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Congestion Avoidance based on RC-MAC Protocol in Wireless Sensor Networks

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***Abstract*- Application for wireless sensor network is notably different in its characteristics and requirement from a standard WLAN. When a critical event triggers a surge of data generated by the sensor, congestion may occur as data packet converge toward a sink, which causes energy waste, throughput reduction, information loss, hidden terminal problem and link failure in contention based MAC protocol. Due to hidden terminal problem the RC-MAC and CSMA/CA protocol sensing is used to reduce the channel contention and radio collision. The formation of a new tree for avoiding link failure-a MAODV routing protocol was introduced in this paper, and the performance of this protocol is measured using the above parameters. The demonstration of a near optimal throughput at each sensor and to achieve congestion avoidance in presence of a multicast routing towards a multiple sink is also done**.

Keywords- *CSMA/CA, RC-MAC, MAODV and Wireless Sensor Network, WLAN.*

I. INTRODUCTION

A Wireless sensor network is a spatially distributed autonomous sensor which is used to monitor physical or environmental conditions, such as health monitoring, object tracking etc., and to co-operatively pass their data through the network to a main location [1,2]. The feasible usage of wireless sensor networks in real world application can only be maintained by overcoming a few technological challenges. Among these challenges, the limited lifetime of the distributed sensor nodes and user interfaces allows the technological utilization in different manner. The WSN usually consists of many number of small sensing devices that are powered by batteries, equipped with less capable processors and limited memory [3,4]. Congestion is a problem that affects all types of network especially for the low- powered, unreliable wireless sensor networks the occurrence of congestion could negatively affect not only the performance of the network, but also the network parameters like throughput, delay, information loss, link failure.

A mote- the sensor node in a WSN is capable of performing some process. The main problem of congestion avoidance in sensor network remains largely open. When a sensor receives more data compared with the forward rate the limited buffer space is full and consequently, the received data has to be dropped. The CSMA/CA is (carrier sense multiple access / collision avoidance) a protocol for carrier transmission in wireless sensor network [4,5]. In CSMA/CA, as soon as anode receives a protocol that is to be sent, it checks to be sure the channel is clear i.e., no other node is transmitting at that time. If the channel is clear, then the packet is sent. Radio collision and buffer overflow are two main types of congestion in a sensor network, solutions against collision include CSMA, TDMA, RC-MAC etc...,

The RC-MAC protocol allows the nodes to effectively utilize multiple channels by reducing unnecessary channel switching and is used to improve the communication throughput of sensor network [2,6]. The receiver-centric MAC protocol consists of two parts: the channel access scheduling and the lost packet re-transmission.

For a multi-hop routing, the mobile nodes can be enabled by dynamically self-starting that is a Multicast Ad-hoc on Demand Distance Vector (MAODV) routing protocol [6]. This also enables the mobile nodes to establish a tree connecting multicast group members [7]. Mobile nodes will quickly respond to link breaks in multicast tree by repairing those breaks in a timely manner. In this event of network partition, multicast trees are established independently in each partition and trees for the same multicast group are quickly connected, if the network components merge.

II. EXISTING METHOD

The challenges in wireless sensor network are congestion, information loss, reducing delay, link failure and power consumption [1,8]. There are different technologies available in wireless sensor network, with the design, implementation and performance evaluation of a different MAC protocol for WSN that combines the strengths of CSMA/CA [6], TDMA and RC-MAC while offsetting their weakness, like CSMA. TDMA, achieves high channel utilization and reducing throughput, low delay under low contention and like RC-MAC [5].

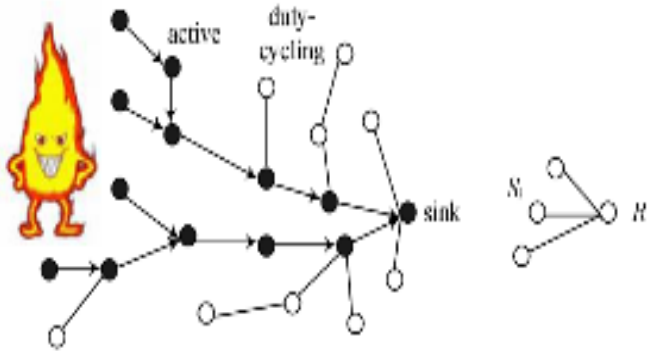

Figure 1. RC-MAC utilizes

III. PROPOSED METHOD

A sensor network comprising of a number of sensors and multiple *sinks* also called base stations *are used here*. The assumptions include a set of stationary sensors distributed in a rectangular area and a collision free MAC. Packet loss due to collisions is independent of design aspects and thus can be abstracted when studying a congestion avoidance and/or control protocol. Congestion causes energy waste, throughput, reduce information loss and link failure contention based MAC protocol, here RC-MAC and CSMA/CA protocol sensing is considered to reduce the channel contention and radio collision due to hidden terminal problems. In this method, we introduce a MAODV routing protocol, estimation routing with formation of new tree for avoiding the link failure. The performance is measured in terms of our MAODV protocol through measurement of parameters.

IV. PROTOCOLS AND TECHNIQUES

A. CSMA/CA and CSMA with ACK

CSMA/CA is a virtual carrier sensing which is used to reduce the probability of radio collision due to hidden terminal problem. Hidden terminals occur when two senders that are not in radio range transmit to a common receiver [3,4]. One way of reducing collision between hidden terminals is to exchange RTS/CTS control packets, before communicating the RTS/CTS to exchange it eliminates most data packet collision. Data transmission requires RTS-CTS-DATA-ACK exchange between two neighboring sensors. Now, consider the following two cases to avoid congestion.

Case1: B may not overhear packets sent by A due to temporary ratio interference. Therefore, its knowledge about A's buffer may be state [5,9].

Case2: when B wakes up from the sleeping mode its knowledge about A's buffer may be state [2].

B. RC-MAC

The RC-MAC protocol that allows node to efficiently utilize multiple channel by reducing unnecessary channel switching. Receiver-centric MAC avoids the interference due to improve communication throughput of wireless sensor network.

It consists of two main part of RC-MAC:

- The channel access scheduling.
- Lost packet retransmission.

The RC-MAC is used to reduce collision and improve communication throughput under heavy traffic loads by utilizing the underlying tree structure in WSN.

C. MAODV Routing Protocol

MAODV is intended for use by mobile nodes in an ad-hoc network. MAODV is a multicast extension of AODV. MAODV routing protocol in Fig.2 explains how to form the tree and how to repair the tree, when link is broken and the merging two previously disconnected tree into a new tree. A node monitors the link status of next hope on the multicast tree, when a link breaks the multicast tree is detected the tree branch should be immediately repaired through the use of the RREQ/RREP/MACT message.

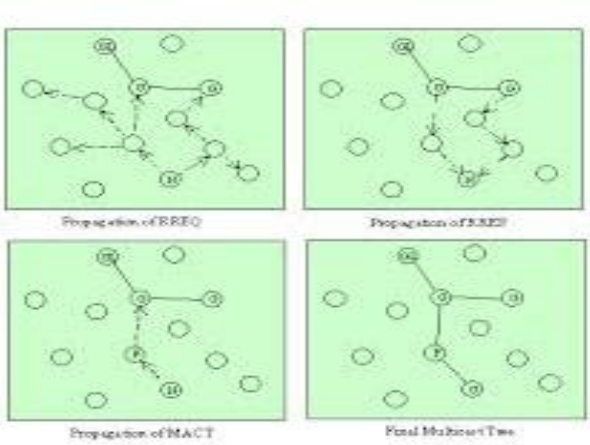

Figure 2. MAODV routing protocol

The message carries a multicast group, group number, corresponding group leader's IP address, the information of the multicast group for repairing multicast trees after a previously disconnected part of the network becomes reachable once again.

D. Link Failure Mechanism

Branches of the multicast tree becomes invalid if a broken link result in an infinite metric which was associated with the next hop route table entry [6,9]. When a broken link is detected between two nodes on the multicast tree, the nodes should delete the link from their list of next hops for the multicast group.

V. SIMULATION RESULTS

Implementation is done using Ns-2 software. Here there are some important sequence that are implemented with the simulator. The experimental set up contains 100 nodes. These 100 nodes are arranged randomly in positions. Since the environment is wireless, the nodes are given in a random motion. In this implementation, the throughput, congestion avoidance, packet loss and node energy consumption are measured.

A. Throughput Comparison

The number of packets that are transmitted in the network is shown in the following graph. Throughput is measured after the CSMA/CA, RC-MAC, and after the MAODV has been rectified. It is shown that the throughput after the tree formation has been overcome is high that is 11.5%.

B. Congestion Avoidance

Fig.4 demonstrates the congestion avoidance scheme. The buffer size at each sensor affects the total source rate over time. After time t=120 seconds, the source rates of all simulations are stabilized and they are very close to one another, which means that a small buffer size can achieve a suboptimal performance and gain. By further increasing the buffer size this is not significant, which agrees with our analytical results.

C. Packet Loss

Fig.5 compares the number of packets dropped with respect to the initial rate. The packet loss is the rate at which the source generates a new data intuitively, when the initial source rate is higher, whose number of dropped packet is roughly proportional to the initial source rate. Using MAODV protocol the packet loss can be reduced.

D. Energy Expenditure

Energy expenditure is inversely proportional to the energy consumption. Energy consumption is measured before implementing RC-MAC and after implementing RC-MAC. First we measure for CSMA/CA and it's combined with RC-MAC and finally with the MAODV protocol. The energy expenditure is high in the case when MAODV protocol is applied in the network. By this the energy is improved by 20%.

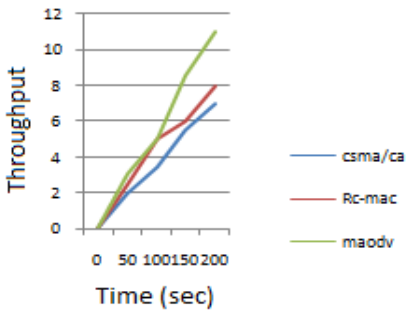

Figure 3. The graph representing throughput comparison

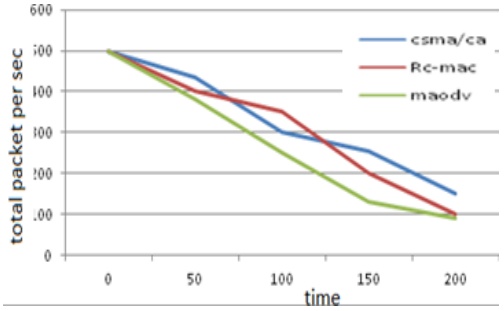

Figure 4. The graph representing by congestion avoidance

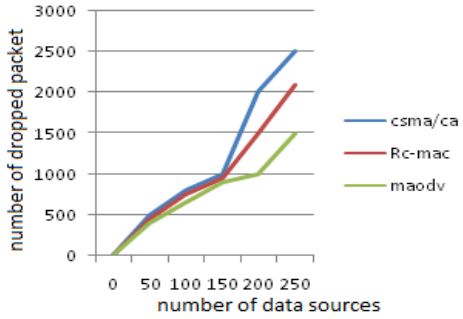

Figure 5. Comparison for packet lost

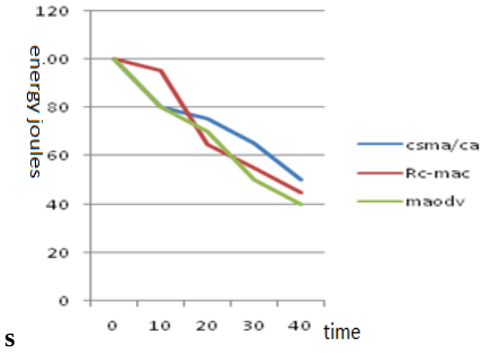

Figure 6. Energy expenditure per packet over time.

VI. CONCLUSION

A new MAC protocol, called MAODV, for wireless sensor networks that can sequentially adjust the behavior of MAC between CSMA/CA and RC-MAC depending on the stage of contention in the network was proposed in this paper. The MAODV routing protocol estimation multicast routing with formation of new tree for avoiding the link failure was done. We thoroughly evaluated the present method by NS-2 software, the simulation results and analysis of parameters like throughput, packet loss, energy consumption and link failure are shown and thus the performance with other protocols are compared and from the results, its clear that the MAODV routing Protocol has High performance and efficiency.

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