Energy Optimization with Cooperative MAC Protocol in Wireless Sensor Networks

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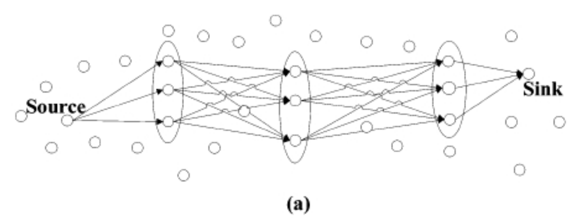
***Abstract* - A new distributed cooperative routing protocol that realizes minimum power transmission for each composed cooperative link, given the link BER (Bit Error Rate) constrained at a certain target level. The key contribution of the proposed scheme is to bring the performance gain of cooperative diversity from the physical layer up to the networking layer. Specifically, the proposed algorithm selects the best relays with minimum power consumption in distributed manner, and then forms cooperative links for establishing a route with appropriate error performance from a source to a destination node. Analytical results are developed to show that our cooperative transmission strategy achieves average energy saving of 82.43% compared to direct transmission, and of 21.22% compared to the existing minimum power cooperation strategy. The upper bound of the capacity of the protocol, and analyze the end-to-end robustness of the protocol to data-packet loss, along with the tradeoff between energy consumption and error rate. The analysis results are used to compare the energy savings and the end-to-end robustness of our protocol with two non-cooperative schemes. The distributed and power efficient cooperative routing algorithm, which constructs the minimum power route with a small number of hops**

***Keywords* - Cooperative network, Grid, Cooperative Transmission, BER**

I. Introduction

The term "wireless" has become a generic and all-encompassing word used to describe communications in which electromagnetic waves to carry a signal over part or the entire communication path. Wireless technology can able to reach virtually every location on the surface of the earth. Ad- hoc and Sensor Networks are one of the parts of the wireless communication. In wireless sensor network data are requested depending upon certain physical quantity. So, wireless sensor network is data centric. A sensor consists of a transducer, an embedded processor, small memory unit and a wireless transceiver and all these devices run on the power supplied by an attached battery.In our model of cooperative transmission, every node on the path from the source node to the destination node becomes a cluster head, with the task of recruiting other nodes in its neighborhood and coordinating their transmissions. Consequently, the classical route from a source node to a sink node is replaced with a multihop cooperative path, and the classical point-to-point communication is replaced with many-to-many cooperative communication. The path can then be described as ―having a width, where the ―width of a path at a particular hop is determined by the number of nodes on each end of a hop. For the example in Fig. 1(a), the width of each intermediate hop is 3. Of course, this ―width does not need to be uniform along a path. Each hop on this path represents communication from many geographically close nodes, called a sending cluster, to another cluster of nodes, termed a receiving cluster. The nodes in each cluster cooperate in transmission of packets, which propagate along the path from one cluster to the next. Between the source and the sink nodes is discovered as an underlying ―one-node-thick path. Then, the path undergoes a thickening process in the ―recruiting-and- transmitting phase. In this phase, the nodes on the initial path become cluster heads, which recruit additional adjacent nodes from their neighborhood. During the routing phase, where the ―one-node-thick path is discovered, information about the energy required for transmission to neighboring nodes is computed. This information is then used for cluster establishment in the ―recruiting-and-transmitting phase by selecting nodes with lowest energy cost. Medium access control is done in the ―recruiting-and-transmitting phase through exchanges of short control packets between the nodes on the ―one- node-thick path and their neighbor nodes.



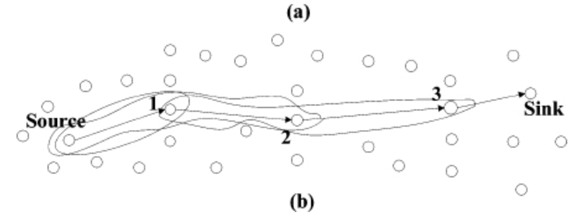


Fig.1. (a) Cooperative Transmission Protocol model (b) CAN Protocol

A key advantage of cooperative transmission is the increase of the received power at the receiving nodes. This decreases the probability of bit error and of packet loss. Alternatively, the sender nodes can use smaller transmission power for the same probability of bit error, thus reducing the energy consumption. One of the goals of this paper is to study the energy savings achieved through cooperation. We also study the increase in the reliability of packet delivery, given some level of cooperation among the nodes.. We compare our cooperative transmission protocol with another cooperative protocol, called Cooperation along Non-cooperative path (CAN) [1], and with two other non-cooperative schemes: the ―disjoint-paths and-one-path schemes. The equivalent of the ―one-node-thick path is called in [1] the ―non-cooperative path between the source and the sink nodes and is found first. However, instead of recruiting additional nodes, in CAN, the last predecessor nodes along the non-cooperative path cooperate to transmit to the next node on the path, as depicted in Fig. 1(b). In this figure, and the non-cooperative path is source-1-2-3-sink. The source node transmits to node 1; then the source and node1 transmit to node 2; then the source, node 1, and node 2 transmit to node 3. Finally, nodes 1, 2, and 3 transmit to the sink. In the disjoint-paths scheme, nodes form a number of disjoint paths from source to sink. The same information is routed independently along the different paths with no coordination between the nodes on the different paths. In the one-path scheme, the ―one-node-thick path is discovered first. Then, each node on the path transmits with power equal to the sum of transmission powers of all the cooperating nodes in a cluster. The analytical and simulation results of our cooperative transmission protocol are compared throughout the paper to the results of the CAN protocol, the disjoint-paths scheme, and the one-path scheme.

II. Related Work

The problem of energy-efficient routing in wireless networks that support cooperative transmission was formulated in [1]. In [1], two energy-efficient approximation algorithms are presented for finding a cooperative route in wireless networks. The two algorithms for finding one cooperative route are designed such that each hop consists of multiple sender nodes to one receiver node. One of the algorithms (CAN) is used throughout this

paper for performance comparison. The works in [2]-[5] focus on MAC layer design for networks with cooperative transmission. In [2], when no acknowledgement is received from the destination after timeout, the cooperative nodes, which correctly received the data, retransmit it. Only one cooperative node retransmits at any time, and the other cooperative nodes flush their copy once they hear the retransmission. Hence, this work focuses on reducing the

transmission errors, without benefiting from the energy savings of simultaneous transmissions. In [3], high-rate nodes help low-rate notes by forwarding their transmissions. The work describes how the helper nodes are discovered. Similarly to [2], only one node can cooperate at a time, and simultaneous transmissions are not used, hence the energy savings are not considered. Likewise, in [4] only one node cooperates in forwarding the data. The IEEE 802.11 protocol was extended in [5] to support multiple antennas per node. The works in [6]-[10] use the model with only one helper node at each hop in addition to the sender and the receiver. The model in [11] utilizes multiple nodes to forward the data, but only one node can transmit at any time. Several good tutorial papers on cooperative transmission have been published (e.g., [12] and [13]). A network is the energy efficient broadcast of source messages to the whole network. The energy consumption increases as the network size grows, and the optimization of efficiency becomes more important.

III. Energy Minimization

A new Cooperative MAC Protocol that realizes minimum power transmission for each composed cooperative link, given the link BER constrained at a certain target level. The key contribution of the proposed scheme is to bring the performance gain of collaborative diversity from the physical layer up to the networking layer. Specifically, the proposed algorithm selects the best relays with minimum power consumption in distributed manner, and then forms cooperative links for establishing a route with appropriate error performance from a source to a destination node. From the simulation results, the total power consumption of proposed routing algorithm can reduce by a couple dB compared to the existing collaborative routing algorithms and plot the capacity of all protocols versus the load in the network. At a small load, the delay needed to recruit the collaborative nodes affects the capacity of collaborative protocol. As the load increases, the interference increases, and the number of concurrent transmissions on the different paths diminishes. The one-path scheme is not resilient to packet loss, and the maximum carried load is affected by the packet loss rate.

A. Block Diagram

In the node parameter the nodes will be created. First, Nodes are positioned on a grid format .The nodes are placed in random manner. The nodes are randomly placed by using the Random manner algorithm. In, the model of cooperative transmission, every node on the path from the source node to the destination node becomes a cluster head

To determine the capacity upper bound for one hop, divide the number of data bits in the data packet transmitted in one hop by the minimum delay needed to complete this transmission. Transmit Side Power Constrained to consummate the power of data packet and then produce the output next block the data can be allocated in to several packets for the easy transmission.

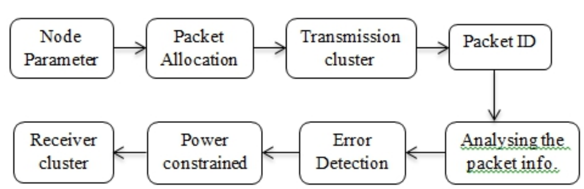


Fig. 2.Block Diagram of Energy Minimization

Then the packet information are analyzed. Each packet has separate ID.The packets are transmitted by using the signal. If the transmitter traveling signal if any noises and unwanted signals are added in Receiver Side Cluster, if any error occurs in signal so identify the error in this block. Which type of error, error in which place, any unwanted signals are included, Several Analysis are included in the block. If error is not occur in the incoming Signal is passing into next Block If Error is occur Which type of error ,Which place in error so identify and Remove the error and the output is given to the next block In the lost section is Receiver Cluster block pure Energy Consummated node signal was occur in this block The Same Transmitting Traveling Signal Same Packet Size, Data Stream, Received From the receiver and the output produced to the next parameter.

B. Cooperative MAC Protocol

We use a cooperative transmission Protocol communication model with multiple nodes on both ends of a hop and with each data packet being transmitted only once per hop. The reason is that in the disjoint-paths and the one-path schemes, when a packet is lost on a path, the whole path becomes useless, and the number of copies of the packet gets smaller as the number of hops increase. Once the number of copies increases in the current hop, the success probability increases in the next hop our model of cooperative transmission for a single hop is further depicted in every node in the receiving. We propose a new Cooperative MAC protocol for two cooperative MIMO schemes Beam forming and Spatial Multiplexing Performance of the CMAC protocol is evaluated in terms of total energy consumption and packet latency for both synchronous and asynchronous scenarios. All the required energy components are taken into consideration in the system performance modeling and a periodic monitoring application model is used. The impact of the clock jitter, the check interval and the number of cooperative nodes on the total energy consumption and latency is investigated. We analyze total energy consumption for the optimal cooperative scheme with the CMAC protocol. Both the transmission and reception total time into three categories which are based on packet types, namely control, cooperative mechanism and data categories. The total time a node spends during successful control packet. The transient energy is included in the total listening energy cost as explained in details in the total time a node spends during successful control packet transmission in cooperative low duty cycle MIMO system.

IV. Simulation Results

In simulation results we can shown the following outputs. Fig.3.shows Node Creation. The node will be created randomly. By using Random Manner Algorithm the node will be created.

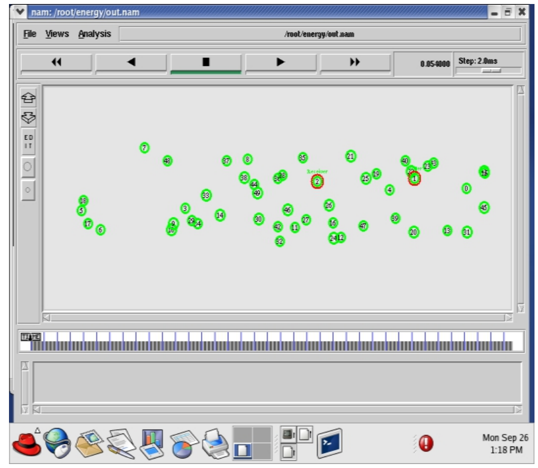


Fig.3. Node Creation

Fig.3.shows the cluster Creation. By grouping neighbor nodes the cluster will be formed. In the cluster the best energy efficiency node can be identified.

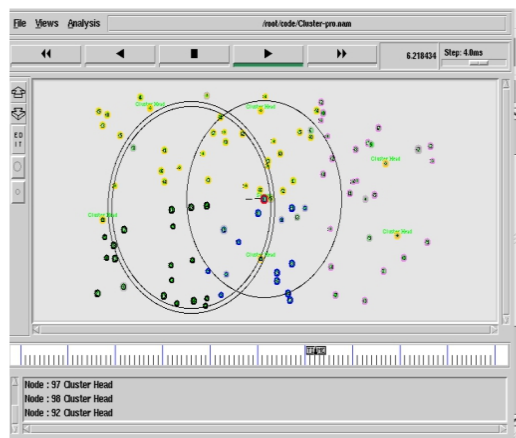


Fig.4. Cluster Creation

Fig.4. shows the cluster creation.Nodesare separated as a cluster.Each cluster have a cluster head. The packets are transmitted from nodes of each cluster to the server continuously.Server provides the ACK to each node.

Fig.5. Packet Sending

Fig.5. shows the packet sending sender to the receiver through the cluster head. All the energy has been lost the node will be reset.

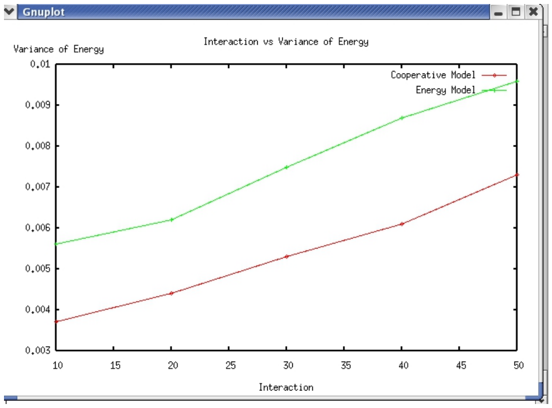


Fig.6 comparison between cooperative model and Energy model

Fig.6 graph shows the comparison between the cooperative and Energy model with respect to the interaction Vs variance of energy. Through this graph cooperative model protocol provide energy consumption for a long time

V. Conclusion

This paper proposed a cooperative MAC protocol and it analyzed the robustness of the protocol to data packet loss. When nodes are positioned on a grid, the energy savings of our cooperative MAC protocol is high compare to the Cooperative Transmission Protocol Thus the cluster was formed and analyzed power consumption using NS2 simulator. The main difference between the cooperative MAC protocol and the existing protocol is power saving mechanism. Power saving mechanism is used to achieve the energy level high compare to other protocol. Above 80% had achieved by using CMAC protocol

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