# An Analysis of RTS/CTS Mechanism for Data Transfer In Wireless Network: A Review

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***Abstract*—In a wireless network, there is a large number of mobile nodes that share the communication medium. The wireless network employs carrier sense based MAC algorithms such as Carrier Sensing Multiple Access (CSMA) and CSMA with Collision Avoidance (CSMA/CA) for efficient sharing of communication channel. But this method does not solve the problem of hidden nodes. Hidden nodes are those nodes that are out of range of other nodes or a group of nodes. The network throughput reduces because of packet collisions caused by these hidden nodes. To solve hidden node problem, the Request-To-Send (RTS) and Clear-To-Send (CTS) mechanism is widely used in wireless networks for reserving the channel to transmit data from source to destination. This paper is aimed to provide a survey on methodology and various algorithms and methods of implementing RTS/CTS mechanism in wireless networks.**

*Keywords***—**RTS/CTS, Collision, Wireless Network, Hidden Nodes, Delay

## I. Introduction

Wireless communication is an emerging technology and becomes a part of everyday's life. An ad hoc wireless local area network (WLAN) consists of a large number of closely located mobile units or nodes that form a network which is not controlled by any centralized point. The IEEE 802.11 standard is a set of the MAC (Medium Access Control) sub-layer and the physical layer specifications for implementing wireless local area network (WLAN) communication [6]. Mobile nodes in WLAN share the communication medium [1]. The network employs Medium access control (MAC) protocol to efficiently and fairly share the communication resources between the nodes. To further enhance the efficiency of operation, carrier sense based MAC algorithms such as Carrier Sensing Multiple Access (CSMA) and CSMA with Collision Avoidance (CSMA/CA) are used. In these algorithms, the mobile terminal first sense the medium to verify that it is idle or busy. If the medium is idle, only then the node tries to transmit its data otherwise it waits for the transmission in progress to finish before starting its own transmission. But these protocols still result in collision events when the multiple nodes transmit at such power levels to a receiver node that the intended receiver node may not be able to correctly receive any of them.

The operation of CSMA based MAC protocols will be efficient when the carrier sensing operation is spatially effective. But the geographical location of the nodes may lead to masked terminal scenarios in many cases and induces blocking. Such a situation creates two major problems: hidden terminal and exposed terminal conditions [1].

Phil Karn originally proposed the use of Request-to-send and Clear-to-Send (RTS/CTS) handshaking scheme leading to the Multiple Access Collision Avoidance (MACA) protocol to solve hidden terminal problem [2]. When a node wants to send data to another node, it first transmits a short Request To Send (RTS) packet to the receiver. If the receiver is ready for this communication, it responds with a Clear to Send (CTS) packet. On the successful reception of CTS packet, the sender advances to transmit the actual data packet. For collision avoidance, nodes that overhear the RTS or CTS packet will hinder their transmission for an adequate long period of time, to allow the sender to receive the CTS packet or to allow the receiver to receive the entire data packet respectively [2].

In RTS/CTS protocol scheme, RTS/CTS packets set the timer for the neighbouring nodes that these nodes do not interfere in communication of the intended nodes [7]. However, if the communication between the intended nodes occurs within a time period that is less than that of the CTS timer, the neighbouring nodes have to wait even when the communication is over. So a kind of delay has been developed. Hence there is a need of advancement in the previous technique to reduce the delay time between a RTS and CTS sequence resulting in higher throughput and network efficiency.

## II. Related work

Wireless network has limited bandwidth and channel conditions are variable [3]. So it is very challenging in wireless networks to differentiate between the priorities of each mobile host. In this paper, three service differentiation mechanisms are introduced based on the contention window variation, DIFS variation and the maximum frame length allowed to each wireless node and RTS/CTS scheme over UDP and TCP layers is used for data transmission. The three different mechanisms do not affect overall efficiency of the system and the data rate sums also remains the same.

The Request-To-Send/Clear-To-Send (RTS/CTS) mechanism is an optional four-way handshaking mechanism used to combat the effects of packet collisions in IEEE 802.11 wireless networks. RTS threshold (RT) value is an important element to study as it decides that when RTS/CTS mechanism should be used. The simulation results indicate that the best performance can be achieved when RT is set to small value that is dynamically adjusted according to the number of contending stations. But the improvement of performance is very small. Thus, it is best to always use RTS/CTS mechanism (RT = 0) in order to avoid complex work designing and implementing dynamic RT mechanism [4].

As the number of the nodes increases, the performance of IEEE 802.11 reduces severely in the terms of delay and throughput [5]. To provide performance analysis of IEEE 802.11 MAC protocols in wireless LANs, accurate discrete probability distribution and approximate continuous probability distributions of the MAC layer service time have been derived and RTS/CTS mechanism is being used for data transmission. The performance analysis in saturated and non-saturated traffic scenarios is being studied and it is observed that for queueing analysis, exponential distribution is a good approximation model for MAC layer service time.

In multi-hop networks, the implementation of RTS/CTS mechanism creates the problem of inter-dependencies that hinders the neighbouring nodes unnecessarily from transmitting over long periods of time [14]. This problem is referred as false blocking. RTS validation is a simple backward-compatible solution to false blocking problem. In this method, a node that uses RTS validation assesses the state of the channel after overhearing RTS packet and will defer no longer if it found that the channel is idle, otherwise it continues deferral. RTS validation method stabilizes the network throughput at high load, increases peak throughput by as much as 50% and reduces average delay.

In [15], the effectiveness of RTS/CTS protocol is studied in a wireless ad-hoc network that has random ALOHA transmissions between nodes. The spatial and temporal impact of the RTS/CTS reservation on the network traffic is quantified as well as the link throughput achieved.

To solve hidden node problem, different techniques and protocol are given in [10] like Increase Transmitting Power From the Nodes, Use Omni-directional antennas, Remove obstacles, Move the nodes, Use protocol enhancement software, Use antenna diversity, Wireless Central Coordinated Protocol etc. Each technique that is provided for solving hidden node problem is for a particular scenario. This paper also discusses the problem of exposed node and it can be solved by using RTS/CTS mechanism only if the nodes are synchronized.

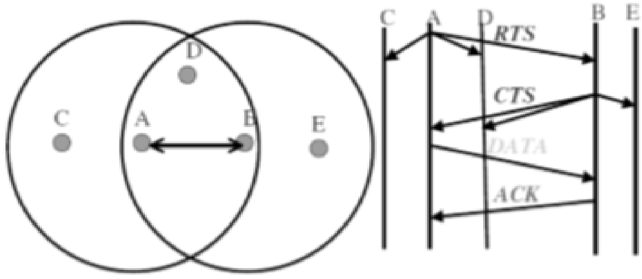


Figure 1. RTS/CTS handshake with ACK [10]

In wireless sensor networks, energy efficiency is an important factor [7]. S-MAC protocol increases energy efficiency by decreasing the listen time by letting nodes go into periodic sleep mode. To avoid collision and overhearing in wireless sensor network, S-MAC follows virtual carrier sense, physical carrier sense and RTS/CTS mechanism. Source node transmits transmission time to all neighbouring nodes so that these neighbouring nodes go into sleep mode until the end of the current transmission to avoid collisions and overhearing and thus reducing energy consumption by nodes.

The use of directional antennas in wireless media access control (MAC) creates deafness problem which may degrade the performance of the network [8]. The CRDMAC protocol uses two sub-channels (i.e. data channel and control channel) and circular transmission of RTR (Ready To Receive) packets to solve deafness problem. The RTR packets notify the neighbouring nodes around the transmitter that current transmission has finished and thus reduces waiting time of the neighbouring nodes. However, this protocol can be enhanced by incorporating various parameters and Quality of Service (QoS) requirements.

If the network has very less number of hidden nodes then use of RTS/CTS mechanism increases the transmission overhead and throughput performance of IEEE 802.11 decreases [11]. To solve this problem, optimized RTS/CTS mechanism is proposed in this paper. According to this method, if the number of hidden terminals is greater than hidden threshold only then RTS/CTS handshaking is used for new transmission and each terminal maintains two types of table i.e. hidden table and neighbour table.

The packet transmission scheduling is proposed in [9] to improve channel utilization under fading channel conditions. Under the packet transmission scheduling, the transmission to the station under fading channel condition is interrupted and the transmission to another station in good channel state is started and an extended RTS/CTS mechanism is being used. The extended RTS/CTS handshake quickly detects the recovery from degraded channel condition and reduces the wasted time even if fading loss occurs. The network throughput increases without degrading the throughput fairness between the stations. The proposed scheduling does not consider power saving element and wireless multi-hop networks.

Due to the RTS/CTS mechanism, various problems arise like exposed node, masked nodes, RTS-induced and CTS-induced problems and these problems degrade the performance of the system [12]. A new control packet has been proposed in this paper that allows successful concurrent transmissions and in this method, the nodes maintain the status of its own transmitter and receiver as well as that of its neighbouring nodes. But there is still need of further research to prevent the situation of hidden terminal problems.

The packet synchronization mechanism is proposed in [13] to minimize attacks on RTS/CTS frames. In this mechanism, the maximum number of packets being sent by requesting or replying node is set as a packet threshold. The packet synchronization mechanism is simple to implement and minimizes attacks on RTS/CTS frames and it also decreases the number of faulty packets and dropping of them. The performance throughput of the network increases due to this mechanism.

## III. Proposed work

The proposed scheme addresses the problem of delay in the RTS/CTS mechanism that is developed due to the extra waiting time of the neighbouring nodes even when the communication is over. The proposed work integrates the concept of RTR (Ready To Receive) packets with RTS/CTS mechanism. When the communication between the intended nodes completes before the expiration of the timer that is set by RTS/CTS packets, the receiving node sends RTR packets to all the neighbouring nodes to notify them that now it is free to communicate, so by doing this, the neighbouring nodes do not wait till the timer expires. So they can communicate without any delay in network

So basically, the upgrade is that earlier communication was taking more time due to the delay, but with introduction of RTR packets, this delay reduces.

## IV. Conclusions

This paper provides a comprehensive survey of various algorithms and methods of implementation of RTS/CTS mechanism for data transfer in wireless network and the proposed methodology. The proposed methodology will reduce the delay that is introduced because of extra waiting time of neighbouring nodes even when the communication is completed.

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