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Modifying MAC to Avoid Collision in Wireless Networks

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***Abstract* - The proposed concept tries to avoid the use of RTS/CTS and maintain the same rate of successful frame delivery. So here implements a method in which a special sequence allots specific time intervals to each node for data transfer. A network in which every node transmits data at a uniform rate can achieve high throughput using this method. But if the data rate of individual nodes is not uniform; For example., half the nodes are idle most of the time. In such a situation a lot of time is allocated to these nodes for data transmission. This problem can be avoided if the MAC layer is modified in such a way that if a particular node is idle during its designated transmission time then the MAC layer can send a modified CTS called proactive message packet to a few randomly selected nodes to send their data during the otherwise idle time. Performance analysis can be done on the basis of overall throughput, drop, energy and throughput of the proposed system in various scenarios.**

Index Terms – Collision avoidance, IEEE 802.11 standards, Packet drop.

I. INTRODUCTION

Data link layer is the second layer of the OSI model. Medium Access control protocol layer is one of the sub layer of data link layer (see Fig. 1). The MAC sub layer provides addressing and channel access control. It acts as an interface between the network's physical layer, and logical link control layer. MAC sub layer uses MAC protocols to ensure that signals sent from different stations across the same channel without collision. MAC determines how to access the medium and data link components. It is a set of rules and its purposes are coordinated and share use of bandwidth, timing synchronization, user datagram transfer function and MAC layer management functions. It is independent of the underlying physical layer.

In the 802.11 protocol, the basic medium access mechanism is the distributed coordination function, which is based on carrier sense multiple access with collision avoidance protocol. It can be used to support asynchronous data transfer. In 802.11 carrier sense is performed both at the physical layer and MAC layer. Physical layer carrier sense is also referred to as the physical carrier sensing. MAC layer carrier sense is also known as a virtual carrier sensing. According to the IEEE standard, MAC sub layer performs some primary functions. They are frame delimiting and recognition, destination station and the source station addressing information, provide protection against errors and access control to the physical transmission medium. MAC layer provides a channel access control mechanism, which is also known as multiple access protocol. This makes several nodes connected to same physical medium to share it. The wireless network is an example of the shared physical medium. It may detect or avoid data packet collisions if a conflict may occur.

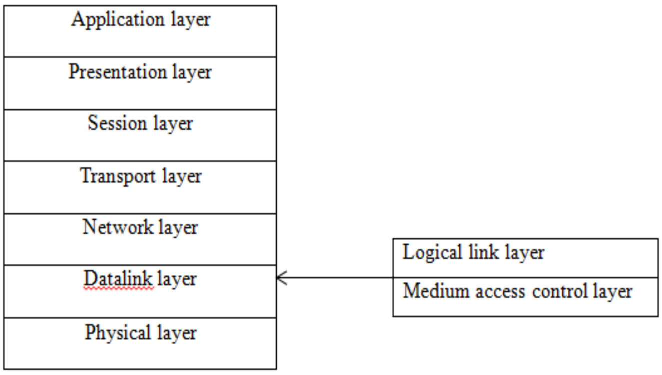

Fig. 1: Architecture of OSI model

Wireless networks avoid collisions to ensure packets reach their destination correctly. In [2], RTS/CTS is used to avoid collision. RTS/CTS add overhead because the sender and receiver have to exchange an additional set of packets before a transmission occurs. The RTS/CTS mechanism is a four way handshaking mechanism to reserve the channel before transmitting a packet, transmitter operating in an RTS/CTS mode to reserve the channel by sending a Request to send frame. After receiving an RTS at the destination, it acknowledges the reception of RTS by sending back a clear to send frame. After receiving the CTS, the channel is reserved for this data transmission, then the sender transmits data and receiver receives the data simultaneously. After receiving the entire data correctly, the receiver sends back an acknowledgement message, it represent the entire data is received correctly. Therefore collisions may occur only on RTS frame, and it is detected by the delay of CTS response, the RTS/CTS mechanism allows to improve the system performance.

Section II describes the motivation and objective of the proposed system. Section III reviews the related works.

Section IV explains the proposed system. Section V present the implementation details and section VI analyse the proposed system. Finally section VII conclude the paper.

II. Motivation And Objective

MAC control messages are necessary for data transmission. For example ACK reveal correctly received data, and RTS/CTS exchange can significantly avoid hidden terminal collision problems. However, even though the information transmitted in MAC control messages is small, but their duration can be quite long, as in addition to the control information, they also need to include the source/destination address, message type, etc.

In this paper, we try to avoid the use of RTS/CTS and maintain the same rate of successful frame delivery. So here implement a method in which a special sequence, that allots specific time interval to each node for their data transmission. Instead of control messages, it employs a special sequence, that convey all control information and change the design properties of the MAC. Both sender and receiver agree upon a set of special sequences to transmit data. But some nodes are idle most of its designated transmission time, so we use a proactive message packet to overcome this problem. This packet is send by either receiver or intermediate node that inform the idle status of node in its own transmission time.

802.11 control message structure consists of preamble, fixed control field, type, addresses and duration. In normal control message transmission contains a preamble and header, it transmits at base rate. By using RTS, CTS, their duration can be longer. The special sequence has no preamble and header fields. So it is shorter and more robust. It uses a special sequence allots specific time interval for data transfer. It correlates instead of decoding, so there is no encoding, therefore overhead can be low.

The sender sends a private control information via special sequence, that convey the receiver address. Then the receiver sends back a channel reservation, which is a public control information. The channel reservation message is unique to all nodes. Hidden terminals also can be detected the channel reservation message. So avoid the hidden terminal problem. After channel reservation, sender send data to the receiver. The neighbouring nodes are idle at this time, because the channel is reserved for that data transmission. After receiving all data, the receiver sends back an acknowledgement, it conveys the sender address. Every sender is associated with an acknowledgement. After this, the receiver sends a channel release message to sender for releasing the channel and other nodes can reserve the channel for their data transmission.

III. Related Work

Collisions and hidden terminals are the main problem in 802.11 networks. MAC control messages are used to avoid collision. For mitigating collisions and address hidden terminal problems, many MAC protocols have been proposed. Recently, several previous works like WiFi-Nano [6] and Back2F [8] have addressed 802.11 throughput overhead reduction, and also they completely neglect the case of hidden terminals.

In [3], introduce a ZigZag decoding, which is a new 802.11 receiver that increases collision resistance. When there is no collision, ZigZag requires no overhead and no change to 802.11 MAC. So it acts like a typical 802.11 receiver. But in the case of collision, it tries to decode the packet and avoid collision. ZigZag resolves a variety of collision patterns. The main idea underlying its decoding algorithm is to find a collision free chunk, which it exploits to bootstrap the decoding process. Like current 802.11, when a ZigZag receiver detects a packet, it tries to decode it, assuming no collision, and using a typical decoder. If decoding fails (e.g., the decoded packet does not satisfy the checksum), the ZigZag receiver will check whether the packet has suffered a collision, and proceed to apply ZigZag decoding.

[7] attempts from collision detection to collision notification. Here, the transmitter has two interfaces, one for data transmission and another for listening. The listening interface is used to listen any notification about the collision. These 2 interfaces are at the physical layer. The transmitter sends the data to receiver. The receiver has only a single interface. Once communication begins, for detecting the presence of interference, the receiver uses a preamble correlation. If the receiver detects a collision, then it stops receiving and immediately notifies the collision to the transmitter. The receiver sends back the transmitted data and collision notification to the transmitter. Transmitters listening antenna detects the collision notification and alerts the transmitter to suspend the transmission. Then transmitter aborts and releasing the channel for other transmitters.

[6] propose WiFi-Nano, a system that uses 800 ns slots to improve the efficiency of WiFi. The main contribution of [6] is WiFi-Nano increases 802.11 throughput. Here a backoff time is used. As soon as the backoff expires, a node transmits its preamble. A node transmitting a preamble continues to attempt for detecting incoming preambles. A node aborts its transmission if it detects a preceding preamble. Speculative preamble is used to reduce slot time duration. Probabilistic collision resolution is used to reduce collision. To preserve fairness, backoff counter rollback and minimize slot size are used. To reduce short inter frame space, speculative acknowledgements are used.

The goal of [5] is to go from collision avoidance to collision resistance. [5] propose a spectrum sharing protocol to achieve high efficiency. In [5], the sender selects some channels and sends copies of its frame to all the selected channels. The receiver receives the sum of all the signals transmitted on each channel and construct a linear system that reflects the relationship between the original message, received message, code and channel coefficients. It can then decode the original message based on receiving messages, code and channel coefficient.

[8] proposes to break away from convention and recreate the backing off operation in the frequency domain. Back2F aims to exploit this knowledge to batch transmissions. Therefore, even with batched transmissions, Back2F roughly

emulates 802.11 and provides similar fairness; throughput improves consistently.

In [1], design, implement and evaluate 802.11ec, which is an 802.11 based protocol. It employs correlatable symbol sequences that together with their transmission timing, convey all control information and change the design properties of the MAC. Correlatable symbol sequences are predefined pseudo-noise binary codewords. These sequences are used instead of control messages. So their duration can be short.

IV. PROPOSED SYSTEM

The proposed concept tries to avoid the use of RTS/CTS and maintain the same rate of successful frame delivery. So here implement a method in which a special sequence allots specific time intervals to each node for data transfer. Continuous data transmission with special sequence method is used for this data transmission, which is a normal scenario without RTS/CTS and it uses special sequence instead of control messages. The shortness and robustness of sequences dramatically reduces vulnerability to collisions. The RTS/CTS is disabled means there is RTS is transmitted before the transmission for allocating the channel. Therefore, if there is no RTS, then receiver cannot send back CTS message. By setting the RTSThreshold to high value, it disabled in that transmission. Control messages are used to avoid collision. But the control messages duration can be quiet long. As in addition to control information, they also need to include source or destination address, message type etc. Special sequence is used to reduce the duration. So we can improve the throughput of the system. A network in which every node transmits data at a uniform rate can achieve high throughput using this method. But if the data rate of individual nodes is not uniform; For example, half the nodes are idle most of the times. In such a situation a lot of time is allocated to these nodes for transmission.

This motivates that if the MAC layer is modified in such a way that if a particular node is idle during its designated transmission time, then the MAC layer can send a modified CTS called proactive message packet to a few randomly selected nodes to send their data during the otherwise idle time. This proactive packet is sent either middle nodes or receiver, which is like CTS. But the difference is CTS wait for RTS reception, but in case of proactive message there is no wait for any reception. This message packet is used for idle node transmission. Proactive means packets are immediately delivered as paths are already established. The proposed system is efficient in terms of throughput, energy and packet drop.

A. Architecture

Architecture of this system is shown in Fig. 3. Here a and b are senders and d is the receiver. These senders transmit data without RTS/CTS in continuous data transmission method with special sequence. Without RTS/CTS means it disabled in that transmission by setting the RTSThreshold to a high value. It uses special sequence instead of control messages. In proactive data transmission, these are transmitted in an intermitted manner. When sender b becomes idle in its own transmission time, then the receiver send a proactive packet to few nodes to inform the idle status of the idle node. The proactive message packet is like CTS and it used to overcome the idle node problem in its own transmission time.

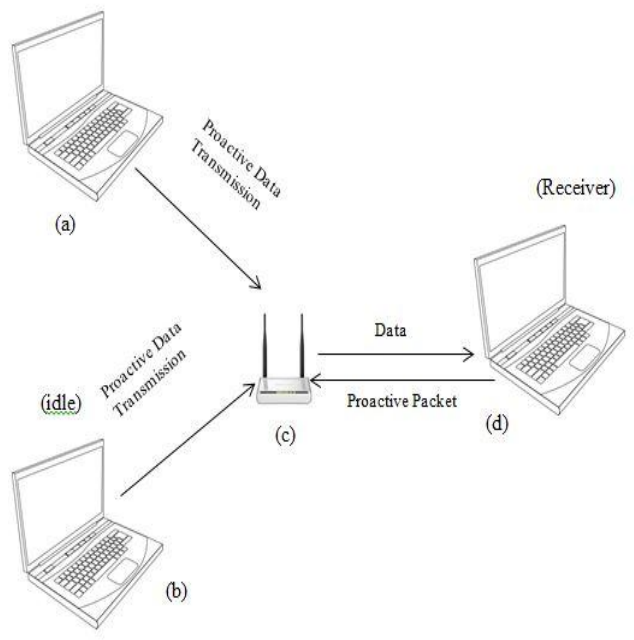

Fig. 3: Architecture of proposed system

B. System Model

The designing of a network scenario results in a network model which consists of sender nodes, intermediary nodes and receiver nodes. Sender nodes can transmit the packets using continuous data transmission method with special sequence, which has RTS/CTS are disabled and data transmission with special sequence. Special sequences are used for data transmission instead of control messages.

The decision on physical layer parameters for configuring the nodes are also done in designing. Node connectivity indicates TCP connections with nodes. Packet flows are take place in simulation scenario. Here source which transmits packets to the sinks. The routing protocols used for packet routing. Efficient routing protocols can provide significant benefits to Ad hoc networks in terms of both performance, reliability and initiates a route discovery process, which goes from one node to the other until it reaches to the destination or an intermediate node has a route to the destination.

In the system model, there are 4 nodes. Two nodes are senders and one is receiver. In continuous data transmission with special sequence method, these two nodes are transmit data using special sequence, which is a time based approach. So a particular node is idle in its own time, to overcome this problem, proactive data transfer method is used. In that method, if any one of node is idle in its transmission time, then the receiver send a proactive message packet to current transmitted node, which informs the idle status of that node with node id.

V. Simulation Environment

Our conclusions are based on the results gathered by extensive simulation of a network model which implements this modified MAC. So we implemented the protocol in the Network Simulator- 2 (NS-2) [10] and evaluated the two methods like continuous data transmission with special sequence and proactive data transmission method. These two methods are used for data transmission without control messages and idle node transmission.

Define options for channel type, radio propagation model, network interface type, mac type, interface queue type, link layer type, antenna model, max packet in ifq, number of mobile nodes and wired nodes and routing protocols. Table I shows the simulation parameters based on NS2. Then initialize global variables, simulator instance and trace file. Set RTSThreshold to 10000. If the RTSThreshold value is high, then RTS/CTS mechanism is disabled in ns2, so there is no RTS/CTS is transmitted. Then setup topography object and god object. Set the nodes position with its x,y,z coordinate axis. Create a TCP agent and attach it to corresponding nodes and create FTP traffic sources and attach it to corresponding TCPs. Then schedule the events.

TABLE I
Simulation Parameters

Parameters	Environment
Channel Type	Channel/WirelessChannel
Radio Propagation Model	Propagation/TwoRayGround
Network Interface Type	Phy/WirelessPhy
Mac Type	Mac/802_11
Interface Queue Type	Queue/DropTail/PriQueue
Link Layer Type	LL
Antenna Model	Antenna/OmniAntenna
Maximum Packet in Interface Queue	5
Number of nodes	4
Routing Protocol	AODV
X coordinate Value	887
Y coordinate value	489
Simulation Stop Time	10.0

In the proposed system, there is only one simulation scenario. In that scenario, these two methods are simulated. Visualized output is same for these two methods. But the generated output files and values are different. Based on these values analyze these methods. The core code level implementation including creation of a separate file named proactive with .cc extension and this is not a part of standard ns 2.35. This core codes have the connection with both TCL files and ns library files. Before simulating the system, the core code must be integrated with standard NS-2.

Throughput is the amount of successful messages or packet delivery over a channel. Number of packets dropped is the number of data packets that are not successfully sent to the destination during the transmission.

VI. Analysis Result

The proposed system is analysed in terms of throughput, energy and packet drop. Here the time versus number of packets dropped have been calculated.

There are two methods are analysed. They are continuous data transmission method with special sequence and proactive data transmission method. In continuous data transmission method with special sequence, control messages like RTS/CTS are disabled. So there is no control messages are transmitted for data transmission. Instead of control messages, special sequence is used. These special sequences allots specific time interval to each node for data transmission. During the transmission time, some nodes are idle in its own transmission time. So a lot of time is allocated to these nodes for data transmission. This problem is avoided by using proactive data transmission method. In this method, MAC layer can send a modified CTS called proactive message packet to some nodes. This packet informs the idle status of the node in its own transmission time.

There are two simulations, first simulation is based on continuous data transmission method with special sequence. It consist of normal scenario without RTS/CTS and special sequence. Second simulation is based on proactive data transmission method. These two simulations are analysed in terms of packet drop and throughput.

Table II shows the packet drop of these methods. Here proactive data transmission is better than method using special sequence in terms of packet drop.

TABLE II
Packet Drop of Methods

Method	Packet Drop
Special sequence transmission	36
Proactive data transmission	32

Throughput defines the total packets received at the destination correctly. Table III shows the throughput of these methods. Here proactive data transmission method is also better than the other method.

TABLE III
Throughput of Methods

Method	Throughput
Special sequence transmission	1005.6 kB
Proactive data transmission	1164.68 kB

Fig. 4 shows graphical representation of two methods based on throughput. Time on x-axis and packet delivery on y-axis. This graph shows the proactive data transmission method is better in terms of packet delivery at destination.

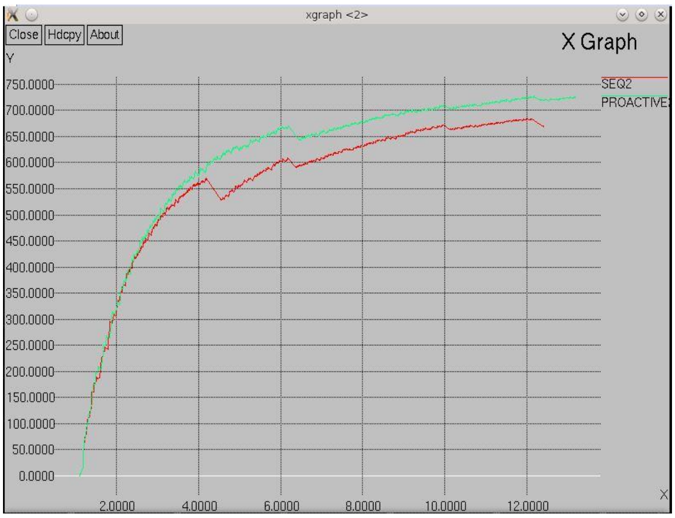

Fig. 4: Throughput

Fig. 5 shows the energy dissipation of receiver. It shows time on x-axis and energy on y-axis. It consist two data transmission methods. In the continuous data transmission method with special sequence, RTS/CTS disabled and special sequence concepts are included. These two methods and proactive data transmission method are shown in fig. 5. This graph shows the proactive data transmission method is better in terms of energy dissipation at destination.

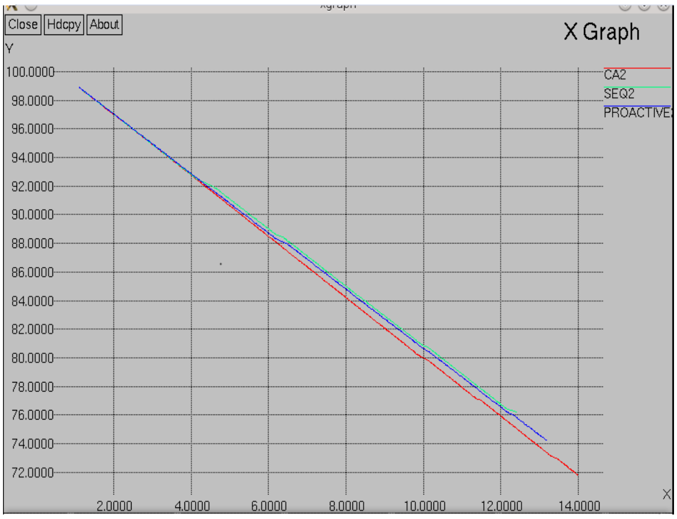

Fig. 5: Energy Dissipation

VII. CONCLUSION

Here a method in which a special sequence allots specific time intervals to each node for data transfer. A network in which every node transmits data at a uniform rate can achieve high throughput using this method. And also implement a proactive data transmission method. If a particular node is idle during its designated transmission time, then the MAC layer can send a modified CTS called proactive message packet to a few randomly selected nodes to send their data. Based on throughput, energy and packet drop, the proactive data transmission method is better than the other.

REFERENCES

[1] Eugenio Magistretti, Omer Gurewitz, Edward W. Knightly, " 802.11ec: Collision avoidance without control messages," in *IEEE/ACM Transactions on Networking*, vol. 22, no.6, Dec 2014
[2] V. Barghavan, A. Demers, S. Shenker, and L. Zhang, "MACAW: A media access protocol for wireless LAN's," in *Proc. ACM SIGCOMM*, 1994, pp. 212–225.
[3] S. Gollakota and D. Katabi, "Zig-zag decoding: Combating hidden terminals in wireless networks," in *Proc. ACM SIGCOMM*, 2008, pp. 159–170.
[4] P. Karn, "MACA—A new channel access method for packet radio," in *Proc. ARRL Comput. Netw. Conf.*, 1990, pp. 134–140.
[5] T. Li, M. K. Han, A. Bhartia, L. Qiu, E. Rozner, and Y. Zhang, "CRMA: Collision-resistant multiple access," in *Proc. ACM MobiCom*, 2011, pp. 61–72.
[6] E. Magistretti, K. K. Chintalapudi, B. Radunovic, and R. Ramjee, "WiFi-Nano: Reclaiming WiFi efficiency through 800 ns slots," in *Proc. ACM MobiCom*, 2011, pp. 37–48.
[7] S. Sen, R. R. Choudury, and S. Nelakuditi, "CSMA/CN: Carrier sense multiple access with collision notification," in *Proc. ACM MobiCom*, 2010, pp. 25–36.
[8] S. Sen, R. R. Choudury, and S. Nelakuditi, "No time to countdown: Migrating backoff to the frequency domain," in *Proc. ACM MobiCom*, 2011, pp. 241–252.
[9] Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) —Specifications, ANSI/IEEE Std. 802.11‖, ANSI/IEEE Std. 802.11, 1999 Edition, 1999.
[10] The ns Manual (formerly ns Notes and Documentation), The VINT Project, Collaboration between researchers at UC Berkeley, LBL, USC/ISI, and Xerox PARC. Kevin Fall hkfall@ee.lbl.govi, Editor Kannan Varadhan hkannan@catarina.usc.edui, Editor.March 14, 2008.