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Performance Comparison of Mac layer protocols in Mobile Adhoc Networks

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Abstract: - **Ad hoc Network based on the IEEE 802.11 standard is one of the fastest growing wireless access technologies in the world today. It is a collection of nodes which dynamically form a temporary network without any infrastructure. The broadcast nature of wireless network critically depends upon the medium access control (MAC) protocols. In this paper, medium access protocol used are CSMA, MACA and Cooperative Medium Access Control (CMAC). These are compared on the basis of throughput and end to end delay using a simulator, for efficient MAC protocol among these. The result shows that the CMAC performs well as compared to CSMA and MACA in terms of throughput, end to end delay.**

Key Words- **CSMA, MACA, CMAC, MAC protocols.**

I. INTRODUCTION

Mobile ad hoc wireless network (MANET) is an autonomous self-organizing system of mobile nodes connected by wireless links where nodes not in direct range communicate via intermediate nodes [1]. As mobile wireless devices are evolving rapidly, consumers of MANET demand both high speed and reliable communication. One of the current trends in wireless communication is to enable devices to operate using various transmission rates [2]. Traditional paradigms for communication network design often call upon a layered approach: each slice within the network stack should only utilize services from those below, for design and implementation simplicity. Physical (PHY) layer and medium access control (MAC) layer standards such as IEEE 802.11a/b/g/n/ac utilize multiple transmission rates in order to accommodate a wide range of channel conditions. It makes the IEEE 802.11 WLAN standards as a natural foundation to implement MANET protocols. MANET protocols can adopt PHY and MAC layer to their devices and implement multihop routing protocols based on IEEE 802.11 functionalities such as rate adaptation [3], clear channel assessment, and OFDM and PLCP preambles. Without considering the MAC layer interactions and signaling overhead due to cooperation, the performance gain through physical layer cooperation may not improve end-to-end performance. One primary issue with continuous participation in MANETs is the network lifetime, because the fore mentioned wireless terminals are battery powered, and energy is a scarce resource. Cooperative Communication (CC) [4] is a promising technique for conserving the energy consumption in MANETs. The broadcast nature of the wireless medium (the so-called wireless broadcast advantage) is exploited in cooperative fashion. The wireless transmission between a pair of terminals can be received and processed at other terminals for performance gain, rather than be considered as an interference traditionally. CC can provide gains in terms of the required transmitting power due to the spatial diversity achieved via user cooperation. In MAC Layer, wireless broadcast medium is used and therefore multiple transmissions can result in garbled data, making communication impossible. A medium access control (MAC) protocol moderates access to the shared medium by implementing some rules that allow these devices to communicate in orderly and efficient manner with each other.MAC delay and jitter guarantees from network. MAC protocols design and selection based performance (throughput, delay, packet delivery ratio). [5]. There are number of MAC protocols proposed for MANET to solve the above discussed problems such as CSMA, MACA, MACAW, MACA-BI, IEEE 802.11, FAMA and more. While studying the MAC protocols, the selection of the MAC protocol depends on efficient performance it provides. CSMA and MACA are found more reliable and basic protocols required for a wireless scenario among these protocols. The Media Access Control (MAC) layer is responsible for regulating node access to a shared communication channel. In our experiments we consider the IEEE 802.15.4 standard MAC protocol, which is designed for low bitrates and low-power communication applications. It consists of a contention-based CSMA-CA protocol that requires nodes to sense a channel before packet transmission. Time is divided into slots. Before transmitting a packet, the sender checks if the medium is idle. In that case, the sender waits for the next time slot and, if the medium is still idle, it assumes it has won the contention and transmits the packet. Otherwise, if the medium is busy, it increases a backoff counter for that packet and schedules a new attempt after a random number of slots. This number is chosen at random between 0 and 2BE − 1, where BE is a backoff exponent having a protocol-specific initial value (we use the default value 3) and is incremented after every backoff. If a packet fails to be transmitted after five backoffs, it is dropped.

II.RELATED WORK

MAC stands for Media Access Control. A MAC layer protocol is the protocol that controls access to the physical transmission medium on a network. It tries to ensure that no two nodes are interfering with each other‘s transmission and deals with any protocols therefore plays very important role in enabling this paradigm by fair sharing of the wireless bandwidth. The medium require possible interference [9]. CSMA was the MAC layer used in the first generation packet radio networks. CSMA prevents collision by sensing the carrier before transmission. A terminal, however, can sense the carrier only within its transmitting range. Transmissions from terminals out of range cannot be detected. Kleinrock et al[10] identified the hidden terminal problem of carrier sensing, which makes carrier sense multiple access (CSMA) performs as poorly as the pure AlOHA protocol when the senders of packets cannot hear one another and the vulnerability period of packets becomes twice a packet length. The BTMA (busy tone multiple access) protocol was a first attempt to solve the hidden-terminal problem by introducing a separate busy tone channel [11]. The same author proposed SRMA (split channel reservation multiple access) which attempts to avoid collisions by introducing a control signal handshake between the sender and receiver [12]. A station that needs to transmit data to a receiver first sends a request-to-send (RTS) packet to the receiver, who responds with a clear-to send (CTS) if it receives the RTS correctly. A sender transmits a data packet only after receiving CTS successfully. ALOHA or CSMA can be used by the senders to transmit RTS [13]. Several modifications of MACA have been proposed which suppress RTS, mostly to transmit multi packet messages or to support real time streams. For example, to increase the channel utilization for multi packet transmissions, Fullmer et al [14] propose in to replace all RTS packets but the first with a MORE flag in the header of the data packet. The same authors propose to use FAMA-NTR in bulk mode to maximize the throughput. For a multimedia application, Lin et al propose to use RTS/CTS only for the first packet of a real time stream. Subsequent packets are transmitted with a reservation scheme that relies on the periodic nature of the multimedia traffic. Cooperative MAC (CMAC) protocol considering the practical aspect of CC is mitigating the throughput bottleneck caused by the low data rate nodes, so that the throughput can be increased. With the similar goal, Zhu et al. [15] have proposed a CMAC protocol for wireless ad hoc network. However, beneficial cooperation considering signaling overhead is not addressed in [16] and [17]. A busy-tone-based cross-layer CMAC protocol [18] has been designed to use busy tones to help avoiding collisions in the cooperative scenario at the cost on transmitting power, spectrum, and implementation complexity. A reactive network coding aware CMAC protocol has been proposed by Wang et al. [19], in which the relay node can forward the data for the source node, while delivering its own data simultaneously. But the network lifetime is not addressed in [20]. A distributed CMAC protocol [21] has been proposed to improve the lifetime of wireless sensor networks, but it is based on the assumption that every node can connect to the base station within one hop, which is impractical for most applications.

III. CSMA AND MACA

CSMA – CSMA is standardized internationally in IEEE 802.11. It is contention based MAC layer protocol for wireless mobile ad-hoc network. This is packet based collision avoidance. It is probabilistic media access control protocol in which a node verifies the absence of other traffic before transmitting on a shared transmission medium. It obeys ―do not interrupt rule‖ to avoid significant number of collisions. It uses carrier sensing methology before any actual transmission of packets means that a transmitter uses feedback from a receiver to determine whether another transmission is in progress before initiating a transmission. It contributes to network traffic because any real data is transmitted in radio range [22].CSMA has to broadcast a signal onto network in order to listen to any other vital. Liu et al. have proposed a CMAC protocols named CoopMAC [23] to exploit the multi-rate capability and aimed at nodes. The channel does not continuously sense the channel but it

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waits for random chosen period to time called backoff factors, which are counter down by backoff counter. It sense channel idle, when the backoff counter reaches zero, node transmits packets. If no transmission takes place for a slot time interval, transmission may proceed [24]. In case of any collision occurs in CSMA backoff factor again works. Multiple accesses mean that multiple stations send and receive on the medium. Transmissions by one node are generally received by all other stations connected to the medium. Generally, there is difference in Tx power and Rx sensitivity as well as distance and location of access point. So, station not is able to _hear ‘another station broadcast. There‘s Hidden and Exposed problem occurs [25].MACA- Multiple access collision avoidance MAC layer protocol is three way handshaking techniques, known as RTS-CTS-DATA. There is no acknowledgment packet (ACK) in MACA scheme. Before transmission of a packet, the nodes operate in RTS-CTS mode to reserve the channel by sending Request-to-send packet. The destination node send a Clear-to-send frame to acknowledge the receipt of an RTS frame, then data is transmitted after successful exchange of RTS-CTS. . This mechanism helps to solve problems only if the nodes are synchronized and packet sizes and data rates are same for both the transmitting nodes. Since the collision may occur on RTS packet and it is detected by lack of CTS response. The packet is scheduled for retransmission in the future. RTS-CTS mechanism increases the system performance by reducing collision. It is suited to combat Hidden terminal problem in CSMA [25].This MACA is not fully solve the hidden node and exposed terminal problem and nothing is done regarding receiver blocked problem. As shown in figure II, sender A wants to send some data so it transmit RTS packet to neighboring nodes, with RTS detail of data is also added in it. B senses the RTS and send CTS to its neighboring nodes so that other

IV. THE CMAC PROTOCOL

In this section, with the objective of prolonging the network lifetime and increasing the energy efficiency, we present a novel CMAC protocol, namely CM. When cooperative relaying is involved, the channel reservation needs to be extended in both space and time in order to coordinate transmissions at the relay. To deal with the relaying and dynamic transmitting power, besides the conventional control frames RTS, CTS and ACK, additional control frames are required. CMAC introduces two new control frames to facilitate the cooperation, i.e., Eager-To-Help (ETH) and Interference-Indicator (II). Eager-To-Help (ETH)• The ETH frame is used for selecting the best relay in a distributed and lightweight manner, which is sent by the winning relay to inform the source, destination and lost relays.

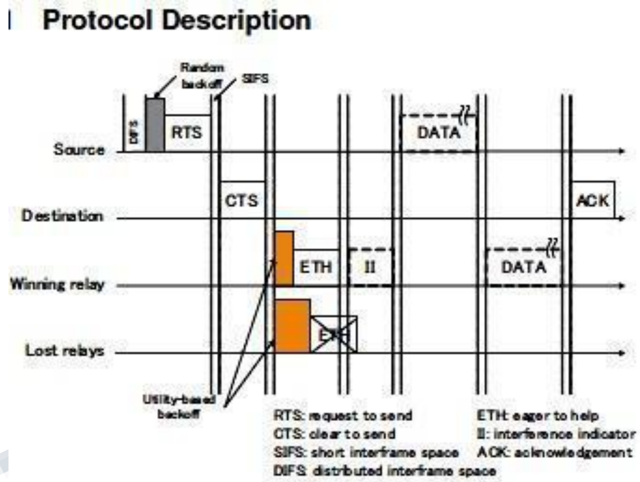

Fig 1. Protocol Description

In this paper, the best relay is defined as the relay that has the maximum residual energy and requires the minimum transmitting power among the capable relay candidates. Transmitting power at the winning relay, in order to enhance the spatial reuse. Among all the frames, RTS, CTS, ETH and ACK are transmitted by fixed power. And the transmitting power for the II frame and data packet is dynamically allocated. We denote nodes in range do not transmit and interrupt. A node after receiving CTS sends data. the time durations for the transmission of RTS, CTS, ETH, ACK and II frames by TRTS, TCTS, TETH, TACK and TII, respectively. The frame exchanging process of CMAC is shown in Fig. 1. Similar to the IEEE 802.11 DCF protocol, the RTS/ CTS handshake is used to reserve the channel at first. As it is know, the cooperative transmission is not necessary in the case that the transmitting power is small.

V. RESULT AND DISCUSSION

To find out which MAC PROTOCOL is more efficient among CSMA, MACA and CMAC there is comparison by setting different number of nodes. The performance metrics used for comparison are; throughput and delay.

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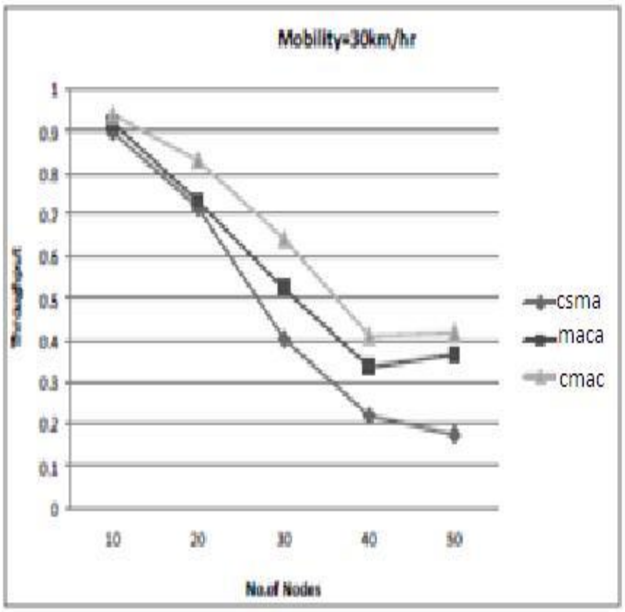

Fig 2. Throughput vs. no. of nodes.

i. Throughput: Throughput is defined as the number of packets flowing through the channel at a particular instant of time. This performance metric signifies that the total number of packets that have been successfully delivered from source node to destination node. Factors affecting throughput are frequent change in topology, unreliable communication, less bandwidth and limited energy.

ii. Average End-To-End Delay: End to end delay metric calculates the time difference between the sending time and receiving time of packet. This end-to-end delay metric shows the packet delivery time. Lower the end-to- end delay, the better the performance of protocol. The performance gain of CMAC over CSMA and MACA raises as the number of terminals increases. The reason can be explained from the following two aspects. First, if the node density is low, some terminals have to play the role as the source and cooperative relay alternately. This additional relay energy cost is expected to impact the performance negatively The growing availability of relay candidates results in balanced energy consumption. To be more specific, if the node density is high enough, the terminals having their own data to send or serving as routing relay are rarely selected as the cooperative relay for other connections. Because their residual energy is lower than the others. Second, the higher the node density is, the higher the probability that relay candidates are located in the ideal positions for the existing source-destination pairs.

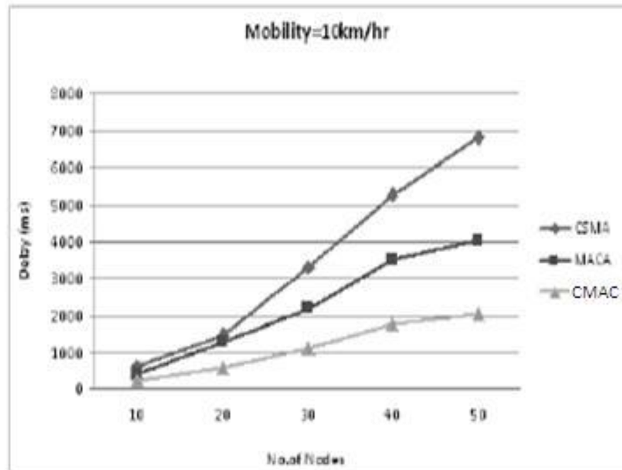

Fig 3 Delay vs. no. of nodes

Thus, high node density leads to a transmitting power reduction for both source and relay by our optimal power allocation scheme. To be specific, at least 2.2 and 3.9 times lifetime improvements for case P_/P = 0.5, and 1.4 and 2.4 times lifetime Improvements for cases P_/P = 2, can be obtained by CMAC over DCF and Coop MAC, respectively. From Figure 2, for CSMA the throughput decreases from 1900bps to 600bps with increase in number of nodes from 5 to 10 .

VI.CONCLUSION

In this paper, we have presented a performance analysis of CSMA, MACA and MACAW. Compared to CSMA and MACA, it is clear that the MACAW is the more suitable MAC protocol for MANET. From results it finds that by using RTS-CTS in MACA it needs more energy and more time to transmit data than CSMA. There is memory overflow at nodes as number of packets sending increases and packet delivery ratio is less in MACA then CSMA. Also with throughput and average end-to-end delay CSMA performs more reliably than MACA. But still there is not a single protocol that improves all the performance metrics. In this paper, comparative analysis of MAC Protocols has been made to explore the future areas of research.

VII. FUTURE WORK

In this discussion of MAC LAYER PROTOCOLS this paper compared on the basis of their performance metrics and their features. This can be further extended by performing simulations on different parameters like improving antenna sensitivity, number of nodes, simulation time, and topology. By this the behavior of protocols can be studied. MANET provides a dynamic environment, thus for minimizing data packet loss in such environment is a challenging task. MACA protocol can be improved by improving the length of data packets that follow each successful RTS-CT. Various security schemes can also be applied for secure exchange of data.

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