Energy Aware Mobile Sink Based RPL Routing Protocol for Wireless Sensor Networks

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***Abstract*: - Wireless sensor network consists of wireless sensor nodes equipped with two tiny batteries (AA batteries). As long as the power is there wireless sensor node can take part in transmission and reception of data. When the sensor node depletes all its energy, energy-hole problem, network partition, low data delivery ratio, reduction in network lifetime will also arise. So, there is a need for energy aware routing protocol to increase the data delivery ratio, network connectivity and network lifetime. The proposed approach uses multi hop cluster based wireless sensor network and mobile sink approach for processing the data from wireless sensor network. To implement energy efficiency in routing the information from wireless sensor network to base station mobile sink based RPL routing protocol is proposed.**

***Keywords*- Energy-hole problem, Mobile sink WSN, RPL.**

I. INTRODUCTION

Energy efficiency is an important problem for wireless sensor networks (WSN) since sensor nodes have limited battery power. Replacing the batteries of sensor nodes is it requires some significant effort; therefore, WSNs have to be able to work without human intervention for a sufficient long period of time. Wireless sensor network contains a collection of nodes have extremely small computing device, memory, transmitter module where all the units rely on small tiny batteries and have bandwidth constraint. At the most, wireless sensor network will be developed in remote area where the human intervention is impossible.

In such hard area the network will be formed ad hoc in the nature and nodes are allowed to sense the event information and sent to a central node called sink or base station for next level of processing and analysis. In the static sink routing the wireless sensor network efficient for small network but when we increase the sensor nodes due to energy hole problem network life time will be decreases. Energy hole problem where many-to-point communication is carried out in reporting the sensed data to the static sink. Sink mobility is useful to avoid energy hole problem and balancing the load depending upon the residual energy, connectivity of the sparse network as well as reliable data transfer.

Some of the applications need sink mobility in the sensor field, ex. Fire detection system, Health care system, disaster management, battle field, intrusion detection, and land Sliding area and so on.[1]. Routing Protocol for Low Power Lossy network (RPL) is the Internet Engineering Task Force (IETF) proposed standard protocol for IPv6 routing over Low power Lossy Networks (LLNs).It is a distance-vector protocol for IPv6 networks comprising low-power devices connected by lossy links. Compared to the traditional network, RPL is designed for significantly higher packet loss rates networks. It provides a mechanism multipoint-to-point traffic from devices inside the LLN towards a central control point or sink as well as point-to-multipoint traffic from the central control point or sink to the devices inside the LLN are supported. Support for point-to-point traffic is also available.

It means RPL is fashion based on a single route strategy. But due to the resource constraints of sensor nodes and the unreliability of wireless links, single-path routing approach cannot be considered effective techniques. In order to manage with the limitations of single-path routing techniques, another type of routing strategy, which is called multipath or multihop routing has become as a promising technique. Especially in case of RPL, Destination Oriented Direct Acyclic Graph (DODAG) differs from a tree mainly in that a node can have a set of parent or more than one parent node [2].

The performance of RPL in three different scenarios, First scenario is evaluating the characteristics of RPL with one sink and others are senders (fixed nodes). Then second scenario is adding mobility, and compares mobile nodes to fixed nodes in order to show how mobility can influence protocol parameters. [3]The rest of this paper is organised as follows: related work is presented in Section II, investigate the static sink and mobile sink, Section IV, simulation results are presented in Section V, and finally our conclusions and future work are given in Section VI.

II. RELATED WORK

In wireless sensor networks, a clustering-based technique is considered as an efficient approach for supporting mobile sinks without using position information. It utilizes a Back bone-based Virtual Infrastructure (BVI) which uses only cluster heads (CHs) to make routing structures. Since sensor nodes have limited energy and are failure-prone, the effective design of both a clustering structure to build a BVI and a routing protocol in the BVI is an important issue to achieve energy-efficient and reliable data delivery [1].

Vijayasree S V et al., [4] proposed Node Lifetime Assessment Based Routing for Wireless Sensor Networks. A method to dynamically roughly calculate the lifetime of the node depends on current consumption, battery capacity and temperature as impact factors. Additionally it is combination with routing method. Routing Protocol for Low power lossy networks (RPL) is employed. The target function of RPL uses rank and Expected Transmission Count (ETX) as measures to build the Direct Acyclic Graph and data transmission is done based on the lifetime of the node depends on the lifetime of the network.

Quen le et al., [5] proposed three multipath schemes based on RPL, first scheme is Energy Load Balancing(ELB), second scheme is Fast Local Repair(FLR) and third scheme is combination of ELB-FLR and integrate them in a modified IPv6 communication stack for Internet of Things(IoT).ELB is compare to RPL more load balanced than because one node chooses preferred parent by considering not only residual energy but also using frequency of parents according to one node. To achieve this new set of objective functions to measure rank based on both hop-count and residual energy. Second scheme is FLR to reduce number of local repairs, which provides more path redundancy to use in emergency situation. FLR helps sensor node to find more multiple paths compared to RPL and fast switch to these path on local repair. Third scheme is combination of ELB-FLR both protocols Finally, Combination of two former methods, called EBL-FLR routing protocol that combine with objective function and load balancing of ELB, FLR and loop detection/avoidance of FLR into RPL. [5]

HaofeiXie et al., [6] proposed comparison of three reactive routing protocols results for Wireless sensor networks (WSNs), Ad hoc On Demand Distance Vector (AODV) routing, Dynamic MANET On Demand (DYMO) routing and RPL. For the purpose of performance evaluation, detailed comparisons are made with AODV and DYMO. AODV is support both unicast and multicast routing in Ad hoc networks. It is an on demand algorithm, meaning that it builds routes between nodes only as want by source nodes. DYMO routing protocol is the current engineering focus for reactive routing in the MANET. DYMO, operates same as AODV, but requires only the most basic route discovery and maintenance procedures. [6]

keweisha et al., [7]proposed importance of wireless sensor network in real time applications such as habitat monitoring, environmental and structural monitoring, start to work in practical . They argued that wireless sensor network is a very promising technology for fire rescue applications. First, they abstracted four specific requirements of this application, including accountability offirefighters, real-time monitoring, intelligent scheduling and resource allocation, and web-enabled service and integration. In this fire rescue application using mobile sink is needed for compare to static sink.

III. COMPARISON BETWEEN STATIC SINK AND MOBILE SINK

A) STATIC SINK

In this network topology as shown in Fig.1 which contain static sink(or)central point, base station , An event is occurred in cluster 1, so h1 send event information to h2 because of after comparing with h4, h2 is the shortest path length here this path is constant path from c1 to static sink.

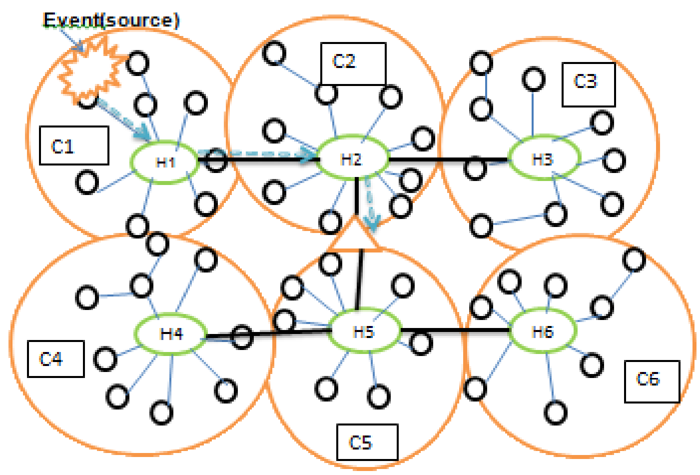

Fig. 1 Static sink network topology

Static Sink(Data collector).

Sensor nodes.

C1,C2,C3,C4,C5,C6: Clusters.

H1,H2,H3,H4,H5,H6: Cluster heads.

After some time h2 will died, because it consumes more energy comparing with h1 that means h2 active time, data transmission is high compare with h1 this is called energy hole problem. When h2 died then h1 cannot be sent any data transmission is to static sink.

Also it is single hope architecture if, h2 fails h1 and h3 cannot be sent any data to sink this is called energy hole problem reduce the network life time. Because of following reasons:

- Single hop architecture.
- Constant sink position.

B) MOBILE SINK

There are three movement models as follows:

- Fixed mobility
- Random mobility

- Controlled mobility

First model is fixed mobility in this model, movement of sink is predefined. Before runtime of programme give position values x-coordinate and y- coordinate with time stamp.

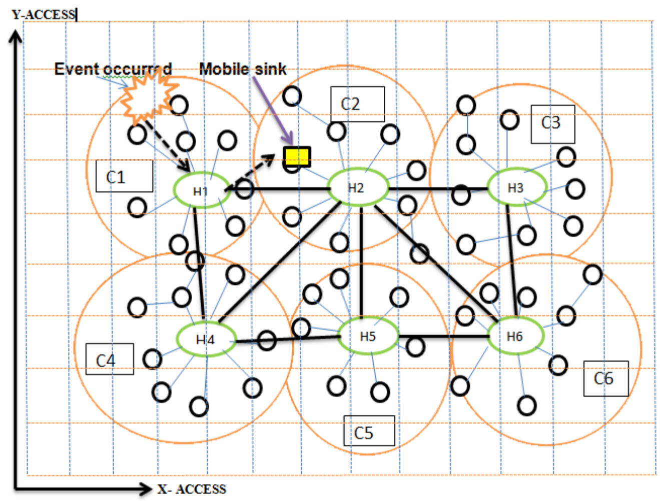

Fig. 2 Mobile sink network topology

Mobile Sink (Data collector).

Sensor node

C1, C2, C3, C4, C5, C6: Clusters.

H1, H2, H3, H4, H5, H6: Cluster heads

Example, when program start at 0.1 time stamp sink position is (0,0),similarly at 0.2, 0.3, 0.4 time stamp sink position is (0,10), (10,0), (10,10). Second model is Random mobility in this model, sink movement is random there is a no position values here it will go randomly. For example, sink is fixed to forest animal so we don't know how that animal will go, it will go randomly depends upon application using this type of model. Last model is controlled mobility model in this model sink movement is controlled by someone in run time. Here sink movement is at runtime this model compare to fixed model it is opposite because sink control is before runtime. For example controlled mobility is use like, Robert controlling through remote controller.

In this below network topology as shown in Fig. 2 which contain mobile sink. In this fixed mobility model, mobile sink will route is predefined, in the form of x-coordinate and y- coordinate**.** Mobile sink position is (60,60)as shown in Fig. 2 When sink is moved one cluster to another cluster as shown in Fig. 2 cluster 1 sent data to direct mobile sink, no need of via cluster 2 and also multi-hop architecture.Mobile sink move around the network topology avoids the longest data transmission paths then improve the network life time. Differences between the static sink and dynamic or mobile sink is source to destination length is reduced. Mobile sink based network topology as shown in Fig. 2 distances between the sources to destination is length is reduced compare to static sink.

In a static sink load balancing is poor, which nodes are close to static sink that nodes are consume more energy compare to which nodes are longest nodes to static sink.in mobile sink load balancing is rich, because of sink is move based on the how should be the load balance around the wireless sensor network topology. When nodes are consume energy equally then automatically network life time will increase then energy hole problem is solved, when network life time is increases then data delivery also high.

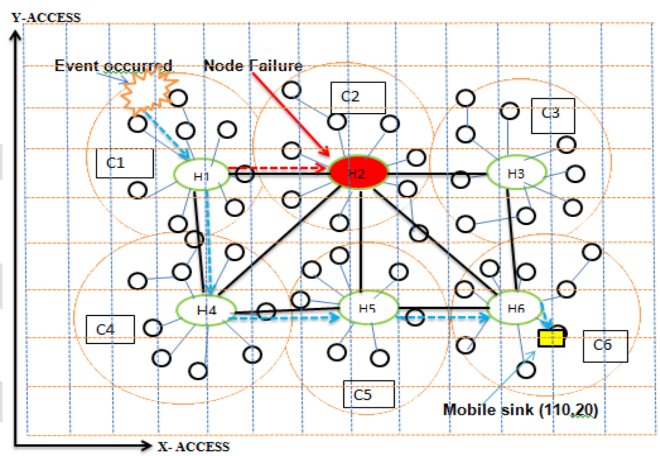

Fig. 3 Mobile sink network topology

Mobile Sink (Data collector).

Sensor node

Failure node

C1, C2, C3, C4, C5, C6: Clusters.

H1, H2, H3, H4, H5, H6: Cluster heads

As shown in Fig. 3 mobile sink is at position (110, 20). Sink is present in C6 but event occurred in C1. Information sent via this route H1-H2-H6 but H2 is died because this node consumed more energy. So this route is fail to send information to mobile sink. Using another route H1-H4-H5-H6 but this is long path compare to previous Hop-count is 2. But now Hop-count is 3 this is called multi-hop routing. In WSNs goal is getting information continues is important without interruption. So life time of network is increased compare to static sink.

IV. SIMULATION & PERFORMANCE EVALUATION

The network environment is designed and implemented using Contiki OS 2.7 in Cooja Network

Simulator. The simulator executes static sink and mobile sink analyse through power tracker. Also execute collect view program and collecting sensor nodes information. In our network topology built first 20 nodes and next 40, 60, 80 respectively. This network topology analysed with static sink and mobile sink. Comparing both networks topologies through power tracker. Simulation created with 80 client nodes as show in figure 4.power tracker window contain mote information, radio on(%) ,Radio TX(%) and Radio RX(%) values. First analysing with static sink network topology with 20 nodes and 40,60,80, respectively.

Table 1
Network simulation parameters

PARAMETERS	VALUES
Operating system	Contiki 2.7
Simulator	Unit Disk Radio Model
Client nodes	**20,40,60,80**
Sink	1
Sink types	Static ,Mobile
Routing protocol	RPL
Sensor node type	Sky mote
INT range	100m
TX	50m
Total simulation time	300 seconds

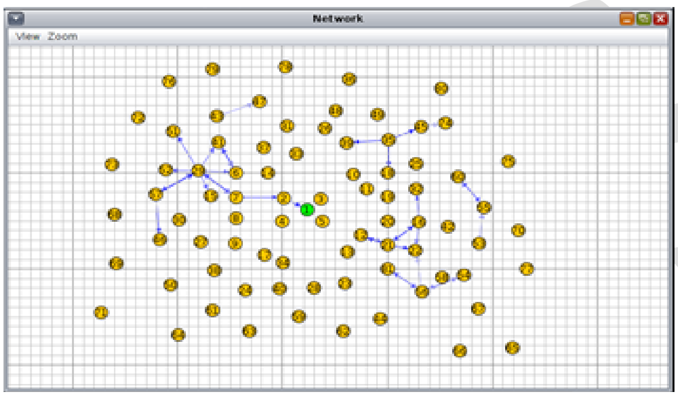

Fig 4: Network window

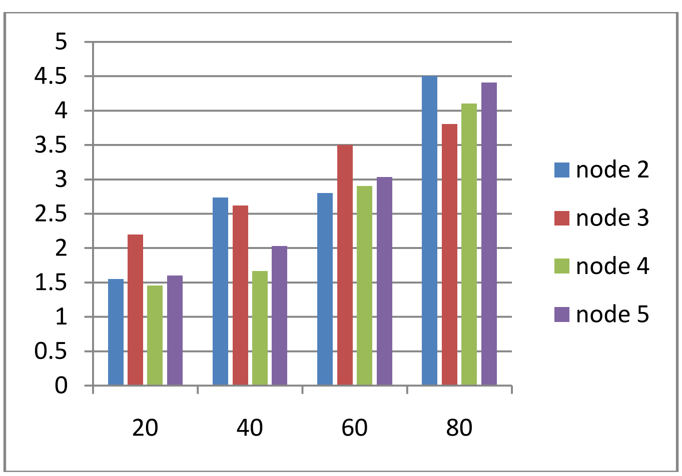

Fig 5: power tracker values analysing with static sink

Analysing energy consumption of nearby nodes as shown in fig 4.2,3,4,5 client nodes are nearby static sink. Above graph as shown in fig 5. When network topology consist of 20 client nodes analysing 2,3,4,5 nodes energy values through power tracker respectively 40,60,80 as shown in fig 5. Next analysing with mobile sink and comparing with static sink graph.

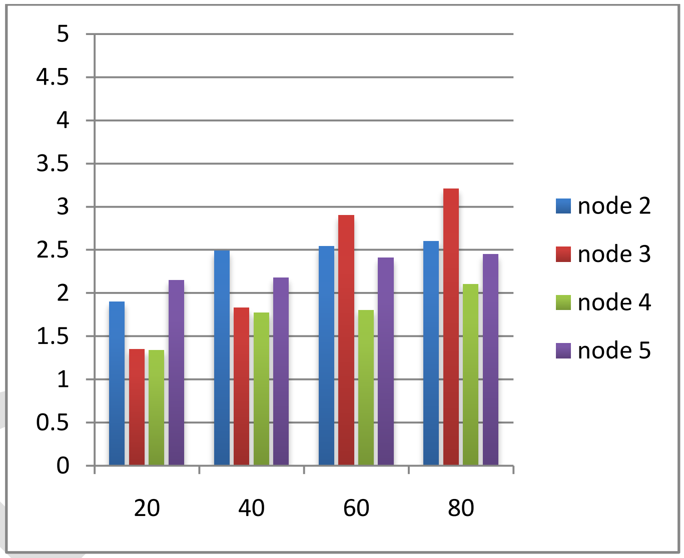

Fig 6: power tracker values analysing with mobile sink

Mobile sink based network topology observing nearby nodes less energy consuming compare to static sink. As shown in fig 6.power tracker values are low compare to static sink power tracker values. Problem is when using static sink source to destination is constant sink position. Nearby nodes consume more energy compare to any other nodes. Results showing nearby nodes consume energy more when using static sink. While using mobile sink nearby nodes consume energy is less as shown in fig 6. Power tracker values.

V. CONCLUSION

In this paper analysed performance of static and mobile sink-based RPL routing protocols was studied in term of energy consumption, data delivery ratio and delay in delivering the packets. It has also been observed that adopting a mobile sink and reducing the energy consumption of the nodes does not necessarily reduce the energy dissipation of wireless sensor network. Instead, a careful selection of the nodes and of mobility radius of the sink is required in order to achieve higher energy efficiency compare to a static sink. Moreover, conclude that in comparison to a static sink placed at the center of the wireless sensor networks, a mobile sink can reduce energy significantly, Irrespective of the mobility radius of the sink.

The simulation results illustrate that mobile sink provides better performance in terms of lifetime, energy consumption and average number of packets communicated to the base station. Thus mobile sink based approach improves the life time of wireless sensor network.

In future, the performance of RPL routing protocol will be studied with more than one mobile sink which will reduce the energy consumption of the WSN & increase the life time of the wireless sensor network.

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