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Evaluation of Energy Consumption using Receiver–Centric MAC Protocol in Wireless Sensor Networks

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ABSTRACT

At present day's wireless sensor networks, obtain a lot consideration to researchers. Maximum number of sensor nodes are scattered that can communicate with all others. Reliable data communication and energy consumption are the mainly significant parameters that are required in wireless sensor networks. Many of MAC protocols have been planned to improve the efficiency more by enhancing the throughput and energy consumption. The majority of the presented medium access control protocols to only make available, reliable data delivery or energy efficiency does not offer together at the same time. In this research work the author proposes a novel approach based on Receiver Centric-MAC is implemented using NS2 simulator. Here, the author focuses on the following parametric measures like - energy consumption, reliability and bandwidth. RC-MAC provides high bandwidth without decreasing energy efficiency. The results show that 0.12% of less energy consumption, reliability improved by 20.86% and bandwidth increased by 27.32% of RC-MAC compared with MAC IEEE 802.11.

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1. INTRODUCTION

The Wireless Sensor Network (WSN) is advanced technology and build up with that has been incorporated into one of the best emerging areas in the communication industry [1]. A number of small wireless sensor nodes are used to exchange information for a long time with a limited battery power capacity in wireless sensor networks. The most important power factor consumption of a node is radio. MAC protocol controls the radio of the sensor node [2].

Generally, wireless sensor networks constitute many numbers of nodes. In Figure 1 depicts that the functionality for dissimilar types of nodes that appearance a wireless network to exist to control their spatial mobility exclusive of lose functionality. Nodes should be capable to detect neighbor nodes in a network and to vigorously correlate to coordinators based on their position [3].

Each node is connected to either one or many nodes. Consider a generic communication network, that network combine nodes and communication links. Every node produces information designed for each node and all other nodes in the network. Distinctive routing scheme considers to deal with various grouping of the follow a) minimize the cost and complexity b) prevention of unreliable communication links, c) maximize network throughput d) minimize end to end delay [4].

Sensor nodes operate with a tiny battery that consumes more power while propagation of a signal, so that energy efficiency is considered as major criteria for designing several MAC protocols. Radio is the

central part of any sensor node and that consumes more power during communication. The competent MAC protocol is capable of enhancing lifetime of several sensor networks. MAC layer protocols in wireless sensor network are classified into four categories: a) synchronous awaking of nodes, b) asynchronous awaking of nodes, c) slotting of frames and d) multi channel approach.

Duty cycle is one of the foremost attribute of asynchronous and synchronous protocols, at this juncture any node can exchange among sleep and active states to save energy, while nodes are able to communicate in active state. Asynchronous MAC protocols are based on the type of communication between two nodes dissimilar in active/sleep mode. In synchronous MAC protocols, all nodes are synchronized at the same time [5].

Medium Access Control is traditionally viewed as an element of the data link layer in the OSI model. Here, coordinates the use of a common transmission medium in multiuser systems and ensure reliable communication greater than interference free channels for each one user [6], [10]. The fundamental prerequisite of a sensor network is reliable delivery of information with lowest amount latency and energy consumption.

On the other hand, the majority MAC protocols were proposes of their concerned about the users are self-governing of each other and challenge for the use of the general transmission channel.

Outstanding to the strict resource constraint of sensor networks, two properties of the system were frequently exploited for designing sensor network MAC protocols: a) the application – needy objectives and b) the helpful nature of the scattered sensors [7].

CSMA is one of the mainly accepted choices for random access networks due to its simplicity and efficient design. Each user has a communication to transmit first senses the channel to see whether or not there is an enduring transmission from further users before it transmit its own data for communication. Hence an attempt was made to avoid collision with other users. When a collision occurs at the destination, each transmitting user wait for a unsystematic back in time before it makes a challenge to transmit the message again. Widely adopted protocol the multiple access with collision avoidance (MACA) protocol that introduce a three way handshake between the transmitter and receiver to solve the familiar hidden terminal problem present in usual CSMA [8].

Three-way handshake planned in MACA resolve this difficulty by having every user transmit a Request-To-Send (RTS) message. At any time it has a packet to send, representing the destination and the length of the deliberate data transmission. The destination user successfully receives the RTS message and has not fulfilled a handshake previously with further nodes; it then decides to respond with a Clear-To-Send (CTS) packet indicating that it is set for the reception. The source then sends an information packet to the destination once the CTS are received [9]. The mechanism of CTS and RTS is shown in Figure 2.

Pei Huang et al, proposed a novel method in by improving the throughput under the heavy traffic load on wireless sensor networks. They discussed the receiver centric development by utilizing the data gathering tree structure in wireless sensor networks [1].

Yeah –time Yong et al, proposed in the method of different transmission range and sensing range for managing dynamic traffic loads in wireless sensor networks. Here limitations are time offer of a transmission, retransmission and high frequency of retransmission [2].

Umesh et al proposed RC-MAC protocol focused on end to end reliable communication and increase the lifetime of the sensor network [4].

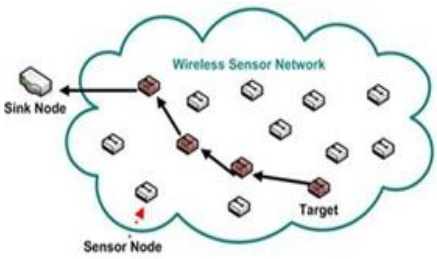

Figure 1. Wireless Sensor Network

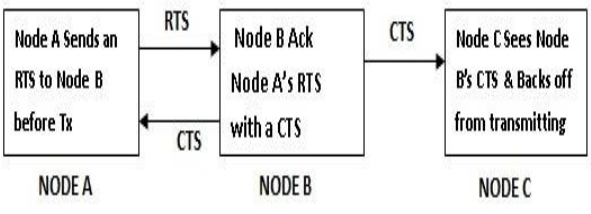

Figure 2. Mechanisms of CTS and RTS

2. RESEARCH METHOD

2.1. Algorithm for RC-MAC

Step 1: Each node sends a beacon message for checking the node status. A node status defines whether the node is sleep node or wake up a node (nib). nib-neighbor id

Step 2: It sends the RTS/CTS message for getting the channel status. After it forms the frame in terms of bandwidth and slot time TX
Step 3: Maximum allowed queue process to be utilized at every transmission slots at T-sec. T-sec – Transmission seconds
Step 4: Tr->propagation variance of delay when transmitter receiver distance is rx. Tr-Transmission rate, rx – reception rate
Step 5: Probability of delivered rate of new entity in (nb) access slots. nb- neighbor node
Step 6: It enters the channel scheduling for assign the channel to communicate. Channel scanning is completed by number of slots per super-frame.
Step 7: Receiver node establish that average one hop delay is high it chooses a shortest path. Energy level is beyond a specified threshold time schedule of helper is not affected
Step 8: First and second cycle includes a cooperative transmission and node updates its status information to intermediate nodes.
Step 9: Receiver nodes have advanced than transmitter node then co-operative transmission will be applied.
Step 10: Analyze the estimated signal interference level. Adjusted of each frame is done as per number of access slots. If it reaches limited threshold it processed a duration.
Step 11: Then it enters noise interference level and estimate the level. Packets are assigned into priority level. Packet transmissions begin with congestion dance.

2.2. Flowchart for RC-MAC Algorithm

In flowchart to transmit data, it's moved from top to bottom, followed by different levels like channel scanning, send RTS, wait CTS, congestion avoidance and processing. In Figure 3, the author proposed the new approach in the form of algorithm. It explains the details in the form of flowchart.

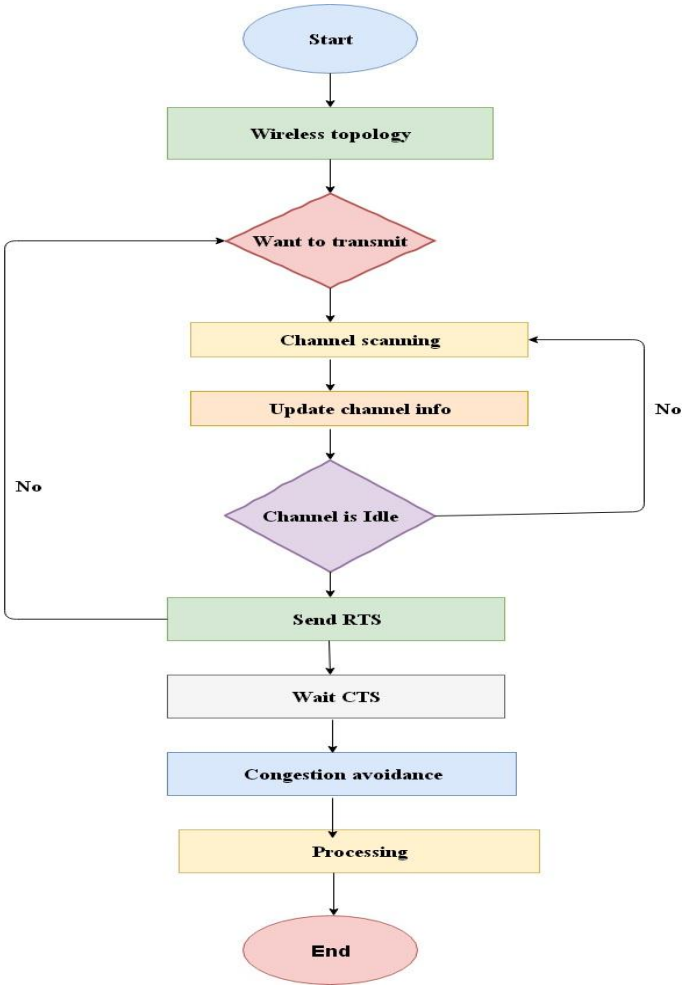

Figure 3. Flowchart for RC-MAC Algorithm

3. RESULTS AND ANALYSIS

NS 2 is chosen for the simulation as set-up consists of the massive network. Set-up contains 100 nodes; size of the packet is 780 bytes, routing protocol is AODV. MAC Protocols used are IEEE 802.11 and RC-MAC. Topology used is MANET. Here table 1 gives the informations used in simulations of experiments.

Table 1. Network Simulation Parameters

Parameter Name	Parameter Value
No Of Nodes	100
Node Type	Static
Area Of Simulation	1000x 1000
Traffic	Cbr
Channel Type	Wireless Channel

3.1. Analysis of Energy consumption, Reliability and Bandwidth in RC-MAC

Figure 4, shown the results of proposed work in terms of energy consumption versus simulation time and in slots of simulation time in 10, 15 & 20 sec. Every time energy consumption will increase with simulation time. The RC-MAC protocol used as MAC protocol in the wireless sensor networks. When node resolute to send information packet, by communication media like wireless media. It will send the data, else goes to wait. Each time information should be moved from the application layer to the physical layer.

The measurement made for performance characteristic of RC-MAC reliability and obtain values are shown in Figure 5. In Figure 5 the author proposed in this work the slots of simulation time in 10, 15 & 20 sec. Every time reliability will increase with simulation time. The RC-MAC protocol used as MAC protocol in the wireless sensor networks. Reliability in wireless sensor networks be able to examine from together the packet level and event level.

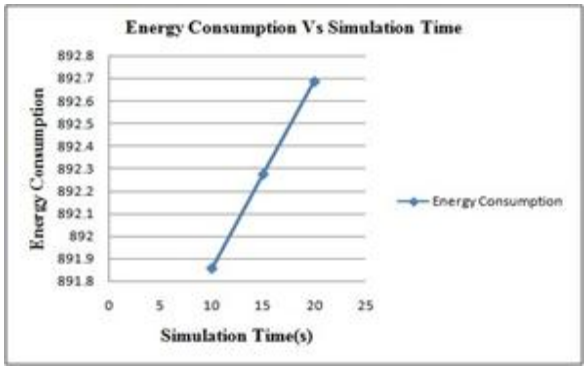

Figure 4. RC-MAC: Energy Consumption Vs Simulation time

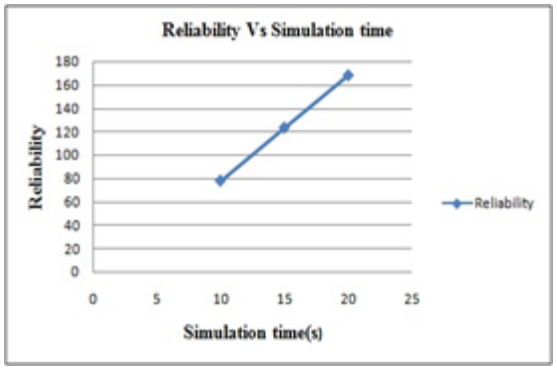

Figure 5. RC-MAC Reliability Vs Simulation time

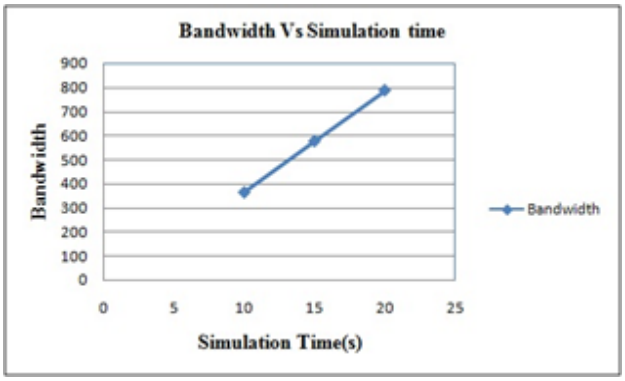

Figure 6. RC-MAC: Bandwidth Vs Simulation time

In Figure 6, the proposed work is the slots of simulation time/bandwidth in 10, 15 & 20 sec. Every time bandwidth will increases with simulation time. Bandwidth increases from 365 to 787.

3.2. Performance Analysis of Energy consumption, Reliability and Bandwidth, Comparison of RC-MAC with MAC IEEE 802.11

Energy consumption is inversely propositional to the energy expenditure. Energy consumption is calculated by implementing MAC and implementing RC-MAC. Figure 7 compares the energy consumption of MAC protocol and RC-MAC protocol. Energy consumption is high in MAC protocol; it's less in RC-MAC protocol. RC-MAC protocol that allows node to proficiently make use of multiple channel by dropping needless channel switching. Receiver-Centric MAC protocol avoids the interference owed to get better communication throughput of wireless sensor network. From the obtained results, the MAC will consume energy more by 0.12% than RC-MAC.

Reliability consist capability to retransmit lost packets, locally or end to end, to guarantee successful delivery. However, any sensor network that is deploying to supply to a significant application will need mechanism to make sure that reliability of data delivery from the sink to the sensors. By using upstream and downstream message is carried out in wireless sensor network. For upstream message, the sender is a sensor node and receiver node is a sink node. For downstream message, the sender is a sink node and receiver node is a sensor node. Figure 8 shows that comparison of reliability of MAC and RC-MAC. Here RC-MAC protocol has more reliable compared to MAC protocol. The results show that reliability is improved by 20.86 % in RC-MAC, compared with MAC.

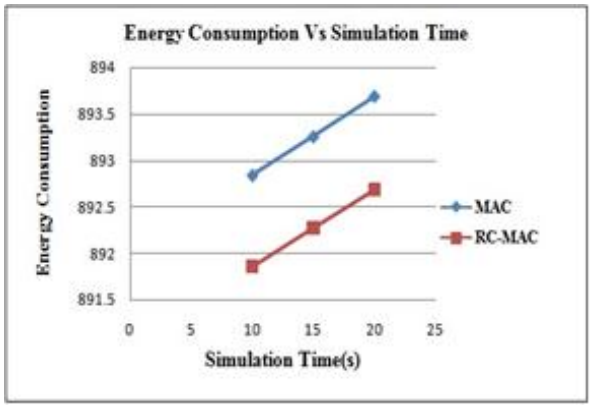

Figure 7. Comparison of Energy Consumption of MAC and RC-MAC

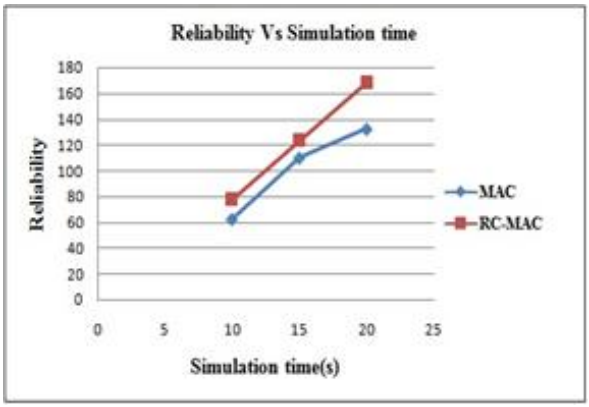

Figure 8. Comparison of Reliability of MAC and RC-MAC

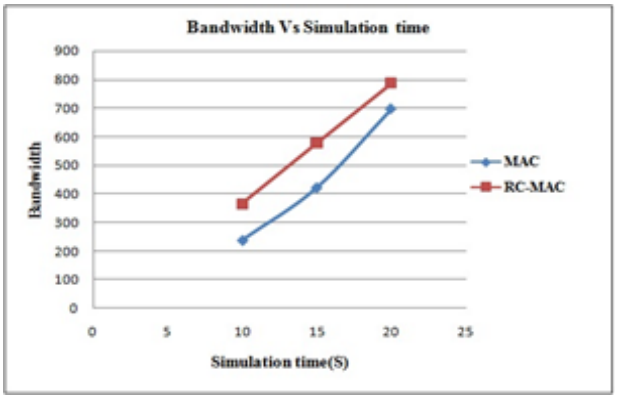

Figure 9. Comparison of Bandwidth of MAC and RC-MAC

Bandwidth represents the quantity of data that can be transmitted over a network in a given quantity of time, frequently spoken in bits per second or bps in wireless sensor network. Figure 9 shows that,

comparison of bandwidth of MAC and RC-MAC protocols, here compared to RC-MAC existing MAC have less bandwidth. A result shows that bandwidth increased by 27.32% of bandwidth in RC-MAC compared with MAC 802.11.

4. CONCLUSION

From the obtained results of the current proposed method, RC-MAC protocol mainly focus on energy consumption, reliability and end to end delay. The factors of congestion control, reliability and energy consumption would help in dropping packet failure rate which results an energy efficient process of the network. In this paper systematically evaluated the current technique using NS2 simulator, the simulation results and analysis of parametric measures like - energy consumption, reliability and bandwidth are exposed and comparing this results with other protocols. Here, the RC-MAC protocol shown better performance and efficiency. The proposed protocol will shows better performance in terms of energy consumption and reliability. Here, the proposed method obtained an improvement in terms of 0.12% of less energy consumption, reliability improved by 20.86% and bandwidth increased by 27.32% of RC-MAC compared with MAC IEEE 802.11.

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