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E-ZET: Enhanced Zone and Energy Threshold Based Clustering Routing Protocol Using Greedy Algorithm and Ant Colony Optimization in Wireless Sensor Networks

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ABSTRACT

WSNs consists of spatially distributed autonomous sensors to monitor physical or environmental conditions such as vibration, temperature, sound, pressure, pollutants and motion to cooperatively pass their data through the network to the main location or base station. In WSN, data is measured by nodes and same is send to Base Station at normal interval. Nowadays, various routing protocols are used in wireless sensor networks. In this paper we have been described zone and energy threshold clustering routing protocol, this is combination of both proactive and reactive approach. The E-ZET protocol divided the whole network in Zones. Each zone has its main cluster head. The greedy algorithm will decide the nodal path from least to high energy consumption as well as the shortest path. This master node will be responsible to transfer to traffic to corresponding node with minimum energy utilization. Further for load balancing and shifting of traffic to the optimal path decided by master node and running greedy algorithm will be decided by Ant Colony Optimization algorithm.

Keywords: Wireless sensor networks (WSNs), Zone routing Protocol (ZRP), Greedy Algorithm (GA), Ant Colony Optimization (ACO), Energy Efficiency, Load balancing, IARP, IERP etc.

I. INTRODUCTION

Wireless sensor networks were initially a research project directed by UC Berkeley. WSNs consists of spatially distributed autonomous sensors to monitor physical or environmental conditions such as vibration, temperature, sound, pressure, pollutants and motion to cooperatively pass their data through the network to the main location or base station. WSNs are particular type of ad-hoc network which consist of number of nodes equipped with a sensor unit, a battery power unit, wireless communication unit and programmable embedded processor. WSNs contain hundreds or thousands of sensor nodes. Each sensor node comprises sensing, transmission, mobility, position finding System, processing, and power units. WSNs can be used for many applications like urgent situation, target tracking in war-fields, military, environment and systematic applications. The one of the challenging area in WSNs is routing of sensor data. Today's, current research in WSNs is routing protocols that are energy aware to maximize the lifetime of network, tolerant to sensor damage scalable for large number of sensor nodes and battery exhaustion.

II. Zone Routing Protocol

The routing protocols are mainly flow three approaches such as proactive, reactive and hybrid.

Proactive: In proactive approach every node builds its own routing table which can be used to find the path to destination. They also respond to any change in network topology by sending updates throughout the network. The advantage of Proactive approach it has no delay in the route determination except it has traffic overhead due to the periodic route update.
Reactive: This is different from table driven approach or proactive. The Reactive routing protocol compute route on demand so it has an advantage that it has a reduced amount of traffic overhead than proactive routing protocol. In reactive approach this only start a route discovery procedure when need. This task does not request the constant updates to be sent through the network in proactive, but this process does cause delays.
Hybrid: This is the combination of proactive and reactive approach.

Zone routing protocol is a hybrid type of protocol means this is a combination of proactive and reactive approaches. The hybrid approach can be more efficient than traditional routing. The main advantage of ZRP is that it requires a small amount of routing information at each node, so it produces much less routing traffic than a pure reactive or proactive scheme. The zone routing protocol have two types:

- Intrazone Routing(IARP)
- Interzone Routing(IERP)

Intrazone routing (IARP): In ZRP, a node proactively maintains routes to destinations within a local neighborhood, which refer to as a routing zone. The collection of nodes is known as routing zone that has a minimum distance from the node in question is not larger than a parameter referred to as the zone radius. Every node maintains its own routing zone. An important consequence, as we shall see, is that the routing zones of neighboring nodes overlap.

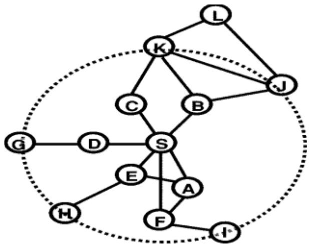

Fig.1 Intrazone routing

In the above figure (fig.1) S is the control node of the routing zone. K , J, G, H and I are called border nodes. In the IARP directly send the information to the destination.

Interzone routing(IERP): On the other hand, IERP uses a scheme, when a node needs a route to a node outside its zone; it performs a border casting by sending a RREQ (Route REQuest) to each node on the "border" of this zone. On receiving such a packet at a border node, it first checks its intra-zone routing table for existence of a route to the requested destination node. If so, a RREP (Route Replay) can be sent; otherwise, it performs another border casting in its zone. This is repeated until a route is found.

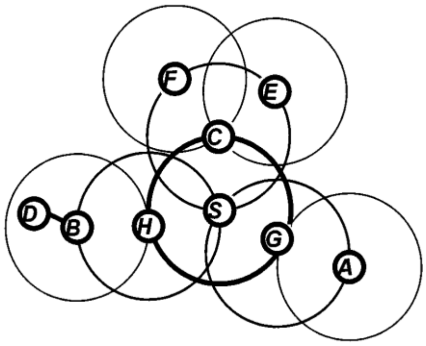

Fig.2 Interzone routing

In the above figure (fig.2), data send from node S to D firstly S checks D is within routing zone or not. If so S already knows the route to node D. Otherwise S sends query to all its border nodes (H, G, and C) and these nodes send the query to next zone nodes and so on until a route is not found. In particular, H sends the query to B, which recognizes D as being in its routing zone and responds to the query, indicating the forwarding path: S –H –B –D.

III. ZRP Architecture

The relationship between ZRP component protocols is illustrated in Fig.3. The proactive approach maintains the routing zone topology that is performed by IARP, through exchange of route update Packets. Route updates are triggered by the MAC-level which notifies IARP when a link to a neighbor is established or broken. IERP simply follow the path from the nodes beyond the routing zone using a query-reply mechanism. IERP forward queries to use the BRP's border cast packet delivery service. Border casting leverages IARP up-to-date view of the local topology to efficiently guide route queries away from the query source.

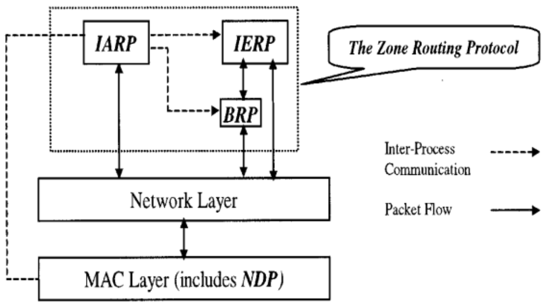

Fig.3 ZRP Architecture

IV. PROPOSED WORK

The wireless sensor networks consist of a numerous number of nodes and shifts or routes the corresponding traffic to belonging node where the traffic is less or energy is less utilized. The conservation of energy of wireless nodes must be minimum enough and fault tolerance must be maintained. Due to leakage of energy the node may be vulnerable to break down or failure. This will be sort out by defining a master node which maintains the energy route from node to node with help of greedy algorithm. With the zone routing protocol will implement a network by using this zone routing protocol the data will be transferred from source to destination.

Basically the zone routing protocol is used for making networks of cluster where each cluster have multiple sink nodes the role of the sink node is to forward data to its nearest neighbor node the whole data transmission will be done using zone routing protocol. The greedy algorithm will decide the nodal path from least to high energy consumption as well as the shortest path. This master node will be responsible to transfer to traffic to corresponding node with minimum energy utilization. Further for load balancing and shifting of traffic to the optimal path decided by master node and running greedy algorithm will be decided by Ant Colony Optimization algorithm. This algorithm will maintain the fault tolerance and will dynamically shift the traffic from least to high energy utilization nodes.

The proposed method will work as follows:

- WSNs contain n number of nodes.
- Each node has its owned threshold value.
- Greedy algorithm is used for best optimal path.
- Ant colony optimization is used for load balancing.
- At the end analysis of energy conservation.
- Stop if no traffic otherwise repeat the whole process.

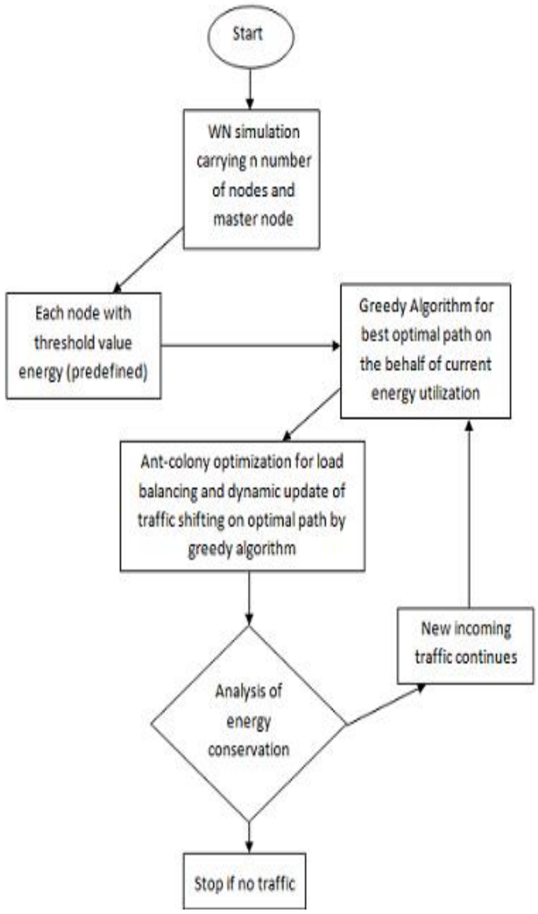

Fig.4 Flow chart of proposed method

V. PERFORMANCE EVALUATIONS

The various simulations have been done using the IDE Netbeans simulation environment to compare the performance of our proposed protocol E-ZET with the Zone and Energy Threshold based Clustering Routing Protocol (ZET), Low Energy Adaptive Clustering Hierarchy (LEACH), and Stable Election Protocol (SEP). The results show that the E-ZET extends the network lifetime and increases the overall throughput, reduces the energy consumption, and optimizes the number of cluster heads.

Simulation Results

IDE Netbeans is used to obtain the desired simulation results. As our proposed protocol work in rounds (transmission time) so the total number of rounds considered for our simulation are 3000. A comparison with E-ZET [12], LEACH [14] and SEP [13] is performed to get the trends of Alive and Dead nodes per round, number of CHs per round, overall throughput of the network and its lifetime.

Figure 5 shows that E-ZET has greater stability time as compared to the ZET [12] LEACH [14] and SEP [13].

The first node of E-ZET is dead after approx. 1700 rounds whereas the first node of ZET, SEP and LEACH is dead after approx. 1200, 1000 and 900 rounds respectively. Considering the total number of rounds i.e. 3000, the stability period of E-ZET, LEACH, SEP and ZET are 34% 20%, 18% and 24% respectively. The network lifetime of E-ZET is 44%, 34% and 16% greater than ZET, LEACH and SEP respectively.

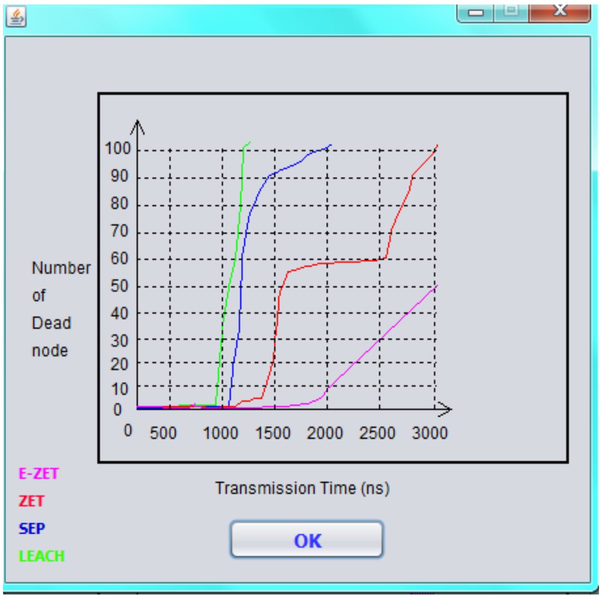

Fig. 5 Total number of dead nodes for 100m × 100m network Number of CHs selected per round

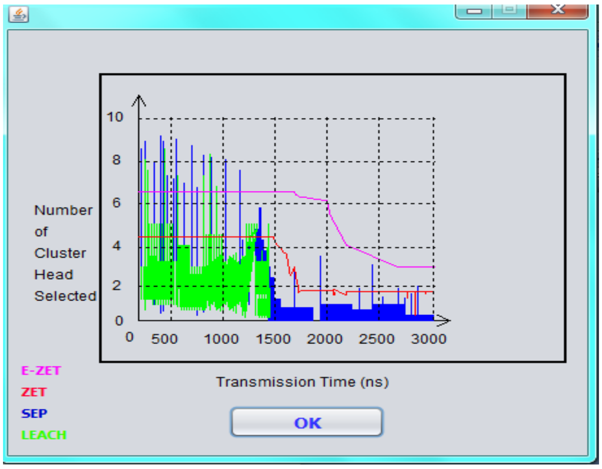

Fig. 6 Number of cluster heads for 100m × 100m network

E-ZET has efficient number of CH selection due to the static Clustering and creation of equal number of regions. In E-ZET fixed number of CHs selected in each round. This leads to efficient CHs selection, bringing longer network lifetime and better stability compared to other distributed clustering routing protocols. On the other hand LEACH and SEP selects number of CHs using distributed algorithm producing random CHs. There is uncertainty in selection of CHs in LEACH and SEP. Random number of cluster heads selected in each round fluctuates due to uncertainty as shown in Fig. 8. These uncertainties decrease the performance of these protocols.

Figure 7 and 8 show that throughput of E-ZET is significantly greater compared to ZET [12], LEACH [14], and SEP [13] in stable and unstable regions. From these results we see that E-ZET guarantees about approx.92%, 89%, and 83% more packets from nodes to the CHs and approx. 91%, 88% and 85% more packets from CHs to the BS in comparison with ZET,LEACH and SEP respectively. The throughput of E-ZET is more than the other protocols because of static clustering and efficient number of cluster head selection. Thus, it proves that E-ZET has higher throughput compared to ZET, LEACH and SEP.

Fig. 7 Comparative throughput (Number of packets to the CH)

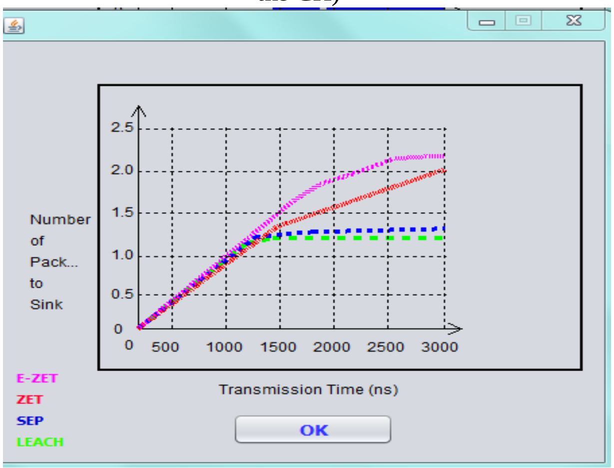

Fig. 8 Comparative throughput (Number of packets to the BS)

VI. CONCLUSION

In this paper, we have proposed a new energy efficient clustering routing protocol, E-ZET for WSNs. The main focus was to enhance the efficiency of CH selection process in the network by dividing the whole network into multiple zones. Proposed E- ZET is a very efficient mechanism for CHs selection while ensuring equal number of cluster heads in each round. In our proposal, the network life time and the stability period have been optimized. Simulation results show that there is a remarkable improvement in network lifetime, stability and throughput when compared with existing routing protocols such as ZET, LEACH and SEP.

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