is a *LCREQ* packet.Sensor node will similar the *Hop_Count* field with its hop value. It is smaller than its hop value, then it put the packet during *TLCREQ*, e.g., the *Hop_Count* field value is 1, its less than hop value infinity of node (1), else drops the packet. If end the time of *TLCREQ* , node begins to take the packets with the lowest *Hop_Count* values as its candidate parents, and packet information records into CIT. Node _then raises the *Hop_Count* field of *LCREQ* packet by 1 and rebroadcasts. Node additionally receives two layer packets from nodes (1) and (4) with same *Hop_ Count* field value. Hence, the candidate parents are like as nodes (1) and (2) Additionally, node (1) receives an *LCREQ* packet from node (4), but the hop value of node (1) equals the *Hop_Count* field. Therefore, node (1) through the *LCREQ* packet. Every node regular flooding the *LCREQ* packet when ever the network level is constructed.

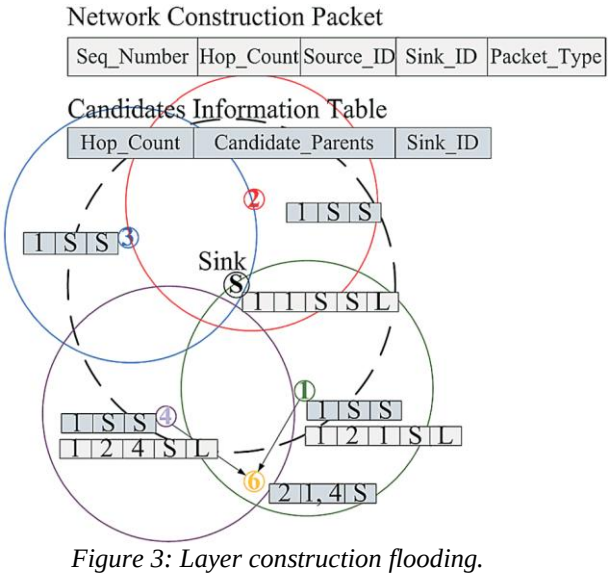

Figure 3: Layer construction flooding.

3.2 Data Dissemination Phase (DDP)

After completed first phase, sensor nodes start disseminating the sensed data to the sink way of the base node. This format is as follows: *<Seq_Number, Source_ID, Dest_ID, Sink_ID,*

Data_Len, Payload>. The *Seq_Number* field is a sequence number of the packet.

If no *RDACK* reply is obtained from *p* between a *TRDACK* time (this time is very short), then node *x* extinguished the record with parent *p* from the CIT. Shows in Fig 4, node 56, with five candidate parents, 20, 38, 39, 37 and 49, sequentially selects a record from CIT. Node 56 first disseminates data packets to parent node 20. If node 20 replies with a *RDACK* packet, then node 56 pass the record at node 20 on last position of CIT. Conversely, if node 20 does not

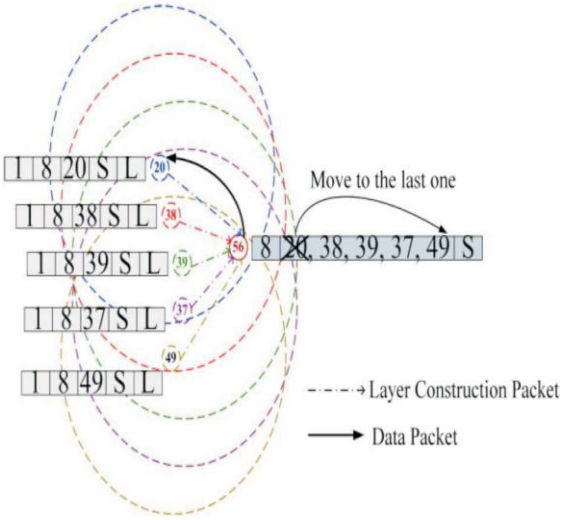

Figure 4: Data dissemination Phase.

Reply with a RDACK packet, and then it's removed from the CIT, since its energy may run out, or its being broken & data packet cannot transfer via this node later. The node is working the same motion as node 56 whenever the data packet reaches the sink node. The data packet can be sending to sink via many paths. The lifetime of the network system can be holding out if sensor node always use different path to forward data packets.

3.3 Network Layer Maintenance

More things, the new sensor node is connecting to the network but not find any candidate parent from its CIT discovers a parent using a *rediscovery mechanism* as follows.

Shows in Fig 5, the NCP an sensor node broadcasts with the it's hop value and *Packet_Type* value C (meaning *Candidate Parent Request, CPREQ)* to its neighbour nodes to cognisant of its existence. Any neighbour nodes receiving this packet check that the pending energy is more than *EThreshold* (50% of the initial energy). This threshold based on the different application of sensor networks.

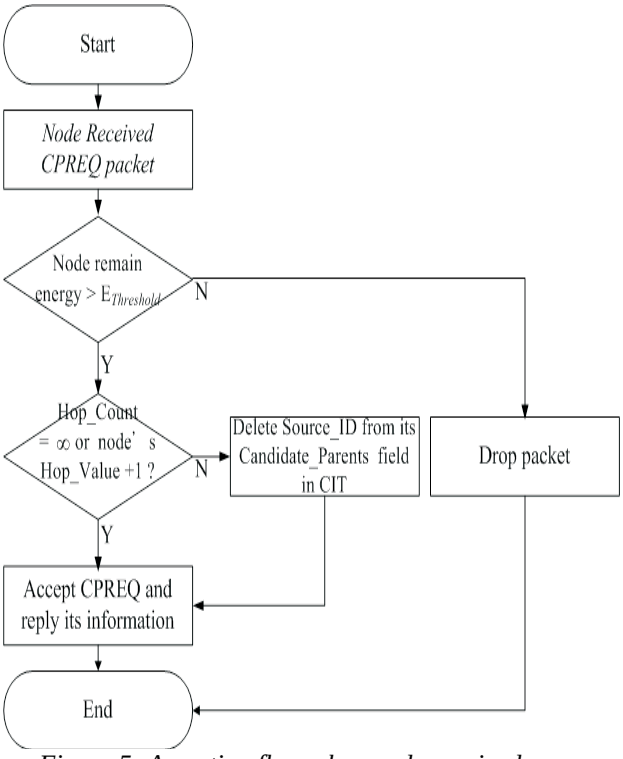

Figure 5: An action flow when node received CPREQ packet

If a neighbouring node has enough energy, then it audits the *Hop_Count* field to identify the request packet. If the request comes from a newly deployed sensor node (*Hop_Count* field is "_"), then the neighbouring node receive the request, and reply with *LCREQ* packet to the joining node by uncasing. Otherwise, the neighbouring node checks whether the *Hop_Count* of the requesting node add its own *Hop_Value* + 1. If "yes", then the neighbouring node accepts the request & replies with a *LCREQ* packet to the joining node by uncasing.

If "no", then it remove the *Source_ID* of this request from its *Candidate_Parents* field in CIT; and replies with a *LCREQ* packet to the connecting a node by uncasing.

4. Mathematical Model for Experiment Analysis

4.1 Input Sets

There number scenario and traffic files needs to generate in order to evaluate the performance of the routing protocols under the different network conditions. In this simulation the main parameter which is varied during the simulation is the number of nodes, number of connections and size of the network. Following are parameters which are varied for these simulations:

_ Nodes of maximum velocity
_ Maximum number of data connections
_ Number of nodes

_Size network area
Here we are considering the simulation for the 10, 20 30 nodes for the different WSN protocols with the increased network size and number of connections.

1) For 10 nodes

Number of Nodes	10
Traffic Patterns	CBR (Constant Bit Rate)
Network Size	500 x 500 (X x Y)
Max Speed	10 m/s
Simulation Time	200s
Transmission Packet Rate Time	10 m/s
Pause Time	2.0s
Routing Protocol	LEACH/PEGASIS/H-Pro

2) For 20 nodes

Number of Nodes	20
Traffic Patterns	CBR (Constant Bit Rate)
Network Size	500 x 500 (X x Y)
Max Speed	10 m/s
Simulation Time	200s
Transmission Packet Rate Time	10 m/s
Pause Time	2.0s
Routing Protocol	LEACH/PEGASIS/H-Pro

3) For 30 nodes

Number of Nodes	30
Traffic Patterns	CBR (Constant Bit Rate)
Network Size	670 x 670 (X x Y)
Max Speed	10 m/s
Simulation Time	200s
Transmission Packet Rate Time	10 m/s
Pause Time	2.0s
Routing Protocol	LEACH/PEGASIS/H-Pro

5.2 Output Sets

1) **Packet delivery ratio:** It is the calculation of the ratio of packet received by the destinations which are sent by the various sources of the CBR.
2) **Normalized routing load:** This metrics is used to calculate the number of routing packets which are transmitting with the original data packet over the network. This metrics indicates the efficiency of routing protocol in the MANET.
3) **End to end packet delay:** This metrics calculates the time between the packet origination time at the source and the packet reaching time at the destination. Here if any data packet is lost or dropped during the transmission, then it will not consider for the same. Sometimes delay occurs because of discovery of route, queuing, intermediate link failure, packet retransmissions etc are considered while calculating the delay. Such kind of metrics we have to measure against the different number of nodes, different traffic patterns and data connections.
4) Throughput: This metrics calculates the total number of packets delivered per second, means the total number of messages which are delivered per second.
5) Energy Consumption: nothing but the average network energy consumption.
In wireless sensor network, the sensor nodes are generally battery powered and it is very difficult to change or recharge batteries for these nodes. So, it must be cheap enough to be discarded rather than recharged, or must be efficient enough to operate only on ambient power sources
6) Residual Energy: Its balanced energy after simulation

5. Comparative Analysis of Energy Aware Routing Protocols

1) Performance of Energy consumption: This graph shows that network life time for investigated H-Pro protocol is more than other routing protocols of WSN like flat routing protocols and PEGASIS protocols.

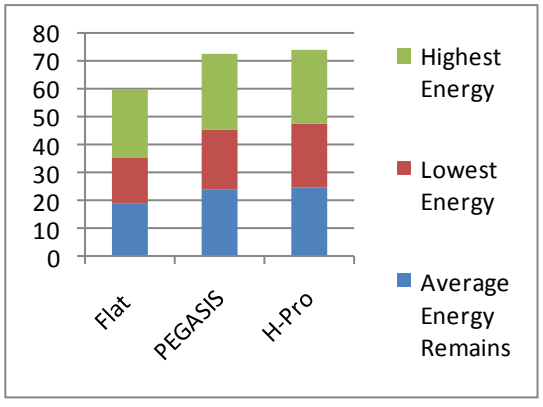

Figure 6: Performance analysis for the nodes energy consumption.

2) End to End Delay Performance

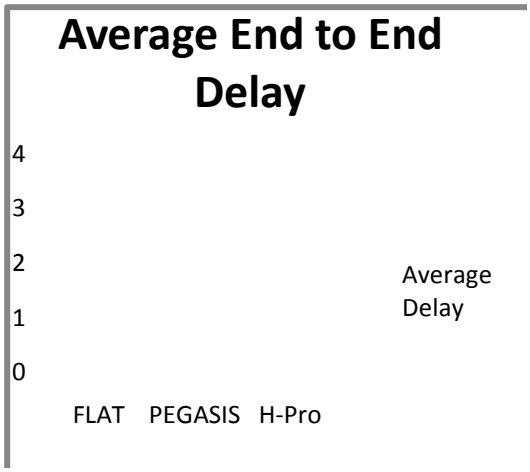

Figure 7: Average End to end delay

Again H-Pro is having the better performance as compared to the PEGASIS and flat routing protocols.

3) Average Throughput Performance

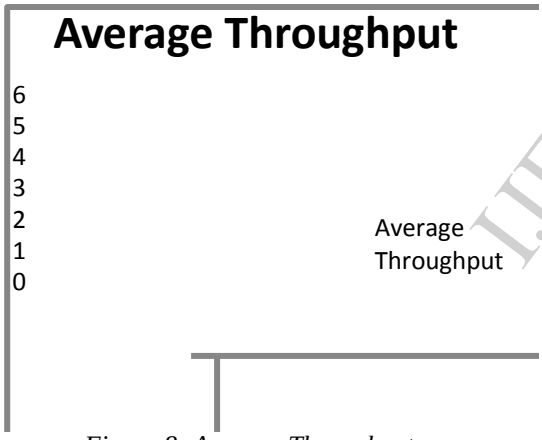

Figure 8: Average Throughput

Hence all above results are fulfilling the research objectives according to the simulation studies. The investigated H-pro protocol is performing better in every case as compare to the other routing protocols of wireless sensor networks. We claim from these results that H-pro protocol is better for extending the network lifetime and improving the performance of sensor network overall as compare to all the existing protocols.
Finally, the hierarchical protocols for the wireless sensor networks routing are having better performance and enhanced system lifetime.

6. Conclusion and Future Work

As we know that, the major concern in the wireless sensor networks is the limitations of energy resources. Network overhead and sensor nodes load are influencing the overall system lifetime significantly. To enhance the system lifetime performance, distributing the load over sensor nodes. In this research article we conducted our studies over the distributed protocol called as H-Pro protocol which is having the main functionality of reducing the overall system path loading mechanism by distributing the energy consumptions among the sensor nodes. The complete path information is not at all maintained by this protocol, only maintaining CIT of them for HMRP protocol. From this study we can conclude few things regarding to the wireless sensor network, first one is that for the sensor network design the major considerations are related to network life time, second flat routing protocols consumptions more nodes energy, finally from the obtained results for H-Pro we can claim that hierarchical based routing protocol is performance more better than any other type existing protocols.
For further work, we would like to suggest to use this protocol with energy efficient MAC approaches like the recent one MEMAC.

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