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# Enhancement Throughput of Adhoc Network using DSDMAC Protocol

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**Abstract -**An Adhoc network refers to a network with no fixed infrastructure and the nodes are assumed to be capable of moving either on their own or carried by the user. However in practice deafness, hidden terminal and exposed terminal problems are some of the common problems causing the overall degradation of the adhoc network. In our project we have developed a novel scheme for Random access based Medium Access control Protocol called "Dual sensing directional medium access control protocol" which makes use of two types of antennas namely directional and omnidirectional for carrier sensing in Medium Access Control protocol. This scheme makes use of one channel for data signal and another channel for control signal carrier sensing. BT1 and BT2 are two different patterns of non interfering sine wave signals which are used for the other nodes to be aware of an ongoing transmission. This scheme enhances the network throughput and lowers delay utilizing the spatial multiplexing gain of the antenna. Network simulator is used in the simulation of our project and the results are presented in the form of snapshots.

## I. INTRODUCTION

Using directional antennas, a higher antenna gain can be achieved, which results in a higher data rate, a larger transmission range, and/or a less transmission power. There are many applications using directional antennas. When used in a network, directional antennas can reduce the number of blocked nodes and achieve higher spatial reuse. However, effective medium-access control (MAC) protocols that support the directional antenna face several challenges. The main challenges of in the case of MAC Protocol are the hidden-terminal, exposed-terminal, and deafness problems severely affect network performance.

Different from the situation with omnidirectional antennas, hidden terminals in networks with directional antennas are located near the source node, as they may not hear the source node transmission and may initiate transmissions, thus leading to collisions.

Deafness, on the other hand, occurs when a targeted destination does not reply when it is transmitting or receiving at a different direction. If it is not handled, failed transmissions due to deafness might be treated as collisions by the source node. Even worse, the source node may conclude that the destination node is unreachable.

Using directional antennas in ad hoc networks poses challenging problems for MAC protocol design. The main theme of this project is to propose a dual-sensing directional MAC protocol (DSDMAC) for networks with directional antennas.

This helps to improve the throughput and delay performance of the wireless networks by minimizing the negative effect of the hidden-terminal, exposed-terminal, and deafness problems.

It also uses a no interfering out-of-band busy-tone signal combined with sensing the activity on the actual data channel to identify deafness situations and to avoid unnecessary blocking. In addition, the protocol avoids the asymmetry-in-gain problem introduced by other solutions.

The integrity of the DSDMAC protocol is verified and simulated using Network simulator-II, which is a formal protocol verification tool. Finally, the simulation results for throughput and delay analysis of wireless ad hoc networks using directional antennas is presented. The performance analysis is validated by simulation results, showing the advantages of applying the DSDMAC protocol, which can outperform efficiently.

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## II LITERATURE SURVEY

Random-access-based MAC protocol design and analysis for ad hoc networks has attracted extensive research [3]–[6]. We focus on those considering directional antenna, which can be classified into the nonbusy-tone-based protocols and the busy-tone-based protocols, as discussed here.

## Related Work

This section deals with a survey of the recent work carried out by researchers in the domain of vehicular adhoc network. The survey of papers is carried out to know the existing techniques being used and to identify their issues.

### A. Nonbusy-Tone-Based Protocols

### Directional Antennas in Ad Hoc Networks

The directional MAC (DMAC) proposed in [7] is one of the earliest protocols that support directional antenna. Based on a modified 802.11 MAC protocol, DMAC uses a per-sector blocking mechanism to block a sector once it senses a request-to-send (RTS) or clear-to-send (CTS) packet. A node can transmit its RTS packet in an omnidirectional fashion when none of its sectors is blocked; otherwise, it beams toward its destination. The omnidirectional transmissions may cause unnecessary blocking, and the protocol requires knowledge of neighbors' locations.

### Medium Access Control Protocols Using Directional Antennas in Ad Hoc Networks

In this paper, it is suggested that RTS/CTS packets be exchanged in an omnidirectional fashion (ORTS/OCTS) using all available sectors. After a successful ORTS/OCTS handshake, the data and Acknowledgment (ACK) are transmitted in the directions from which the OCTS/ORTS are received at the maximum power. The protocol is efficient in minimizing the hidden-terminal problem. However, it creates a severer exposed-terminal problem and cannot handle the deafness problem.

### Multihop Medium Access Control Protocol

A multihop RTS MAC (MMAC) protocol is proposed where all packets including RTS/CTS should use directional transmission (DRTS/DCTS). Nodes, however, may listen in an Omnidirectional mode while they are idle. The deafness problem still exists as not all neighboring nodes can receive the DRTS and DCTS.

### The Directional Virtual Carrier sensing protocol

Assuming a steerable antenna system to point at any specified direction. Each node maintains a list of neighbors and their directions based on the address of arrival (AoA) of any sensed signal. The AoA information is used to directly beam RTS packets to their destinations. If no location information exists, the RTS packets are omnidirectionally transmitted. A directional version of the network allocation vector is maintained for channel reservation. The protocol handles some basic functions required to support the directional antenna, and it cannot handle the hidden-terminal and deafness problems.

### A distributed, asynchronous directional-to-directional MAC protocol for wireless ad hoc networks

A circular directional RTS in which an RTS packet has to be transmitted multiple times in each direction. This helps to identify the location of the source node by its intended destination who replies a CTS packet at the direction of the source. Sending the RTS packet at all possible directions helps to notify the neighbors about the intended communication. However, this would not eliminate the deafness problem. The protocols also require synchronization mechanisms and cause undesired waste of time. In addition, the previous RTS/CTS-based mechanisms cannot be used for multicasting and broadcasting [13].

## B. Busy-Tone-Based Protocols

### The Tone-Based DMAC (Toned MAC)

The tone-based DMAC (Toned MAC) protocol proposed in [14] uses two separated channels, i.e., a data channel and a control channel. While the data channel is used to transmit the RTS/CTS/DATA/ACK packets, the control channel is used to transmit a busy-tone signal. A unique busy tone is assigned to each wireless node, and therefore, it can be identified, and each node should maintain a hash function for all neighbors' locations. When a source node has data to transmit, it transmits a directional RTS packet toward its destination immediately after sensing the medium at the intended direction. The destination node in response replies with a directional CTS packet back to the source node.The source and destination nodes continue with exchanging the actual data at the specified directions, and meanwhile, they omnidirectionally transmit a busy tone. If the source node detects a busy tone rather than receive a CTS packet, it then concludes a deafness situation. The protocol can identify some deafness situations; however, there are chances to miss the busy-tone signal from either or both the source and destination nodes, which do not guarantee a deafness-free protocol. In addition, to avoid the hidden-terminal problem, the busy-tone signal needs to be simultaneously transmitted as the RTS packet, and it also needs to be sensed before any other transmission. In [15], the busy-tone signal to be transmitted by the destination node toward the direction of the source node only is proposed. The communication first starts with a DRTS/DCTS PACKET exchange in a directional manner. The redundant busy-tone signal would serve as another way to inform other nodes of the ongoing transmission in case they missed the DCTS packet. However, the deafness problem, which degrades the performance of the protocol, has not been addressed.

### Dual-Busy-Tone Multiple Access with Directional Antennas (DBTMA/DA)

Dual-Busy-Tone Multiple Access with Directional Antennas (DBTMA/DA), which was proposed by Huang *et al*. [16], is a modified version of the Dual Busy-Tone Multiple Access (DBTMA) in [17] to accommodate the nodes with directional antennas. As in the original DBTMA, the DBTMA/DA uses two distinctive busy tones: a transmitter's busy tone ($BT_t$) and a receiver's busy tone ($BT_r$). The receiver turns on its $BT_r$ upon receiving the RTS packet, whereas the transmitter turns on its $BT_t$ upon receiving the CTS packet. Therefore, hidden terminals are notified after the CTS is being transmitted by the receiving node, leading to a large gap during which several collisions may occur.

## III SYSTEM ANALYSIS AND DESIGN

System analysis and design is to deliver the requirements as specified in the feasibility report. It defines the components, modules, interfaces, and data for a system to satisfy specified requirements.

## A Dual Sensing Directional Medium Access control Protocol

The proposed DSDMAC protocol uses two well-separated wireless channels, i.e., a data channel and a busy-tone channel. The data channel carries the data packets and the RTS, CTS, and ACK packets on a specified direction (DRTS, DCTS, DDATA, and DACK). On the other hand, the busy-tone channel will be used to transmit a sine-wave busy-tone signal on all other directions. Only the source and destination nodes will transmit the busy-tone signal. The protocol assumes that the directions of all reachable destinations or forwarders are predetermined (during the node discovery period for example)

### Transmitting and Receiving With DRTS/DCTS

When the link layer of a wireless node receives data packets from its higher layer, it senses the activity on the data channel at the specified direction. If the specified sector is not blocked, the data channel is idle, and no $BT_1$ is present, it immediately transmits a DRTS packet and turns on its $BT_1$ signal at all other directions. In case a $BT_1$ was sensed, other nodes should postpone any DRTS until $BT_1$ disappears. Otherwise, the source node waits until the tagged sector is unblocked and becomes idle for the period of a distributed interframe space (DIFS). It then generates a random back off interval before transmitting its DRTS packet. The backoff interval is randomly chosen between 0 and CW - 1, where CW is the initial contention window size. The backoff counter is always frozen whenever the node senses an activity on the data channels at the specified direction or whenever the sector at the specified direction is blocked (e.g., by DRTS/DCTS from other nodes). Once the backoff counter reaches zero, the node transmits its DRTS packet at the

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specified direction and turns on its $BT_1$ signal over all other directions. The source node should change the $BT_1$ to $BT_2$ after finishing the DRTS packet transmission plus SIFS duration. We will discuss the reason for the BT switching shortly.

On the destination side, the receiving node (to which the DRTS packet is addressed) replies after an SIFS period with a DCTS packet at the specified direction and turns on its $BT_2$ signal at all other directions. It then waits for the data packet. Once the data packet is successfully received, the destination node acknowledges it by sending a DACK packet at the same direction. After that, it turns off its busy-tone signal.

$BT_1$ is used to avoid the hidden-terminal problem. Because DRTS cannot be sensed by the nodes in the hidden terminal area , these nodes can avoid initiating a new DRTS when they sense the $BT_1$. $BT_1$ can be turned off after the DRTS plus an SIFS because the nodes in $A_h$ can sense the CTS to avoid collision.

$BT_2$ is used to solve the deafness problem. When a node is directionally transmitting or receiving, it will not be able to respond to other DRTS. When a source notices a failed DRTS, it should check whether there is a $BT_2$ from the receiver's direction. If not, it concludes that there is a collision for the DRTS; otherwise, the receiver is busy in other transmissions. Therefore, if the source node does not receive a DCTS packet within a specified CTS-Timeout interval and it senses a $BT_2$, it reschedules the transmission of the packet for a later time (after the busy tone has disappeared) without doubling its backoff CW; if there is no $BT_2$, it reschedules the transmission of the packet for a later time and doubles its backoff CW.

Once the source node successfully receives the DCTS, it directionally transmits the data packet. After that, if the source node does not receive a DACK packet within a specified ACK–timeout interval or it detects a transmission of a different packet, it reschedules the transmission of the data packet for a later time and doubles its backoff CW.

## B.DNAV Mechanism

When a node receives a valid DRTS packet, it should set it's per sector directional network allocation vector (DNAV) timers. It also should block all of its sectors for a period with duration of SIFS + DCTS, as shown in Fig. 4.1. We call this time $DNAV_{DRTS}$ time. Unless a DCTS packet is received, the node should unblock its antenna sectors when the $DNAV_{DRTS}$ timer is expired. If a DCTS packet is received, then only the receiving sector and the sector from which a previously DRTS packet is received (if applicable) should remain blocked for a period with a duration of $2 \times SIFS + DDATA + DACK$, so the node will not initiate any transmissions to interfere the ongoing transmission. We call this time $DNAV_{DCTS}$ time, as shown in Fig. 1. Using this DNAV design, we can minimize the exposed-terminal problem without increasing the collision probability.

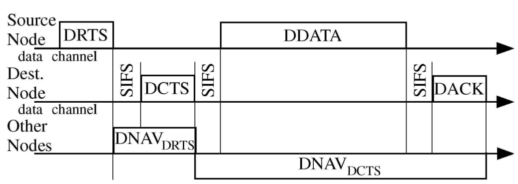


Fig.1 DNAV setting

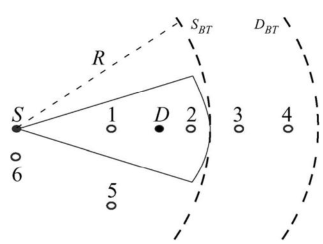


Fig 2: Case study.

# IV ALGORITHM

## A. Steps for Initialization

- Step 1: Initially all the nodes in the network are in idle state.
- Step 2: Both busy tones BT1 and BT2 are off state.
- Step 3: nodes in the network keep sensing for request signals .

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## B. Steps for solving the hidden and exposed terminal problems

- Step 1: when source needs to communicate with the destination node initiate the BT1 in the omnidirectional pattern indicating the source node is busy.
- Step 2: Send the DRTS signal to the destination node along with the Destination node address.
- Step 3: when the CTS signal is received from the destination after SIFS(Short inter frame space) indicating to transmit the data from the source node .
- Step 4: data packets are transmitted from source end to the destination end
- Step 5:successful transmission of the data is conformed only after DACK signal is received from the receiver

## C.Steps for solving the Deafness problems

- Step1:BT2 signals are enabled when the source and destination nodes are directionally Transmitting/Receiving
- Step2: when a source node notices failed DRTS, Check for BT2 signal from the receiver direction
- Step3: If BT2 signal is not present it indicates the there is a collision for the DRTS or receiver is busy in other transmission.
- Step4: If the source node receive a DCTS packet within a specified CTS Timeout interval and it senses a BT2it reschedules the transmission of the packets for a Later time (after the busy tone has disappeared) .

## D.Case Study and State Transitions of DSDMAC

To further illustrate how the DSDMAC meets its design goal, we use an example with the network configuration shown in Fig. 2. The source and destination nodes (*S* and *D*) are marked with solid dots. Nodes 1, 2, 3, and 4 are located on the same line connecting node *S* and node *D*. Nodes 5 and 6 are located at different directions. The dashed curve $S_{BT}$ marks the circular region of node *S*'s busy-tone signal range with a radius of *R*. Likewise, the dashed curve $D_{BT}$ marks the circular range of node *D*'s busy-tone signal. The message exchanges among these nodes are shown in Fig1. , where the arrow within each packet indicates the direction used to transmit that packet.

As shown in Fig. 2, node *S* waits until nodes 1 and 2 finish their communication. Meanwhile, nodes 3 and 4 may independently start their communication because the direction from node 3 to node 4 is not blocked. When node *S* senses no $BT_1$ in the busy-tone channel and no new activities in the data channel, and its corresponding antenna sector toward *D* is not blocked, it starts its transmission to node *D* after a backoff period. Any further transmission from node 1 to node 2 must be deferred until node *S* finishes. However, node 5 can independently start its transmission toward node 2 because the direction from node 5 to node 2 is not blocked. As a hidden-terminal, node 6 will be blocked from transmission while it hears the $BT_1$ from *S*, and it will then receive *D*'s DCTS and avoid collisions.

The state transition diagram for the DSDMAC protocol is shown in Fig 3. Although the states are self-explanatory, the following highlights the most important states, which are different from the IEEE 802.11 MAC protocol. The system is initially in its idle state until a packet arrives from the higher layers or a packet arrives from another node. When a packet arrives from the higher layers,

there is no new activity in the data channel, no $BT_1$ is sensed, and the corresponding antenna sector is not blocked, the system moves to the "Send DRTS & start BT" state and sets a timer to wait for the DCTS. Otherwise, the system moves to the "Wait" state until the channels become idle and the sector is unblocked; then, it moves to the "Bakeoff" state.

In case the timer expired without receiving a DCTS packet and a $BT_2$ signal is presented, the system skips the "Double backoff counter" state, as it concludes that its destination might be busy toward other directions. In this case, the system will directly go to the "Wait" state. This transition helps the DSDMAC protocol to avoid the deafness problem.

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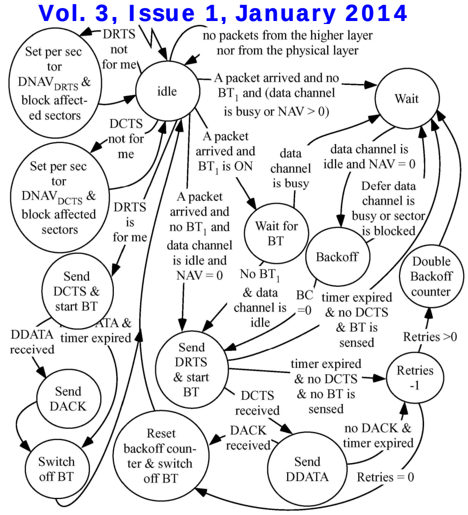


Fig. 3. DSDMAC system state transition diagram

## V RESULT ANALYSIS

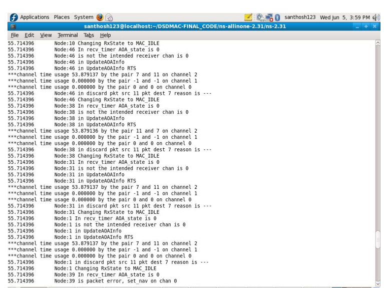

Figure 4: commands needed use for terminal in Linux fedora 9 to get the simulation results NS-2

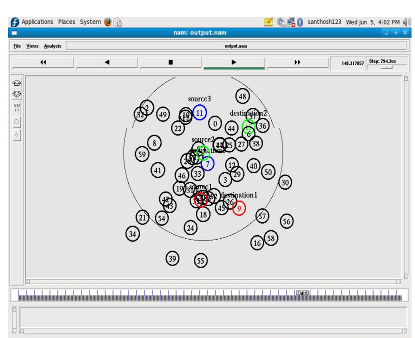

Fig 5: transmission of busy tone signal during node under communicating state.

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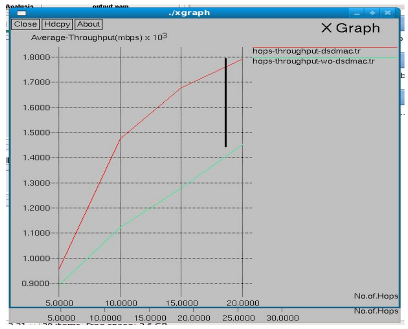

Fig 6: Plot of average Throughput Vs No of Hops.

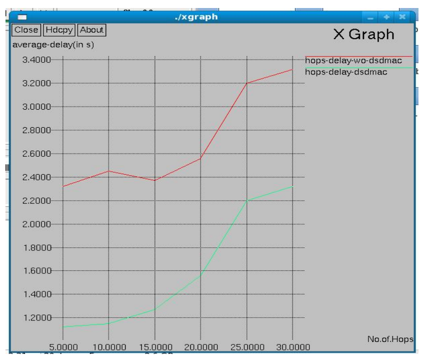

Fig 7 Plot of Average hop delay Vs No of Hops.

## VI.PERFORMANCE EVALUATION

When the node density is getting higher, our proposed protocol can have even higher performance gain, as our protocol is the only one not affected by the blocking and deafness problems With the proposed DSDMAC, the delay can also be improved by increasing the number of antenna sectors. Fig. 13 shows the analytical confidence intervals of the simulation results. First, the accuracy of the analysis is validated by the simulation. Second, the results show that, with DSDMAC, more antenna sectors per node can result in a higher throughput. This is attributed to the reduction in the collision probabilities when more antenna sectors are used, as shown in Fig. 12.

In addition, given the DSDMAC protocol can appropriately deal with the deafness, hidden-terminal, and exposed terminal problems, much higher throughput can be achieved in a dense network due to the spatial multiplexing gain by using the directional antennas. As shown in Fig. 14, when the node density figure shows that, in addition to the higher throughput, a smaller MAC delay can be achieved using DSDMAC with directional an-tennas. With 50 nodes per hop, while the average delay versus the average number of nodes using one, four, eight, and 16 antenna sectors.

## VII. CONCLUSION

The proposed “Dual Sensing Directional Medium Assess Control Protocol” is a novel technique in Wireless multihop Adhoc networks. This new protocol differs from the existing protocols by relying on the dual-sensing strategies to identify deafness, resolve the hidden-terminal problem and avoid unnecessary blocking. The Performane of this project indicate a higher network throughput and lower delay. DSDMAC has been verified using a formal protocol verification tool called NS-2. Simulation Results have shown that the DSDMAC protocol can greatly improve the performance of wireless Network using directional antennas.

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