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Resource Allocation in IEEE 802.16e Mobile WiMAX Networks: Survey

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Abstract: WiMAX (Worldwide Interoperability for Microwave Access) provides Internet access across the and have a wide range of services. It has been observed many researchers working on quality of services, applications and resource allocation. WiMAX networks incorporate several Quality of Services (QoS) mechanisms for guaranteed services for data, voice and video. The problem of assuring QoS is that how to allocate available resources. For resource allocation, what are the parameters to be define because the IEEE standard does not include any scheduling mechanism. It has become an important problem to solve more efficiently for the manufacturer to design the equipment, which should handle the resources optimum and efficient way. The paper discusses the key issues and design factor to be considered for the resource allocation. We also present the resource allocation techniques proposed ideas. We classify the proposed channel condition based hybrid mechanism. The goal of this study is to elaborate the proposed techniques, which are used for resource allocation.

Key words: Resource allocation · IEEE 802.16e Mobile · QoS · Scheduling

INTRODUCTION

The mid of 1990, telecommunication companies developed the idea of broadband wireless networks for deliver the internet connectivity for businesses and individuals. The main aims behind this thinking were produced a network with speed, capacity and reliability. In 2001, the WiMAX was established for promoting the 802.16 standard. Then in 2003 the IEEE came out with 802.16a and in 2004, the 802.16 standard was released and then the combination of IEEE 802.16a,b and c extended the WiMAX services to a 30 mile range.

WiMAX is a wide area network (WAN) technology that offers robust services to users and equal to a digital subscriber line (DSL). It is full duplex service with uplink and downlink channel. The long range of WiMAX provides quality of services (QoS), scalable architecture and high data throughput. Due to the vast increase in the contemporary applications, broadband wireless access is becoming more and more important.

Recently, researchers are focusing on enhancing the various aspects of WiMAX implementation such as QoS, Scheduling, Fairness, Throughput, security and complexity of algorithms, [1-3]. A large number of industrialists and scientists along with collaboration of various academic institutions have found WiMAX forums. These forums are trying to ensure the mature version of WiMAX mobile services. The experimental service of this technology is in progress and regular feedback will be incorporated in the next coming more mature standard, which will be helpful for the implementation and rolling out of WiMAX network [4]. Initially, the standard was released in 2001, which supports the point to multipoint, later on new enhancements were introduced and the latest version was released in 2009. This revision includes the mobility support and the required quality of service parameters [5].

The resource allocation is used to assign the resources to different demanding entities in the system. It's an important part of resource management. In a network, the resource allocation means scheduling the requests of different users in a well-organized way. In OFDMA system, the resource allocation is a process to allocate sub carrier with adequate resources, while remain connected to the network so that the SS can conveniently communicate with another SS or BS. In [6] the resource allocation of sub carrier is proposed by assuming equal sub carrier allocation irrespective of the channel status

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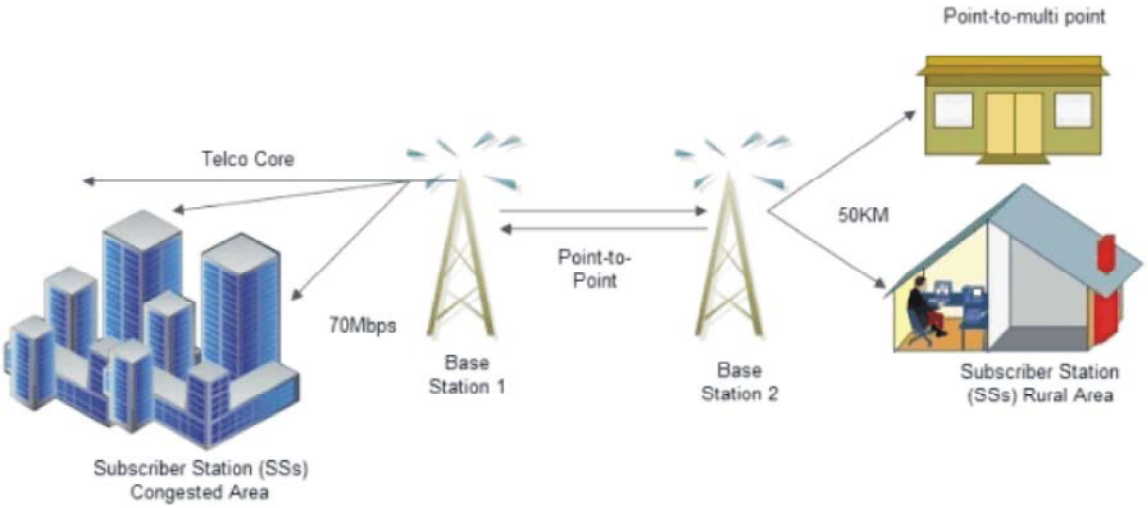

Fig. 1: WiMAX Deployment Scenario

and the data rate. The ideal channel state information is assumed by using fixed modulation for all subcarrier to all users [7-8].

Considering the literature review related to the resource allocation in WiMAX, there are different mechanisms. Two main techniques have been discussed in the literature and used for resource allocation; one is Linear Search Technique [9] and the other one is Root Finding Method [10-11]. They have proposed the Network Utility Maximization (NUM) concept for allocation of resources considering QoS Class. However, to use the existing techniques for improvement and better utilization of resources. By using the QoS with the status of the channel, the process of resource allocation can be enhanced, currently best of our knowledge no one has worked on this approach.

Background: WiMAX is one of the wide area network (WAN) categories, which provide flexible and easy deployment solution to high-speed communication. It supports a verity of services utilizing advanced multiple access technique. This means that the network will be able to accommodate the users with different service classes. In IEEE802.16e standard, Orthogonal Frequency Division Multiple Access (OFDMA) supports broadband access infrastructure in the wireless environment. It also increases the multiuser diversity.

As the bandwidth in any network is an asset and is limited, so the performance of the system depends on the efficient resource utilization. Improving the efficiency of resources allocation plays a vital role. A good resource allocation scheme will increase the spectrum efficiency and provide the available resources to the user in best and efficient manner. In Orthogonal Frequency Division Multiple Access (OFDMA), the bandwidth is divided into sub carriers [12]. These subcarriers are allocated to the subscriber and controlled by the BS. The policy of resource allocation depends on the BS. Grouping of these carriers is called as sub-channel and these sub-channels are represented by different Frequency Division Multiple Access (OFDM) symbols known as slots. In WiMAX standard, slot is defined as a minimum resource, which can be allocated to an SS [13]. Frame of WiMAX is further subdivided into two i.e. uplink and downlink subframes. Both uplink and downlink supports duplexing using Time Division Duplexing (TDD) or in Frequency Division Duplexing (FDD). In TTD, the communication is achieved by using the same channel in different time slots. In TDD, the downlink and uplink sub frames are separated by receiver transmit transition gap (RTG). In FDD, simultaneous communication is achieved by using different sub-channels. The throughput of uplink or downlink is proportional to the number of subcarriers allocated to the corresponding SS and the achievable rate of each subcarrier [5].

While working in wireless network environment different subcarrier have diverse channel gain; each subcarrier fades independently for different SS. Considering such diversity is a motivation for designing of some mechanism for the resource allocation in OFDMA network. Various researchers have been worked out on the efficient utilization of the resources in WiMAX network, scheduling for resource allocation and modulation based on channel condition [11].

In the real scenario, the subscribers have the different data rate at different locations from the base station, so the approach in [9] don't reflect the practical solution, but for considering the practical approach in [10-11] in order to reflect the real scenario. In [10] users are allowed to set their data rate based on the QoS and by using proportional rate constraint. Each user data rate can be satisfied with constraint to the channel status of the user.

WiMAX standard IEEE 802.16e supports five service classes namely, UGS, ertPS, rtPS, nrtPS and BE. All of these classes have different QoS requirements. Considering the QoS requirements and the mobility of users in the coverage area with variable channel status, allocation of resources in fair manner and efficiently is a complex issue [14, 15].

Main objective of the WiMAX schedule is to ensure the QoS requirements for five classes identified on the basis of required services. To ensure this quality of services some researchers had proposed different algorithms, which are the variation of commonly used scheduling algorithms [16, 17]. As each service class has different characteristics so it requires different QoS requirements, on the basis of these requirements, the classes are classified as Unsolicited Grant Service (UGS), Extended Real Time Polling Service (ertPS), Real time polling service (rtPS), Non Real Time Polling service (nrtPS) and Best Effort (BE).

In IEEE 802.16e mobile WiMAX networks, several other scheduling techniques are applied depending upon the quality of the signal [1]. The main two types to be defined are temporal fairness and throughput fairness [18]. Theoretically all the users will be getting the same service but due to mobility and load on the network, the service provider has to face challenges in the fair allocation of resources to each user. The user will face the problem in resource utilization at different levels of QoS whether the service provider fixes the number of slots or not, allotted to each user.

If the service provider fixes the number of slots and the user is in an odd area then service provider has to allocate more resources. The user can get the same quality of service as compared to the user in the average area that will affect the throughput of the network. If the service provider does not provide extra resources to the user in an odd area then fairness issues arise in term of QoS of the network service provider such as getting enough throughput from allocated resources. To achieve the fairness, the service provider can implement Proportional Fairness (PF) and Generalized Weighted Fairness algorithms (GWF) to assure the QoS.

In communication system, throughput is defined as utilization of the available resources among the users in well-organized way by considering all the constraints[19] which may be the demand, QoS, channel status. Throughput of the system depends on the resources available and their use. When the allocation of resources is made on the basis of fixed allocation scheme, the resource utilization may be hampered due to variation in signal to noise ratio (SNR) of the channel in wireless network environment. To increase the network throughput, a mechanism has to be devised that should consider the channel status as well as QoS.

Form the last few years, different areas of WiMAX have been intensively investigated and a lot of progress has been done. Current work on WiMAX focuses on mobility specified in IEEE 802.16-2009 standards. These standards do not provide any specific technique to be followed as a mechanism for resource allocation. Focusing on the resource allocation, it is an open issue for the researchers to derive mechanism based on available literature. Considering the QoS in WiMAX and the scheduling of the resources based on the channel SNR, modulation scheme is to be selected along with the code rate [19]. It is fact that the scheduling for resource allocation in a wireless network is a critical problem [20]. The objective of the scheduler is to maintain the QoS, fairness and throughput of the system. To achieve QoS, fairness and throughput needs concentration by the researchers to investigate and estimate the status of the channel which can significantly affect the performance of the network because the modulation technique applied will depend on the channel status and distance of the user from BS.

These algorithms ensure allocation only on the basis of resource availability otherwise drop the request. [21] presented extra bandwidth granting (EBG) scheme to improve the efficiency based on the average packet size for the QoS classes. [22] presented an optimization technique considering the max carrier to interference ratio. [23] has proposed time frequency allocation with the channel condition for ensuring the QoS based on priority. Therefore, scheduling has to be given special attention for WiMAX to consider the key issues and design factor. Till now the work done regarding resource allocation is normally based on the scheduling of existing resources and applying the modulation technique on the basis of node distance and the SNR of the channel. For the best utilization of existing resources such as capacity, channel assignment and bandwidth allocation in WiMAX networks, the required class for QoS and SNR of the channel should be considered simultaneously.

In [24] proposed a dynamic uplink channel allocation based on SINR to reduce the overhead and increase throughput of the network. In [25] for better utilization of bandwidth and reduction in interference, Genetic Algorithm is used for resource management. [19, 26] used adaptive modulation to maximize the throughput based on traffic throughput between two available adaptive resource adjustment schemes. Also in order to achieve the higher resource utilization, Weighted Round Robin scheduling is used. This algorithm improves delay time and multi-cast traffic throughput by considering the SNR modulation technique for the improvement in reduction of delay time from of 8 to 10%. To achieve the optimum throughput in [27] dealt with an efficient algorithm for spatial reuse using the concept of dynamic programming in order to investigate the conflicts, free set of nodes that can be activated to obtain the optimization in the throughput.

Resource allocation in mobile WiMAX can be improved and made more efficient by using the Artificial Intelligence (AI) techniques. Fairness among the users for getting the resource is another important aspect. Channel gain status will be a major factor for deciding the allocation of resource. Two main techniques have been used for the allocation of resources; one is Linear search Technique [9] and the other is Root Finding Method [10]. In linear search technique, resources are allocated to the users by first calculating the total bandwidth required and the data rate of the user. Then all sub-carriers are searched and sorted out in descending order according to their channel gain. Then the sub carriers are allocated to each user and this process is repeated until all the users have been served, or the channels are occupied.

Other technique used in resource allocation is Route finding Method; in this method the resources are allocated based on the target data rate. Each user gets the resources in a cyclic manner. This allocation remains continued in the loop by finding the user with requirement and allocates any unused subcarrier. This process continues until fulfilling the user requirements or the allocation of all the resources. The problem with this method is; it does not find the number of resources required by each user. Second issue with this method is; it does not consider the channel quality (SNR) of the user [9-10].

Through Literature following points have been extracted as hurdles in order to resolve the concerned issues.

- QoS is not an optimum parameter for resource allocation.
- To allocate resources on the basis of quality of service classes will not be enough efficient to give optimum throughput.
- The allocation of resources based on the service channel status will not be able to distribute resources fairly being a user at poor SNR location.

Hence there is a need of more work to be done to develop an efficient technique for allocation of the available resources for throughput on the basis of SNR.

Architecture of WiMAX: WiMAX network can be grouped into three parts.

- To access the network mobile station used by the end user
- Access Service Network (ASN) consists of BS/s and gateway/s to make radio access network (RAN) at the edge.
- Connectivity Service Network (CSN), to provide core functions of the network and connectivity of IP

Quality of Service Classes in WiMAX: In order to achieve QoS requirements to support various traffic requirements, the system should be ready to look forward to almost any kind of application. The support for various traffic profiles in QoS is of prime importance in the designing of future multiple access schemes. The system providing quality of service should be fair for each user, who could not inhabit the service for others [20]. QoS classes in WiMAX are; Unsolicited Grant Scheme (UGS), Extended Real Time Polling Service (ertPS), Real Time Polling service, Non Real Time Polling Service (nrtPS) and Best Effort Service (BE).

UGS; Provides fixed an amount of bandwidth allocation designed for constant bit rate (CBR), ertPS.

Designed for the VoIP and similar to UGS in terms of the allocation of resources as BS has to maintain the rate when the connection is active Table 1.

nrtPS: This class of service is designed to allocate the resources for the real time traffic, variable bit rate that can be accommodated in such as compressed videos. The parameters of QoS and UGS are same but require minimum reserved and maximum sustained traffic rates. BE: This class of service does not guarantee any delay or throughput. Bandwidth will be allocated to mobile station (MS), if left over by the other classes.

Resource Allocation and Management in WiMAX: Resource Allocation and Management has been a serious research issue for last few years. The convolution has

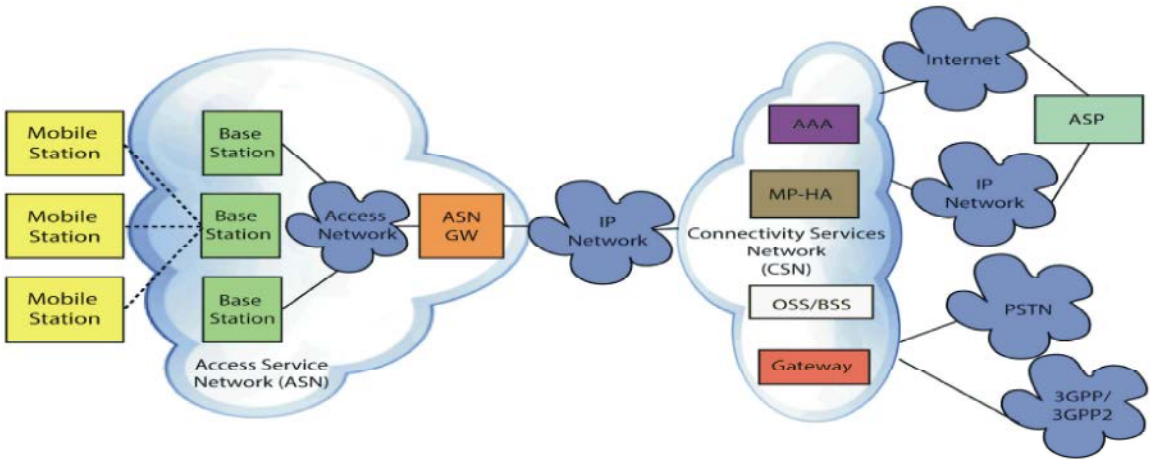

Fig. 2: Architechture of WiMAX

Table 1: QOS classes

QOS	Pooling Mechanism	Application	Band Width Request	Parameters	Technique
UGS	Unicast polling	CBR, Real time periodic, traffic	Reverse Bandwidth Additional bandwidth may be allocated on request	MST Max. latency Have tolerance against jitter Grants scheduling	Fix
ertPS	All kind of Polling	Video, VoIP	Allows Piggyback Reserves bandwidth during setup.	Minimum reserved Traffic Max latency UGS Interval	Dynamic
rtPS	Unicast polling	Real Time Video, VBR	Allows all kind of polling	Uplink grants scheduling sustainable traffic rate, MRTR	Dynamic
nrtPS	All kind of Polling	Variable size data, FTP	Allows	Traffic priority Max. sustained traffic rate	Dynamic
BE	All kind of Polling	Web Traffic	Allow Piggyback Allows all kind of polling	Minimum reserved traffic rate	Dynamic

Table 2: Review Technique for Proposed Research

Author	Focus area	Consideration	Technique	Remarks
(Muayad S.2011)	Scheduling and resource allocation	SNR and Power	Cross Layer	Through put
(Zookang,2003)	Resource allocation	SNR	Root Finding	
(Da, 2009)	Resource Allocation	SNR	Linear search	Complex
(Wong, 2004)	Resource allocation	SNR	Linear search	Fairness achieved
(Lu, 2006)	Resource Allocation	SNR		Fix no of resource allocation

enlarged on the basis of numerous causes, for example, the obtainable synthesis of various changed and uncommon network channels. Due to increase in traffic, users and demanding applications, burden on the network has exponentially increased. To handle this situation we have to manage the network resources properly.

In the wireless environment, there are several techniques which cover the large geographical area. In the wireless network for communication, there are some specific standards like WiMAX 802.16e. WiMAX (Worldwide Interoperability for Microwave Access) is deliberate for city areas and large coverage purpose. These networks have exclusive characteristics, structures and limitations. Generally, diverse networks obligate precise features, for illustration effective occurrence, reserve exposure and movement analysis. Diverse features are appropriately used for changed submissions, per network requirements and limitations, for example, extraordinary hustle but fixed situation or a small hustle but extra ordinary flexibility. Allocating resources dynamically in the wireless network is a non-linear process and highly complex [28]. The complexity increases when allocating resources for heterogeneous traffic with different quality of service requirements such

as in WiMAX. Dynamic allocation of resources with respect to channel quality increases the overall throughput of the network [10].

Related Work: In [29], an adaptive resource allocation algorithm applicable to multi traffic OFDMA is proposed. This algorithm allocates the resources according to the quality of service requirement of the users. This technique assumes perfect channel state and allocates the fixed no of resources to traffic classes. In [6] resource allocation utilizing the multi user diversity is proposed based on the channel condition of the user. This technique allocates transmission channel which can handle delay requirement of the real time users. The result is analyzed based on the average throughput, QoS delay, fairness index and the number of sub carriers allocated to the users. When considering the allocation of resources on the basis of the awareness about the channel this shows that the performance of the channel aware allocation is better than the channel unaware mechanism. In [8] sub carrier allocation algorithm that increases the spectral efficiency. This scheme is stable even the number of users is too large. This mechanism has two main parts first considering the user requirement based on their channel success rate. Then the rest of users are allocated considering the minimum band width wastage. Proposed algorithm is evaluated based on the effective utilization of the bandwidth and throughput of the network. In [30] the study presents the resource allocation, strategy for allocating higher layer data to the basic resource allocation of OFDMA. This scheme considers two simple allocation methods. Adaptive Slot Allocation (ASA) and Reservation Based Slot Allocation (RSA). Both methods consider a fair resource allocation among different service flows (SFs). The ultimate objective is to maximize the capacity of the system subject to quality of service (QoS) constraint for each type of (SFs) on the basis of channel quality.

The study presented a reduced user based complex resource allocation structure for the scheme based on OFDMA. To implement the effective scheduling, the BS scheduler requires to find the burst profile and bandwidth allocated to each user by taking into consideration of sub channel quality and service class. Each connection possesses different QoS parameters and different levels of the degree of satisfaction [23]. The modulation and coding scheme will be according to the signal to noise ratio (SNR). The algorithm calculates the priority of each user by service class and the resource requirement. In BS scheduler, each user has the queue for protocol data unit (PDU) and each user has the priority queue and different degree of satisfaction. The user with different connections belong to different SNR values of sub channels and then calculating the priority of each user, the BS scheduler sorts out and serves the users by their priorities. The proposed algorithm performed well as compared to maximum Carrier to Interference Noise Ratio (MAX-CINR) and modified Proportional Fairness (PF) scheme in all SNR regions from high to low such than average of SNR was observed better than 128 dB. However, the satisfaction degree of MAX-SNR is 60% in most cases, while not considering the QoS requirements in resource allocation. As a technique used for resource allocation is adaptive [23]. To improve throughput of the system, the resources are allocated in two dimensions i.e. frequency and time.

Existing Techniques: In the study [31] according to under given reference presented a new resource allocation scheme called extra bandwidth granting (EBG) for the improvement in transmission efficiency. The advantage of the scheme is, it can be used with existing scheduling algorithms. This scheme is helpful for reducing the queue delay. Mechanism of the scheme is to divide bandwidth into two sub frames, Uplink and Downlink. Any uplink service flow belongs to the service class; the size of the packet and arrival time is variable. To allocate the resource may get the two types of delay [21]. First, the arrival of the packet that it may contain the DL sub frame and to UL sub frame. The next starts from the next coming packet and ends at the beginning of the data transmission. If the bandwidth is not complete the packet will wait for the next. When the BS has scheduled the packet of the current frame according to the request of the service flow there may be some bandwidth remaining at the end of downlink sub frame and uplink sub frame. Now BS will trigger a scheduler in the UL map of any service flow some extra bandwidth and some packets which have arrived and yet not considered for requesting the resource may be transmitted by the extra slots. If the bandwidth is not enough for the packet then this process will not be executed. In this mechanism, the division of the bandwidth according to the service flow and using EBG queue delay can be improved significantly.

In [17] proposed dynamic resource allocation architecture (DRAA) for broad band wireless system. The proposed algorithms implements cross layer architecture by using the functionalities according to the standard. The performance of the model is evaluated using the well-known scheduler. The proposed model

presented a module like packet scheduling, hybrid ARQ and link adaption. DRAA selects the spectrally efficient Modulation and Coding Scheme (MCS) to maximize the achievable bit rate by maintaining the predicted block error rate simultaneously. To perform adaptive modulation and coding, the information about the state of a channel must be measured and reported to feedback channel. In [32] proposed a new algorithm which can handle the services considering the status of channel delay and the capacity of the buffer on the basis of these parameters algorithm achieved high throughput and better utilization of the resources. In proposed mechanism, four different buffers were used for each service. The scheduler visits each buffer to find the number of slots required for transmission but to transmit the fixed size of packets and the value of SNR may require a variable number of slots for transmission. The packets in this algorithm are treated on a first come first serve basis. To handle the variable packet size, both variable bit and constant bit rate applications are required. The packets are transmitted based on the earliest deadline first (EDF). In BE traffic packets are transmitted based on the information from the buffer size. Being considering the SNR value and the packet size of user resources are allocated. The problem with this algorithm is that if the required numbers of slots are not enough then the packet will be lost. D. S. Shu'aibu et al presented the slot allocation algorithm for real time and non-real time traffic of mobile WiMAX [1]. Allocation of the slot is based on the wireless link. To estimate the status of the channel which is based on path loss. The path loss of the wireless link is a function of distance between the traffic and the BS and the other factors. The signal to noise ratio is calculated by:

$$SNR = \frac{P_t \beta_l \beta_t}{1^* R_n}$$

As the packet size is limited to the power of two values. The SNR received for each transmitted packet is a pseudo random value drawn from a normal distribution as it is clear that the real time traffics are very much sensitive to have delay and variable packet size which is having its own SNR. The allocation of resources is done on the basis of two parameters that are packet size and the SNR value which decides the number of slots required for each packet. For each service, different buffers were used so that packets after the filling of the buffer will be lost. The algorithms allocated the resources considering the status of the channel. The algorithm does not consider the fairness factor of weak channel and no mechanism to handle the complexity of mechanism. In [33] evaluated the performance of four popular schedulers. We come to know that no single scheduler can perform better for all classes. An adaptive scheduling scheme is proposed where all scheduling is dependent on the flow of each service class and results in terms of improvement of throughput and minimizes delay and packet loss ratio. To find out the best scheduling algorithms we need to adapt an intuitive approach. To design the fuzzy based adaptive scheduling techniques. The selection of best scheduler based on the current traffic context information such as number of flows of each QoS class and totally requested throughput. Centre of gravity CoG method is used for the FAST to find the point value such that vertical line would slice make the set into two equal sections. This technique provides best performance in terms of delay and packet loss ratio with more stability. The proposed mechanism introduces a cost in terms of computational time to select an optimal scheduler using the FIS and to switch from one scheduler to another.

D.S. Shu 'aibu *et al*., proposed the partition of bandwidth for better management. As the single call admission control algorithms cannot maintain the required quality standards without the support of scheduler. The bandwidth is partitioned into three parts in order to simplify the complexity of a mechanism a handover traffic algorithm was used. To analyze the service critically with increase the service flows the blocking and dropping probability became less and the bandwidth was utilized better [34]. Deyun Gao et al presented an analytical model which was developed to demonstrate significant improvement in capacity of voice to propose optimized resource allocation scheme. The author analyzed the MAC protocol as frame structure and designed a practical cooperation mechanism [30]. At the other end, author also proposed optimal resource allocation for different applications to eliminate its capacity bottleneck. To allocate resources effectively and by eliminating the Access Point (AP) bottleneck, we require throughput balancing of data links being shared by the users. To achieve optimal resource allocation, an adaptive adjustment of EDCA parameters is required.

In the proposed algorithms user linked quality, service flow and selection for modulation maintain the buffer for each service and the packet is stored in the appropriate buffer in order to be transmitted while possessing its own SNR. For downlink session two parameters; packet size and SNR are applied for allocation of vital number of slots in packet.

In [35] WiMAX, most capable standard that carries out heterogeneous traffic classes in broadband wireless network, at high rate of data within an extensive reporting area, to achieve a fair distribution of resources among the users while using various modulation techniques. The modulation in OFDM allows using adaptive modulation by considering the performance of narrow band channel for improved system capacity, high data rate and reliability for efficient utilization of the resources. In the current paper, the author analyzed the AMT's for improving the throughput and LOS propagation needed for high working frequencies. In the present system, OFDMA technique is used and the UL and DL are distinguished by adaptive thresholds and each sub frame is further grouped in to finite number of physical slots.

The author [36] presented an important cross layer scheduling algorithm for QoS. The MAC for more than one connection is applied with derived adaptive modulation and coding technique. The priority is dynamically updated based on the channel and service status. To utilize the bandwidth more efficiently, enjoy flexible stability and low implementation complexity is proposed in the current research. Proposed schedule offers prescribed delay and rate that guarantees for real time and non-real time traffic using bandwidth efficiently by using different kind of service. Performance is measured using standard and the delay guard time that were set heuristically.

Channel Aware Scheduler: The BS scheduler can use the carrier to handle interference and CINR, which is too fed back to measure directly on the basis of the previous transmission from the same MS. The type of a wireless medium and the user's mobility can affect the allocation of resource mechanism. A MS may get resource from the BS but due to high channel loss rate unable to transmit data successfully. In general, the scheduler favors the user with good quality of the channel by handling multi user diversity, fading the optimal resource allocation in order to use the finest channel. To the increase of throughput of the system the scheduler uses the property of multi user diversity.

On the basis of primary objectives, the CRS can be grouped into four types i.e. fairness, system throughput and power optimization.

A new algorithm capable of handling all service flow typed with better throughput and better frame utilization. Name of the earlier algorithm handles the condition and status of wireless channel link. In the proposed scheduling algorithm, buffers used for each traffic with the serial number along with service flow identification, SNR and the arrival time of the packet along with the size. To find out the quantity of slots required, packet transmission depends on the amount which may vary considering the traffic. Being variable packet size in non-real traffic delay and latency may vary and be scheduled based on the earliest deadline first. Some traffic types don't require any kind of QoS attached while the buffer capacity is considered and then packets are transmitted. Being the sensitive to delay and variable in packet size the real time traffic is always treated with earliest deadline first (EDF) but the SNR value differs. Two parameters packet size and SNR value are used to assign the required slots for each packet. If the required number of slots on the current frame is not enough to schedule the current packet in considering the delay, the packet may be dropped. The cross layer approach shows that the wireless link condition should be a part of scheduling in the process of resource allocation for the better utilization of slots and throughput [32]. In this paper, the author [30] presented a generalized flow approach for the calculation for time required for the satisfaction of the minimum demand of the use to be done by linear programming. To find optimal allocation, the figure of poly matching in general exponential is the size of user subcarrier and represented by bipartite graph and naïve approach. Using the higher SINR optimal algorithm once the subcarrier is decided when power is divided among the subcarriers using standard water filling technique. HSO achieves the optimal selection under high SINR performance ratio close to unity or higher. This performance is better than the two simple greedy subcarrier allocation heuristics. In [25] to reduce the interference noticed in varied wireless networks and to improve the bandwidth utilization by applying genetic algorithms for RMU, they incorporated the concept of genetic algorithm into the dynamic design of broadband wireless system with high spectral efficiency. This frame work emphasis on the working of schedule and selection of link. The working of proposed mechanism is evaluated by considering the carrier to interference. According to WiMAX standard the functionality of the crossed-layer architecture is implemented by the given scheme. The basic standard for adaptive mechanism is to activate the diversities of inherent system that are found in different system domains. In [37] allocation of slot is a challenge that traffic has its own quality of service requirement since wireless link of the network is the function of time.

Table 3: Channel Aware Scheduler Analysis

Scheduling	Traffic Class	Pros	Cons
Proportional fairness	nrtPS and BE	Long term Fairness	Lack of short term fairness
A generalized weighted fairness	nrtPS and BE	Weighted fair for throughput fairness	Scalability issue
Modified L.W.D.F	rtPS and nrtPS	RT and NRT traffic can be processed	Difficult to find out the optimum for ant class
Exponential higher bandwidth allocation	BE	Throughput maximize	Fairness issue
Throughput maximization	BE	Maximize the throughput	Fairness issue

Slot allocation is made on the status of the channel. Packets transmitted from the subscriber station will have the estimated wireless link condition and hence the scheduler will use this input to schedule the packet. Considering the SNR value of channel proposed algorithm have achieved higher throughput. It shows that the link condition has very important role to play in allocating slots. Two parameters packet size and SNR value are used to allocate the required no of slots of each packet. Loss of packet may occur if the latency may reach before transmission. In [38], the paper defined a utility function that represents system performance considering the co channel interference among different cells. In this distributed resource allocation, each BS attempts to increase the system performance. In proposed system, each BS tries to maximize the performance. In [33], the author evaluated the performance of four popular schedulers. We come to know that no single scheduler can perform better for all classes. An adaptive scheduling scheme is proposed where all scheduling is done on the basis of flow of each service class and results in terms of improvement of throughput and minimizes delay and PLR. In this [39] presented the design of general algorithms to achieve the concurrent transmission both in uplink and the downlink for the improvement of throughput. As the scheduling is done using two most prominent methods like the distributed scheduling and the centralized scheduling. In the use of distributed method, there is no need of any well-defined BS for centralized method such that the BS is responsible for the slot allocation. Considering the algorithm we found that this works fine only in the fixed environment by not considering the mobility and as well as bit error rate that may affect the performance of the algorithm [39] [39] [39] [38] [39] (Jain, et al., 2008) [39] [48].

Resource Allocation: Resource allocation while maintaining the throughput of the network is another problem for the operator. Provision of enough resources tolow or poor SNR user will affect the throughput of the network while allocating the fixed amount of bandwidth will raise the fairness issue. In order to accomplish the aforementioned goal, the research has been strategically planned. Initially, a basic technique will be developed considering the basic factor discussed in the literature and the problem highlighted. The resource allocation mechanism presented in the linear search technique [10-11] need to improve for better performance. In linear search technique, resources are allocated to the users by first calculating the total bandwidth required and the data rate of the user. Then all sub-carriers are searched and sorted out in descending order according to their channel gain. Then the sub carriers are allocated to each user and this process is repeated until all the users have been served, or the channels are occupied. This technique considers the channel gain and user data rate for the allocation of resource. Another method for the allocation of resource is the root finding [9-10]. This method has the deficiency of not considering the important factor “SNR” of the channel. SNR of the channel plays a major role in the throughput of the network resources and increases the efficiency of the overall network.

The overall bandwidth of the network is divided into partitions to facilitate the different queues. These queues will be populated by RFT processor based on user’s input according to targeted parameters calculated from the system information. Each user in the network is free to use any application and can raise a request for the resource randomly. To handle the different service classes any priority queue can be assigned, but the critical issue arises when the status of the channel (SNR) is considered. When the user request for the service is received, the BS updates its status considering the demand of the resource based on the quality of service class and the channel status of the user. In the proposed model, the user must go through the two processes after admitting for the service.

CONCLUSION

After literature review, we found that the resource allocation in WiMAX network can be investigated and has large scope of research to be conducted. For this purpose, we purposed a technique and applied using different scenarios. Our proposed scheme has the option to calculate the resource required to each priority

queue and then allocate the resource on priority basis. This scheme shows the maximum utilization of available resources but in some cases it may affect the allocation for the bottom queue while having the least priority for the execution of process. In the future, we are working on this issue that how it can better manage the resource for the process in the bottom queue. This will help to solve the different issues of fairness problem which we will address in the next coming task as well as the throughput of the network.

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