Energy Balanced AODV to Improve Network Lifetime and Energy Efficiency in Wireless Sensor Network

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***Abstract*- In wireless sensor networks (WSNs) one of the most important issue is collecting and processing data from the environment and sending that data from source to sink node. Sensor nodes in WSNs are connected through wireless links. The main use of these nodes are sensing the data when placed in the environment field and sending those sensed data to the base station. In this paper mainly we focus on the problem of maximizing the lifetime of a network and reduce the energy consumption. The proposed system implements the AODV protocol with the help of node level residual energy and hop count along the path towards the destination. In this implementation of AODV protocol along with RREQ message we have to add minimum residual energy (Min-RE) field. The default value of Min-RE field is set as -1.To find a route to destination node first source node broadcast the RREQ packet to the neighbors once the neighbors receives the RREQ packet updates the Min-RE value and rebroadcast the packet to the next nodes until the packet arrives at a destination node, hence the proposed protocol find a route to destination that have minimum number of hops and sufficient energy in intermediate nodes.**

***Index terms*: wireless sensor network, energy consumption, network lifetime, residual energy.**

I. INTRODUCTION

A wireless sensor network (WSNs) consists of light-weight, low power, small size of sensor nodes. Sensor networks are deployed in various application fields such as environmental monitoring, surveillance, industrial control, disaster recovery, and battlefield [1]. It is well known that energy is one of the extremely critical resources for battery-powered WSNs. To extend the lifetime of the network as long as possible, energy efficiency becomes one of the most important feature in WSNs. In order to improve the energy efficiency there are many number of routing protocols available in WSNs, but every routing protocol have their own advantages and disadvantages. Most existing routing protocols attempt to find the minimum energy path to the sink to reduce energy usage at nodes. However, one of the question arises whether it is sufficient to focus on the energy efficiency or any other objectives such as coverage and network lifetime should also be taken into account [1] [2].

Basic features of sensor networks are dynamic network topology, self-organizing capabilities, limited power, node failures and mobility of nodes, multi-hop routing, and large scale of deployment and short-range broadcast communication. In sensor networks nodes have restricted storage, computational and energy resources; so according to these restrictions nodes will not use energy efficiently. [3] Additionally the ad hoc routing protocols, support IP style addressing of sources and destinations for conventional wireless networks. The IP style addressing schema is also use intermediate nodes for the purpose of end-to-end communication between arbitrary nodes in the network. It is possible for any-to-any communication but this approach may be not suitable for unwanted traffic in the network because resulting in extra usage of already limited node resource. So wireless sensor networks many to one communication paradigm is widely used to send their data to a common sink for processing. This is many to one communication results also in non-uniform energy in the network.

According to the periodicity of communication Sensor networks can be divided in two classes such as event driven and continuous dissemination. In order to increase energy efficiency routing protocols are generally implemented to support one class of network. In continuous dissemination networks, routes will be automatically reconstructed, but in event-driven networks if an events occurs then routes will be constructed [4]. However sensor nodes are constrained in bandwidth and energy supply. Such constraint combined with a large number of sensor nodes these nodes have necessitated energy-awareness ta the layer of networking protocol and the stack including network layer also. In wireless sensor network research routing of sensor data has one of the challenge because the routing protocols mostly focus on energy aware to maximize the lifetime of the network[8] [9], tolerant to sensor damage and battery exhaustion and scalable for large number of sensor nodes.

Based on previous routing protocols most of the protocols nodes closer to the destination tend to loss their energy faster than the others [3]. This uneven energy depletion decreases the coverage ratio and reduces the network lifetime [4]. Nodes closer to destination means the nodes one hop away from the destination deplete their energy, the depletion of energy is approximately 93 percent of initial energy left at the nodes farther away. Such unbalance of energy consumption imbalance is definitely not desirable for the long term of the network [8]. Even though the sensor nodes consume their energy more, the connectivity between the source and the destination can be maintain long time thus resulting makes does not make network partition.

The Energy-aware routing protocols mostly focus only on energy efficiency that means find the optimal path to optimize the energy consumption it is also useful for balancing energy consumption [7]. The power efficient energy-aware routing protocol for WSNs mainly based upon the on-demand ad hoc routing protocol since which determines the proper path with the help of residual energy. The aim of proposed protocol is to extend the lifetime of the network and optimize the energy consumption with the help of AODV and residual energy and avoiding the unbalanced exhaustion of node when traffic congestion occur on particular network.

II. RELATEDWORK

As mentioned, various literatures focus on energy efficiency whose target is to find an optimal path to minimize energy consumption on local nodes or in the whole network [5], [7], [8]. Some existing routing protocols have recognized the problem of energy imbalance and hot spot problem.

The first algorithm is based on the Bellman-ford routing algorithm [5]. It is one type of proactive protocol and it belongs to the table driven family that means it maintains routing table and if any event occur then it will be automatically updated. The routing table contains information about old routes, shortest prevent distance and also first node on the shortest path to every others in the networks. By using sequence number we are prevent the loops and count to infinity problem. Each node have their own sequence numbers and these are chosen randomly [5] [6]. Each node periodically update the sequence number and in the normal update. Once the node receive the packet or data it will automatically increase the sequence number by two other wise increase by one.

DSDV is a hop-by-hop distance vector routing protocol that means each node maintain information about routing in the form of routing table. The main advantage of DSDV is it guarantees loop freedom compare to traditional distance protocols.

AODV is a combination of both DSR and DSDV. AODV is mainly works on on-demand mechanism of route maintenance from DSR and route discovery plus the use of hop-by-hop routing, sequence numbers, periodic beacons from DSDV [6]. In AODV the source node broadcast the ROUTE REQUEST (RREQ) message to the neighbours, the RREQ message contains sequence numbers of source and destination. Once the neighbours recieve the RREQ message it will rebroadcast the RREQ packet to its neighbours this process repeat until it reaches to the sink node [6] [7]. Each node that forwards the RREQ creates a reverse route for itself back to source node that means if the RREQ message reaches to destination node it generates the ROUTE REPLY (RREP) that contains the number of hops and sequence number of source node and most recently seen by the node generating the reply.

III. PROPOSED SYSTEM

Our proposed system implements the energy saving routing protocol in the limited battery sensor network in order to improve the network lifetime. The implementation of AODV performs the route discovery similar to the AODV protocol but the only difference is we have to add minimum residual energy to the RREQ message and by default the value of residual energy set as -1 when source node flooding the RREQ message for finding the route discovery[5][7]. In order to find a route from source to destination, source node broadcast the RREQ packet along with minimum residual energy to its neighbours [8]. Once the neighbours receive the RREQ message its update the residual energy value and rebroadcast the RREQ message until it reaches a sink node. If the neighbours receive a RREQ message, it increase the hop count value by one and replace the Min-RE value by minimum energy value of the route [9], if Min-RE is greater compare to its own energy value; otherwise Min-RE remains same. The proposed protocol find the routes that have the least hop count and minimum residual energy of nodes relatively large and then find a proper route among them, which route consume minimum network energy by using the following formula.

α= Min-RE/number of hops

Where Min-RE is minimum residual energy on the route and number of hops is the hop count between source and destination.

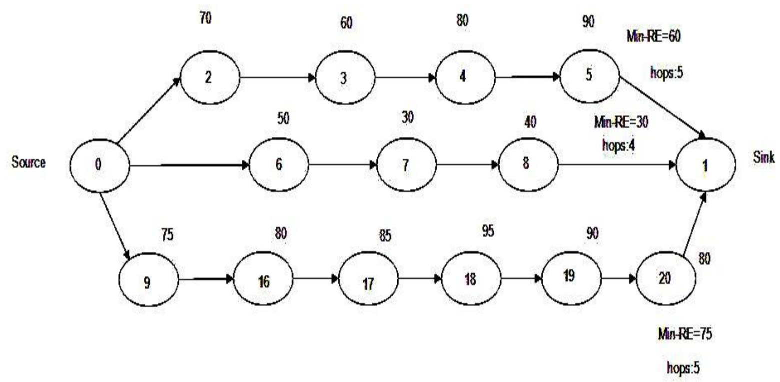

Fig 1: A sample network for establishment a routing path

In Fig1, there are three routes are available. Node 0 broadcast the RREQ and Min-RE to its neighbours 2,6,9 and once the node 2,node6, node 9 receives the RREQ then update the Min-RE value by70,50,75 respectively this process continue until the RREQ packet reaches to destination node 1, after reaching the RREQ packet to its destination node 1 we have to calculate the network energy based the number of hops and Min-RE value of route once calculate the network energy we can select the path of heighest value 'α' so in the example <0-2-3-4-5-1> is path of forwarding the packets to the sink node because the value of 'α' is more compare to other routes.

IV. SIMULATION RESULTS

1. Energy consumption

The sum of energy consumption of all the nodes in the network is called energy consumption of network. The difference between energy of the node at the start of the communication and the energy of the node at the end of communication is called node energy consumption. By using the following formula we can determine the energy consumption.

Energy Consumption=∑ (initial energy-residual energy)

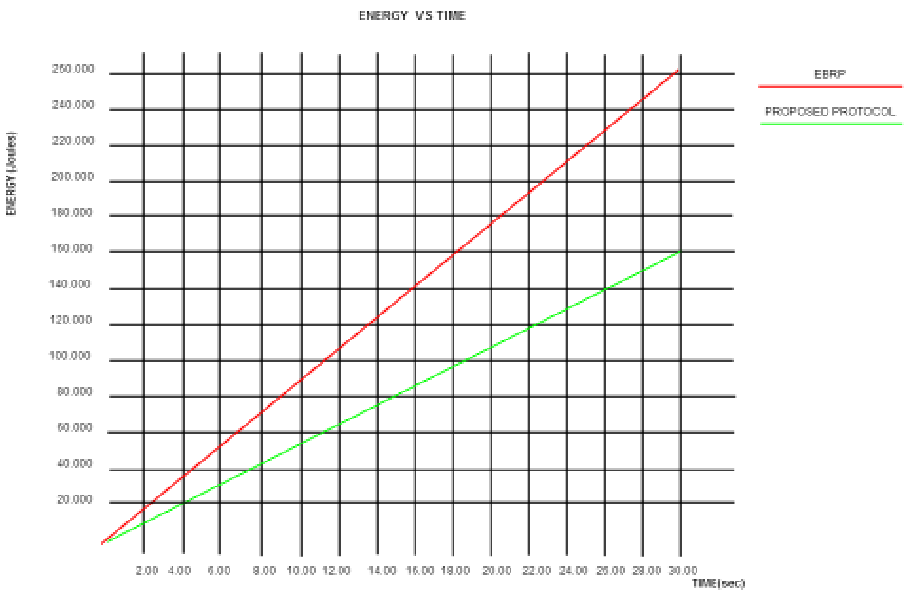

Fig 2. Energy consumption

In Fig 2, the top line represents the existing protocol energy consumption, bottom line represents the proposed protocol energy consumption that means hoe the energy loss during data transmission time. We observed that the comparison of energy consumption between Energy balanced routing protocol (EBRP) and implementation of AODV protocol. At the time of 0 sec both start to transfer the data or packets to sink node, but after some time that means 30sec the EBRP loss more energy compare to proposed protocol.

2. Throughput

The rose colour (top) line represents the proposed protocol throughput and the bottom line represents the EBRP protocol throughput.

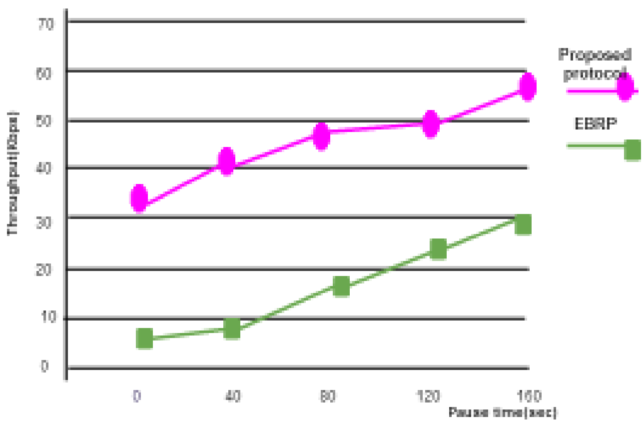

Fig 3: Throughput

In Fig 3 the throughput of AODV is a high growth from 40kbps at pause time 0 sec to 61 kbps at time 40 sec but in EBRP 6.15kbps at time 0 sec and increase by approximately 14kbps at pause time 120 sec. According to the simulation results presented in Fig 3, better performance is shown by AODV. Throughput increase increases in both protocols along with increasing of the pause time but AODV improves the throughput compare to existing (EBRP) routing protocol.

V. CONCLUSIONS

We observed that Ad-hoc on demand distance vector routing protocol reduces the energy consumption compared to other routing protocol with the help of residual energy and hop count. In this route discovery process path is largest minimum residual energy and least hop count is chosen. According to neighbours range of nodes adjust the transmission power of the node. Thus proposed protocol optimize the energy consumption compare to existing protocol.

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