Global Journal of Computer Science and Technology
Network, Web & Security
Volume 12 Issue 11 Version 1.0 June 2012
Type: Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals Inc. (USA)
Online ISSN: 0975-4172 & Print ISSN: 0975-4350

An Enhanced QoS Provisioning Approach for Video Streams using Cross Layer Design in IEEE 802.16

By V.R.Azhaguramyaa, S.J.K.Jagadeesh Kumar & M.Venkateshwaran
Sri krishna college of technology, kovaipudhur, coimbatore

Abstract - Wimax networks are increasingly deployed for commercial use because of its high bandwidth. This has necessitated application level changes in QoS provisioning techniques. In this paper, we propose an efficient method at the application layer of the wimax architecture. The video stream is partitioned at the application layer into I, P and B frames. Frames corrupted at receiver are detected using negative acknowledgements received from the physical layer. Probability of Byte Loss (BL) is calculated at physical layer which is used to calculate the redundant data. Redundant data is communicated from PHY layer to application layer via link layer using cross-layer signalling mechanism. Redundant data is piggybacked into the subsequent frame and sent only if BL is less than 0.2. This technique has improved the throughput of the network considerably which is evident from the performance analysis.

Keywords : *Application Layer, Cross layer design, QoS, video streaming, WiMAX.*

GJCST-E Classification: *H.4.3*

AN ENHANCED QOS PROVISIONING APPROACH FOR VIDEO STREAMS USING CROSS LAYER DESIGN IN IEEE 802.16

Strictly as per the compliance and regulations of:

An Enhanced QoS Provisioning Approach for Video Streams using Cross Layer Design in IEEE 802.16

V.R.Azhaguramyaa [α], S.J.K.Jagadeesh Kumar [σ] & M.Venkateshwaran [ρ]

Abstract - Wimax networks are increasingly deployed for commercial use because of its high bandwidth. This has necessitated application level changes in QoS provisioning techniques. In this paper, we propose an efficient method at the application layer of the wimax architecture. The video stream is partitioned at the application layer into I, P and B frames. Frames corrupted at receiver are detected using negative acknowledgements received from the physical layer. Probability of Byte Loss (BL) is calculated at physical layer which is used to calculate the redundant data. Redundant data is communicated from PHY layer to application layer via link layer using cross-layer signalling mechanism. Redundant data is piggybacked into the subsequent frame and sent only if BL is less than 0.2. This technique has improved the throughput of the network considerably which is evident from the performance analysis.

Keywords : Application Layer, Cross layer design, QoS, video streaming, WiMAX.

I. Introduction

With increasing demands in high-data-rate services and multimedia applications in wireless communications, the IEEE 802.16 standard family and the associated Worldwide Interoperability for Microwave Access (Wi-MAX) forum are developed and formed to support the broadband wireless access (BWA) in a wireless metropolitan area network (WMAN). Worldwide Interoperability for Microwave Access (WiMAX) is a MAC and PHY layer wireless communication technology for outdoor broadband wireless coverage at a municipal, regional or state wise level. The set of standards that define WiMAX are developed and maintained by IEEE 802.16 Working Group [1, 2]. Two major variants of WiMAX have emerged and are being deployed: 802.16d standards support fixed or slowly moving users and 802.16e supports mobile users. Mobile WiMAX is designed to support a wide range of applications ranging from video streaming to web browsing. All of these applications require different levels of Quality-of-service (QoS) and this imposes a variety of different performance requirements on the MAC and PHY layers.

Author α : PG Student, Department of Computer Science and Engineering, Sri Krishna College of Technology, Coimbatore.
E-mail : vrazhaguramyaa@gmail.com
Author σ : Prof. & Head, Department of Computer Science and Engineering, Sri Krishna College of Technology, Coimbatore.
E-mail : jagadeesh_sk@rediffmail.com
Author ρ : UG Student, Department of Computer Science and Engineering, Sri Krishna College of Technology, Coimbatore.
E-mail : venkatteshviji@gmail.com

a) OFDMA

Mobile WiMAX utilizes Orthogonal Frequency Division Multiple Access (OFDMA) modulation where the Orthogonal Frequency Division Modulation (OFDM) sub carriers are shared among the users. Thus the available system profiles are dependent of the subcarriers numbers that are utilized.

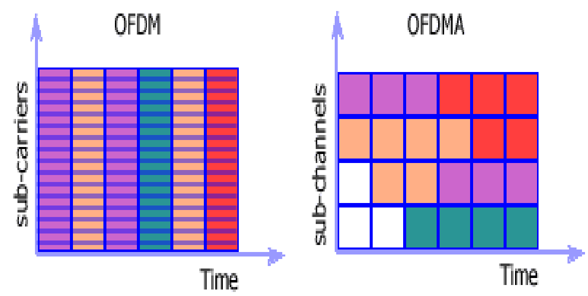

Fig. 1 : Sub Channelization in OFDM and OFDMA

In OFDM PHY, multiple subscribers use a time division multiple access (TDMA) to share the media. Combination of time division and frequency division multiple access in conjunction with OFDM is called Orthogonal Frequency Division Multiple Access (OFDMA) [12]. Figure 1 illustrates a schematic view of the two 802.16 PHYs discussed above.

Further in WiMAX systems, the data sub carriers are grouped into basic resource set units called slots. A slot is the minimum amount of resources that can be allocated to a certain user and its size in terms of sub carriers is specific to the subchannel allocation algorithm.

b) MIRACLE

A framework called Multi Interface Cross Layer Extension (MIRACLE) is designed where a set of dynamic libraries are loaded to add support for multi technology and cross-layering. A patch which also facilitates the use of dynamic libraries in ns2 is available. Working with dynamic libraries allows the development and subsequent use of new features without the need for re-compiling the whole simulator [13]. These libraries can be loaded on demand at simulation time. Moreover, the architecture is highly modular as it allows the interconnection of multiple down and upstream modules at every layer in the protocol stack. Dedicated and broadcast channels are allocated, at each node, for the inter-layer communication of control as well as data messages. The framework can be used to simulate wired networks as well as a mixture of wired and wireless architectures.

II. Related Work

H. Schwarz *et al.* proposed an approach called Scalable Video Coding (SVC) that reduces the complexity at the server side and supports various types of clients. It encodes high quality video streams into groups of bit streams' including one base sublayer and multiple enhancements sublayers [9]. All clients subscribe for the base sublayer. The purpose of enhancement sublayers is to improve the video quality. The clients are given the option of choosing the enhancement sublayers depending on their network connection and the available resources.

J.She *et al.* illustrated an active frame dropping approach for streaming real-time video over IEEE 802.16 networks. In this approach, the base station drops a frame if it does not guarantee the safe delivery of the frame at the receiver's side with the application delay limit [10].

Hung-Hui Juan *et al.* proposed a cross-layer design between the streaming server and mobile WiMAX base stations [5] and showed that for each user the implementation of multiple connections with feedback information of the available transmission bandwidth is critical for supporting H.264/AVC-based scalable video coding in which the transmission packets can be further separated into multiple levels of importance.

James She *et al.* presented a cross-layer framework in which cross-layer design is applied to WiMAX IPTV multicast to guard against channel diversity between different receivers [6]. The solution again utilizes scalable video layers but, instead of a mapping onto different connections, superposition coding is employed. In such coding, more important data are typically modulated at BPSK whereas enhancement layers are transmitted with higher-order modulation such as 16QAM. A cross-layer unit performs the superposition at the BS, whereas at the subscriber stations video layers are selected according to channel conditions.

Ehsan Haghani *et al.* proposed a scheme to improve the MPEG video streaming quality for the end users [3]. Their solution concentrates on assigning priority to the more important frames and protects them against dropping.

L. Al-Jobouri *et al.* [4] put forth a cross layer protection mechanism through rateless encoding where the lost packet is recovered with the help of the additional redundant data added in the corresponding packet.

Lai-U Choi et al. has taken the problem regarding the quality of video streaming and they have provided the solution in which parameters from radio link layer and application layers are abstracted and based on that decision is distributed and the application layer and radio link layer will co-operate according the decision to provide a good quality video[14].

Nicola Baldo *et al.* presented a framework of dynamic libraries called miracle (Multi InteRfAce Cross Layer Extension) which extends the functionality of NS2 [13]. Its modular architecture aids in reusability and interoperability of codes. It has an embedded engine to handle cross layer messages.

III. Proposed Scheme

a) System Design

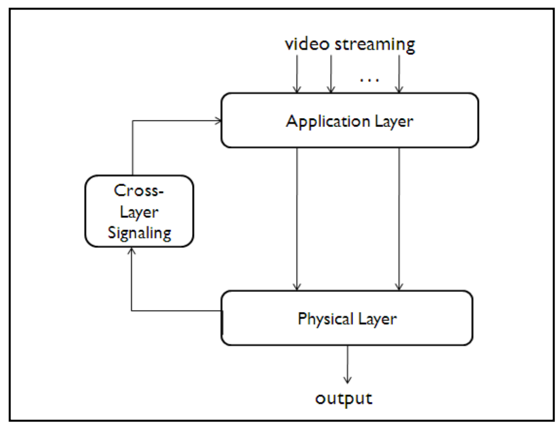

Fig. 2 : Schematic Representation of Proposed System

In the proposed cross-layer scheme, video partitioning is done at application layer. Video packets are transmitted to PHY layer then receiver signal strength is measured which is the basis of probability of channel byte loss (BL). The BL serves to predict the amount of redundant data to be added to the payload. BL is found and then communicated from the PHY layer via the link layer to the application layer using the cross-layer signaling mechanism. The packets with redundant data transmitted from application layer and in PHY layer Adaptive Modulation and coding is used to increase throughput. The whole process illustrated in Figure 2.

b) Video Partitioning

In an H.263 codec, when data-partitioning is enabled, inter-coded slices are normally divided into three separate partitions. I-frames are the least compressible but don't require other video frames to decode. P-frames can use data from previous frames to decompress and are more compressible than I-frames. B-frames can use both previous and forward frames for data reference to get the highest amount of data compression. Receipt of a partition-I carrying packet is sufficient to enable a partial reconstruction of the frame. In adverse channel conditions, duplicate partition-I packets are transmitted. On the other hand, the duplicate partition-I stream should be turned off during favorable channel conditions. In order to decode partition-P and -B, the decoder must know the location from which each MB was predicted, which implies that partitions P and B cannot be reconstructed if partition-I is lost [4].

c) Cross Layer Signalling

An IEEE 802.21 Media Independent Handover (MIH) service provides a framework for cross-layer signalling that could be enhanced for more general purposes. IEEE 802.16g - Management Plane Procedures and Services consists the provision of cross-layer signaling. Upper-layer services, known as MIH users or MIHU communicate through the middleware to the lower layer protocols. One of the middleware services, the Media Independent Event Service (MIES) is responsible for reporting events such as dynamic changes in link conditions, link status and quality. In the proposed work, BL is found then BL and redundant data is communicated from the PHY layer via the link layer to the application layer using the cross-layer signalling mechanism [13].

d) Channel Adaptation

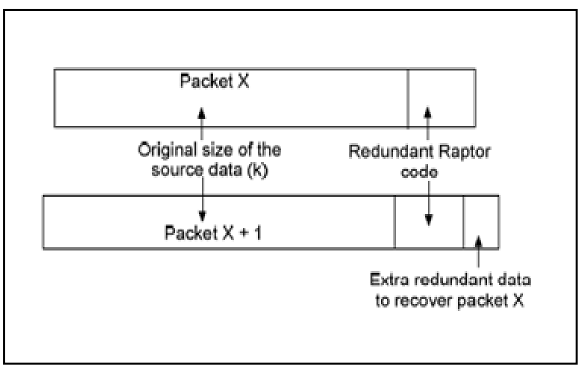

Fig. 3 : Additional redundant data piggybacked to the source data and original redundant data to the payload portion of packet to recover previous erroneous packet

When a negative acknowledgement is received by the physical layer The probability of channel byte loss (BL) serves to predict the amount of redundant data to be added to the payload. In an implementation, BL is found and then communicated from the PHY layer via the link layer to the application layer using the mechanism cross-layer signaling. The IEEE 802.16e standard specifies that an MS should provide channel measurements, which can either be Received Signal Strength Indicators or may be Carrier-to-Noise-and-Interference Ratio measurements made over modulated carrier preambles.

If the original packet length is L, then the redundant data is given simply by,

$$R = L\times BL + (L\times BL^2) + (L\times BL^3) + \dots = L / (1-BL) - L \quad (1)$$

Where,

L - Packet length

BL - Byte Loss

R – Redundant data.

To achieve an incremental increase in redundant data, rateless channel coding is used. If a packet cannot be decoded, despite the provision of redundant data then additional redundant data are added to the next packet which is illustrated in Figure 3.

IV. Experimental Results

The simulation of WiMAX environment is done using NS 2.33 with MiracleWimax0.0.1 framework. Simulation scenario consists of one Base Station Node and 49 Mobile Nodes. The mode of operation is Point-to-multipoint (PMP). Table 2 shows some of the simulation parameters.

V. Simulation Parameters

PARAMETER	VALUE
Bandwidth	10 Mbps
Avg.Coverage area of Base Station	500 m
Maximum Height of Antenna	1.5 m
Transmission power of Base Station	0.025 W
Frequency	914 MHz
Propagation	Free space
Burst Time	500 ms
Idle Time	10 ms

a) Throughput Analysis

There is a considerable increase in Throughput which is depicted in Figure 4. Throughput is varied based on different modulation schemes.

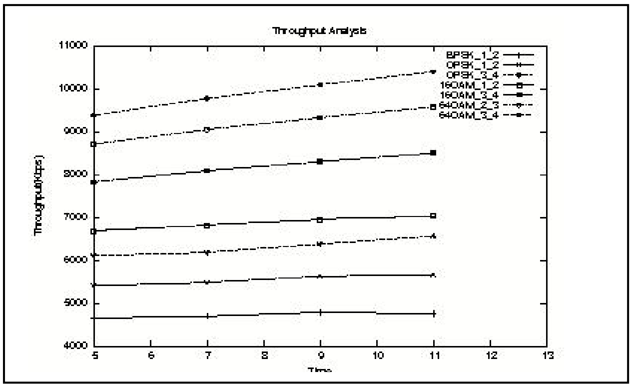

Fig. 4: Throughput vs. SimulationTime graph

In our proposed scheme, mandatory coding is AMC and as a optional technique Rateless encoding. With AMC the frame corruption is reduced. But if it is there any loss then Rateless coding used in conjunction with AMC and thus corrupted frames can be recovered.

VI. Conclusion

This paper employed an enhanced QoS provisioning approach in which corrupted frame is recovered by adding the redundant data to subsequent frame. This method uses piggy backing mechanism which improves the throughput and reduces the delay. Scarce radio resources of wimax network are better utilized through cross layer design.

Enhancing the same work for all type of service classes and comparison between this scheme and other cross layer schemes are reserved for future work.

References Références Referencias

1. IEEE 802.16-2004, IEEE Standard for Local and Metropolitan Area Networks –Part 16: Air Interface for Fixed Broadband Wireless Access Systems, October2004.
2. IEEE 802.16e-2005, IEEE Standard for Local and Metropolitan Area Networks –Part 16: Air Interface for Fixed and Mobile Broadband Wireless Access Systems Amendment. 2. Physical and Medium Access Control Layers for Combined Fixed and Mobile Operation in Licensed Bands, February 2006.
3. Ehsan Haghani, Shyam Parekh, Doru Calin, Eunyoung Kim and Nirwan Ansari, “A Quality-Driven Cross-Layer Solution for MPEG Video Streaming Over WiMAX Networks,” IEEE Transactions On Multimedia, vol. 11, no. 6, pp 1140-1147,Oct. 2009.
4. L. Al-Jobouri, M. Fleury, and M. Ghanbari, “Cross-layer Scheme for WiMAX Video Streaming,” 3rd IEEE Computer Science and Electronic Engineering Conference (CEEC), pp 86-91, 2011.
5. H.-H Juan, H.-C. Huang, C. Huang, and T. Chiang, “Cross-layer mobile WiMAX MAC designs for the H.264/SVC scalable video coding,” *Wireless Networks*, vol. 16, no. 1, pp. 113-123, 2009.
6. J. She, X. Yu, P.-H. Po, and E. H. Yang, “A cross-layer design framework for robust IPTV services over IEEE 802.16 network,” *IEEE J. Sel. Areas Commun.*, vol. 29, no. 2, pp. 235-245, 2009.
7. Kawadia and P.R. Kumar, “A cautionary perspective on cross layer design,” *IEEE Wireless Commun. Mag.*, vol. 12, no. 1, pp. 3-11, 2003.
8. K. Balachandran, D. Calin, E. Kim, and K. M. Rege, “Proactive content rate selection for enhanced streaming media quality,” in *Proc. IEEE Sarnoff Symp.*, pp. 1–6, Apr. 2008.
9. H. Schwarz, D. Marpe, and T. Wiegand, “Overview of the scalable video coding extension of the H.264/AVC standard,” *IEEE Trans. Circuits Syst. Video Technol.*, vol. 17, no. 9, pp. 1103–1120, Sep. 2007.
10. J. She, X. Yu, F. Hou, P.-H. Ho, and E.-H. Yang, “A framework of cross-layer superposition coded multicast for robust IPTV services over WiMAX,” in *Proc. IEEE Wireless Communications and Networking Conf. (WCNC)*, Apr. 2008, pp. 3139–3144.
11. Seok-Yee Tang, Peter Muller and Hamid R. Sharif, “WiIMAX Security and Quality Of Service An End-to-End Perspective,” First Edition, Wiley, 2010.
12. J. G. Andrews, A. Ghosh, and R.Muhamed, *Fundamentals of WiMax*. Prentice-Hall, 2007.
13. Nicola Baldo, MarcoMiozzo, Federico Guerra, Michele Rossi and Michele Zorzi, “Miracle: TheMulti-Interface Cross-Layer Extension of ns2,” EURASIP Journal onWireless Communications and Networking, Vol. 2010, Article ID 761792, pp 1-16.
14. Lai-U Choi, Wolfgang Kellerer, and Eckehard Steinbach, “On Cross-Layer Design for Streaming Video Delivery in MultiuserWireless Environments,” EURASIP Journal onWireless Communications and Networking, Vol. 2006, Article ID 60349, pp 1–10.
15. http://www.isi.edu/nsnam/ns/ns