A SURVEY ON MAC PROTOCOLS FOR WIRELESS MULTIMEDIA NETWORKS.

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Abstract

This article presents a survey on medium access control protocols for wireless multimedia networks. A basic overview of MAC protocol concepts is presented, and a framework is developed for comparisons. The MAC protocols covered in this article include Random Access protocols, Contention less protocols, TDMA CDMA, third-generation WCDMA schemes and Hybrid protocols proposed for wireless Multimedia Networks. The operation of each protocol is explained, and its advantages and disadvantages are presented. Finally, a qualitative comparative outline of the discussed protocols is provided.

KEYWORDS:

Medium Access control, Multimedia networks, TDMA, CDMA, and WCDMA.

I. INTRODUCTION

Mobile communications has become ubiquitous these days. Wireless Multimedia is becoming increasingly popular as they provide users the convenience of access to information and multimedia services any time. With the advent of multimedia applications, there is now need for higher bandwidth and faster data rates. The upcoming wireless cellular infrastructures such as third generation (3G and fourth generation (4G) are deemed to support bandwidth requirements, faster data rates with different quality of services for multimedia applications. Wideband Code-division multiple accesses (WCDMA) has emerged as one of the most promising multiple-access techniques for future wireless multimedia networks and has been selected for IMT-2000 systems by standardization bodies all around the world [1].Compared to the narrow-band CDMA, wideband CDMA can support services with much higher rate. It is also flexible to deliver multimedia traffic. Many multimedia applications are packet oriented, hence optimized third generation techniques that support variable bit rate and packet capabilities with quality of

service requirements will be needed. In a wireless system consisting of a number of mobile terminals or nodes that transmit traffic of any type on a shared medium to a centralized base station, a procedure must be used for effective utilization of network resources and for quality of service requirements. This procedure is known as a Medium Access Control (MAC) protocol. [2]

MAC protocols are classified into three main groups. These are Contention less protocols (Polling, Random Address polling, and Token passing), Contention protocols or Random Access protocols (Aloha, slotted Aloha, and CSMA), Channelization protocols (FDMA, TDMA, CDMA). In contention less protocols the scheduling is done in a fixed fashion and each node is allocated a part of the resource. In contention protocols no node is superior to another node and none is assigned control over another. These protocols utilize direct, asynchronous competition to determine access rights for transmission. The contention protocols that suffered from hidden terminal interference and instability (i.e., throughput breakdown) at high network loads.

Channelization[28] is a multiple access method in which the available bandwidth of a link is shared in time, frequency or through code. In frequency-division multiple access (FDMA), the available bandwidth is divided into frequency bands. Each station is allocated a band to send its data. Each band is reserved for a specific node and it belongs to the node all the time. In time-division multiple access (TDMA), schemes resource is divided into the time slots and the node transmits its data in its assigned time slot. Finally, Code-division multiple access (CDMA) divides the resource into a collection of codes through which assigned users can coexist on the same channel [31].CDMA allows multiple transmissions to occupy the channel at the same time without interference by using spatial coding techniques which spread the information bits over a broadened channel, allowing the information retrieval from the combined signal.

First-generation mobile systems, such as the Advanced Mobile Phone System (AMPS), NMT system etc used FDMA technique. They are based on circuit-switched technology and designed for voice, not data. These systems suffered from limitations like low service quality, long call setup time, inefficient use of bandwidth, susceptible to interference, support only for speech, insecure transmission. For second generation systems, the most used multi-access schemes have been TDMA and CDMA.TDMA based systems GSM, IS-54 and CDMA based systems IS-95 uses digital technology which results in higher quality voice as well as basic data services. These systems support data, speech and facsimile services and use the encryption mechanisms to protect the data and speech. GSM is incorporated with advanced schemes as High Speed Circuit Switched Data (HSCSD), General packet Radio Services (GPRS), and Enhanced data Rates for GSM Evolution (EDGE) to increase the data rates that are available to the users. The need for higher capacity higher data transfer rates and global roaming were the driving forces behind the introduction of a third generation wireless networks.

Specifically, one of the most important aspects of 3G is enhanced packet-data access. 3G systems are covered under the IMT-2000 umbrella, and in Europe are referred to as UMTS (Universal Mobile Telecommunication System). UMTS is based on the WCDMA (Wideband Code Division Multiple Access) air interface, providing simultaneous support for a wide range of services with different characteristics on a common 5 MHz carrier. The 3rd Generation Partnership Project (3GPP) standardization committee has also released a specification on MAC protocol [3,29,30]. In this specification, the MAC architecture, channel structures, services, and MAC functions are defined. However, no specific access scheme is specified for the MAC protocol. Thus, the design of the MAC protocol for wideband CDMA networks is still an open problem.

This survey examines MAC protocols for wireless networks carrying multimedia traffic. In section II the basic Random Access and Contention less MAC protocols are explained. In section III we present channelization protocols for multimedia networks .Hybrid MAC protocols are discussed in Section IV. We provide a qualitative comparative outline of the protocols in section V. Finally section VI concludes the paper.

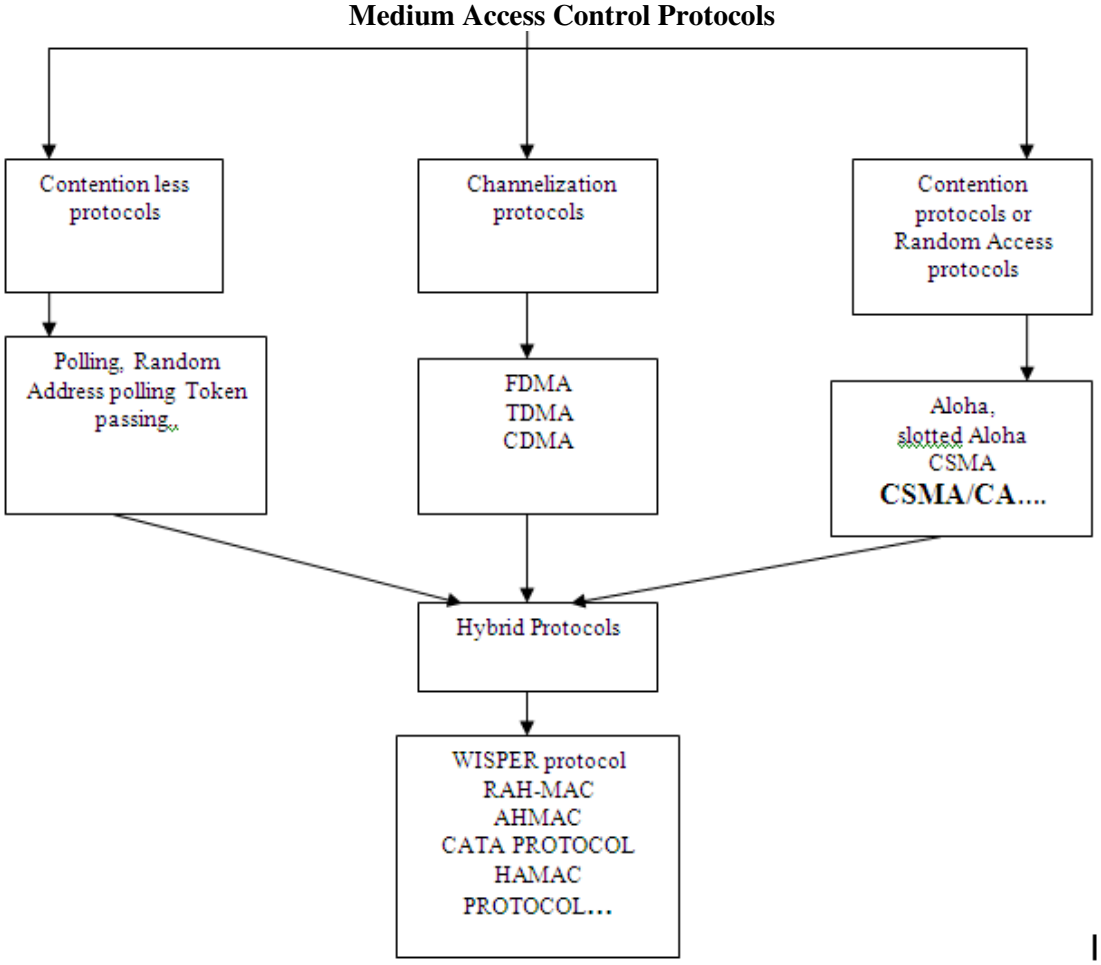

Figure1: Classification of MAC protocols.

2. RANDOM ACCESS PROTOCOLS.

2.1 CSMA/CA

The basic CSMA scheme has come up with the concept of collision avoidance by using random back-off time. So, the CSMA/CA uses binary exponential back-off algorithm in order to create some fairness for waiting time and to reduce the probability of collisions between transmitting nodes. The back-off algorithm in CSMA/CA just tries to avoid collisions, but could not remove it all. Depending on the size of the Contention Window, values of random back-off time either so small that causing many collisions or values may be quite big causing unnecessary delay. CSMA/CA has failed to solve the hidden and exposed terminal problems.

2.2 Multiple Access with collision avoidance (MACA)

In order to overcome the hidden and exposed terminal problems in CSMA/CA, the new technique multiple access with collision avoidance (MACA) was introduced. It uses two additional packets Request-to-Send (RTS) and Clear-to-Send (CTS). The RTS/CTS are the control packets exchanged between two nodes just before the transmission of actual data. The binary exponential back-off (BEB) algorithm is also applied to provide fairness while accessing the medium. When a sender wants to send the data and finds the medium free, it first sends an RTS packet to the receiver. After receiving the RTS, the receiver responds with the CTS packet, provided that the receiver is willing to accept the data. All other stations hearing RTS or CTS come to know that particular stations are busy and hence they avoid interfere that transmission. After transmitting the RTS packet, if sender does not receive the CTS packet within a designated period, it is assumed a collision and eventually will time out. The packet is scheduled for retransmission in the future.

2.3 MACA for Wireless (MACAW).

This is based on RTS/CTS scheme of MACA .It gives acknowledgment (ACK) packet after each successful data frame It uses additional Data-Sending (DS) packet to be sent by a node before transmission of actual DATA packet .The DS packet informs the overhearing nodes that RTS-CTS exchange has been successful and data transmission is about to begin. The overhearing nodes defer all their transmissions till the Data and ACK packets have to be exchanged. It also uses the Request-for-Request-to-Send (RRTS) packet. A node receiving the RTS packet may not be able to reply with its CTS packet if it is busy with another transmission. That increases the back-off counter of the sender. To avoid the problem it transmits RRTS packet to the sender as soon as it becomes free. As a result, sender will transmit RTS packet as early as possible [4]. It uses control packets RTS/CTS along with ACK, DS and RRTS that increase the overhead and the load of traffic.

2.4 IEEE 802.11 MAC

The standard IEEE 802.11 focuses only on physical and medium access control (MAC) layers. The three different access mechanisms defined for IEEE 802.11 MAC are CSMA/CA, MACA/MACAW, Polling method. The first two methods can also be categorized as Distributed Coordination Function (DCF), it offers only asynchronous data service. The third method called Point Coordination Function (PCF) and it offers both asynchronous and time-bounded service. The IEEE 802.11 MAC schemes are also called Distributed foundation wireless medium access control (DFWMAC) [5].

The distinctive feature of 802.11 MAC is the fix parameters for waiting time before accessing the medium. The parameters are defined as follows.

DCF inter-frame spacing (DIFS): Any node in the network if finds the medium free for the transmission, it has to wait first for duration of DIFS. This parameter has longest waiting time and has lowest priority of medium access.

Short inter-frame spacing (SIFS): It is the shortest waiting time for medium access, and used before sending the ACK or polling responses. It has highest priority being shortest waiting time.

PCF inter-frame spacing (PIFS): This waiting time is used in polling method. An access point has to wait PIFS before accessing the medium. This waiting time is between DIFS and SIFS, and obviously has medium priority.

2.4.1 IEEE 802.11 MAC with CSMA/CA

This standard is based on CSMA/CA using BEB algorithm. Every time when a node finds the medium free, then it has to wait for the time of DIFS. After DIFS, a node starts its back-off time if the medium was busy in last cycle, and then it can transmit data if the medium is free. After receiving the required packet a receiver waits for SIFS and then replies with ACK packet. It uses *back-off timer* in the random back-off time algorithm. A node finishes its back-off time very first and finds the medium if it is free, it will start its transmission. But other nodes having longer back-off time would not continue to count down, rather they pause their back-off timer (Br). After getting the channel idle and wait for DIFS, the nodes will resume their paused back-off time. This implies that the deferred nodes are not supposed to choose back-off time again but they carry on with the same value until it finishes.

2.4.2 IEEE 802.11 MAC with RTS/CTS

To overcome the hidden and exposed terminal problems, the 802.11 MAC introduces RTS/CTS control packets. The algorithm has same functionality of *DFWMAC with CSMA/CA* but with the extension of RTS/CTS and network allocation vector (NAV). A node finding the medium free then it waits for DIFS. Now if the medium is free then it will transmit request-to-send (RTS) packet to the desired node. If receiver is ready to accept the data then it will wait for SIFS and send a CTS packet to transmitter. After receiving the CTS from receiver, the sender will send the data after waiting for SIFS. The receiver will wait for SIFS after receiving the data and then reply with ACK packet. Any station overhears an RTS or CTS packet, will set the NAV to defer itself from medium access until the end of data transmission and corresponding ACK frame received by sender. NAV is the virtual sensing as it reserves the medium exclusively for one transmission. It also specifies the point at which deferred stations can try to access the medium again. The transmission has been completed and NAV also lets the medium free to start the cycle again. This scheme successfully avoids hidden problem, but exposed terminal problem emerges more.

2.5 Contention less protocols.

2.5.1 IEEE 802.11 MAC with Polling

The polling is the entirely different approach for medium access control as compared to the previous discussed schemes. It uses point coordination function (PCF) mechanism instead of DCF. It offers time-bounded service as well besides asynchronous data service. The concept of PCF is that it requires an access point (AP) that controls the medium access and polling of the stations in the network. Polling is the technique that all the stations communicate through an AP. They do not contact directly with each other rather AP allows each station one by one to send the data. AP is like master and all other stations are its slave. AP has a list of stations used for polling. The list is based on some priority like round robin, randomly or reservation etc. When the AP finds the medium idle, then it has to wait for PIFS before accessing the medium. As PIFS is smaller than DIFS than no other station can access earlier. After waiting for PIFS, AP sends data to the first node as a downlink. This node sends data on the uplink after waiting SIFS. Now, the AP waits SIFS this time and sends data to second node. The polling continues in the same way with other node in the list. The AP will poll all nodes in the list, even the stations do not want to send data will also be polled.

3. CHANNELIZATION PROTOCOLS

3.1 Time-Division Multiple Access Protocols. (TDMA MAC PROTOCOLS)

TDMA protocols are classified according to the duplexing technique. They are Frequency-division duplex (FDD) and Time division Duplex (TDD). FDD provides two carrier frequencies, the uplink frequency is used to carry traffic from node to base station and while the downlink frequency carries traffic from the base station to the node. In time-division there is only one carrier frequency and it is used for both uplink and down link on time shared basis.

3.1.1 TDMA with FDD Dynamic Packet Reservation Multiple Access. (DPRMA)

Dynamic Packet Reservation Multiple Access (DPRMA) is a MAC protocol developed for wireless ATM networks [6]. It is based on the classical PRMA protocol [7,8] . PRMA used for voice and data traffic and enable more users to be supported than time slots by using the silent periods characteristic in voice traffic to serve alternating data traffic. DPRMA is a demand-based assignment scheme that uses slotted ALOHA for reservation contention periods. Here slots are allotted as per the band width requested by the user. The user submits an initial rate request, by setting the appropriate reservation request (RR) bit in the header of the uplink slot and the reservation acknowledgment (RA) bits are received in the header of downlink messages. The user monitors the slot reservation (SR) bits in the message header of the downlink channel to determine in which slots it may send packets. If slots are not available for real time services data slots are preempted and they are kept in a queue and preempted slots are given to real time services. The use of full size request slots for contention period waste the bandwidth.

3.1.2 Centralized Packet Reservation Multiple Access (CPRMA)

CPRMA is a demand access scheme with contention-based reservation period [9]. Unlike DPRMA, CPRMA transmits corrupted packets. In CPRMA, the base station schedules packet transmissions for nodes. The reservation requests are transmitted in the upper link and successful reservation is acknowledged by the base station. The base station issues a command the node can transmit packets on the assigned slots. If there is collision, collision resolution is initiated and it is continued till all the packets transmit data successfully. The polling is done according to the scheduling algorithm for multimedia traffic to provide QOS. In CPRMA slots are dynamically assigned to provide accurate combination of traffic. The bandwidth can be served according to individual user rather than real and non real time traffic in DPRMA. It is a complex than DPRMA.

3.1.3 Dynamic TDMA with TDD (DTDMA/TDD)

The MAC protocol combines all three resource sharing methods: dedicated, random, and demand assignment. DTDMA/TDD provides both fixed and shared allocation of VBR and dynamic allocation for CBR,ABR. Users send transmission requests to the base station in the dedicated reservation slots using slotted ALOHA random access. The base station then broadcasts slot allocation and acknowledges successful reservations. For CBR traffic, slot allocation is performed once during call establishment. When CBR slots are not available arriving CBR calls are blocked. Like CBR, VBR slots have fixed allocation, but unused slots are shared with other traffic classes. Arriving VBR calls are also blocked when VBR slots are not available. ABR, UBR traffic, slots are allocated a dynamic reservation of ABR, UBR slots and unused CBR and VBR slots. This was designed for wireless ATM networks.[10].This protocol cannot be useful for most demanding user.

3.2. Code Division Multiple Access Protocols (CDMA MAC Protocols).

CDMA is a multiple access technique where all the nodes in a cell transmit on the channel simultaneously using the orthogonal utilizing the whole spectrum. Spread-spectrum techniques are frequency hopping and direct sequence. In frequency hopped spread spectrum the users transmit their data on spectrum which is generated by varying the frequencies according to algorithm. In direct sequence spread spectrum the user's data is spreaded using a Pseudo-random sequence code (PN code) and modulated then transmitted. The PN codes are orthogonal. By using CDMA technology resources are shared efficiently supports multiple users with variable data rates for different types of traffics ensuring QOS. The development of third-generation systems includes the evolution of GSM and UTRA to the TDMA/CDMA and WCDMA standards. The wireless multimedia CDMA MAC protocols as pure WCDMA protocols and hybrid TDMA/CDMA protocols.[11]

3.2.1 A MAC Protocol for a Cellular Packet CDMA Carrying Multi rate CDMA

This protocol is designed for a direct sequence CDMA (DS CDMA) cellular network carrying multiple traffic types [12].It is a packet oriented MAC protocol which can handle different traffic types with priorities. The users are classified into different types based on their traffic rate. As traffic arrives from the source each traffic type is buffered in a finite-length buffer. The user will be in idle, active, and blocked, states based on the state of the buffer and the success of the previous data transmission. If there is a packet in the queue, the user attempts to transmit it at the beginning of the next slot. If there is no packet in the buffer, the user assumes the idle state. If the data transmission failed, the user assumes it as blocked state. If an idle user's information source generates packets, the packets are queued in the transmission buffer and the user assumes the active state. An active user attempts to transmit the packet with probability **P** which have different values for different users. A lower **P** corresponds to a higher priority. If the transmission is successful, the user attempts to transmit the next packet in the queues if it is not empty, and the user's state remains unchanged; if the queue is empty and no new packets have arrived, the user assumes the idle state. If the transmission fails, the user assumes the blocked state and user attempts a retransmission with probability ***P.*** *T*he use of information packets in contention periods increases delays; packet loss and effects the throughput.

3.3 WCDMA MAC PROTOCOLS.

Wideband CDMA can be categorized into pure wideband CDMA and wideband time division (TD) CDMA. Pure wideband CDMA uses frequency division duplex (FDD) to organize the uplink and downlink transmissions, while wideband TD-CDMA uses time division duplex (TDD). TDD mode is well-suited for indoor environments with high traffic density and applications with highly asymmetric traffic [13].

Wideband TD-CDMA mode resource units include both time slots in a frame and codes in a time slot due to slotted frame structure. Multi-code (MC) operation and multi-slot operation are normally used to allocate resources [14].

Wideband FDD CDMA mode does not have the choice of multi slot operation because the resource units only include codes in a frame. In order to improve the flexibility of resource allocation in FDD mode wideband CDMA, orthogonal-variable spreading-factor (OVSF) is used [14]. A mobile terminal can have multiple codes and the OVSF of each code can be variable. Thus, both MC operation and OVSF operation are used in FDD mode wideband CDMA.

i) In [15], a proposal for an RLC/MAC protocol for wideband CDMA is presented .For packet data services; there are two basic methods to transmit data. First, short and infrequent packets

with no delay and minimum overhead are transmitted in an ALOHA basis using the random access channel (RACH), a channel common to all terminals in the cell, used for issuing transmission requests. In the case of larger packets, the terminal will request a DCH a dedicated code with fast-power-controlled transmission on the RACH. The network will answer the request indicating a set of possible transmission formats .If the load is low, the system will indicate the specific Transmission format and the time the user can start transmitting the data. If the load is high a set of transmission formats will be sent to the user and user has to send another transmission request to receive the specific transmission format. The data rate of the terminal will be varied depending on the network load. For real time data transmission it follows same procedure as in data format. This proposal does not consider how to allocate resources to different services. In highly loaded conditions if short packet transmissions are done the performance of the protocol could be severely degraded, because of excessive packet collisions that involve delays in accessing the channel and loss of short data packets, and also increase in the interference level produced by many non-fast-power-controlled packet transmissions.
ii) An uplink MC CDMA system architecture is proposed to support various traffics with different QOS requirements [16]. The received power level of each code channel is controlled by a power allocation algorithm so that BERs of all services maintain quality of service. This proposal does not consider scheduling mechanism for allocating resources to different services. The scheduling scheme for non real- time traffic is based on first-in first-out (FIFO) queuing and round-robin queuing. The average message transmission delay of non-real-time traffic can be very large when a lower priority is assigned.

Hai Jiang et.al.[25] have proposed MAC scheme which can achieve bit-level QoS, low overhead, accurate channel and interference estimation along with high bandwidth efficiency. The scheme also has the potential to support packet-level QoS and service differentiation. They also propose a distributed MAC scheme to address these limitations, where active receivers determine whether a candidate transmitter should transmit its traffic or defer its transmission to a later time.

Liang Xu et.al. [26] have proposed a class of dynamic fair scheduling schemes based on the generalized processor sharing (GPS) fair service discipline, under the generic name code-division GPS (CDGPS). The CDGPS scheduler uses both the traffic characteristics in the link layer as well as the adaptively of the wideband CDMA physical layer to perform fair scheduling on a time-slot basis, by using a dynamic rate-scheduling approach other than the conventional time-scheduling approach. Soft uplink capacity is characterized for designing efficient CDGPS resource allocation procedure. A credit-based CDGPS (C-CDGPS) scheme is proposed to further enhance the utilization of the soft capacity by trading off the short-term fairness.
Jennifer Price and Tara Javidi [27] have proposed a cross-layer approach to optimal rate assignment in multi sector CDMA networks. The algorithm was a “one-shot” algorithm; which implies that it combines the MAC and transport layer protocols to control interference and congestion simultaneously. They investigated the dual-based algorithms in which the delay associated with addition of intermediate queues at each wireless source provides the necessary information for coordinating MAC and transport layers.

Rekha Patil and A. Damodaram [32] have proposed, a cross-layer based joint scheduling and power control algorithm with the objective of minimizing the interference level and call rejection rate. For achieving that, the algorithm determined the optimum set of admissible users with suitable transmitting power level. They solved the multiple access problems in the distributed power control algorithm, the set of powers that could be used by the scheduled users to satisfy their transmissions were determined.

4 .HYBRID MAC PROTOCOLS.

The hybrid protocols apply to both the TDMA and CDMA categories, but are discussed here in relation to CDMA

4.1 WISPER protocol

A novel Medium Access Control (MAC) protocol called Wireless Multimedia Access Control Protocol with Bit Error Rate (BER) scheduling, in short WISPER,[17] for WCDMA based systems is proposed. WISPER utilizes the novel idea of scheduling the transmission of multimedia packets according to their Bit Error Rate (BER) requirements. The scheduler assigns priorities to the packets and performs iterative procedure to determine a good accommodation of the highest priority packets in the slots of a frame so that packets in the slots of a frame so that packets with equal or similar BER requirements are transmitted in same slots. The packet allocator accommodates packets in slots according to the following criteria.

1. Accomodate packets in empty slots with same traffic class that have same BER requirements.
2. Accomodate packets in empty slots with different traffic classes with stringent BER requirements.
3. Accommodate packets in empty slots with different traffic classes with relaxed BER requirements.

By using the protocol the packet with equal or similar BER a requirement are transmitted in the same slots and through put is maximized.

4.2 RATE ADAPTIVE HYBRID MAC (RAH-MAC).

RAH-MAC [18] is combination of polling and contention MAC protocols. When a mobile terminal or node has data it uses the contention time slot to join the base station polling list. The time slot allocated by the base station is based on mobile terminals demanded service class. A node transmits data after it receives the polling message from the base station. The base station has two polling lists, one list is used for voice terminals and other list is used for data terminals. Three types of polling messages contention start poll (CSP), contention end poll and data transmission poll are used. There are two flag bits in contention start poll message to indicate which Mobile terminals can use the contention mini slots. When all Mobile Terminals uses the Contention time, a priority based slotted Aloha is used. In this protocol back up voice terminals are given more priority than non backup voice terminals. If no slots are used by the voice terminals the remaining left slots in the frame are allocated to the data terminals. When mobile terminal successfully joins a base station polling list, it detects SINR and determines the optimal transmission rate. Base station transmits the optimal rate back to the mobile terminal in the acknowledge packet. When base station polls the Mobile terminal it sends DTP message which includes transmission rate and interference power level. The Mobile terminal after receiving DTP message detects signal power. If suggested rate matches the calculated rate base station transmit packet using suggested rate. Otherwise Mobile terminal transmit pilot symbols to tell base station to switch its receiving rate. In this protocol more priority is given to voice traffic but not for data traffic.

4.3 ADAPT MAC PROTOCOL (ADAPT)

This protocol [19] is based on channel allocation TDMA protocol and contention protocol .Each mobile terminal is assigned a slot in a frame considering as owner. In each slot their is sensing

interval in which only the slot owner may contend for the channel by initiating hand shake and the other users (non owner) cannot transmit data.
A several mobile terminals tend for slot give rise to collision. If collision is detected the mobile terminal must remain salient for the remainder of a slot. A node which has not received RTS have to differ transmission of its data packet until its assigned slot will occur or some later slot determined by back off scheme.

4.4 Collission Avoidance Time Allocation PROTOCOL. (CATA PROTOCOL).

CATA [20] protocol is based on contention and reservation protocols. Each slot is sub divided into five mini slots. The first four mini slots are control ones labeled as CMS1, CMS2, CMS3, and CMS4 and are used to secure and reserve time slots and the last slot labeled DMS used for transmission of data packets. It supports Unicast, Multicast, Broadcast transmission services. The receiver of a flow informs other potential source nodes about the reservation of the slot, and also informs them about interferences in the slot. Acknowledgements are used at the beginning of each slot for distributing slot reservation information to senders of broadcast or multicast sessions. The CMS1 and CMS2 are used to inform neighbors of the receiving and the sending nodes about the reservation. The CMS3 and CMS4 are used for channel reservation. This protocol is unstable for certain traffic loads and mobility rates.

4.5 HAMAC PROTOCOL

Hybrid adaptive MAC protocol (HAMAC) [21] based on TDMA, reservation, and contention protocols. It allow the contention channel to transmit data, unlike many other proposals in which the contention channel is used only for reservation and control signaling. It can efficiently adapt to the traffic the variance in CBR, VBR, and ABR traffic due to the mobility of mobile devices. The protocol uses a novel preservation slot technique to overcome the packet contention overhead in packet reservation multiple access (PRMA) like protocols, while keeping most isochronous service features of TDMA protocols to serve voice and CBR traffic streams.

4.6 Hybrid TDMA/CDMA PROTOCOL.

Hybrid MAC protocol for multimedia traffic in wireless net works [22].This protocol is combination of TDMA and CDMA channel allocation schemes. In this protocol a frame is divided into different time slots and a time slot can be used simultaneously by different users using their orthogonal CDMA codes .The author proposed three scheduling schemes,

1. No reservation for any traffic class.
2. Complete reservation for each traffic class.
3. Partial reservation for each class of traffic.

Among the three proposed schemes the partial reservation scheme is more advantage when compared to others. Slots are allocated for Traffic classes in fixed pattern.

4.7 ANALYTICAL MODEL MAC MULTI PROTOCOL.

In the design the merits of the OFDMA,TDMA and CDMA systems[23] are combined to improve the through put .The reservation and polling methods of MAC protocols are used to handle both low and high data traffics of the mobile users. In this protocol frame is divided into different slots and the slots are transmitted with users CDMA codes.

5. COMPARISON OF MAC PROTOCOLS

Random Access Protocols.				
Sl.No	**Algorithm**	**Principle / slots assignment**	**Advantages**	**Disadvantages**
1.	CSMA/CA	Carrier sensing scheme using random back-off algorithm	Simple algorithm	1. Unfairness in waiting for back-off time. 2. Hidden and exposed terminal problems. 3.Through put low at higher loads
2.	MACA	RTS/CTS	Simple algorithm	1.use of extra packets RTS/CTS cause overhead 2. not completely hidden and exposed terminal problems 3. Remain susceptible to instability.
3.	MACAW	RTS/CTS	Reduces the back off time using RRTS	Use of packets of ACK, DS and RRTS are used in the network that increases the overhead and the load of traffic.
4.	IEEE 802.11 MAC with CSMA/CA	Carrier sensing with addition of DIFS, SIFS and back-off timer.	Great deal of fairness and improvement for accessing the medium.	Hidden and exposed terminal problems
5.	IEEE 802.11 MAC with RTS/CTS	Carrier sensing with RTS/CTS And Virtual sensing with DIFS, SIFS and	Solve the hidden terminal problem	1. Results delay for higher traffic. 2. Exposed terminal problem emerges.

		ACK		
6.	IEEE 802.11 MAC with Polling	Polling with PIFS / SIFS	No hidden and exposed terminal problems And Centralized	The nodes have to wait for their polling. It causes delay in the network. There is also extra overhead if one station has nothing to send but the base station will poll it in each turn.
Channelization protocols				

Sl.No	Algorithm	Principle / slots assignment	Advantages	Disadvantages
1.	TDMA-FDD-DPRMA	1.demand-based assignment scheme that uses slotted ALOHA for reservation contention period 2.slots are allotted as per the band width requested by the user	More priority is given to real time services**.**	The use of full size request slots for contention period waste the bandwidth
2.	Centralized Packet Reservation Multiple Access (CPRMA*)*	1.demand access scheme with contention-based reservation period 2. slots are allotted as per the band width requested by the user and availability	Mini size request slots are used saving the bandwidth. .	It is a complex than DPRMA.
3.	DTDMA/TDD	1.based on dedicated, random, and demand assignment 2.CBR,VBR-Circuit mode	Mini size request slots are used saving the bandwidth.	Fixed slots are given priority than variable slots. This protocol cannot be useful for most demanding user.

		VBR,ABR-dynamic mode		
CDMA MAC PROTOCOLS				
1.	A MAC Protocol for a Cellular Packet CDMA Carrying Multi rate CDMA	According to traffic class and required traffic rate	handle different traffic types with priorities	Different transition probabilities and packet queue size
2.	RLC/MAC	According to load, traffic class and rate	BER of traffic classes are controlled using Power control algorithm	Different transmission formats specified for transmission
3.	MC CDMA system	According to traffic class and required traffic rate	BERs of all services maintain quality of service	transmission delay of non-real-time traffic can be very large

Hybrid MAC protocols

Sl.No	Algorithm	Principle / slots assignment	Advantages	Disadvantages
1.	WISPER protocol	1. Based on TDMA and CDMA 2. Slots are filled according to the BER requirements. 3.WISPER is a reservation-based protocol.	protocol is simple to implement in that only one power level can be used for each slot rather than several power levels depending on the number of traffic classes	when congestion occurs, voice packets are the first to be sacrificed.
2.	RAH-MAC	Combination of polling and contention MAC protocols	Data transmission rate is dynamically adjusted based on the channel condition and it uses variable transmission rate	More priority is given to voice traffic but not for traffic.
3.	ADAPT	TDMA protocol and contention	Dynamically manages the	Only slot owners can transmit data

		protocol	band width	in their slot others cannot use it and channel is not efficiently utilized
4.	CATA PROTOCOL	Contention and reservation protocols	More flexible in terms of bandwidth management when compared with allocation protocols	1.More slots are used for secure and reservation . 2. un stable for certain traffic loads and mobility rates.
5.	HAMAC PROTOCOL	1.TDMA, reservation, and contention protocols 2.This protocol uses a novel reservation slot technique to overcome the packet contention overhead in packet reservation multiple access (PRMA) like protocols. CBR,VBR,ABR are used	1.Results in very low delay in case of light traffic load. 2.Dynamic bandwidth allocation strategy 3.Eliminates the reservation overhead of CBR traffic, which results in less contention	RAH-MAC is superior than HAMAC
6.	Hybrid TDMA/CDMA Protocol	TDMA+CDMA	Capacity of system increased	Slots are allocated for Traffic classes in fixed pattern
7.	Analytical Model MAC Multi protocol**.**	OFDMA,TDMA and CDMA systems	Capacity of system increased	Results in delay for certain traffic

Main considerations in the design of protocol for wireless multimedia system are

1. To use multiple accesses to make efficient use of allocated bandwidth

2. To increase throughput, capacity and channel utilization

3. To reduce delay, jitter, overhead and to maintain quality of service.

4. The protocol should be capable of supporting different traffic classes which will have different bit rates.

5. The protocol should not be static and the resource should be allocated dynamically according to user's requirement.

6. CONCLUSION

Many MAC protocols are proposed for wireless multimedia networks. We describe the operation of several Random access protocols or Contention protocols, Contention less protocols, Channelization protocols, and Hybrid MAC protocols for wireless multimedia networks. In contention protocols no node is superior to another node and none is assigned control over another. The contention protocols performed better at low network loads and in stable at high network loads. In contention less protocols the scheduling is done in a fixed fashion and each node is allocated a part of the resource and it results delay in the network. Channelization protocols generally use fixed slot assignments preventing adaptation to changing network conditions. A single protocol cannot handle all the demands of multimedia applications and so hybrid protocols are designed. In summary most current protocols are hybrid protocols which combine features of two or more protocols for effective utilization of resources and to maintain quality of service.. Future research must focus on design of scheduler, radio resource management algorithms and methods to increase throughput, capacity and to reduce end to end delay, contention and to maximize utilization of bandwidth for different multimedia traffic classes.

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