International Journal of Computer & Information Technologies (IJOCIT)
www.ijocit.ir & www.ijocit.org
ISSN = 2345-3877

Hybrid Resource Allocation and Scheduling Technique for WiMAX Networks

Mohamed Ahmed Alamein[1] *,Wilson Jeberson[2], Ahmed M Husein Shabani[3]
Department of Computer Science and Engineering,
Samhigginbottom Institute of Agriculture, Technology and Science, Allahabad 211004, Jamia Millia Islamia, New Delhi, India
Email: wafi1011@yahoo.com[1], Jeberson@rediffmall.com[2] , ahm_eeed@yahoo.com[3]

Abstract: - In 802.16 WiMAX networks, both persistent and dynamic resource allocation schemes have their own pitfalls. Hence designing an efficient resource allocation scheme becomes a crucial task. Considering the pit falls of both these resource allocation techniques, in this paper, we employ a hybrid resource allocation (HRA) and scheduling algorithm for WiMAX networks. Persistent allocation is used for UGS service based on delay and queue waiting time and dynamic allocation and scheduling is used for rtPS and nrtPS services, considering minimum bandwidth requirement and channel quality. Based on feedback information from SS, resource utilization level can be estimated and retransmission of lost frames can be scheduled. Simulation results show that the proposed hybrid technique yields 71% increase in capacity, 43% reduction in delay, 74% reduction in packet drop and 5% reduction in MAP overhead when compared to the persistent technique, when the number of user is increased. Similarly it yields 46% increase in capacity, 36% delay reduction, 59% packet drop reduction and 15% MAP overhead reduction when compared to the dynamic allocation technique.

Keywords:- WiMAX, Hybrid resource allocation, Persistent Resource Allocation with Adaptive Dropping (PRA-AD) algorithm, MAP overhead.

1. Introduction

IEEE 802.16 WiMAX is signified as a standard for accessing wireless broadband networks. It is thought up by Institute of Electrical and Electronics Engineers (IEEE) to satisfy various end users requirements. It exploits Orthogonal Frequency Division Multiple Access (OFDMA) with the spectrum ranges between 1.25 MHz and 28 MHz. It benefits both Time Division Duplexing (TDD) and Frequency Division Duplexing (FDD). Beam forming and Multiple Input Multiple Output (MIMO) are some of the sophisticated techniques used by WiMAX. Apart from this, it makes use of advanced coding techniques such as space-time coding and turbo coding.

WiMAX is extensively used in data, telecommunications (VoIP) and IPTV services (triple play). The bandwidth range of WiMAX makes available broadband connectivity through variety of devices to overall the world. WiMAX adds significant enhancements:

- It improves NLOS coverage by utilizing advanced antenna diversity schemes and hybrid automatic repeat request (HARQ).
- It adopts dense sub-channelization, thus increasing system gain and improving indoor penetration.
- It uses adaptive antenna system (AAS) and multiple input multiple output (MIMO) technologies to improve coverage.

- It introduces a downlink sub-channelization scheme, enabling better coverage and capacity trade-off. [1][2][4][7].

1.1 Need for Resource Allocation

An IEEE 802.16 wireless network is one of the standards for Broadband Wireless Access (BWA) in Metropolitan Area Networks (MANs). This 802.16 wireless networks can support various IP based high speed broadband wireless services such as streaming video, FTP, email, chatting, and so on. WiMAX is one of the recent broadband wireless communication technologies, which supports resources allocation services. To increase the coverage and throughput, relay stations were introduced. To deal with the eventually increasing of the more traffic to compete with the limited QoS ad been a huge challenge. To handle these increasing traffics, WiMAX supports adaptive modulation and coding, such that the distance between the subscriber station (SS) and the base station (BS) determine the type of QoS to be used for the video transmission. Allocating the resources for video transmission dynamically in wireless network is highly complex and non-linear. It becomes even more complex when the wireless network is designed for heterogeneous traffics with different quality of service (QoS) requirement like WiMAX network. [3][4][5][14].In downlink resource allocation, 802.16 WiMAX networks employ multiple closely spaced sub-carriers, which are grouped in sub-channels. These sub-carriers will form a sub-channel which need not be adjacent. In the downlink allocation, a sub-channel may be intended for different users depending on their channel conditions and data requirements. Then the destination node can allocate resources to user devices with lower Signal-to-Interference-and-Noise Ratio (SINR) per sub-channel with less resource to user devices with higher SINR. [13]. The key concerns on the resource allocation and scheduling for nrtPS traffic are the fulfillment of its minimum throughput requirement and improvement of resource utilization with acceptable delay. Efforts on improving resource utilization and reducing experienced delay are in general contradictory since high resource utilization can be achieved by assigning the resource to the subscriber stations (SSs) with good channel conditions, while leaving the SSs with poor channel conditions starved and experienced a long delay. Although nrtPS connections are delay-tolerant, they should not be starved for too long since otherwise the flows will suffer considerable performance degradation. Therefore, how to compromise the resource utilization and experienced delay of each SS is a challenging and important issue [12]. The resource management is crucial to guarantee the system performance of a wireless system [5].During the video transmission resources allocation is the important factor in the wireless networks, since the dynamic resource allocation, the allocation of the resources is dynamically changed as the channels change. During the transmission of these video frames, if any frames get lost or dropped, to retransmit these frames the network consume lot of power. The main aim of the resource allocator is the allocating the resources required for the video transmission i.e., number of slots, for each user in each WiMAX frame. It is difficult to achieve the maximum throughput in the WiMax networks since each transmission demands different quality of services and this is possible to achieve only through the resource allocator in the networks. We require this resource allocator in order to use the resources in an efficient manner [3][4][6] .

1.2 Problem Identification

Fixed or Persistent Resource Allocation scheme persistently allocates resource for a VoIP user over multiple frames, eliminating the need to reallocate the user in every frame. Thus, it results in considerable overhead reduction and makes more resources available in the frame. The PA scheme yields a large capacity gain compared to the conventional dynamic allocation (DA) scheme. However, this PA scheme is particularly designed for periodical packet arrival traffic and mainly focused on VoIP traffic. Further, when the inter arrival time is not periodic; its performance is drastically degraded. Second, the PA scheme is hard to adapt to the dynamically varying channel states, because it allocates the same modulation coding scheme (MCS) for a long period. Finally, one of the downsides of persistent allocation is the resource holes. This can be rooted by the changeover of user scenario from active to idle state and though the dropping mechanism drops the data packet in proactive manner, in rare cases, it may cause resource holes. [16]. this resource holes can be prevented using resource shifting mechanism. In this technique, initially the size and location of the holes is broadcasted. Based on the information, the remaining users are allocated with the resources accounting for the holes. This mobile WiMAX system allocates frequency–time resources on a per-frame basis. The information about resource allocation is delivered in map messages at the beginning of each frame. Therefore, the resource allocation can be changed frame by frame. Moreover, the amount of resources in each allocation can range from one slot to the entire frame. This highly dynamic resource allocation (DA) is particularly well suited for burst data traffic, even in rapidly varying channel conditions. However, the use of MAP messages results in large signaling overhead when data for many users are multiplexed in a frame, because the MAP messages should indicate the detailed information about resource allocation for all the multiplexed users, and the MAP message should robustly be encoded to ensure that all the mobile stations (MSs) in the system can decode them. [16].Both persistent and dynamic resource allocation schemes have their own upsides and downsides. Therefore, designing an efficient resource allocation scheme becomes a crucial task. In consideration of upsides in persistent and dynamic resource allocation mechanisms, in this paper, we employ a hybrid resource allocation and scheduling technique for WiMAX networks. To be exact, in this paper the persistent allocation technique is used for allocating periodic fixed size data such as VoIP traffic and the dynamic allocation is used for allocating non periodic traffic types. That is the hybrid resource allocation technique is modeled in such a way that persistent and dynamic allocation schemes are well-adjusted together to present an ideal resource allocation scheme.

2. Literature Review

Djamal-Eddine Meddour et al., [8] have proposed we propose a cross layer optimizer named XLO between scalable video streaming application and IEEE 802.16 MAC layer. The main objective is to allow video streaming applications to adapt its parameters according to 802.16 MAC layer conditions and resource availability. XLO uses the existing service flow management messages exchanged between a base station (BS) and a subscriber station (SS) and make them available to the video streaming application via a specific XLO interface. The authors have also introduced an enhanced admission control function at the BS that takes into account video adaptability property. The advantage of this approach is that it has effectiveness for better quality of services with the resources available. James She et al., [9] have proposed a MAC-layer Active Dropping (AD) scheme for achieving effective resource utilization and maintaining application-level quality of services in real-time video streaming over the emerging wireless broadband access networks based on time-division multiple accesses (TDMA). By proactively dropping the MAC-layer protocol data units (MPDUs) of a video frame that are unlikely to meet its application-layer delay bound, the proposed scheme releases the precious transmission resources to the subsequent frames or other competing service streams. The advantage of this approach is that it leads to more efficient resource utilization than that by the conventional prioritization-based cross-layer approaches which simply manipulate transmission and/or retransmission priority of each MPDU. Jia-Ming Liang et al., [10] have defined an energy-conserved uplink resource allocation (EURA) problem in 802.16j networks under the transparent mode, which asks how to arrange the uplink resource to 1) satisfy mobile stations (MSs) requests and 2) minimize their energy consumption. Objective 1 is necessary while objective 2 should be achieved when objective 1 is met. The above bi-objective problem is especially important when the network is non-saturated. The EURA problem is NP-hard and they proposed a heuristic with two key designs. First, they have exploit relay stations to allow more concurrent uplink transmissions to fully use the frame space. Second, they have reduced MS transmission powers by adjusting their rates and paths. The advantage of this approach is that it can save up to 80% of MS energy as compared with existing work. A.Nascimento et al., [11] have proposed a Dynamic Resource Allocation (DRA) strategy that can provide operators the flexibility to deliver broadband traffic with high spectral efficiency. The DRA unit constitutes a scheduler, Link Adaptation (LA), Resources Allocation (RA) and Hybrid Automated Repeat Request (HARQ) components inter-working seamlessly. The potential for the DRA to deliver QoS is achieved through service classification lists, where higher priority is given towards retransmitted packets, and subsequently to first-time transmitters with packet delay. The advantage of this approach is that DRA scheme has the capacity to provide enhanced coverage for NRTV (Near Real Time Video) services in wide area networks (WANs).Fen Hou et al., [12] have proposed an efficient yet simple design framework for achieving flexible resource allocation and packet scheduling for non-real-time polling service (nrtPS) traffic in IEEE 802.16 networks. By jointly considering the selective Automatic Repeat request mechanism at the media access control layer as well as the adaptive modulation and coding technique at the physical layer, this proposed framework enables a graceful tradeoff between resource utilization and packet delivery delay while maintaining the minimum throughput requirements of nrtPS applications. The advantage of this approach is that inter-service time, delivery delay, good put, and resource utilization, are investigated for performance evaluation.

3. Proposed Solution

3.1 Overview

In this paper, initially the resources which have to be allocated are analyzed through dynamic and simple flexible resource allocation approaches. For UGS (or) VoIP traffic requests the fixed or persistent allocation is used. Here, the timeslots are allocated for the frames based on the application-layer delay bound and queue waiting time. The data blocks of a frame which do not meet the application-layer delay bound can be proactively dropped. The resources allocated for these frames can be released and used for subsequent frames. For rtPs traffic, the dynamic allocation is used. For nrtPs traffic, the minimum bandwidth requirement and delay bound are analyzed. The number of users that can be served is decided based on the channel quality and delay bound. The number of slots to be allocated is then determined based on the minimum bandwidth. The users are categorized according to the traffic types. Here the traffic list in each queue is sorted in the descending order of the channel quality given by the SINR.

On receiving the DL sub-frame, each SS send the feedback information about the resource utilization level through selective ARQ to the base station following the UL sub- frame. Based on the feedback, the retransmission list is scheduled. Based on the resource utilization level, the flexible scheduling approaches reschedule the allocated slots for rtPS and nrtPS flows.

3.2 Hybrid Resource Allocation

Our technique describes the mechanism to utilize both persistent and dynamic resource allocation mutually. It consists of two algorithms Persistent Resource allocation with Adaptive Dropping (PRA-DA) algorithm and Dynamic Resource Allocation (DRA) algorithm. Then a Hybrid resource allocation (HRA) algorithm is used to adaptively switch between these two algorithms.

The persistent allocation technique is used for allocating periodic fixed size data such as VoIP traffic. The dynamic allocation is used for allocate non periodic traffic types.

Initially utilizing the persistent technique, the periodic data are allocated into downlink (Dl) sub-frame. Then the data blocks of a frame does not meet the delay (δ), they are proactively dropped using the dropping scheme given in section 3.3.1.The other non-periodic data are allocated using the dynamic allocation technique. Both the phases of resource allocation are described in the following sections.

3.2.1 Persistent Resource Allocation with Adaptive Dropping (PRA-AD)

This approach finds its application related to UGS or VoIP traffic requests. Initially BS is assigned with the scheduling cycle τ in order to allocate the resources to different traffic queues. When the data packet reaches the BS, initially it is stored in the cache and analyzed whether any data packets are already available in the queue. If data packet already exists in its cache, then the newly arrived data packet has to wait until they become first component in the transmission queue. The waiting time of the data packet in the queue $(T_{wait(i,t,j)})$ is defined using the following equation (1)

$$T_{wait(i,t,j)} = (j-i)*\tau + (n+1-(j-i))*T_{ist} + T_L(t(i,t,j) + T_u(i,t,j) \quad (1)$$

where

$(j-i)*\tau + (n+1-(j-i))$ = number of scheduling cycles experienced by frame i in the queue at time t.

τ = scheduling cycle

T_{ist} = inter-service waiting time for the frame.

T_L (t (i, t, j) = time utilized for transmission of data packet of previously cached frames in scheduling cycle j.

T_u (i, t, j) = total timeslots consumed for transmission (either success or failure) of data packets of frame i in the scheduling cycle j.

Otherwise, the new data packets arrived in BS are served and transmitted in the forthcoming schedule with fixed amount of Ts given by

$$q(i,t,j) = \delta - (T_{wait(i,t,j)}) \quad (2) \quad [9]$$

where t = universal time detected in the BS (Counting starts from zero)

j = current scheduling cycle index (starts from one)

δ = The maximum delay experienced by the application layer for a video frame.

For demonstrating the allocation of time slot, we take the following samples

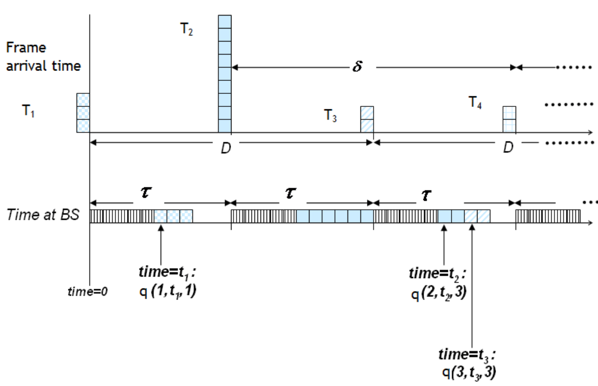


Figure 1: State of successful transmission of data packets of the requested traffic.

$$q(3, t_3, 3) = \delta \; T_{wait}(3, t_3, 3) = T_{wait}(2T_{ist} + 2)$$

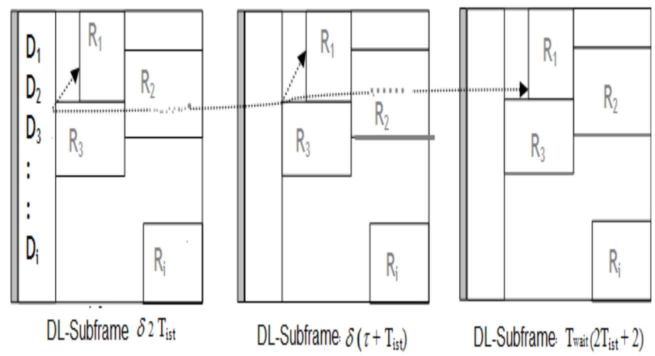


Figure 2: Persistent resource allocation scheme

Figure 2 demonstrates the downlink sub frame of persistent resource allocation scheme. Here D1, D2 …. Di represents the data elements and R1, R2…Rn represents the resources.

The base station assigns the time frequency resources in sub-frame (δ 2 T_{ist}) which is valid in subsequent sub-frames such as $\delta(\tau + T_{ist})$, $(T_{wait(2} \; T_{ist} + 2_{)})$ and so on. As the BS utilizes the single assignment for multiple frames, the overhead is reduced. The data blocks of a frame which do not meet the delay (δ) can be proactively dropped. The dropping scheme is illustrated in the PRA-AD algorithm.

3.2.1.1 PRA-AD Algorithm

Let z be the maximum bit streams in a frame tolerable to losses. Let Vi(t) be the data packet count of frame i at time t. Let Fth be the trust threshold

In prior to the transmission of data packet, the trust value (F) is estimated at time t.

$$F \rightarrow F\,(V_i(t), q\,(i, t, j))$$

Here the value of Vi(t) is initially set to $V_i^{\min}$ (t), which is the minimum quantity of data packet ($V_i^{\min}$ (t)) of frame i that need to be received by the receiver within δ.

$V_i^{\min}$ (t) = Vi * (100-z) %

The transmission of data packet is proceeded until F > Fth.

After each data packet transmission or retransmission, the q (i, t, j) is minimized by one at time t+1.

For each effective transmission or retransmission, Vi (t+1) is reduced by one data packet from Li (t) at time t.

Vi(t+1)=

$$\begin{cases} V_i(t)-1, & \textit{for effective delivery of data pakcet at } t \\ V_i(t), & \textit{otherwise} \end{cases}$$

If Vi(t) = zero

Then

Vi (t) is assigned the value of Vi (t) - $V_i^{\min}$ (t)

End if

This is performed to transmit more the data packets greater than $V_i^{\min}$ (t) for frame i, if permitted by the resources.

Without considering Vi(t).

If F >F_{th}

Then

The data packet is transmitted

Else

At once, BS drops the remaining data packets of frame i in the queue.

The resources allocated for these frames can be released and used for subsequent frames.

End if

Thus proposed dropping scheme drops the data packet of the delayed frame in a proactive manner and offers good chances of transmission.

3.2.2 Dynamic Resource Allocation (DRA)

The resource holes created by dropping scheme are allocated using DA. Apart from resource holes, there are some possibilities for changes in allocation period of PA. Here, the changes are reasoned by channel conditions. In general, lower MCS are used during poor channel conditions and higher MCS are used while channel condition is good. When channel condition drastically becomes poor, we need to make use of lower MCS and more slots are needed to be allocated. In this case, the slots are allocated using DA. This is so to prevent error packet reception. Further, the previous allocation is allocated to other requests using DA in order to lessen resource holes. When the channel condition is turn to be better, we are prerequisite to employ higher MCS and fewer slots are to be allocated. In this event, we are calculating the gain slots owing to channel improvement. If gain slots are greater than overhead that required for reallocation, then reallocation of packet is performed with higher MCS via DA. As a result, the reallocation utilizes the link adaptation and resource holes are lessened by allocating previous allocation to another user. Conversely, if gain slots are lesser or equal to the overhead that required for reallocation, then reallocation of packet is not performed. This category of resource allocation is utilized for rtPS traffic. The base station performs the time frequency resource assignments in frame n, n+T, n+2T.

Here T represents the time of allocation. The dynamic resource scheduling involves the allocation of resources of any location in the frame. This is demonstrated using the following figure 3.

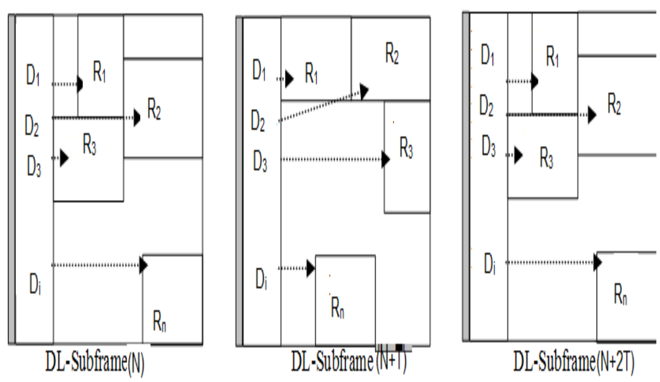


Figure 3: Dynamic resource Allocation.

3.2.2 .1 DRA Algorithm

Here D1, D2 …. Di represents the data elements and R1, R2…,Rn represents the resources.

Let Y be the number of users chosen at each frame.

Let BW be the bandwidth offered to sub-stations

Let σ_x be the signal to noise ratio interference ratio (channel condition)

1) Initially, for every frame, Y user with maximum channel condition (σ_x) are selected. Then the selected users are provided with the chance of transmission.

2) Each selected user is offered with the slots based on minimum BW needs of the nrtPS traffic and channel condition of entire users related to BS. The minimum bandwidth required for the traffic is maintained using the automatic repeat request and adaptive modulation and coding technique. This in turn satisfies the tradeoff between the delivery delay and the resource utilization.

3) **If** Y is set to 1

Then

Maximum resources are utilized with long delay and minimum σ_x

Else if Y = (Total_no_of_substations_ related_ to_ BS)

Then

Resource utilization and delay are to the minimum level.

End if

4) Each user upon receiving the downlink sub-frame transmits feedback information related to resource utilization level to BS following upper link sub-frame. This is performed utilizing selective Automatic Repeat request (ARQ) process. Based on the feedback information, BS schedules the re-transmission instead of immediate re-transmission using following condition shown in step 5

5) BS initially verifies the RC (Explained in Note).

If the users of RC are not allocated with the slots,

Then

Slots allocation is made pending

Residual transmission power DPres is estimated as

DPres = Pmax - DPtx (3)
where Pmax= maximum transmission power of BS and
DPtx = total data transmission power [11]
Retransmission catalog is assigned with slots based on modulation and code scheme (MCS) and transmission power.
For each selected user, the time slots are allocated based on the MCS as

$$i = \max_{i=MCS_{group}} [(\psi_i (1 - BER_i)] \quad (4)$$

where MCS_{group} = group of modulation and coding schemes,
ψ_i = throughput achieved and BER_i = block error rate

End if

For the dynamic allocation, the traffic catalog in each queue is sorted based on the channel quality indicated by the SINR (σ_x) in descending order. BS then selects the user with maximum σ_x.
The selected users are categorized according to the traffic types. For each user, the below mentioned catalogs are estimated.
Preliminary transmission catalog (PC): This is occupied by the user with Hybrid Automated Repeat Request (HARQ) process number 0 in idle manner. Also it contains the bits waiting in the queue to be transmitted by the BS.

Re-transmission catalog (RC): This is occupied by the user with (HARQ) process number 0 in active manner and awaiting retransmission process.

The DRA algorithm is demonstrated through the resource allocation mapping.

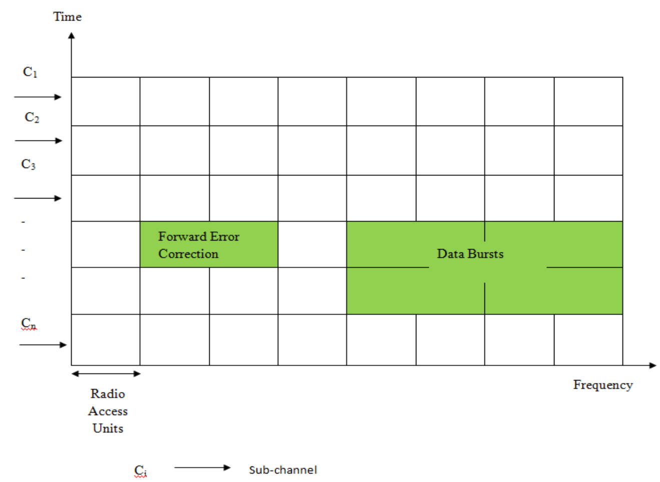


Figure 4: Resource Allocation Map.

Figure 4 demonstrates the resource allocation map. It is defined as a matrix of sub-channels per Orthogonal frequency-division multiplexing (OFDM) symbols. This map consists of forward error correction (FEC) block with one sub-channel and four OFDM symbols. i.e. one time slot is assigned to each coding symbols. The FEC block is defined using the radio access unit. A data burst contains a set of continuous radio access units mapped onto the resources space. For example, if OFDM symbols = 20 and Ci = 10, then Radio access units = 10*10=100 units per frame. These estimated units stores the data concerned with the user assignment and Modulation and Coding Scheme (MCS) used. Each time when the BS receives the data frame, the resource allocation map is updated. Then it broadcasts the information of updated map via existing channel. The user uses this information to perform packet transmission and demodulation with MCS methodology.

Then nrtPS packets are allocated by means of DA. Earlier to the beginning of DA allocation, resource holes and changes in PA are monitored. As we discussed in section- 3.3.1, resource holes can be recognized through broadcasted messages. By exploiting this information, resource holes in PA region are get allocated first and then remaining sub frames are allocated.

3.3 Hybrid Resource Allocation (HRA) Algorithm

Both the PRA-AD and DRA algorithms are adaptively used in the HRA algorithm which is given below:

1. Let REQ be the request for resource allocation

2. Consider $D_1, D_2, \ldots D_n$ be the data elements

3. Let PA be persistent allocation scheme and DA be dynamic allocation scheme

4. Let CC_i be the channel condition of link i, where i = 1,2…n and MCS be the modulation and coding scheme

5. Assume G (n) as the number of gain slots and $O_{head}(r)$ as the overhead *value required during reallocation*

6. REQ arrives for resource allocation

7. If (REQ = UGS || VoIP)

7.1 Data bursts are allocated as per PRA-AD algorithm into DL sub frames

8. Else if go to step- 15

9. At the end of PA allocation, DRA algorithm is triggered

10. DA scheme monitors the DL sub frame for resource holes and channel condition

11. If (CC_i = Poor) then

11.1 Lower MCS is used

11.2 More slots are allocated using DA

11.3 Previous allocation is shifted to other user through DA

12. Else if (CC_i = Good && $G(n) > O_{head}(r)$) then

12.1 Packet is reallocated and Higher MCS is used through DA

12.2 Previous allocation is shifted to other user through DA

13. Else if (CC_i = Good && $G(n) \leq O_{head}(r)$) then

Figure5: Pseudo Code for Proposed Work

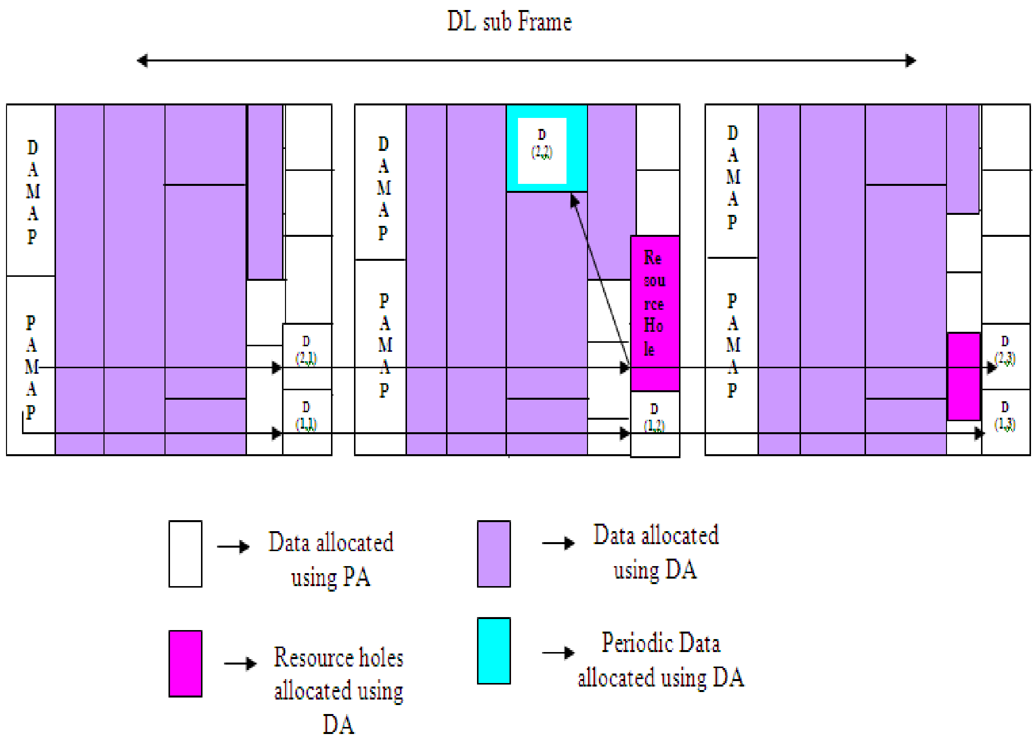
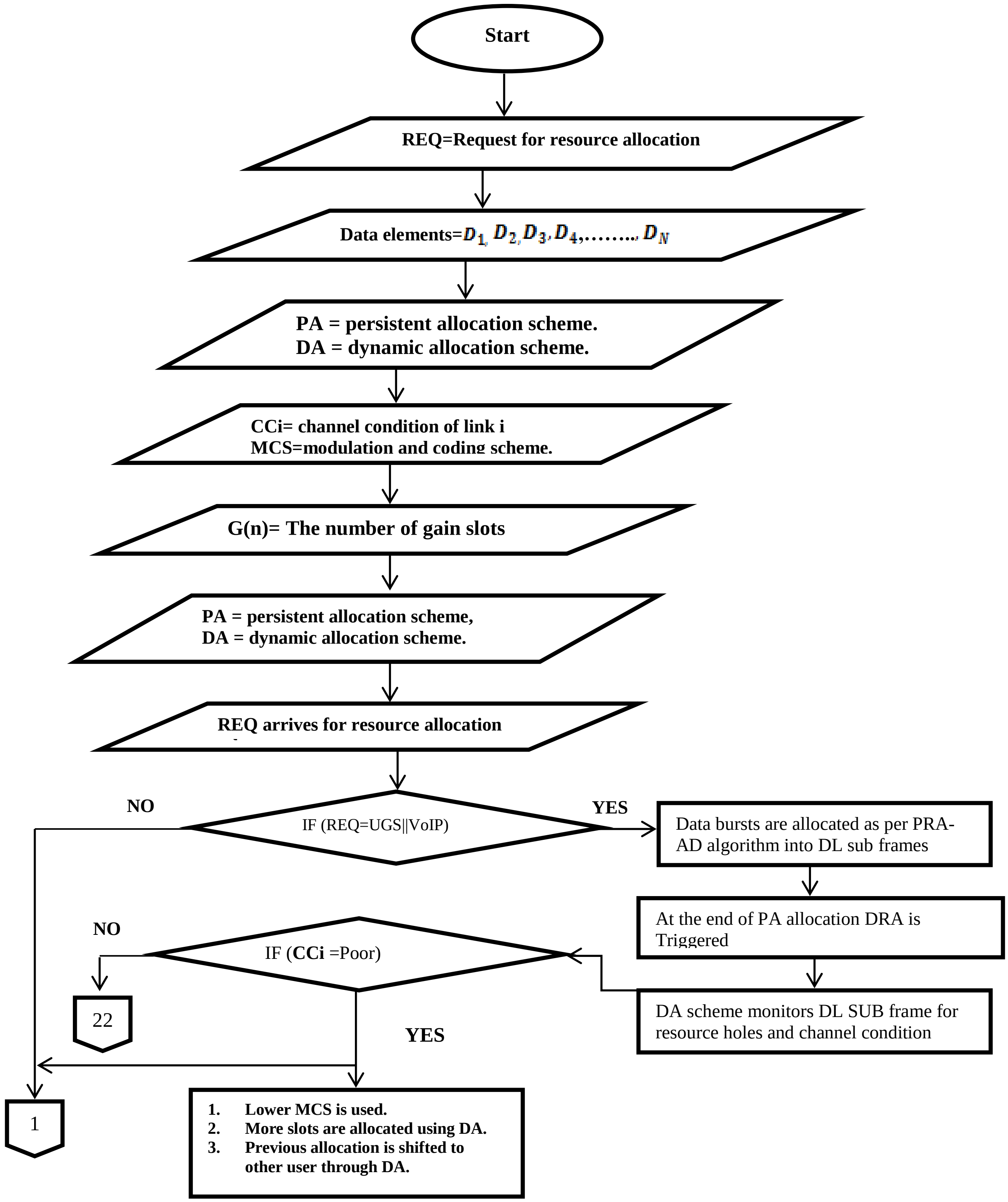


Figure-5 Hybrid Resource Allocation Algorithm

Figure 6: illustrates the above described technique.


Start
REQ=Request for resource allocation
Data elements=$D_1, D_2, D_3, D_4, ..., D_N$
PA = persistent allocation scheme.
DA = dynamic allocation scheme.
CCi= channel condition of link i
MCS=modulation and coding scheme.
G(n)= The number of gain slots
PA = persistent allocation scheme,
DA = dynamic allocation scheme.
REQ arrives for resource allocation
NO
IF (REQ=UGS||VoIP)
YES
Data bursts are allocated as per PRA-AD algorithm into DL sub frames
At the end of PA allocation DRA is Triggered
DA scheme monitors DL SUB frame for resource holes and channel condition
NO
IF (CCi =Poor)
22
YES
1
1. Lower MCS is used.
2. More slots are allocated using DA.
3. Previous allocation is shifted to other user through DA.

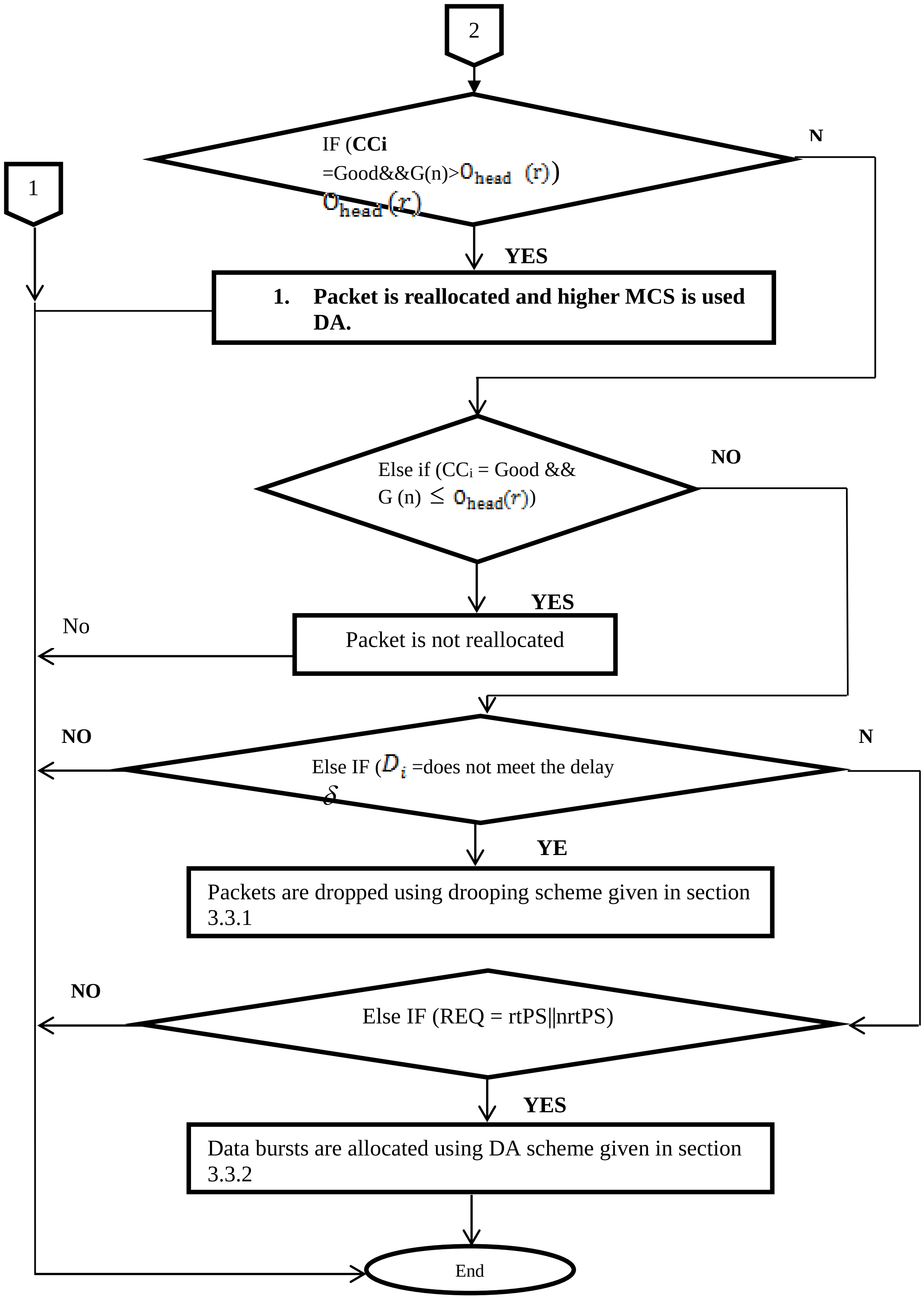


Figure 7: Flowchart of Our Propsed Work

4. Simulation Results

4.1. Simulation Model and Parameters

Network simulator (NS2) [15] is used evaluate performance of the proposed Hybrid Resource Allocation and scheduling technique. The proposed scheme is implemented over IEEE 802.16 MAC protocol. In the simulation, clients (SS) and the base station (BS) are deployed in a 1000 meter x 1000 meter region for 50 seconds simulation time. All nodes have the same transmission range of 500 meters. In the simulation, for UGS traffic, VoIP is used. For rtPS and nrtPS flows we use Video and CBR traffic flows. There are 8 downlink flows from BS to SS.

The simulation settings and parameters are summarized in table 2.

Table1. Simulation Settings

Area Size	1000 X 1000
Mac	802.16
Clients	10
Radio Range	500m
Simulation Time	50 sec
Routing Protocol	DSDV
Traffic Source	VoIP, CBR and Video
Physical Layer	OFDMA
Channel Error Rate	0.01
Packet Size	1500 bytes
Frame Duration	0.005
Users	10,15,20,25 and 30
No. of Flows	8

4.2 Performance Metrics

We compare our proposed Hybrid Resource allocation (HRA) technique with scheme with the existing Dynamic and Persistent techniques. We mainly evaluate the performance according to the following metrics: packet drop, MAP overhead, capacity improvement and packet delivery ratio. The parameters are extracted from the trace file. The performance results are presented in the next section.

4.3 Results

4.3.1 Based on Users

The performance of the 3 techniques are evaluated by varying the number of users from 10 to 30. Figures 8 to 11 show the results of capacity, delay, packet drop and MAP overhead of the 3 algorithms.

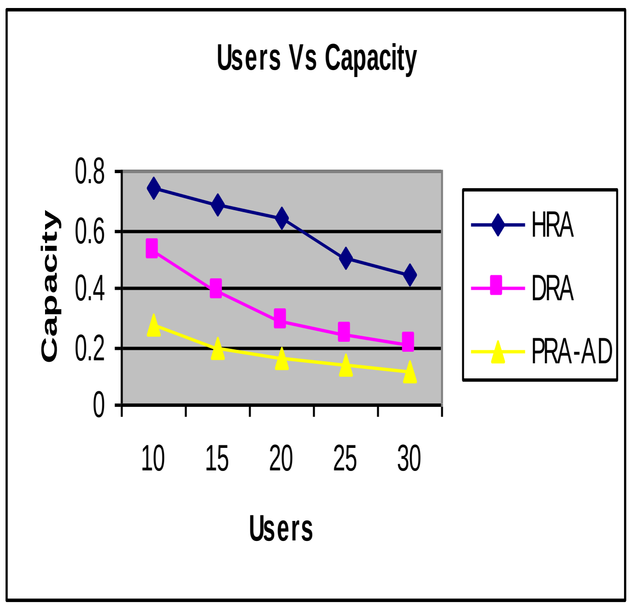


Figure 8: No. of Users Vs Capacity

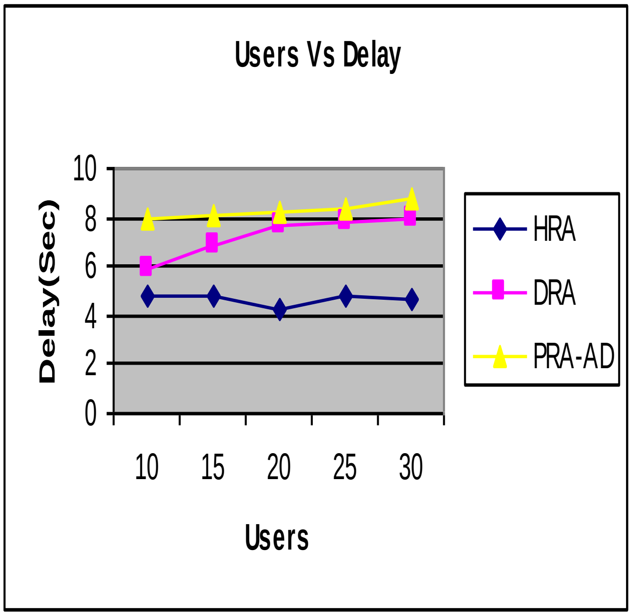


Figure 9: No. of Users Vs Delay.

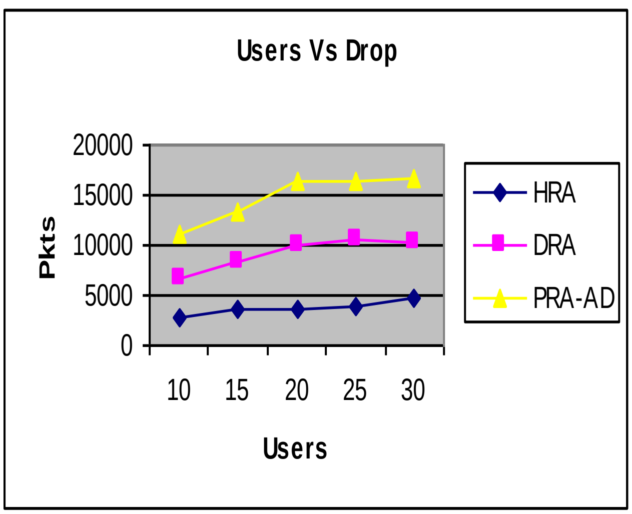


Figure 10: No. of Users Vs Packet Drop.

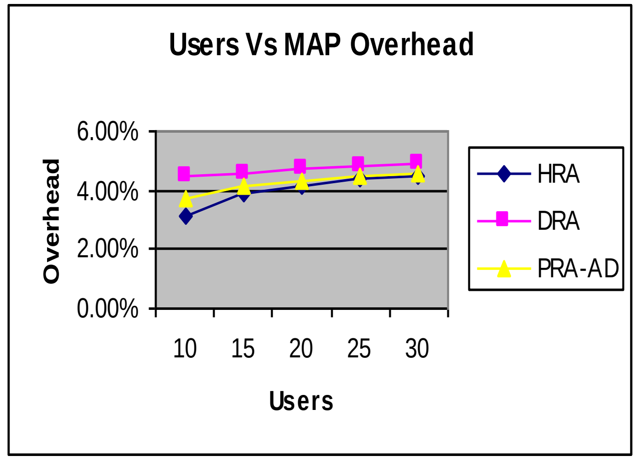


Figure 11: No. of Users Vs MAP overhead

The measured capacity for the 3 algorithms by varying the users is given in figure 6. It can be seen that PRA-AD has the lowest capacity compared to DRA and HRA, since it has the worst delay and drops. The capacity of Hybrid technique is 71% more than PRA-AD and 46% more than DRA as it can allocate more users by the use of adaptive dropping.

Figure 7 shows that the delay obtained for PRA-AD is more followed by DRA. As per figure 7, the delay reduction for HRA is 43% and 34% when compared to PRA-AD and DRA algorithms, respectively, since it drops the frames which do not meet the delay criteria in PRA-AD algorithm.

HRA algorithm reduces the packet drop 74% lesser than the PRA-AD algorithm and 59% lesser than the DRA algorithm, as depicted in figure 8. This due to the fact, that the channel quality and resource utilization are taken into account by the feedback from the DL sub frames.

As denoted in figure 9, the MAP overhead is naturally high for DRA when compared to PRA-AD and HRA. The MAP overhead is reduction for

HRA algorithm compared to PRA-AD is 5.8% whereas it is 15% when compared to DRA.

5. Conclusion

In this paper, we have proposed a hybrid resource allocation for video transmission over 802.16 wireless networks. Initially, the resources allocation strategies are applied based on the traffic types. A fixed or persistent allocation technique is used for Unsolicited Grant Service (UGS) or Voice over Internet protocol (VoIP) traffic based on delay and waiting time of the queue. The data blocks of a frame which do not meet the delay are proactively dropped. A dynamic allocation technique is used for Real-Time Polling Service (rtPS) traffic. Here the traffic list in each queue is sorted in the descending order of the channel quality given by the signal to noise ratio. For Non-Real Time Polling Service (nrtPS) traffic, the resource allocation is decided based on bandwidth.

Simulation results it has been shown that the proposed hybrid technique yields 71% increase in capacity, 43% reduction in delay, 74% reduction in packet drop and 5% reduction in MAP overhead when compared to the persistent technique, when the number of user is increased. Similarly it yields 46% increase in capacity, 36% delay reduction, 59% packet drop reduction and 15% MAP overhead reduction when compared to the dynamic allocation technique.

References

[1] Mohammed Sabri Arhaif, “Comparative Study of Scheduling Algorithms in WiMAX”, International Journal of Scientific & Engineering Research, Volume 2, Issue 2, February-2011.

[2] Chakchai So-In, Raj Jain and Abdel-Karim Tamimi, “Scheduling in IEEE 802.16e Mobile WiMAX Networks: Key Issues and a Survey”, IEEE JOURNAL ON SELECTED AREAS IN COMMUNICATIONS, VOL. 27, NO. 2, FEBRUARY 2009.

[3] D. S. Shu’aibu, S. K. Syed Yusof and N. Fisal, “Dynamic resource allocation in mobile WiMAX using particle swarm optimization techniques”, International Journal of the Physical Sciences Vol. 6(5), pp. 1009-1014, 4 March, 2011.

[4] So-In, Chakchai, Raj Jain, and Abdel Karim Al-Tamimi. “Resource Allocation in IEEE 802.16 Mobile WiMAX.” (2010).

[5] Hua, Yao, Qian Zhang, and Zhisheng Niu. “Resource allocation in multi-cell OFDMA-based relay networks.” INFOCOM, 2010 Proceedings IEEE. IEEE, 2010.

[6] So-In, Chakchai, Raj Jain, and Abdel-Karim Al Tamimi, “Generalized weighted fairness and its application for resource allocation in ieee 802.16 e mobile wimax.” Computer and Automation Engineering (ICCAE), 2010 The 2nd International Conference on. Vol. 1. IEEE, 2010.

[7] Rakesh, Jha, A. Wankhede Vishal, and Upena Dalal. “A Survey of Mobile WiMAX IEEE 802.16 m Standard.” International Journal of Computer Science, Vol. 8, No. 1, April 2010.

[8] Meddour,DjamalEddine,AlaeddineAbdallah, ToufikAhmed and RaoufBoutaba, “A cross layer architecture for multicast and unicast video transmission in mobile broadband networks.” Elsevier, Journal of Network and Computer Applications (2011).

[9] James She, Fen Hou, Basem Shihada and Pin-Han Ho, “MAC-Layer Active Dropping for Real-time Video Streaming in IEEE 802.16

Networks.", GESJ: Computer Science and Telecommunications 2 (2011): 31.
[10] Liang, Jia-Ming, You-Chiun Wang, Jen-Jee Chen, Jui-Hsiang Liu and Yu-Chee Tseng, "Efficient resource allocation for energy conservation in uplink transmissions of IEEE 802.16 j transparent relay networks." Proceedings of the 13th ACM international conference on Modeling, analysis, and simulation of wireless and mobile systems. ACM, 2010.
[11] Nascimento, Alberto, and Jonathan Rodriguez."Dynamic resource allocation for IEEE802. 16e.", Springer, Mobile Lightweight Wireless Systems (2009): 147-159.
[12] Hou, Fen, James She, Pin-Han Ho and Xuemin (Sherman) Shen "A flexible resource allocation and scheduling framework for non-real-time polling service in IEEE 802.16 networks." Wireless Communications, IEEE Transactions on 8.2 (2009): 766-775.
[13] Wang, Hua, and Lars Dittmann. "Adaptive radio resource allocation in hierarchical QoS scheduling for IEEE 802.16 systems." Global Telecommunications Conference, 2007. GLOBECOM'07. IEEE. IEEE, 2007.
[14] Aggelos K. Katsaggelos, Yiftach Eisenberg, Fan Zhai, Randall Berry and Thrasyvoulos N. Pappas, "Advances in efficient resource allocation for packet-based real-time video transmission." Proceedings of the IEEE 93.1 (2005): 135-147.
[Network Simulator: http:///www.isi.edu/nsnam/ns.
[16] Young Ik Seo, and Dan Keun Sung, "Virtually Dedicated Resource Allocation for VoIP Traffic in the Downlink Mobile WiMAX System with Hybrid ARQ", IEEE Transactions on Vehicular Technology, Vol- 60, No- 2, 2011.

Authors Profile

Mohamed Ahmed Alamein: received BE in computer science and engineering from Tripoli university in 1999 Tripoli Libya, M.tech 2009 from JAMIA HAMDARD and recently is Ph.D. Department of Computer Science and Engineering Samhigginbottom Institute of Agriculture, Technology and Science, Allahabad The area of interest is wireless network.

Ahmed M Husein Shabani: Bachelor of Science in Electronics & Communication Engineering, Engineering Academy Tajoura, Tajoura, Libya, Master in Electronics & Communication Engineering with gold medal from Jaypee Institute of information Technology (JIIT), Noida, India and, Ph.D. in March 2014 from Electronics & Communication Engineering Faculty of Engineering & Technology, Jamia Millia Islamia, New Delhi, India. The area of interest is Information Security (Cryptography), Network security, Networking, wireless Broadband (Wi-Max), Telecommunication.

Wilson Jeberson: Head & Associate Professor Department of Computer Science and Engineering Samhigginbottom Institute of Agriculture, Technology and Science, Allahabad.