International Journal of Communication Systems and Network Technologies
Vol.3, No.2, 2014

Extensive Survey on Medium Access Control Protocol with Probable Problems

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Abstract-The mobile Adhoc network is deployed in the environment where traditional wired network cannot be established due to its required features and their limitation. In MANETs the omnidirectional and directional antennas have been used for performance optimization. In this paper extensive survey of various protocols at MAC layer has been done and comparative analysis has been done, which will help in optimization of network performance and intern throughput.

Keyword- *AODV, MANET, transmission power, CBR.*

I. Introduction

MANET is a collection of nodes, which are mobile in nature generally, due to this mobility of the nodes, mobile Adhoc network is more acceptable in several application domains such as military application, collaborating and distributed computing application, commercial application. Mobile adhoc network is an infrastructure less network. There are two types of communications possible in MANET first is direct communication (node can communicate with the node that are in direct radio range of node as shown in Fig 1, and other is multi hop communication (node can communicate with the node that are not radio range of node, communication is possible through the node that are in radio range as shown in Fig 2.

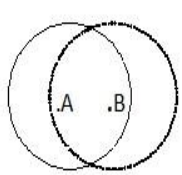


Fig. 1: Direct communiction

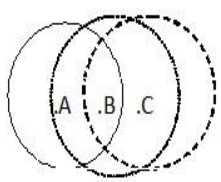


Fig. 2: Multi hope communiction

The communication protocols followed by the nodes are as per the standard network criteria and are adjusted according to the terrain conditions. However, there is no management of nodes from any external source or entity and all the nodes are independent to do self-organization and management according to the predefined conditions and concepts.

II. Literature Review

IEEE 802.11 DCF is a random access protocol which uses a CSMA/CA as a carrier sense protocol and for handshaking [1]. In [2] sender node who have data to transmit sense the channel and transmit the RTS (Ready to Transmit), all the node who are the neighbor of sender (i.e. similar radio range) receive this RTS. All the node except intended receiver can differ their transmission, intended receiver can response with the CTS (Clear to send), similarly all the nodes who are the neighbor of intended receiver (i.e. similar radio range) receive this CTS, and differ their transmission (except source node).After this successful handshaking of RTSCTS source node transmit data and after receiving the data intended receiver response with ACK. So this scheme can transmit RTS/CTS/DATA/ACK [2]. In fig3

DOI- 10.18486/ijcsnt.2014.3.2.03
ISSN: 2053-6283

source node A transmit RTS packet after receiving this RTS packet intended receiver node B can response with CTS packet, this CTS packet is listen by the node C who is the neighbor of node B, now node C differ their transmission then node A transmit DATA packet and receiver after receiving DATA packet successfully response with ACK packet. The Timing/Delay diagram of control signal is shown in Fig.3 with its delay parameters for various request and data packets.

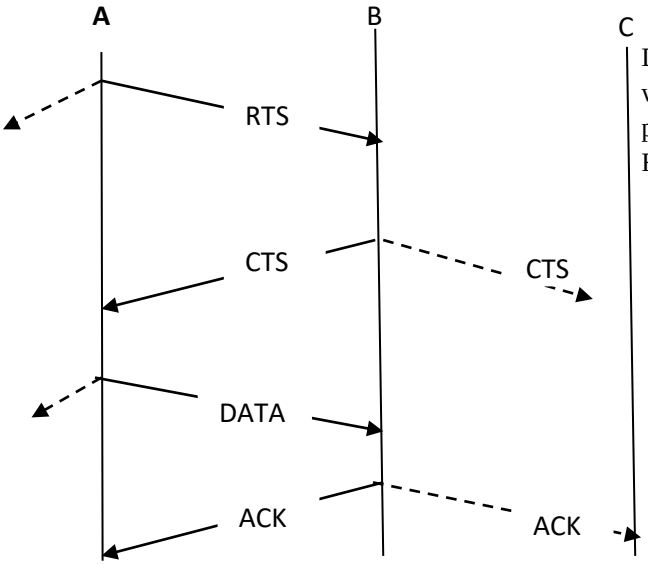


Fig. 3 Timing Diagram of Control Signals

Antenna model:

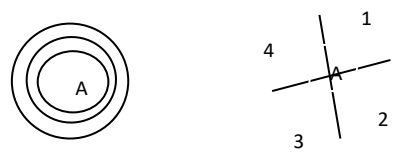
"An antenna is a transmission device, or transducer, between a guided wave and a free space wave, or viseversa" [13]. There are two important fundamental of antenna: Directivity (D) & Gain (G). The directivity of antenna is measured as a ratio of maximum power density emitted in strongest radiation direction to the power density emitted uniformly in all direction.

$$D = \frac{P(\theta,\varphi)max}{P(\theta,\varphi)Avg} \quad (1)$$

Traditionally 802.11 DCF uses a Omni directional antenna which can transmit or receive equally in all the direction, while Directional antenna is able to transmit or receive more in one direction then other direction. Directional antenna typically consist one higher main lobe and other small side lobes. According to Friss equation, received power P_R at distance d from the transmitter is given by equation 2 [28], here G_T and G_R are transmitter and receiver Gain respectively, k is a constant and α is path loss.

$$P_R = \frac{P_T G_T G_R}{K\, d^{\alpha}} \quad (2)$$

Directional Antenna: The other protocols used in the work is with directional antenna, which improves the performance. The comparison diagram is shown in Fig.4 below.



Omni directional Antenna Directional

Fig.4 Comparative coverage

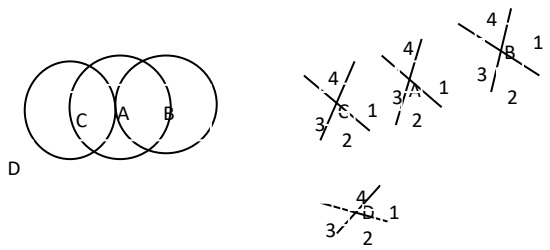
III. Benefits of directional Antenna over Omni directional Antenna

Directional Antenna comes with several advantage, like higher Gain, improve spatial reuse, minimize the no of blocked node, provide higher data rate even minimum transmission power [7], these quality of directional antenna get more attraction then omni directional antenna. Each node install with a directional antenna, with N antenna element locate into fixed sector each spanning an angle of $(360/N)^{o}$.[9].The signal gain and beam width can be controlled more efficiently as the antenna elements are increases.[12]

DOI- 10.18486/ijcsnt.2014.3.2.03
ISSN: 2053-6283

Spatial reuse

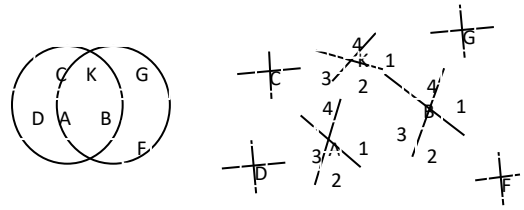
Spatial reuses is one of the main reason that attract researcher interest in directional antenna, as shown in fig 5 ,directional antenna improve the spatial reuse , fig 5(a) there is a five node A,B,C&D deployed with directional antenna. If node A want to communicate with node B it radiate RTS packet in all direction because of Omni directional antenna, this RTS packet is also received by the node C(node C is in radio range of node A) as shown in Fig. 5 below.



(a)omni directional antenna (b) Directional

Fig 5: Spatial reuse

There are two type of antenna model is used in MANET, Traditionallyomnidirectional antenna is used , omnidirectional antenna radiate the power in all direction , next is directional antenna which radiate the power in dedicated direction shown in fig 4. But in Omni directional mode ,the electromagnetic energy of the signal is radiated over a large region of space, only small portion of its, is received by the intended receiver But Directional Antenna with M antenna element solve this efficiency problem. In Directional Antenna electromagnetic energy of signal is radiated only one direction i.e. concentrate in one direction [12][29]. Now if node C want to communicate with node D, it can't communicate even transmission in between node A &B can't interfere with this transmission .But when these node are deployed with directional antenna fig 5(b) transmission in between node C & D are possible even though the transmission in between node A & B is in progress. Shown in fig5(b) Beam1/node A is directed toward the beam 3/node B, transmission between node A& B is done through these pair of beam.Beam 3/node A is directed toward beam 1/node C and Beam 2/node C is directed toward beam 4/node D. [4]RTS packet to node B is transmitted through beam 1/node A and its received through beam 3/node B, due to directional antenna node C is free to communicate with node D No of blocked node. No of blocked node is another reason that motivate to use directional antenna When nodes are deployed with the Omnidirectional antenna,and communication between two nodes are in progress then all the node that either come in radio coverage range of sending node or receiving node are blocked themselves[2].If number of blocked node is reduced, it increase the spatial reuse[8].



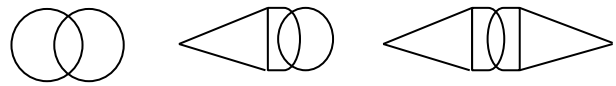
(a)omni directional antenna (b) Directional

Fig 6 . No of Blocked nodes

In fig 6(a), communication between node A and node B is in progress than node K,D,C,G,and node F blocked because these nodes are in radio range of node A and node B.But when nodes deployed with directional antenna only those nodes block themselves, whose beam overhear this transmission [4] .In fig 6(b), transmission between node A and B are going through beam 1/node A and beam 3/node B, only beam 2/node K overhear this transmission, so node K is block other nodes are not blocked

Transmission range

In contrast to Omni directional antenna, transmission range of directional antenna is increases. In fig7 three different transmission ranges



(a) O-O transmission (b) D-O transmission (C) D-D transmissi

Fig. 7 Coverage Area of protocols

(a) O-O transmission range
(b) O-D transmission range
(c) D-D transmission range

DOI- 10.18486/ijcsnt.2014.3.2.03
ISSN: 2053-6283

D-D transmission range> O-D transmission range>> OO transmission range

III Challenges of Directional Antenna

Directional antenna provide many benefit with these benefits, it's also introduces some serious problem such as Directional Hidden Terminal problem, Directional Exposed Terminal Problem, Deafness, Head of Line ,Neighbor location etc, with these problem the throughput of network is degraded. In this section, we will discuss these problem

Directional Hidden Terminal Problem

The hidden Terminal problem refer to the collision of packet at the receiving node due to the simultaneous transmission of those node that are note with in the direct transmission range of the sender, but are within the transmission range of the receiver. Collision occurs when both node transmit packet at the same time without knowing about the transmission of each other[10].There are two kind of Hidden Terminal problem

Due to unheard DRTS/DCTS

In the fig 7, when communication in between node A and K is in progress, node B send DRTS to node F, this DRTS cannot hear by the node A, because node A beam formed in the direction of node K. Now when communication between node B and F is in progress node A finished its transmission to node K and want to communicate with node B, send DRTS to node B ,this DRTS frame is collide with the ingoing transmission between node B and F.

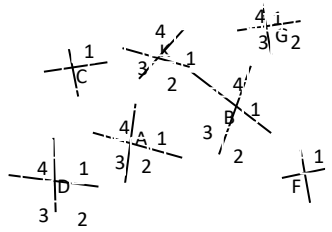
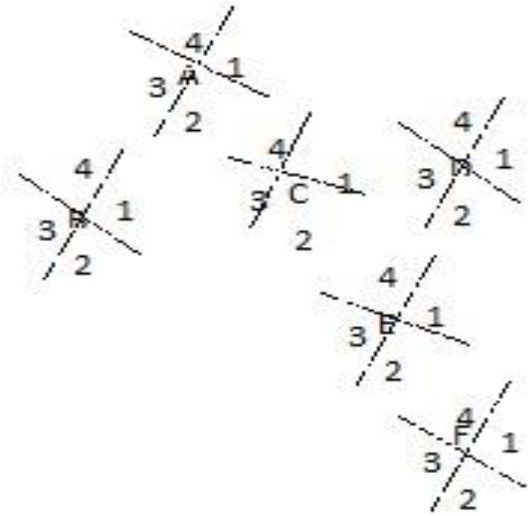


fig 7

Due to asymmetric Gain:

This type of Hidden terminal problem is arises due asymmetric gain of antenna. Gain of directional(G_d) is Greater than the Gain of Omni directional antenna (G_o) i.e. G_d>>G_o[20].



In fig8 Node E have data to node F, node E sense the channel and send DRTS to node F,node F ack with DCTS. Node A is far away from node E,so it cannot receive this DRTS .If node A want to communicate with node D, it sense the channel omnidirectionally , it cannot detet the ongoing transmission between node E&F due to G_o<<G_d. collision can occur.

Directional Exposed Terminal Problem

The exposed terminal problem refer to the inability of a node ,Which is blocked due to transmission by a nearby transmitting node ,to transmit another[10].In fig 7, Beam 2/ node K is directed toward beam 1/node A and beam 3/node B. If node K have a data to node B ,it send DRTS to node B, this DRTS packet is also received by node A because beam 1/node A is directed toward the beam2/node K. If node A want to communicate with node D, it deny the transmission while beam3/node A is free i.e. node A exposed their transmission.

Deafness

Deafness is causes when the intended receiver is fail to response with CTS packet. It means receiver is deaf, and sender continuously transmit the RTS packet, this RTS packet is drop due to the deafness of intended receiver and sender increase their backoff.[20][29]. In fig7, Node D transmit data packet

DOI- 10.18486/ijcsnt.2014.3.2.03
ISSN: 2053-6283

to node B through the node A, in this scenario beam1/node D is directed toward the beam3/node A and beam 1/node A is directed toward the beam 3/node B. Node D transmit packet to node A for a node B, now node A is beamform in the direction of node B to transmit the data received by the node A, node D is unaware about this transmission due to directional antenna ,node D continuously retransmit the RTS packet to node A and increase the backoff period

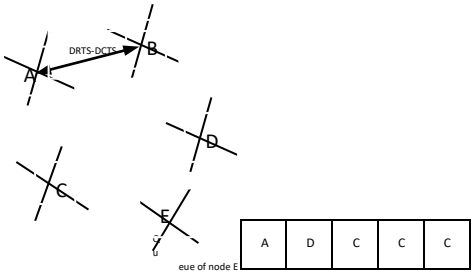


Fig 9

Head of line problem

The Head of Line(HOL) is another problem that affect the overall performance of the network.It act as a severe problem in case of directional antenna .All the node in the network used the First In First Out policy(FIFO). whenever any node receive any data packet for other is maintain its in a queue, queue work in(FIFO) policy.[14].In fig9,node have FIFO queue to maintain the all outgoing packet. Node A is communicating with node B, node E have a packet for node A,D and C. All these transmission is blocked by the node A(communication between node A & B is in progress)[18]

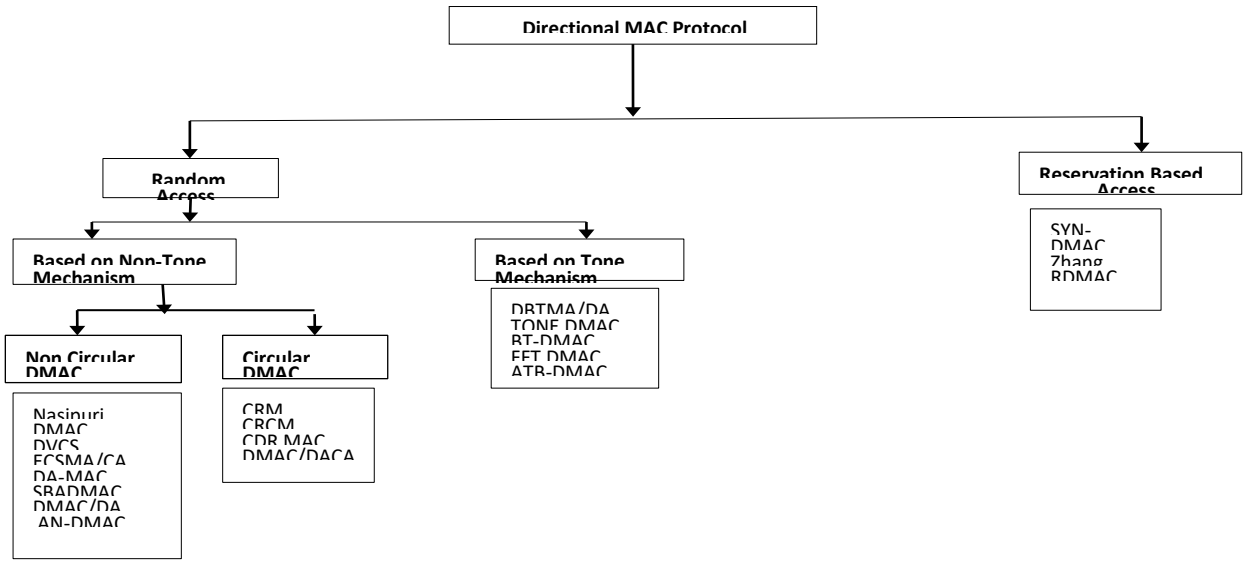


Fig 10. Classification of MAC protocol with directional antenna

IV Classification of D-MAC

MAC Protocol with directional antenna can be broadly classified into two categories random access and reservation based access. Random access protocols allow the stations to access the shared medium randomly through contention with each other. Synchronized access protocols allow the stations to access the medium based on a predetermined schedule which can be achieved through local and/or global synchronization. 1.Random Access Protocol

DOI- 10.18486/ijcsnt.2014.3.2.03
ISSN: 2053-6283

Random Access Protocol in MANET based on the CSMA/CA protocol. Whenever node want to access the wireless medium first performing the carrier sensing, if medium is free station can transmit ,if medium is busy node differ their transmission according to random period of time. Further divide the random Access protocol in a "Tone Based Protocol" and "Non Tone Based protocol".

1.1 Non Tone Based Protocol

There are so many Non Tone based protocols defined inliteture [3-9] .These protocols are purely rely on the RTS-CTS mechanism based on IEEE DCF[1][2] . To improve the overall performance of network DATA and ACK is transmitted directionally after small RTS-CTS exchange. However, there are several variations in

literature, how RTS/ CTS packets are transmitted in order to deal with the challenges associated with beamforming antennas. They are also divided into two category "Non Circular Protocol "and "circular Protocol".

1.1.1 In Non circular DMAC,RTS-CTS frame is transmitted either omni-directionally or directionally[39].These protocol uses several method to identify the location of neighbor GPS,AOA caching, DoA [3][4][5].

1.1.2 In circular DMAC protocol RTS packet is transmitted circularly to cover the entire area in fig -11 [5][6][12][29]

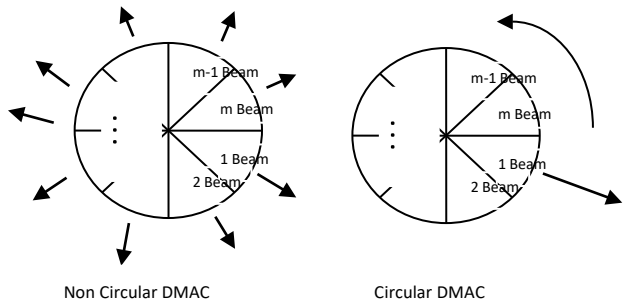


fig 11

1.2 Tone Based Protocol

Here we review the DMAC protocols that are uses the tone in their transmission. A tone is a pure sinusoidal wave, it is a unmodulated signal with a particular frequency. Tone not containing any information so there is no need of decoding but only detection to be needed[22].In tone based Protocol, Tone are typically transmitted by the busy node to inform the neighbor about the ongoing transmission however to protected from the collision.

2 Reservation Based Protocol

Main challenge faced by the Directional Antenna is the location of the neighbor. In reservation based protocol ,all the node reserve the channel in the prior bases so no conflict is occur between the nodes. [32][33][34]

Review of the Non tone based protocol

Nasipuri et al [3] recommended one of the initial Directional MAC protocol, which utilize the Omni directional RTS and Omni directional CTS to know the location of each other, then it transmit directional DATA packet and ACK packet. Demerit of this method, it is assume that the range of the directional transmission is same as the Omni directional transmission. Receiver who is not intended for the CTS, blocks its antenna similarly node who is not intended for the RTS, blocks its antenna. Overhearing is one of the major problem in this case because of overhearing bad spatial reuse.

Y.Ko et al[4] proposed a variation in traditional IEEE 802.11 DCF[1].Recommended that RTS packet is transmitted Directionally but receiver response Omni directionally . It assume that sender known the Location of the intended receiver by any other hardware device such as GPS. In proposed D-MAC protocol , if sender receive data packet from the upper layer.Sender transmit DRTS packet to keep away from the unwanted waiting time if direction of any one beam is blocked. Receiver response with OCTS, to avoid the collision at the receiver side. Once the DRTS-OCTS exchange is completed ,Data packet is transmitted directionally followed by the Directional Ack. But This DMAC protocol suffer from the collision at the sender side due to the DRTS.

DOI- 10.18486/ijcsnt.2014.3.2.03
ISSN: 2053-6283

Takai et al [7] recommend the idea of DVCS (Directional virtual carrier sensing) here it send DRTS and DCTS, they assume that receiver location is already known by the sender by the other hardware device such as GPS. They uses a concept AOA(angle of arrival) cache mechanism, whenever any node hear any signal from the neighboring node it estimate the AOA cache .This AOA cache information further use by the node when it become a source node for any data packet.They also proposed each node maintain a DNAV(Directional Network Allocation Vector),it use by the node for virtual carrier sensing.

M.K.Dholey et al [8]proposed a new concept to reduce the hidden terminal problem in directional antenna. Introduce a Enhance CSMA/CA protocol by which reduce the number of blocked node in MANET.As number of blocked node is reduces it increases the spatial reuse. In this proposed method, whenever any node have data packet to transmit first it sense the channel, if channel is free it transmit the ORTS packet. This ORTS Packet is received by the all nodes, which comes in direct radio broadcast range of the source node and they blocked themselves for SIFS period. Similarly intended receiver response with the OCTS packet and which is also received by all the neighboring nodes of the intended receiver and they blocked themselves for SIFS period. But the nodes who received ORTS as well as OCTS blocked themselves for total communication. i.e. only those nodes are blocked they directly interferer the ongoing communication and other nodes are free to communication. The simulation result show that by reducing the number of blocked node the overall performance of the network is improve.

Woongsoo et al [27],proposed a new protocol to handle the Deafness Problem in directional MAC known as Deafness-aware MAC protocol (DA-MAC).In proposed method single channel is divided into two logical channel Data channel and Control channel. Node can listen both the channel omni directionally. If node have data to transmit, It transmit DRTS frame from both the channel toward the direction of the intended receiver and intended receiver can also response with DCTS on both the channel. Data packet is transmitted only by the data channel but control channel is in listening mode. This proposed protocol is a able to distinguish the deafness from the collision by dividing the channel into two logical channel. The simulation result show that ,if nodes are in communication then only data channel is blocked ,it means node can listen the channel by their control channel so it is able to identify the actual reason of network failure.

S.Motegi et al [15] ,Extend the method [30] for directional antenna, to deal with the hidden node problem. Author proposed the method to mitigate the directional hidden terminal problem known as DATAframe fragmentation and short Busy Advertisement Signal (SBA-DMAC).In this MAC protocol ,if node have a data to transmit first it exchange Directional RTS-CTS and fragment the data frame and insert some small interval in between the fragments .Sender transmit the first fragment of data frame from the beam toward the intended receiver. After successful reception of this first fragment receiver sent short Busy Advertisement Signal, to inform all the neighbor about ongoing transmission. The simulation result show that proposed protocol reduce the hidden node by inserting the time interval in between the fragments of data frame but size of the frame is another problem and this method is not work well in case of lightly loaded network.

Takata et al [16],proposed a new protocol to overcome the issues raised by the directional MAC protocol, named as Directional MAC with Deafness Avoidance (DMAC/DA). This protocol simply a tradeoff between the deafness and WTS (Wait to send) additional control frame. After the successful handshaking of RTS -CTS, WTS (wait to send) frame is transmitted by the sender and the intended receiver to avoid the deafness. The simulation results show that DMAC/DA perform better than the circular directional MAC protocols .

Jia feng et.al[11], proposed a Advance notification strategy to deal with the deafness problem named as Advanced Notice Directional MAC(AN-DMAC).Deafness can occur due to lack of knowledge about the surrounding ,this protocol give the information about the surrounding activity with least overhead. In AN-DMAC protocol a node who is interested in the transmission send Advance notice packet to their neighbor, with such advance notice neighbor can be able to find the potential transmitter in their surrounding environment .Cooperation mechanism is also include in this protocol to extend the reliable transmission of AN. Simulation result show that
AN_DMAC has less overhead in comparison to CDR-MAC

DOI- 10.18486/ijcsnt.2014.3.2.03
ISSN: 2053-6283

Korakis et al [5], propose the circular RTS MAC(CRM) protocol,it is the first protocol with circular transmission. In this protocol transmitter transmit RTS frame in a circular fashion by which the transmitter can able to scan the entire area and all the neighbor nodes can know about the upcoming transmission. One of the major issue in case of directional MAC is neighbor location , by using Circular RTS each node can be able to maintain the location information in the location table.There is no need to transmitter ,know the direction of the receiver and receiver can recognize the direction of the transmitter by using selective diversity. In this scheme transmission is done CRTS/DCTS/DATA/ACK. Analysis of simulation result show that significantly large overhead ,and DCTS does not inform nodes behind the receiver so collision can occur(Hidden Terminal Problem)

Jakllari et al [6], proposed the Circular RTS and CTS MAC(CRCM) protocol, in Which RTS and CTS Packet circularly transmitted prior to Data transmission. It is a extension of CRM[5] Protocol,in CRM [5]only RTS frame is transmitted circularly therefore neighbor of receiver is unaware about the ongoing transmission However collision can occur. In contrast to CRM,CRCM required to transmit CTS circularly to inform the neighbor of the receiver about the upcoming transmission, therefore CRCM provide protection from the collision at the receiver side. For location tracking and maintance,location tables are used and figure out the location of the node

T.Korakis et al [12],Author proposed circular Directional RTS-MAC (CDR-MAC)protocol, CDRMAC protocol simply a extension of CRM[5],which represent efficiency in a static environment .In CDRMAC protocol Circular RTS frame is transmitted as[5],to inform all the neighbor about upcoming transmission. Simtransmission ulation result show that the protocol work well in static as well as in mobile scenario

Yihu li et al[29],proposed a another directional MAC protocol to avoid deafness and Collision problem named as directional MAC with deafness avoidance and collision avoidance(DMAC-DACA), in proposed protocol node transmit several Sweeping RTS/CTS packets anticlockwise to inform the neighbors about the upcoming transmission. This sweeping RTS/CTS is followed by the basic RTS/CTS. To avoid deafness Deaf Neighbor Table(DNT) and deafness vector(DV) are used, whenever any node receive sweeping RTS/CTS , maintain information about the deaf neighbor in DNT and in DV maintain the duration. The DMAC-DACA protocol ,to avoid the collision DNAV mechanism is used. Simulation result show that DMAC-DACA significantly increase the performance and improve the throughput. Simulation result also show that deafness is much more serious problem then the hidden terminal problem.

Review of the Tone Based Protocol

Z.Huang et al[17] enhance the idea of the Dual Busy Tone Multiple Access(DBTMA)[31] for the Directional Antenna name as Dual Busy Tone Multiple Access with Directional Antenna (DBTMA/DA). In the proposed protocol channel is divided into two channel :DATA channel & control channel, DATA channel is used for transmitting data packet whereas control channel is used for transmitting the control packet .There are two busy tone ,Transmit busy Tone(BTt) and receive busy tone(BTr) with two separate frequencies are used. Whenever node has data to transmit ,it sense the BTr ,if BTr is not detecting node transmit RTS omni directionally. When RTS is received by the intended receiver and BTt is not detecting receiver node respond with the directional CTS and turn on the BTr tone. After receiving CTS source node turnon the BTt and send the DATA frame, turnon the BTt until the transmission is completed. Simulation result show that the overall network performance is improved.

R. Choudhury et al [19], proposed a a tone based mechanism that that allows neighbors of a node to classify congestion from deafness, and react appropriately named Tone-DMAC. In this proposed protocol, After the completion of every data transmission session Out of band Tone is transmitted by the communicating devices. This tone is transmitted OmniDirectionally,it is received by all the neighbor of the communicating device, now neighbors are able to distinguish the deafness from the collision. The Simulation result show that the Tone-DMAC protocol efficiently mitigate the adverse effect of DMAC

H.N. Dai et al[20],proposed Busy Tone Directional MAC (BTDMAC) protocol to solve the most common problem directional MAC is ” Direction of the neighbor

DOI- 10.18486/ijcsnt.2014.3.2.03
ISSN: 2053-6283

node". BTDMAC utilize the DNAV[7] with two busy tone "transmitting Busy Tone(BTt)"& "Receiving Busy Tone (BTt)" to solve the Deafness and Hidden terminal Problem. This Busy tone is also subdivided into two sub tone "ID Tone" and "Beam no Tone". If any node have a data to send, it check the busy Tone, if busy Tone is not available then node transmit the data. Simulation result of BT-DMAC show that the probability of successful data transmission is increases.

Y.Li et al [22], proposed a Tone base Directional MAC protocol to deal with the problems arises with the directional antenna known as Flip-Flop Tone directionalnMAC (FFT-DMAC) protocol. Proposed protocol deploy with two pair of tone ,first pair of tone is used to solve the Deafness problem and second pair is utilize for Hidden Terminal Problem and Exposed terminal Problem.In FFT-DMAC transmission is performed as DRTS/FFT_1^+/FFT_2^+/FFT_1^+/DATA/ FFT_2^-/ FFT_1^-/ FFT_1^- . In This proposed protocol each node maintain two set of list: Deafness node List(D-List) & Ongoing Transmission Node List(T-List). If node have a data to transmit ,it send DRTS packet, intended receiver send the omni directional FFT_1^+ tone however all the neighboring node insert receiver in the D-LIST and intended receiver response with the directional FFT_2^+tone ,upon send transmitting FFT_1^+ to inform all the neighbor about ongoing transmission. after successful reception of data receiver node response with FFT_2^- treat as a ACK of data and inform all the neighbor node unblock the D-List.

R.Rashmi et al[23], proposed introduced a Auxiliary Tone Based Directional MAC (ATB-DMAC) that utilize the eight narrow band Auxiliary tone to solve the Deafness, Hidden Terminal and Exposed Terminal Problem. In ATB-DMAC auxiliary tones are use to inform all the neighbor about the ongoing transmission. Simulation result show that with high density network the probability of collision and hidden nodes are minimized.

Review of reservation Based Access

J.wang et al [32], proposed Directional MAC to address the Hidden Terminal, Exposed terminal and Head of Line blocking problem named as SYN-DMAC for Adhoc network with synchronization. Assumed that all the nodes are synchronized by receiving GPS signal and any other synchronization scheme. There are Three time Phases in each cycle" Random Access Phase" ,"DATA Phase "and "ACK Phase". Phase I is dedicated for Channel contention and route discovery. Phase is dedicated for Parallel collision free Data transmission similarly Phase III is dedicated for Parallel contention free ACK. The simulation result show that the SYN-DMAC improve the throughput in comparison with IEEE 802.11 MAC Protocol.

Zhang et al[33], proposed a pure directional transmission and reception based MAC protocol. Time is divided into frame and each frame is divided into three sub frame. First sub frame is dedicated to neighbor discovery , the second sub frame is used for reservation and Third for Data Transmission.And these sub frame is also divided into several slots and these slots are divided into several mini slot.The neighbor discovery is performed by the scanning and three way hand shaking, during this phase two pair of nodes are agree on the future time slot. In reservation subframe two nodes point their beam toward each other and perform exchange with each other.The simulation result show that the proposed protocol work well in comparison to IEEE 802.11 when jamming is present.

J.J. Chang et al[34], Proposed a Reservation-based Directional MAC (RDMAC) Protocol for multi-hop wireless networks with directional antennas. This proposed protocol operate in session, each session comprise a reservation period and a transmission period and reservation period is also comprise a "Probing Phase". In RDMAC beam pattern announcement and detection mechanism is employ to tackle the problem with minor lobes. Through this neighbor nodes able to identify the minor lobes of ongoing transmission. In probing phase ORTS/OCTS exchange is conducted but in beam indication phase DRTS/DCTS exchange is perform and in transmission phase DATA and ACK is transmitted directionally. The simulation result show that RDMAC outperforms existing solution in term of higher throughput and lower delay

DOI- 10.18486/ijcsnt.2014.3.2.03
ISSN: 2053-6283

V. Comparison of DMAC Protocol

Protocol	Transmmission of packet				Tone transmission	carrier sensing	Beam forming	Antenna Used		Hidden Terminal/Exposed Terminal Problem	deafness	HOL
	RTS	CTS	DATA	ACK				Type	Beam			
Nasipuri	Omni	Omni	Dir	Dir	n/a	Omni	DoA	switched	Single	NO	NO	NO
DMAC	Dir	Omni	Dir	Dir	n/a	Omni	GPS	switched	Single	NO	NO	NO
DVCS	Dir	Dir	Dir	Dir	n/a	Omni	AoA Cache	Adaptive Array	Single	NO	NO	NO
ECSMA/CA	Omni	Omni	Dir	Dir	n/a	Omni	DoA	switched	Single	Yes	NO	NO
DA-MAC	Dir	Dir	Dir	Dir	n/a	Omni	DoA	switched	Single	Yes	Yes	Yes
SBA-DMAC	Dir	Dir	Dir	Dir	n/a	Omni	AoA Cache	switched	Single	Yes	NO	NO
DMAC/DA	multi Dir	multi Dir	Dir	Dir	n/a	Omni	Assumed	switched	Single	Yes	Yes	NO
CRM	multi Dir	Dir	Dir	Dir	n/a	Omni	DoA	switched	Single	Yes	Yes	NO
CRCM	multi Dir	multi Dir	Dir	Dir	n/a	Omni	DoA	switched	Single	Yes	Yes	NO
DMAC/DACA	multi Dir	multi Dir	Dir	Dir	n/a	Omni	GPS	switched	Single	Yes	Yes	NO
DBTMA/DA	Omni	Dir	Dir	Dir	dir/dir	Omni	DoA	switched	Single	Yes	NO	NO
Tone DMAC	Dir	Dir	Dir	Dir	Omni	Omni	DoA	switched	Single	No	Yes	NO
BT-DMAC	Dir	Dir	Dir	Dir	Omni/Omni		AoA Cache	switched	Single	Yes	Yes	NO
FFT-DMAC	Dir	0	Dir	Dir	Omni/dir	Omni	Assumed	Adaptive Array	Single	Yes	Yes	NO
ATB-DMAC												
SYN-DMAC	Dir	Dir	Dir	Dir	n/a	Omni	Assumed	switched	Single	Yes	Yes	Yes
Zhang			Dir	Dir	n/a		Scanning	Adaptive Array	Single	NO	NO	NO
RDMAC	Omni	Omni	Dir	Dir	n/a	Omni	DoA	switched	Single	Yes	Yes	Yes

VI. Conclusion

In this paper, surveyed various directional MAC Protocol and discuss their merits and demerits. Directional MAC protocols are designed to fully exploit the directional antenna. In this paper classification of the directional MAC in recently years has been investigated in detail and found that some protocols are based on random access strategy, random access protocols further divided into non tone based protocol that completely rely on RTS/CTS mechanism and tone based protocol the required additional control information tone transmission. However, authors have not given any concrete reason for getting low performance by using one or another protocol. It is therefore proposed to investigate

DOI- 10.18486/ijcsnt.2014.3.2.03
ISSN: 2053-6283

further the reasons and the possible solution for getting rid of various problems faced while using directional MAC Protocols.

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DOI- 10.18486/ijcsnt.2014.3.2.03
ISSN: 2053-6283