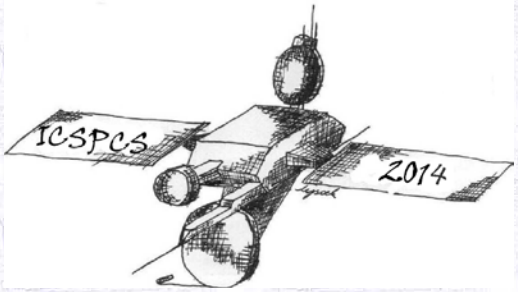

8th International Conference on Signal Processing and Communication Systems

15 - 17 December 2014, Gold Coast, Australia

University of Nebraska's The Peter Kiewit Institute

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Welcome Message from the General Chairman

The 8th International Conference on Signal Processing and Communication Systems ICSPCS 2014 is held in the resort town of Gold Coast, Queensland, Australia. On behalf of the Organizing Committee, it is my pleasure to welcome you to the ICSPCS'2014. Similar to its predecessor editions, ICSPCS'2014 provides a friendly technical and professional environment for ultimate networking among researchers in the field of signal processing and wireless communications. The roots of ICSPCS go back to a series of successful symposia and workshops, namely, the International Symposia on DSP and Communication Systems (DSPCS), and Workshops on the Internet, Telecommunications and Signal Processing (WITSP). Accordingly, the topics covered by ICSPCS stretch over the entire protocol stack of modern telecommunication systems from the physical and data link layers to networking and application layers along with the related processing, applications, and services. I am happy to announce that the Organizing Committee has been successful in achieving an official technical co-sponsorship of the IEEE Communications Society for the conference and we are happy that ICSPCS'2014 has been listed in the IEEE database of conferences and the proceedings will be published in IEEE Xplore.

This year, a total of 282 papers were submitted from 26 countries from Asia, Australia, Europe, Middle East, Africa, and Americas. After a rigorous and peer review process based on full-paper submission with at least three peer reviews per paper, the program committee finally accepted 49 papers for oral presentation and 39 papers for poster presentation at the conference. The mode of presentation of the accepted papers have been decided based on the suitability of the contents to be presented in that mode and it does not reflect the quality of papers. The technical program for this year covers a range of topics such as wireless communications, communications theory, communication systems, networks and protocols, information and network security, localization and tracking, signal processing for multimedia and communications, and medical applications. The program will be complemented by a keynote lecture "Modeling Molecular Communications at NANO-SCALE with Applications in Medicine and Microbiology" that will be delivered by Prof. Tadeusz A Wysocki of the University of Nebraska - Lincoln.

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Putting together and organizing an international conference is always a team effort. Therefore, we wish to thank the authors for preparing and submitting their contributions to ICSPCS'2014. We would like to offer our sincere thank to the technical program committee and reviewers for their hard work to ensure a high quality program on a timely manner. We express our sincere gratitude to our sponsors for their great support: IEEE, IEEE Communications Society, and The Peter Kiewit Institute.

We hope that like previous years, ICSPCS'2014 brings together researchers and scientists from academia and industry in areas of signal processing and communication systems to present their latest research results, exchange new ideas, and create new collaborations. We wish you all a pleasant and enjoyable stay at the beautiful Gold Coast, Australia!

Abbas Jamalipour

General Chair, ICSPCS'2014

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- ***Adaptive Transmission Schemes for Free-Space Optical Channel*** Mohmed Salah (UniSA, Australia), William G Cowley (University of South Australia, Australia) and Khoa D. Nguyen (University of South Australia, Australia)
- ***A New Space Time Coding Scheme for the Multiple Input Single Output Wiretap Channel*** Sylvie Perreau (University of South Australia, Australia)
- ***Iterative Based Time Domain Equalization Method for OFDM Signal under High Mobile Environments*** Pongsathorn Reangsuntea (Mie University, Japan), Pisit Boonsrimuang (King Moungkut's Institute of Technology Ladkrabang, Thailand), Kazuo Mori (Mie University, Japan) and Hideo Kobayashi (Mie University, Japan)
- ***Analysis of Beam Pattern and Spatial Capacity of Massive Antenna Array Networks with Non-Uniform User Distribution*** Zhiyu Zhang (Nanyang Technological University, Singapore), Kah Chan Teh (Nanyang Technological University, Singapore) and Kwok Hung Li (Nanyang Technological University, Singapore)
- ***On Biased Projection Method*** Norisato Suga (Tokyo University of Science, Japan) and Toshihiro Furukawa (Tokyo University of Science, Japan)

Session 8 – Wireless Communications - 2

Wednesday - 11:00 AM - 12:40 PM

- ***Modified GroupCast Retries Block Acknowledgement Scheme in IEEE 802.11aa standard-based for Multimedia Applications*** Muhammad Afzal (Yeungnam University, Korea), Byung-Seo Kim (Hongik University, Korea) and Sung Won Kim (Yeungnam University, Korea)
- ***L1 Norm Minimization approach to MIMO detector*** Yo Hashimoto (Tokyo University of Science, Japan), Katsumi Konishi (Kogakuin University, Japan), Tomohiro Takahashi (Tokyo University of Science, Japan), Kazunori Uruma (Tokyo University of Science, Japan) and Toshihiro Furukawa (Tokyo University of Science, Japan)
- ***MIMO Enhanced Slotted Cooperation in Urban Vehicular Networks*** Ovitigalage Perera (Queensland University of Technology, Australia) and Dhammika Jayalath (Queensland University of Technology, Australia)
- ***Resource allocation in OFDM-based cognitive radio networks with multiple AF relays*** Shashika Biyanwilage (University of Western Sydney, Australia), Upul Gunawardana (University of Western Sydney, Australia) and Ranjith Liyanapathirana (University of Western Sydney, Australia)
- ***Enhanced Multi User Detection Technique of Overloaded MIMO Systems Using Network Coding Based HARQ*** Amna Qayyum (National University of Sciences & Technology & Military College of Signals, Pakistan), Adnan Ahmed Khan (National University of Sciences and Technology, Pakistan) and Khawaja Tauseef Tasneem (Iqra University, Islamabad & University of Canterbury, Pakistan)

Session 9 – Signal Processing for Communications - 3

Wednesday - 1:30 PM - 3:10 PM

- ***Protection of Primary Users in Areas Where Cognitive Radio is Deployed*** Andrew J Kerans (James Cook University, Australia) and Janina Mazierska (James Cook University, Australia)
- ***An Iterative FFT Approach to Tomlinson-Harashima Precoding*** Ismail Mohamed (The University of Queensland, Australia) and Vaughan Clarkson (The University of Queensland, Australia)
- ***Dynamic, Data-Driven Spectrum Management in Cognitive Small Cell Networks*** Chang-Shen Lee (National Chiao Tung University, Taiwan), Wei-Chong Chen (National Chiao Tung University, Taiwan), Shuvra Bhattacharyya (University of Maryland, USA) and Ta-Sung Lee (National Chiao Tung University, Taiwan)
- ***Interference Minimization Based Power Allocation for Cognitive Radio Networks Operating in TV White Spaces*** Shashika Biyanwilage (University of Western Sydney, Australia), Upul Gunawardana (University of Western Sydney, Australia) and Ranjith Liyanapathirana (University of Western Sydney, Australia)
- ***Adaptive Channels' Selection for Hierarchical Cluster Based Cognitive Radio Networks*** Pawel Skokowski (Military University of Technology, Poland), Krzysztof Malon (Military University of Technology, Poland), Jan Kelner (Military University of Technology, Poland), Jerzy Dolowski (Military University of Technology, Poland), Jerzy Lopatka (Military University of Technology, Poland) and Piotr Gajewski (Warsaw Military University, Poland)

Session 10 – Wireless Communications - 3

3:30 PM - 5:10 PM

- ***Maximisation of Sum Rate in Cognitive Multi-cell Wireless Networks with QoS Constraints*** Enlong Che (University of Technology, Sydney, Australia), Hoang D. Tuan (University of Technology, Sydney, Australia), Tam Ho (University of Technology, Sydney, Australia) and Ha Nguyen (University of Saskatchewan, Canada)
- ***Performance Evaluation of an Adaptive Semi-Persistent LTE Packet Scheduler for M2M Communications*** Nusrat Afrin (University of Newcastle, Australia), Jason Brown (University of Newcastle, Australia) and Jamil Y Khan (The University of Newcastle, Australia)
- ***Empirical Vehicle-to-Vehicle Pathloss Modeling in Highway, Suburban and Urban Environments at 5.8 GHz*** Okechukwu J Onubogu (Queensland University of Technology, Australia), Karla Ziri-Castro (QUT, Australia), Dhammika Jayalath (Queensland University of Technology, Australia), Keyvan Ansari (Queensland University of Technology, Australia) and Hajime Suzuki (CSIRO, Australia)
- ***Outage Performance of Opportunistically Placed Low-powered Base Stations in Heterogeneous Cellular Networks*** Aroba Khan (University of Sydney, Australia) and Abbas Jamalipour (University of Sydney, Australia)
- ***Outlier-Aware Spectrum Sensing in Cognitive Radio Networks*** Gaurav Kapur (IIT Kanpur, India) and Ketan Rajawat (Indian Institute of Technology Kanpur, India)

Modified GroupCast Retries Block Acknowledgement Scheme in IEEE 802.11aa standard-based for Multimedia Applications

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***Abstract*— Multicast is a more efficient method of supporting group communication than unicast, as it allows transmission to multiple destinations using fewer network resources. The demands for video multicast have been increasing rapidly with the improvements in multimedia technologies. Therefore, the reliable delivery of video frames is an important task. Recently, IEEE 802.11aa standard defined new features for the reliable multicast. However, there are still a few limitations. Therefore, in this paper, we propose a modified block acknowledgment scheme for video streaming to overcome the scalability limitation of the block acknowledgment scheme in IEEE 802.11aa standard. Simulation results show that our modified block acknowledgement scheme performs well in terms of reliability and peak signal to noise ratio.**

Keywords—reliability; 802.11aa; Block ACK; MPEG-4;

I. INTRODUCTION

Video streaming service via multicast is a promising technology for multimedia services over wireless local area networks (WLANs) [1]. The video multicast frames need to be reliably delivered to all stations in the multicast group. The legacy system based on IEEE 802.11 standard [2] is known to support only unreliable multicast service due to lack of retransmission of lost packets. In IEEE 802.11e standard [3], enhanced distributed coordination access (EDCA) offers differentiation and prioritization among four different types of traffics classes. IEEE 802.11aa standard [4] extended the existing EDCA prioritized mechanism of IEEE 802.11e standard. In 802.11aa, two additional queues are added within the existing EDCA access categories in order to provide prioritization within both audio and video streams [5]. The main features of medium access control (MAC) in IEEE 802.11aa standard are stream classification service (SCS) and groupcast with retries (GCR) service. In this paper, we focus on GCR service. The detailed overview of GCR scheme is provided in section II.

In a carrier sense multiple access with collision avoidance (CSMA/CA)-based scheme, overheads in MAC and physical (PHY) layer are the main reason for system inefficiency [6]. To lessen the overhead, a block acknowledgement (BA) scheme has been proposed in IEEE 802.11e [7] standard. In GCR-BA scheme, a group of packets destined to the same receivers are allowed to be transmitted without being acknowledged individually. After the transmission of block, the sender initiates a block acknowledgement request (BAR) packet to ensure the number of packets that have been received successfully. Receivers then respond with a BA packet. The efficiency of the BA scheme comes from the fact that the overhead is greatly reduced, because distributed inter-frame space (DIFS) and backoff times only occur before the first packet of the block and only one acknowledgement (ACK) packet is used for all the packets in a block.

Most research efforts on multicasting in IEEE 802.11 standard-based WLANs have focused on improving transmission reliability by incorporating automatic repeat request (ARQ) into protocol architecture. Kuri et al. [8] proposed a leader-based protocol (LBP) for WLANs. This protocol chooses one of the multicast receivers for the exchange of ready-to-send (RTS), clear-to-send (CTS), and ACK packets. However, LBP does not consider the numerous parameters associated with video compression techniques, such as frame types and frame size. Choi et al [9] extend their leader-based multicast service (LBMS) using the new network management messages in the IEEE 802.11v standard. However, they focus on the usage of the management message, not directed multicast service (DMS). Santos *et al.* [10] evaluate DMS and GCR in the heterogeneous traffic environment where video multicast and unicast data traffic coexist. However, the video quality achieved by these schemes is indirectly evaluated. They measure only the multicast throughput, the multicast delay, and the coexisting unicast throughput.

Tang and McKinley [11] showed that packet loss is exacerbated when more receivers start sending feedback packets. Moreover, multicast feedback causes more data packet loss than unicast. Their results indicate that the loss density, which directly affects the amount of feedback from receivers, has a significant impact on the performance of reliable multicast protocol in WLANs [14]. Y. shin et al. [1] present various reliable multicast schemes, including application layer forward error correction (FEC), reliable multicast protocol in the emerging IEEE 802.11v [12], and 802.11aa [4] standards, and evaluate those via simulations. Simulation results confirm that GCR with BA achieves high reliability when there are a small number of multicast receivers. However, as the number of receivers increase, the feedback increases because of ACK packet from each

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receiver, and eventually the average peak signal-to-noise ratio (P S N R)

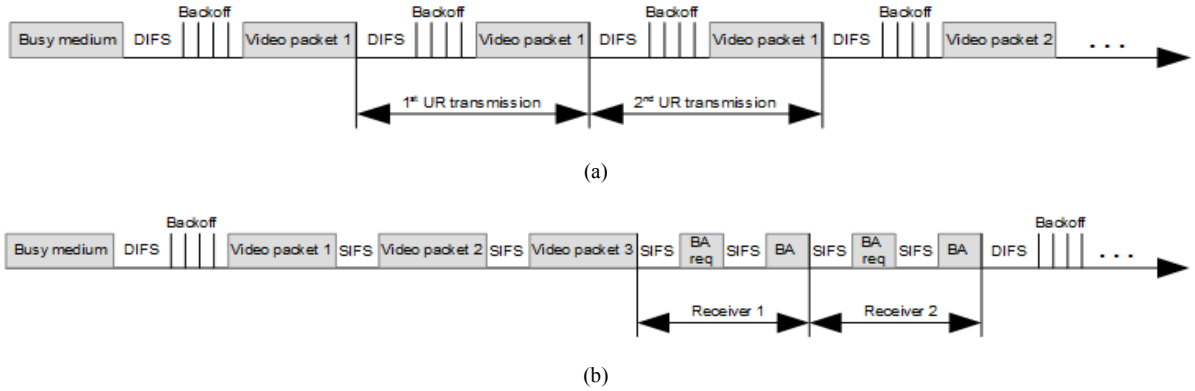


Fig. 1. Operation example of (a) GCR Unsolicited Retry, (b) Block ACK.

decreases. Therefore, in this paper, we propose a modified GCR-BA scheme of 802.11aa standard for multimedia traffic to overcome the scalability limitation of GCR-BA scheme and to limit the control overhead. Considering the significance of different frames as shown in [13], there is no control packet for P- and B-frames in our proposed BA scheme.

The rest of the paper is structured as follows. Section II discusses the GCR mechanism in detail. Section III presents the proposed protocol in detail. Section IV discusses the performance analysis, and finally, Section V concludes the paper.

II. GroupCast with Retries Services (GCR)

Multicast transmissions over 802.11 standard-based WLANs still have inefficiencies such as the unreliability caused by the lack of ACK packets. In order to provide a robust and reliable multicast audio/video streaming, 802.11aa standard specifies different schemes for reliable multicast transmission, namely: GCR unsolicited retry (GCR-UR), and GCR block ACK (GCR-BA) [5]. However, the standard does not give any insight into the performance of each mechanism.

A. GCR Unsolicited Retry

In GCR-UR mechanism, multicast frames are transmitted several times without waiting for any ACK packet after each transmission. The number of retry should be limited to a threshold fixed by the transmitter. Retry threshold depends on the applications requirements. Although this mechanism improves the reliability by increasing the delivery probability, it leads to increasing the overhead when the number of retry is large, and becomes meaningless when the channel quality between transmitter and receivers is good. Fig. 1a represents an operational example of GCR-UR scheme.

B. GCR Block ACK

This mechanism is considered as extension of the BA scheme defined in IEEE 802.11v and IEEE 802.11n standards. In this scheme, sender transmits a BAR packet to all multicast members. The receiver station sends an ACK packet only when it is requested by a BAR packet. Therefore, this mechanism offers the best reliability than other ACK policies. Fig. 1b shows an example scenario of the GCR-BA operation.

III. Proposed Protocol

Moving Picture Expert Group 2 (MPEG-4) and H.264 are widely used standards for video compression and contain intra-coded (I-frames), predicted (P-frames) and bidirectional frames (B-frames) [14]. I-frames are the most important for reconstructing video as they contain the most visual data. They are particularly significant because they prevent the propagation of errors from previously damaged or incorrectly predicted frames in subsequent frames. An MPEG-4 file constructed of I-frames alone would have excellent video quality, but would also have poor compression. The loss of a P- and B-frames do not have as great an effect on the final video quality compared to the loss of an I-frame during transmission. The I-frame is used as a reference frame to start the new group of picture (GOP). The transmission timeline of packets belonging to I-frame of GCR-BA scheme and our proposed protocol is shown in Fig. 2. In Fig. 2, packet 1, packet 2, and packet 3 belong to one I-frame. Since the loss of an I-frame has the worst impact on the performance of video quality compared to the loss of P- and B-frames. Therefore, each receiver transmits the BA if the packet belongs to I-frame.

In Fig. 2, the I-packet 2 is corrupted because of channel error. In case of collision a whole block will be retransmitted. The transmission time line of packets belonging to P- and B-frames of BA and proposed protocol is shown in Fig. 3(a), and 3(b), respectively. If the packet belongs to the P-and B-frame, there is no BAR and no BA. This will help to minimize the control overhead and hence increase the scalability of GCR-BA scheme.

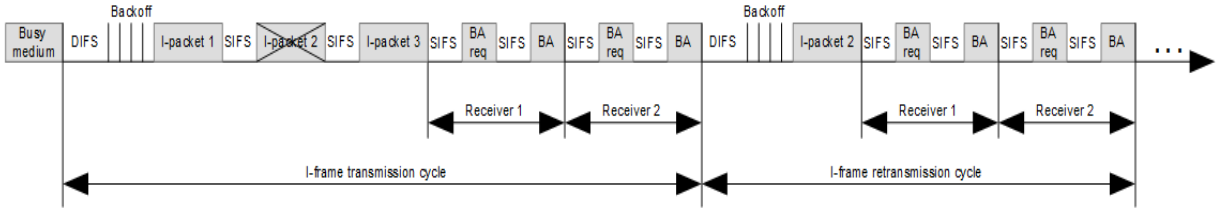
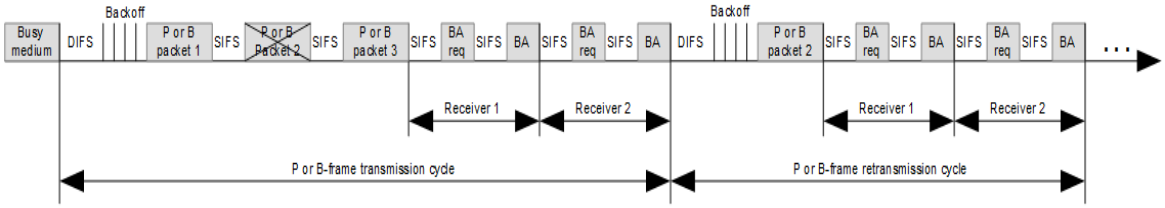
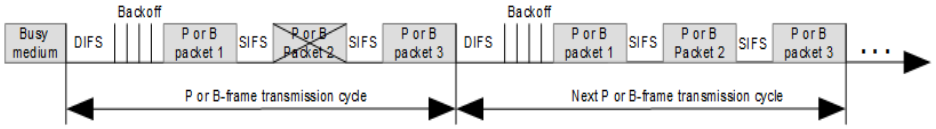


Fig. 2. Transmission timeline of packets belonging to I-frame of GCR Block ACK and proposed protocol.



(a)



(b)

Fig. 3. (a) Transmission timeline of packets belonging to P- and B-frame of GCR Block ACK scheme, (b) Transmission timeline of packets belonging to P- and B-frame of proposed protocol.

IV. Performance Evaluation

We comparatively evaluate the reliable multicast schemes using a network simulator (NS-2) version 2.35 [15], and video framework Evalvid [16]. Evalvid is a complete framework and tool-set for evaluating the quality of video transmitted over real or simulated communication networks. We assess the performance of the following schemes: legacy 802.11 multicast, GCR-UR, GCR-BA and our modified GCR-BA scheme. We consider different number of retries (1, 2, and 3) for GCR-UR. We assume that stations experience identical channel conditions, and they suffer from the same channel error probability. In simulation, the source reads the compressed video file from the video encoder, then fragments the large video frames into smaller segments, and transmits over simulated wireless networks. The maximum transmitting packet size is 1000 bytes. Simulation parameters are described in Table. 1. We measure the reliability and PSNR. The reliability is defined as the number of successfully received frames divided by the number of frames transmitted. To measure the video quality on multicast receivers, the PSNR is calculated. PSNR is one of the most widespread objective metrics used to assess application-level QoS of video transmissions. This objective method is described by the International Telecommunication Union in the following equation [16]

$$PSNR(n)_{db} = 20\ log_{10}\left\{\frac{V_{peak}}{\sqrt{MSE(n)}}\right\}, \quad (1)$$

where $V_{peak} = 2^k - 1$ is the maximum possible pixel value of the image where k is the number of bits per pixel. For example, when a pixel is represented by 8 bits per sample, V_{peak} is 255.

Mean square error (MSE) is an estimate of error variance, and the value of MSE is given as

$$MSE(n) = \frac{\sum_{i=1}^{N_{col}} \sum_{j=1}^{N_{row}} [Y_S(n,i,j) - Y_D(n,i,j)]^2}{N_{col} N_{row}}, \quad (2)$$

where N_{col} and N_{row} are the total number of columns and rows in the input images, i and j are the current column and row positions, n is the current frame number, Y_s and Y_D are the luminous component of the source and destination image, respectively, as defined by Ke et al. [16].

TABLE I. SIMULATION PARAMETERS

Parameter	Value
CW_{min}	16
Cw_{max}	1024
GOP Pattern	IBBPBBPBB
Frame rate	30 fps
Transmission rate (Mbps)	6 Mbps
Video sequence	*Carphone*
Traffic Type	MPEG-4

Fig. 4 shows the reliability versus the channel error probability when the number of nodes is 20. As shown in the figure, the reliability of all schemes decreases as the channel error probability increases. When the channel error probability is less, GCR-BA scheme performs well because there is retransmission of all types of frames in GCR-BA scheme. However, our proposed protocol only retransmits packets belonging to I-frames which decrease the reliability when there is low probability of packet loss because of channel conditions. With higher channel error probability the packet loss rate is high. As a consequence, retransmissions occur frequently. These retransmission themselves increase network traffic, and hence packet collisions. Our proposed protocol tries to minimize the retransmission and ACK to stop sender from transmitting lost packet, BAR, and BA of P- and B-frames. Legacy 802.11 multicast protocol performs worse because there is no ACK and no retransmission of lost packet. However, the reliability improves in GCR-UR when we increase the number of retries as shown in Fig. 4.

Fig. 5 presents the performance with the different number of multicast members with fixed channel error probability of 0.1. For all protocols, the average PSNR decreases as we increase the number of multicast members. Legacy 802.11 multicast protocol shows the worse performance because there is no retransmission of lost packets. The average PSNR of the proposed protocol is higher than BA, GCR-UR and legacy 802.11 multicast protocols because of the lower drop probability of the proposed protocol. When the number of nodes is less than 25, the average PSNR of the proposed method is less than GCR-BA scheme because there is no retransmission of packet belonging to P and B-frames in our proposed protocol, which causes the higher drop. However, when the number of nodes is higher than 25, the average PSNR of the proposed method is higher. Fig. 5 also shows the average PSNR of GCR-UR scheme with retries of 1, 2, and 3, respectively. It can be observed that average PSNR increases when we increase the retry limit. Fig. 6 shows the PSNR of the different protocols when the number of nodes is 30.

From the results, we can confirm that legacy 802.11 multicast protocol is less reliable than others. The reliability in GCR-UR scheme depends on the number of retries. GCR-BA scheme achieves high reliability when the number of multicast members is less, but has the scalability problem. The similar behavior is also shown in [1]. Our proposed protocol is less reliable than GCR-BA scheme when the number of nodes is less. However, it performs well, when there are a higher number of nodes in multicast networks and hence helps to eliminate the scalability problem of GCR-BA scheme.

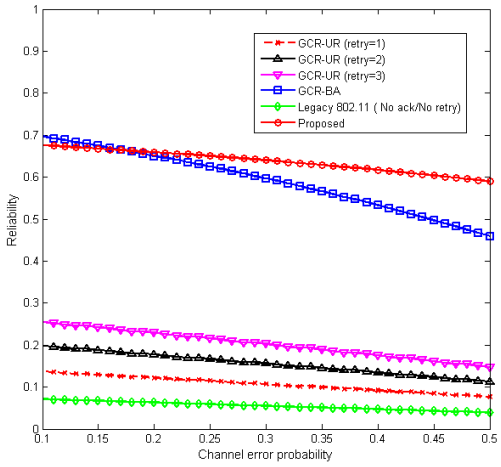


Fig. 4. Reliability vs. channel error probability (when number of nodes is 20).

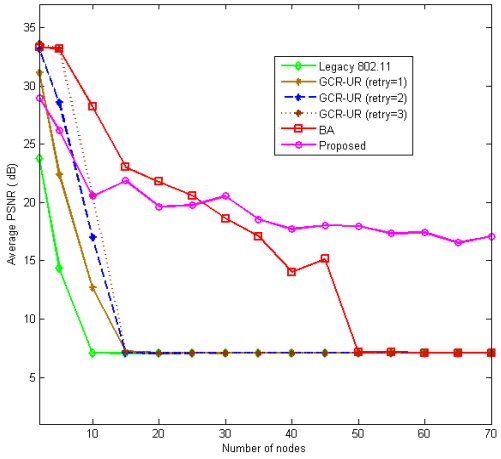


Fig. 5. Average PSNR as a function of number of nodes (when channel error probability is 0.1).

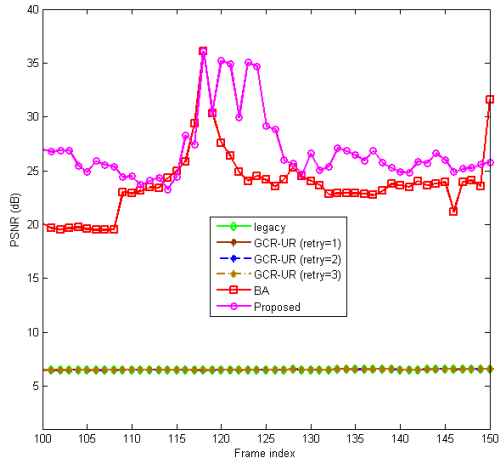


Fig. 6. PSNR of the video sequence (when number of nodes is 30).

V. CONCLUSION

Reliable delivery of video multicast is an important problem. Therefore, 802.11aa specifies a different scheme i.e., GCR-BA for reliable multicast transmission. In this paper, we propose a modified GCR-BA scheme for multimedia applications to address the scalability problem of GCR-BA scheme. Proposed protocol performs well in terms of reliability and peak signal-to-noise ratio compared to GCR-BA scheme when number of nodes is large. This is a positive step towards handling scalability problem in wireless networks, which is of greater importance. The legacy 802.11 multicast shows the worse performance. Whereas, the performance of GCR-UR depends on retry limits. In the future, we plan to extend our work toward adaptive retransmission according to channel characteristic, importance of video frames, and number of member's nodes in multicast networks.

ACKNOWLEDGMENT

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