

## Chapter 84

# Intelligent Bandwidth Allocation of IPTV Streams with Bitstream Complexity Measures

**Sandro Moiron**

*Instituto de Telecomunicações, Portugal*

**Rouzbeh Razavi**

*Bell Laboratories, UK*

**Martin Fleury**

*University of Essex, UK*

**Mohammed Ghanbari**

*University of Essex, UK*

### ABSTRACT

*IPTV video services are increasingly being considered for delivery to mobile devices over broadband wireless access networks. The IPTV streams or channels are multiplexed together for transport across an IP core network prior to distribution across the access network. According to the type of access network, prior bandwidth constraints exist that restrict the multiplex data-rate. This paper presents a bandwidth allocation scheme based on content complexity to equalize the overall video quality of the IPTV sub-streams, in effect a form of statistical multiplexing. Bandwidth adaptation is achieved through a bank of bit-rate transcoders. Complexity metrics serve to estimate the appropriate bandwidth share for each stream, prior to distribution over a wireless or ADSL access network. These metrics are derived after entropy decoding of the input compressed bit-streams, without the delay resulting from a full decode. Fuzzy-logic control serves to adjust the balance between spatial and temporal coding complexity. The paper examines constant and varying bandwidth scenarios. Experimental results show a significant overall gain in video quality in comparison to a fixed bandwidth allocation.*

### INTRODUCTION

Internet Protocol TV (IPTV) media streams are delivered across converged telecommunications networks to a home network end device such as a set-top box or PC, or increasingly to mobile devices (Singh et al., 2008). The use of managed networks

and IP framing differs from (Maisonneuve et al., 2009) Internet or Web TV, which is streamed over best-effort IP networks. Before distribution to individual devices, multiple videos streams will share a multimedia sub-channel. Other types of data will form other sub-channels or pipes. TV channels may be multiplexed onto an MPEG-2

DOI: 10.4018/978-1-4666-7456-1.ch084

transport stream (TS), and it is also possible (Wagner et al., 2009) to employ the Real-time Transport Protocol (RTP) to encapsulate MPEG-2 packets (usually between 6 and 7 MPEG-2 TS packets, each representing a TV channel, per RTP packet). Broadcasters have generally employed a Constant Bit-Rate (CBR) multiplex of streams (Böröczy et al., 1999) previously stored at a high quality. This paper is essentially about how to achieve the bandwidth allocation of the TV channels or video sub-streams within the multimedia sub-channel.

When the video sub-streams within the multimedia sub-channel leave a managed core-network, they will be accessed over various network types such as Asymmetric Digital Subscriber Line (ADSL) (Zheng & Lin, 2000), broadband wireless including IEEE 802.16 (WiMAX) (She et al., 2007), or a passive optical network (Hermsmeyer et al., 2007). For example, in Lee et al. (2009) the architecture of an IPTV scheme for mobile WiMAX is illustrated. The IPTV content passes over the core IP network before reaching an access control router to a set of WiMAX base stations. At that point, in the solution of Lee et al. (2009) a controller for the WiMAX Multicast and Broadcast Service (MBS) intervenes at the access control router. Popular content is extracted from the IPTV multimedia sub-stream is extracted for distribution via MBS as near-Video-on-Demand (NVoD), while other content is sent as true VoD by unicast to mobile devices. Where IPTV differs from terrestrial and normal satellite distribution is that the MPEG2-TS or RTP multiplex content mix can be made flexible through session control feedback mechanisms.

As the IPTV bandwidth may be constrained by a particular type of access network technology, a practical solution, (Kasai et al., 2005) is to employ a transcoder bank to resize the video streams' bit-rates to fit within the constraints of the target access network, especially when the access network is a mobile one. Transcoding can dynamically and selectively modify the bit-rate of each stream within the multimedia sub-channel in

order to fit the available bandwidth of the access network channel, a form of statistical multiplexing. In this way, IPTV can be extended to mobile devices.

However, allocating bandwidth to video streams simply on the basis of efficient usage and fair distribution of bandwidth, for example in Jain et al. (1996), is not necessarily wise, because the delivered video quality of some video streams will be more affected by a reduction in bandwidth than by others. Both unwarranted degradation of quality and unnecessarily high video quality may arise. This is also the reason why allocating bandwidth based on the past statistics of data-rates may be ill-advised, as it fails to account for the impact of such allocations on the delivered video quality. A further weakness of statistical allocation for variable bit-rate video is that such approaches are not appropriate if the input data-rates have high variances. Smoothing of the data-rates may be applied to remove the impact of intra-coded I-frame data but this can affect latencies. Thus, video streams within a multimedia sub-channel cannot have bandwidth allocated in the same way as other data but should take account of the video stream content in a dynamic manner.

The goal of our paper's statistical multiplexing scheme is to dynamically adjust the bandwidth share between several concurrent streams based upon their content complexity in order to equalize their delivered video quality. Ideally, the quality of all video streams will then fall within an acceptable range, being neither too high nor too low in quality. Broadcast quality video normally falls within the range 30–38 dB. As an illustration, consider the rate-distortion (R-D) curves in Figure 1 for three reference video sequences. At an initial target input rate of 1 Mbps, the objective quality of the *Mobile* video sequence is on the boundary of that range while the quality of both the *Highway* and *Bridge-closed* sequences exceeds that range. Hence, there is a need to equalize their objective quality. The proposed scheme computes spatial and temporal complexity measurements by extracting

19 more pages are available in the full version of this document, which may be purchased using the "Add to Cart" button on the publisher's webpage:

[www.igi-global.com/chapter/intelligent-bandwidth-allocation-of-iptv-streams-with-bitstream-complexity-measures/124581](http://www.igi-global.com/chapter/intelligent-bandwidth-allocation-of-iptv-streams-with-bitstream-complexity-measures/124581)

## Related Content

---

### Sustainable Urban Development: Strategies To Support The Melbourne 2017 - 2050

Koorosh Gharehbaghi, Bambang Trigunaryah and Addil Balli (2020). *International Journal of Strategic Engineering* (pp. 59-72).

[www.irma-international.org/article/sustainable-urban-development/255142](http://www.irma-international.org/article/sustainable-urban-development/255142)

### The Power of Visionary Leadership in Transforming the Indian Education System

M. Durairaj, Simanchala Das, K. Ezhilmath, H. Mickle Ancy, Sujay Mugaloremutt Jayadeva and S. Murugan (2024). *Challenges of Globalization and Inclusivity in Academic Research* (pp. 162-185).

[www.irma-international.org/chapter/the-power-of-visionary-leadership-in-transforming-the-indian-education-system/339853](http://www.irma-international.org/chapter/the-power-of-visionary-leadership-in-transforming-the-indian-education-system/339853)

### Sydney Metro and Melbourne Metro Rail Stochastic Comparison and Review: Scrutiny of AI

Koorosh Gharehbaghi, Kathryn M. Robson, Neville Hurstand Matt Myers (2021). *International Journal of Strategic Engineering* (pp. 28-38).

[www.irma-international.org/article/sydney-metro-and-melbourne-metro-rail-stochastic-comparison-and-review/279644](http://www.irma-international.org/article/sydney-metro-and-melbourne-metro-rail-stochastic-comparison-and-review/279644)

### Persistence of Knowledge across Layered Architectures

Janet Fredericks (2015). *Collaborative Knowledge in Scientific Research Networks* (pp. 262-282).

[www.irma-international.org/chapter/persistence-of-knowledge-across-layered-architectures/119827](http://www.irma-international.org/chapter/persistence-of-knowledge-across-layered-architectures/119827)

### Digital Forensic Investigation of Social Media, Acquisition and Analysis of Digital Evidence

Reza Montasari, Richard Hill, Victoria Carpenter and Farshad Montaseri (2019). *International Journal of Strategic Engineering* (pp. 52-60).

[www.irma-international.org/article/digital-forensic-investigation-of-social-media-acquisition-and-analysis-of-digital-evidence/219324](http://www.irma-international.org/article/digital-forensic-investigation-of-social-media-acquisition-and-analysis-of-digital-evidence/219324)