COOPERATIVE PROTOCOL FOR QOS ROUTING IN WIRELESS SENSOR NETWORKS

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ABSTRACT

In cooperative networks, optimum path should be selected based on QoS parameters and then the node will recruit the neighboring nodes to form a cluster and assist in communication. QoS based routing for wireless sensor networks helps to select optimum path for routing and it improves the overall performance of the network. In this paper, we have modeled a QoS based cooperative protocol for wireless sensor networks. We have analyzed the energy consumption of nodes and throughput. We have compared the energy consumption and throughput of our proposed QoS based cooperative protocol with existing cooperative transmission protocol. Network Simulator 2 (NS 2) is used to model the method and the comparison results show that the QoS based cooperative protocol outperforms the existing cooperative protocol in terms of energy of nodes and throughput.

Index Terms: Cluster, Cooperative Transmission, Energy, QoS Routing, Wireless Sensor Networks (WSN) Introduction *(Heading 1)*

I. INTRODUCTION

In wireless sensor networks, the nodes often spend most of their energy on communication. In many applications, the nodes are small and have limited and non-replenish able energy supplies. For this reason, energy conservation is critical for extending the life time of these networks. One recent technology that allows energy savings is cooperative transmission. In cooperative transmission nodes will cooperate then simultaneously receive, decode and retransmit data packets. Our QoS based cooperative protocol model consists of number of nodes that are capable of cooperating, to reduce the consumption of energy.

In QoS based cooperative protocol, all the node in the path from the basis node to the sink node becomes cluster head. The cluster head node creates the one node thick path based on Qos constraints by recruiting other nodes in its neighbourhood, coordinating their transmissions. The optimum path will be selected and the nodes will act as a cluster head and helps to recruit the neighbouring nodes and forms a transmitting cluster and receiving cluster. Figure 1 shows the QoS based cooperating protocol for cooperative transmission of data.

Our QoS based cooperative protocol consists of two phases. 1. Route Identification phase 2. Recruitment and transmission phase. In the route Identification phase, the initial path between the source and the sink node is identified as a fundamental one node thick path. This one node thick path should be identified based on the QoS parameters. The QoS parameters that we have considered are bandwidth, delay, queue length, and energy of the node. QoS based routing protocol can search for the path with sufficient resources. In recruitment and transmission phase, the nodes on the initial path are responsible for selecting the adjacent nodes from the region by functioning as cluster heads.

A key advantage of QoS based cooperative protocol is that the received power at the receiving node is significantly increased. This cuts the likelihood of bit error and packet loss. Then the sender nodes can reduce the energy consumption by transmitting with lesser transmission power for the same possibility of bit error and QoS based routing guarantees the ability of a network to deliver predictable results.

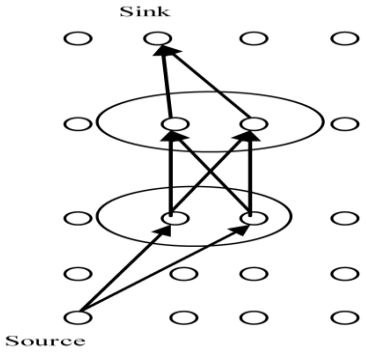

Fig.1. Cooperative network

We compare our QoS based cooperative protocol with cooperative transmission protocol.

In this paper, we analyze the simulation results of our cooperative protocol and then compared the result to the results of the cooperative communication protocol

RELATED WORKS

Energy efficient protocol for cooperative network was formulated [1]. Analytical models were used to evaluate the performance of the protocol in terms of robustness, data loss, energy conservation and the capacity. This paper does not consider the Qos parameters [1].

Two energy efficient algorithms are used to find the cooperative route, where each hop consists of several sender nodes to single receiver nodes [2]. MAC layer design is focused [3] the cooperative nodes retransmit the data, when no acknowledgement is received from the destination after timeout. This work mainly focuses on the reduction of transmission errors. It does not consider energy saving criteria.

The data is transferred from the sender by multiple antennas and the receiver receives it by multiple antennas Cost of implementing multiple antenna at each node is the main drawback in this method, Further, it is impractical in wireless sensor networks [4].

A MAC protocol based on centralized cluster architecture is described. In this clustering mechanism nodes in the cluster cooperate to move the data to the next cluster head on the path of the sink [5]. Nodes belonging to a cluster cooperate with each other to

forward the data to only the next cluster head on the pathway to the sink. This centralized architecture leads to much higher energy usage for the cluster maintenance [5]. On the other hand, distributed mechanisms are less susceptible to single point of failure and are more capable in the cluster maintenance operation

II. PROPOSED PROTOCOL

In wireless sensor networks, we consider a regular grid topology, where the nodes are located at equal distance from each other, based on MAC layer packets (RTS/CTS) exchange each node should identify its topology that is its neighbouring nodes. Each node will exchange hello packets to its neighbouring nodes which are all in communication range. After exchanging hello message, the node adds its QoS parameters to hello information.

Route Identification phase: In route identification phase of the protocol, "one node thick" route from the sink node to source node is selected based on QoS metrics. QoS metrics that is taken into consideration are the delay, bandwidth, energy and packet loss which can be reflected on the node and link. For every node, the metrics are delay function, bandwidth function, packet loss function and energy function. After defining Qos metrics of the node and the link, the Qos metrics of the path is calculated. The optimum resource path will be selected as one node thick route from the sink node to source node through exchange of short control packets.

Recruitment and transmission phase: In recruitment and transmission phase recruitment is done dynamically per step, starting from basis node and continuing, step by step, until the packet reaches the destination node. When a packet is received at a destination node, it becomes the receiving cluster which acts as a sending cluster and the new receiving cluster will start developing. Then the sending cluster head synchronizes its nodes to the nodes of the receiving cluster.

The example in figure 2, demonstrates the operation of the "recruitment and transmission phase". The node 2 is the sending cluster and we consider that it has to send a data packet to node 5. The node 2 sends a Recruitment Request packet to node 5, when node 5 receives this packet, node 5 acts as a cluster head and it starts the receiving cluster formation. From the route identification phase node 5 knows that the next node is node 8. Node 5 broadcast to its neighbors a Novice packet. The Novice packet includes the id of the prior node and the next node and extreme time to respond. The nodes which receive the Novice packet are called as probable recruits. The probable recruit replies to Novice packet as Novice Grant packet.

The Novice Grant packet informs the cluster head that the nodes are available at the receiving end which is ready to cooperate. After the maximum time to respond the nodes collect the number of grants, the cluster head selects m-1 cooperating nodes. Then node 5 will send the Clear packet which includes the selected nodes for cooperation. The Clear packet informs the sending cluster head about the formation of cluster and it inform the probable recruit whether they are selected for cooperation or not. After receiving the Clear packet from node 5, node 2 sends the sends the Confirm packet to the nodes in the sending cluster to synchronize their data transmission packets.

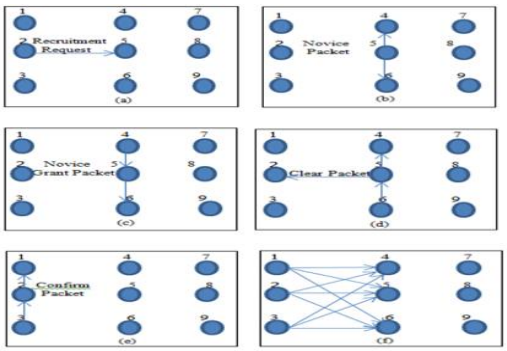

Fig.2. Example of recruitment phase operation (a) Recruitment request. (b) Novice *packet. (c)* Novice *Grant packet. (d) Clear packet. (e) Confirm packet. (f) Data Transmission packet*

PERFORMANCE EVALUATION

The implementation is done based on Dynamic Source Routing (DSR) protocol using network simulator 2. We have two phases 1. Route Identification phase 2. Recruitment and transmission phase.

In the experiment, the nodes are positioned on a grid (5×7) topology in 630×570. We assume the band width to be 1 MB, the length of the data packets is 256 bytes, the number of nodes for cooperation is m= 3. The metrics we evaluate are: energy consumption and throughput. We have considered 36 nodes, the nodes are placed on grid topology. The energy is initially set to 100 joules. The total energy consumption measures the sum of the energy of all packet transmissions. The throughput is measured which is defined as the ratio of number of packets received to the time in seconds.

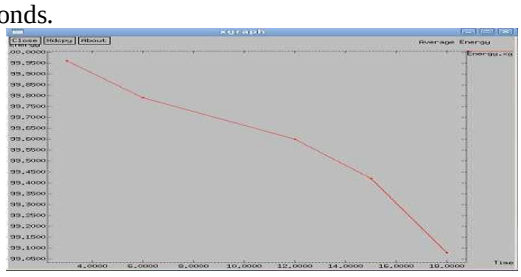

Fig.3. Performance of energy consumption

Throughput: In our QoS based cooperative protocol, we have achieved high throughput. The throughput is defined as the ratio of the number of packet received to the times in seconds. The performance of throughput is shown in the figure 4.

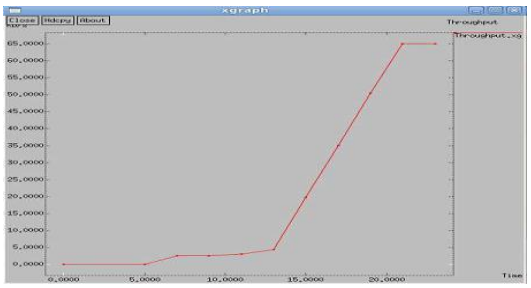

Fig.4. Performance of throughput

Comparison results

The energy consumption is less in QoS based cooperative protocol compared to the cooperative transmission protocol.

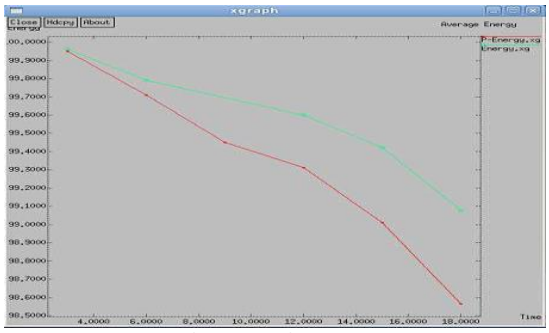

Fig.5. Performance of energy comparison.

The throughput is high in QoS based cooperative protocol compared to the cooperative transmission protocol.

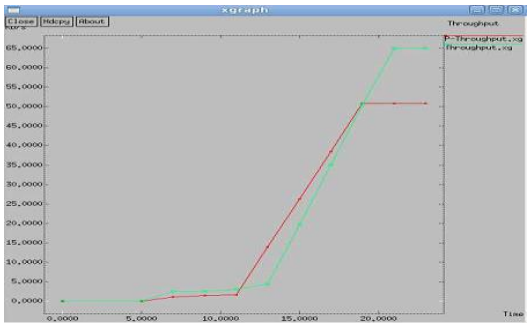

Fig.6. Performance of throughput comparison.

III. Conclusion

In this paper, we evaluate the performance of QoS based cooperative protocol. The QoS based cooperative transmission provides low energy consumption and increment in the network lifetime. The one node thick path is selected based on QoS metrics and the node cooperation made in the recruitment and transmission phase. The nodes in sending cluster synchronize their transmission power and thus the receiving node will have the sum of all signal powers from the sending nodes. This helps the nodes to receive data packets without error and loss. This saves energy and helps to gain high throughput. The comparison results show that the QoS based cooperative protocol has improved performance over node failure, throughput and energy.

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