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RESEARCH ARTICLE

An Improved Energy Efficient Multipath Routing in WSN

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Abstract— The objective of the paper is to provide energy efficient Multipath routing in wireless sensor network in order to improve the network lifetime. In traditional system single path routing is used which tracks one node at a time. But it does not use optimization methods and imposes no performance constraints to reduce energy consumption. This single path routing is simple and scalable but it is not optimal to maximize the network lifetime and connectivity. So to overcome this problem multipath routing approach is implemented in this proposed system. The proposed system consists of i) Topology discovery ii) Data communication iii) Energy efficient maximum lifetime routing. This proposed method improves the network lifetime by selecting the multiple paths to deliver data from source to destination. On comparison with the other existing system the proposed system achieves the better end to end delay, jitter and packet delivery ratio.

Keywords— Energy efficiency; multipath routing; Energy Efficient Routing; Network lifetime

I. INTRODUCTION

A wireless sensor network (WSN) consists of spatially distributed sensor nodes that kindly monitor environmental condition. WSNs are used in many industrial application areas such as environment monitoring, pollutant monitoring, and healthcare applications. WSN is composed of two types of nodes: sink nodes and sensor nodes. First, sensor nodes collect surrounding information with sensors; second, a sink node is in charge of connection between the Internet and sensor nodes. A sink node acting an important role as a gateway, so it has redundant components for the high reliability. Sensor nodes are typically equipped with low-end components, because generally hundreds or thousands of sensor nodes are needed for a WSN to provide the secure monitoring function. Sensor nodes generally run with battery power, hence the power is the most important resource in WSN [1].

Ad-Hoc On-Demand Distance Vector (AODV) Routing Protocol maintains only the routes that are presently in use, in that way reducing the load on the network. However, they still have some in-built limitations. Since routes are only maintained while in use, it is typically required to carry out a route discovery before packets can be exchanged between two nodes. There may be a chance of data loss if the route discovery process takes a long time to discover the path between source and destination. Multipath Routing is an alternative routing technique selects the multiple paths to deliver data from source to destination. Energy Efficient Routing Protocol is used to improve the network lifetime and balances the energy consumption well among the sensor nodes [2]. Multipath Energy Efficient Routing protocol has main goal to consume energy optimally.

This paper makes the subsequent contributions:

- A multipath search algorithm is to discover multiple paths between sources and sink nodes.
- It keeps a set of good paths and chooses the node state based on cost function of the path.
- The path selection is done using the minimum energy transmission over the network nodes.

A. Issues and Challenges of WSN

1) Energy Efficiency: Efficient energy use, sometimes simply called energy efficiency, is the goal to reduce the amount of energy required to provide products and services.

2) ***Accuracy****:* The accuracy of a measurement system is the degree of closeness of measurements of a quantity to that quantity's actual value.

3) ***Scalability*****:** It is the ability of a computer application or product (hardware or software) to continue to function well when it is changed in size or volume in order to meet a user need.

4) ***Security****: Security* is the degree of resistance to, or protection from, harm. It applies to any d valuable asset, such as a person, dwelling, community, nation, or organization.

5) Deployment: Deployment means setting up an operational sensor network in a real world environment. Deployment of sensor network is a labor intensive and cumbersome activity as do not have influence over the quality of wireless communication and also the real world puts strains on sensor nodes by interfering during communications. Sensor nodes can be deployed either by placing one after another in a sensor field or by dropping it from a plane.

There are many challenges in Wireless Sensor Network in which energy efficiency is the most important. In the existing system since the energy efficiency is less where all the sensor nodes are mostly in active mode. Hence Energy Efficient Routing Protocol method is proposed that would improve the performance and network lifetime of wireless sensor network in terms of energy efficiency.

The rest of the paper is structured as follows: Related work is discussed in section II. In section III, more details about the methodology of the proposed system are described. In section IV experimental results are described. Conclusion presented in section V.

II. RELATED WORKS

Y. Zhuang, J. Pan, and L. Cai proposed an Minimizing Energy Consumption with Probabilistic Distance Models [3]. The energy consumption has a prolong lifetime of wireless sensor network and minimize energy cost .In grid-based clustering model average distance between two communicating sensors are calculated. Once the grid structure is established nodes can communicate locally with their grid head and reach the data processing center or the sink node, through neighbour grids. The drawback of this method is forwarding the node

can communicate not only with the nodes in their immediate neighbour grids, but also the nodes further away towards the destination and also reduces the number of hops needed to reach the destination.

S. Saqaeeyan, M. Roshanzadeh proposed a system for IEATH: Improved Energy Aware and Two Hop Multipath Routing Protocol in Wireless Sensor Networks [4]. In Wireless sensor networks in terms of energy source are limited, because of this type of wireless communications and channel errors are not possible to reach the correct packet to the destination. Energy-efficient route detection and relaying of data from the sensor nodes to the sink the duration of the network is maximized. The proposed algorithm is to improve the quality of services in this network while sending packets. Multipath forwarding methods guarantee that a packet of information sent to the destination without any delay. Routing decisions based on information nodes are located in the two jumps. Using hybrid method data transmission can be enhanced. The consequences show that the rate of release data packets reduced in this way and thus the reliability of packet is increased, besides the energy efficiency of sensor nodes effectively improved. Therefore this algorithm increases the lifetime in wireless sensor networks.

C. Sengul, M.J. Miller, and I. Gupta proposed an Adaptive Probability-Based Broadcast Forwarding in Energy-Saving Sensor Networks [5]. In Probability-Based Broadcast Forwarding (PBBF), can be used in conjunction and it exploits the redundancy in broadcast communication and forwards packets using probability based approach. The goal of performance is to evaluate the PBBF in terms of its ability to tune latency, energy, and reliability of broadcast .The main goal of PBBF is to provide application designers trade off knobs, p and q, to achieve the desired operation points in terms of energy, latency, and reliability. The drawback of this method is to minimize resource usage to optimize performance metrics such as latency and reliability is to reduce the energy consumption for proactive wake up and in duty cycling puts nodes to sleep and wake periodically.

Y.M. Lu and V.W.S. Wong proposed an Energy-Efficient Multipath Routing Protocol for Wireless Sensor Networks [6]. In multipath routing protocol is used to find multiple disjoint paths between a pair of sink and source nodes. Multi path routing has three phases, the initialization phase, the path search phase, the data transmission and path maintenance phase. In initialization phase, each node will have the sink table and the neighbouring node table updated. Each node then broadcasts a connectivity message to its immediate neighbours. The path search phase is initiated when a set of nodes detect the incentive and the selected source node begins to send the aggregated data to the sink node. In Data Transmission and Paths Maintenance Phase after multiple paths are discovered, the source node begins to transmit data packets with the assigned rates on each path. The node energy consumption measures the average energy dissipated by the node in order to transmit a data packet from the source to the sink. The drawback of this method is to improve the integration of data aggregation and support the node with limited mobility and to improve the scalability and increase the energy efficiency in multipath routing protocol.

Saira Banu, R.Dhanasekaran, proposed A New Multipath Routing Approach for Energy Efficiency in Wireless Sensor Networks [7].In Wireless Sensor Networks (WSNs), sensors nodes are structured in random. Routing in wireless sensor networks is a challenging task. This task may direct to a number of routing protocols which successfully use the limited resources available at the sensor nodes. Here all the routing protocols are attempt to find the optimal path. In order to determine the alternative path quickly, there is need to reduce

energy path and time. The New Multipath Routing Approach (NMRA) is used to increase the energy efficiency in WSNs. NMRA consists of three phases. First, the multipath routing is constructed to create a set of neighbours that address all nodes that are able to transmit data from the source. Second, the optimal energy path is established to estimate minimum energy consumption aims to maintain the data packet flow in the wireless sensor network unobstructed. Third, the energy consumption model is developed where residual energy consumption is increased using energy model. The proposed NMRA achieves better delivery ratio, improved network lifetime and less delay.

III. METHODOLOGY

In Multipath routing method the Energy Efficient Routing Protocol is used to improve lifetime of the network. Energy Efficient Routing Protocol is used to minimizes and balanced the energy consumption well among the sensor nodes. Multipath energy efficient routing protocol aims to consume the energy optimally. Multipath routing is an alternative routing technique, which selects the multiple paths to deliver data from source to destination. Multipath routing technique combines transmission energy reduction and distribution of this energy over the entire network. A block diagram shows the topology discovery in Fig.1.

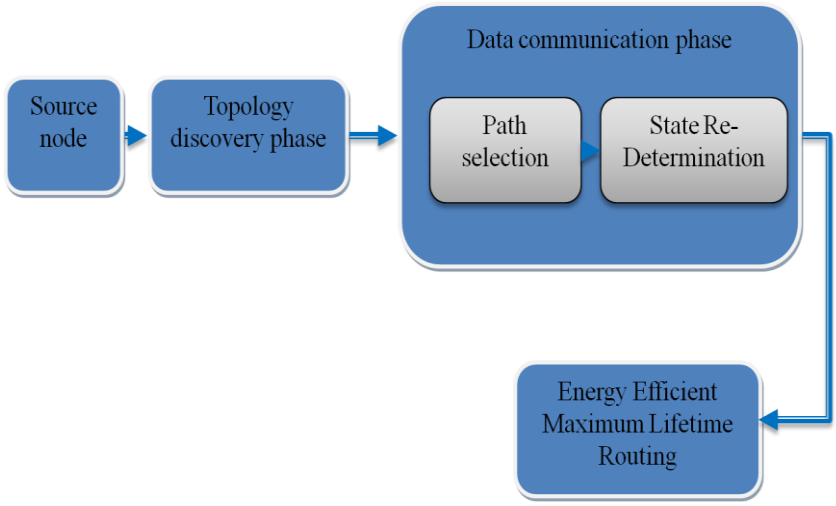

Fig. 1 Block Diagram

A. Topology Discovery

The major activities in this phase are routing path formation for each node and creation neighbour table. The sink node initiates the connection by flooding the network in the direction of the source node. It also sets the "distance" field to zero before sending the signalization packet called NEIDET: Neighbours Detection. These NEIDET packets are broadcasted again by all nodes of the network until the packet is received by the source nodes. Every intermediate node forwards the NEIDET packet only to the neighbours that are closer to the source node. Thus at a node N_i, the NEIDET packet is sent only to a neighbor N_j, which satisfies Eqs.(1) and (2):

$$d(i, j) < R_i , \quad (1)$$

$$d(i, BS) < \sqrt{(d(j,i)^2 + d(i,BS)^2)} \quad (2)$$

Ad hoc on demand Distance Vector (AODV) routing protocol is used to calculate current state of the node. AODV protocol is intended to accommodate networks that are large as several nodes that are communicated with sink nodes. To decide the distance between sender and receiver, and the signal strength of received packet is measured. Using received packet the distance between two nodes could be determined.

B. Data Communication

In data communication when a node detected an event, it should send data related to that event to the sink. All nodes know their least cost route to the sink. The steps are as follows

- Path selection step
- State Re-Determination step

In Path selection step the source node sends the data packet to any neighbours in the NIT (Neighbour Information Table).NIT for all its neighbours concerned with minimum path cost. The State Re-Determination step will execute in all neighbours if it is less than a predetermined threshold.

Steps:

Step 1: N_j be the neighbour of node N_i

Step 2: Neighbour Information Table NIT_i be the neighbour of N_i

Step 3: NIT-$CONC_i$ be the neighbour of N_i with concerned state

Step 4: All data packet received by neighbour N_i

Step 5: Calculate energy threshold of N_i

C. Energy Efficient Maximum Lifetime Routing

Greedy approach for energy efficient routing is the concept of classifying neighbours based on node energy level and their distance between nodes. Some neighbours may be more favourable to choose than the others, not only based on distance, but also based on energy characteristics. It suggests that neighbour selection scheme may be needed to avoid the weak nodes. The transmitting node forwards packet it to the neighbour which is alive and has the distance equal to or less than the average distance of all its neighbours and among those neighbours having the maximum energy level.

Steps:

Step 1: Initialize randomly deployed nodes in network where number of nodes to be deployed in the network.

Step 2: For every node of network find (n)

Step 3: detect neighbours of the node and add it to the Neighbour table where s is the source and d is destination.

Step 4: Findavg(n,d)

Step 5: For all nodes if node is alive

Step 7: Else drop the packet

IV.EXPERIMENTAL RESULTS

In Multipath routing protocol multiple paths are selected to deliver the data from source to destination. The mobility nodes are created first in the scenario. Fig. 2 Routing path of data (source to sink) running scenarios of 40 nodes for maximizing the lifetime of node.

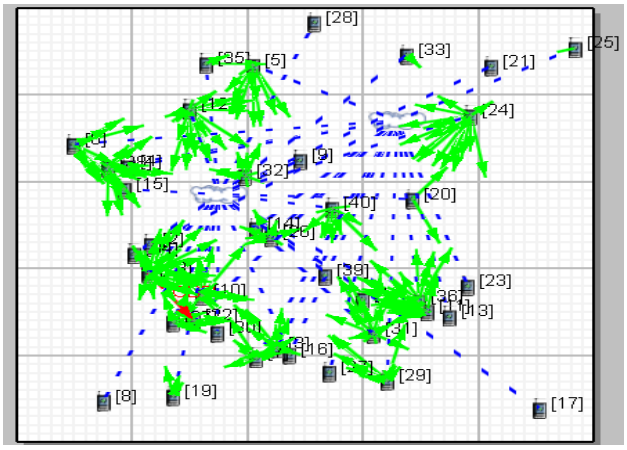

Fig. 2 Running stage

Qualnet provides Packet Tracer tools to analyse information contained in trace files. Packet Tracer presents the trace data in a structured visual format that can easily be interpreted. It provides search, sort, and filter functionality for meaningful and efficient results, and provides the following:

- Support for viewing trace data of packets through multiple protocols across layers and nodes in a tabular format.
- Support for viewing the protocols and their attributes in a hierarchical tree format. The ability to search attributes of the protocols for matches to various conditions.
- Support for column sorting, string searching, and moving to a particular record of the tabular trace data shows in Fig.3.

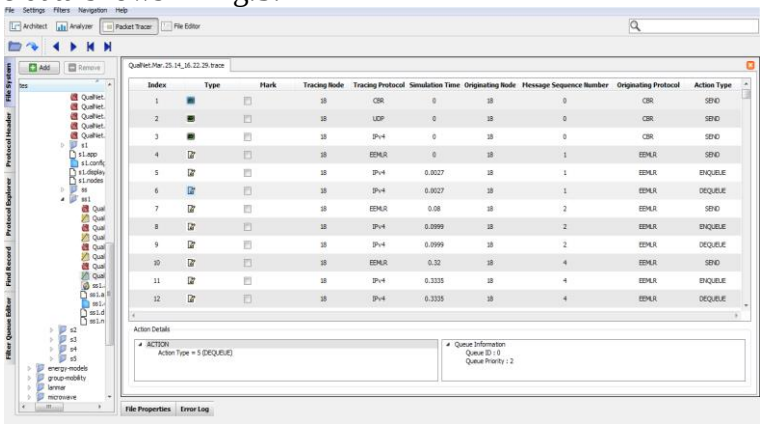

Fig.3 Packet Tracer

Energy Efficiency Routing Protocol is compared with AODV which improves the network lifetime of node. Then calculate the packet delivery ratio using number of packets sends in client side and the number packets received in server side.

The packet delivery ratio has the number of deliver data packet to the receiver to the number of data packets to the sender. This illustrates the level of delivered data to the destination shows the Fig. 4.

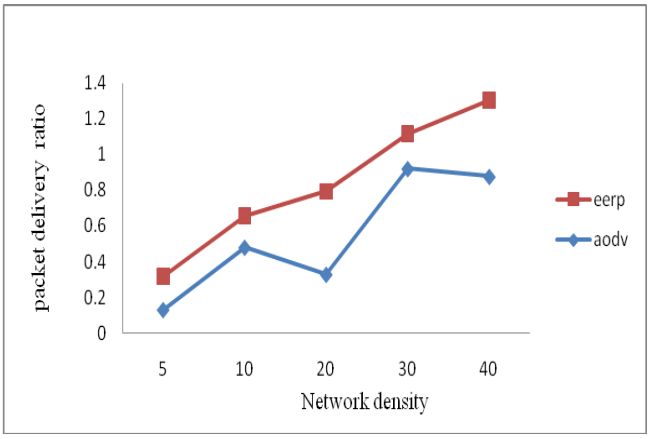

Fig. 4 Packet delivery ratio

Fig.4 shows that the packet delivery ratio of the AODV is less compared to the packet delivery ratio of Energy Efficient Routing.

Fig. 5 calculates the Jitter is the variation in latency as measured the unpredictability over time of the packet latency across the network.

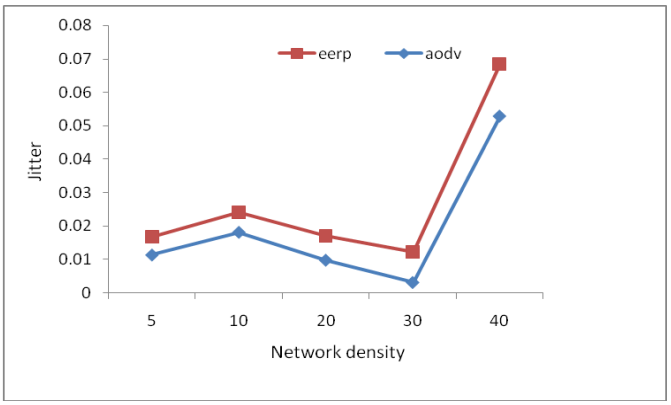

Fig. 5 Jitter

Fig. 5 shows that the average Jitter of the AODV is less compared to that of Energy Efficient Routing method.

Fig. 6 shows the End to End delay: the average time taken by a data packet to arrive in the destination. Σ (arrive time – send time) / Σ Number of connections

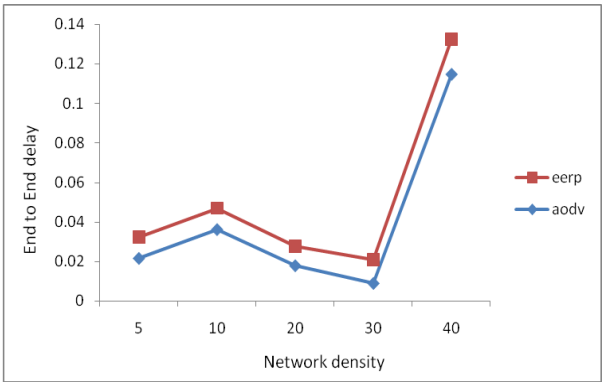

Fig. 6 End to End delay

Fig. 7 shows the Throughput of the packet measuring the maximum data throughput in bits/sec and transfers a large file from one system to another system and measure the time required to complete the transfer or copy file.

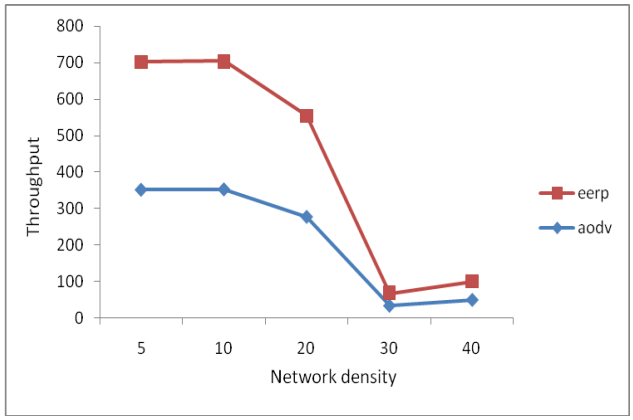

Fig. 7 Throughput

Fig. 7 shows that the throughput of AODV is less compared to that of Energy efficient routing protocol.

From the above analysis, it is found that

- Energy Efficient routing protocol delivers more packets than AODV protocol
- End to End delay of Energy efficient routing is less than AODV protocol
- Energy efficient routing provides improved throughput and jitter when compared to AODV

When comparing with AODV protocol, Energy efficiency routing protocol increase the network lifetime and hence it is proved the better energy efficiency is achieved using Energy efficiency Routing method.

V.CONCLUSION

Multipath routing is an energy efficient technique to route data in WSN. This paper proposed a greedy approach for Energy efficient routing protocol. Its main goal is to consume energy optimally. In Energy efficiency routing protocol each node has the number of neighbours through it can route packets to the base station. The NIT for all its neighbours concerned with minimum cost function. Simulation results show that Energy efficient routing minimizes and balances the energy consumption and improves the network lifetime in WSN.

From the performance analysis, it has been found that Energy efficient routing improves network lifetime by 57 percent.

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