# Analysis of processing in digital terrestrial television with statistical multiplexing for standards DVB-T

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***Abstract*—The changes in the different standards for digital terrestrial television (DTT) have as target to increase the spectrum efficiency used by a channel, to add interactive services, video on demand, and others. To do that, they must improve the processes of compression and multiplexing made over the contents (video and audio) that will be transmitted. This study assesses the compression level for the Digital Video Broadcasting standard (DVB), the encapsulation and multiplexing of contentlevel transport streams (TS). The TV Headends of the DTT signals, have the function of emit the television content in a pointto-multipoint system using Single Frequency Networks (SFN),for this reason must to emit the different contents multiplexed to form a single TS. In the digital signal processing two multiplexing techniques have been considered: statistical multiplexing, where be develop variations in the bitrate in each of the contents depending of his priority and fixed multiplexing where be develops a fixed bitrate for each content, having lower spectral efficiency by channel with respect to statistical multiplexing.**

**Being the statistical multiplexing one digital processing technique that has begun to implement in some regions of the world, is pertinent to check that existing models permits to evaluate the treatment techniques in the TV Headends for it was characterized a TS with ten contents (audio and video), by the norm ETSI TR 101290.This study verified the performance of the statistical multiplexing model in the audio and video contents, under the DVB standards with variations in bit rate content, characterizing the measures according to the standard guidelines for DVB systems measures in TS.**

## I. Introduction

### A. Digital Terrestrial Television(DTT)

The digital processing of the television entails signal transmission of different video content in standards HD (High Definition) and SD (Standard Definition) multiplexed over a certain bandwidth. For this they have generated standards such as ATSC, ISDB-T, DTMB y DVB-T (Digital Video Broadcasting).

The efficiency of spectrum for the digital terrestrial television applications is very important, because they have increased the quantity and quality of content, but they have kept the bandwidths in transmission systems. For this analyze is utilized the standards DVB-T y DVB T2 whose compression of audio and video content is based in MPEG-2 (Moving Picture Experts Group) y MPEG-4 respectively. Now is presented a migration of the standard DVB-T to DVB T2 and the two compressions types must operate in the same system of broadcasting. For this reason is necesary, the behavior analyze of frames digital television transport with MPEG-2 and MPEG-4.

### B. TRANSPORT STREAM IN DVB

The digital terrestrial television has combined contents of video, interactive services and audio that they are operating within the same broadcast transmission system, for this reason they must be multiplexed into a single transport stream(TS) as shown in Figure 1 [1].

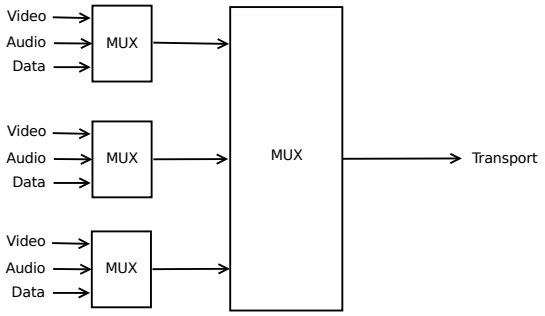


Fig. 1. Multiplexing transport stream [1]

The International Telecommunications Union in the radio communication sector (ITU-R) defines a model for the transmission of digital television broadcasting. In which establishes the transport stream (TS) like the transmition source in the radiofrequency system (RF)[1] as shown in Figura 2. Due to more complexity of images and data is required multiplexing using CBR(Constant Bit Rate) and VBR (Varible Bit Rate). The VBR (Variable Bit Rate) is based on the rate-distortion theory, where the bandwidth is shared between all programs and the proportion of each program depends on the complexity of the content [2].

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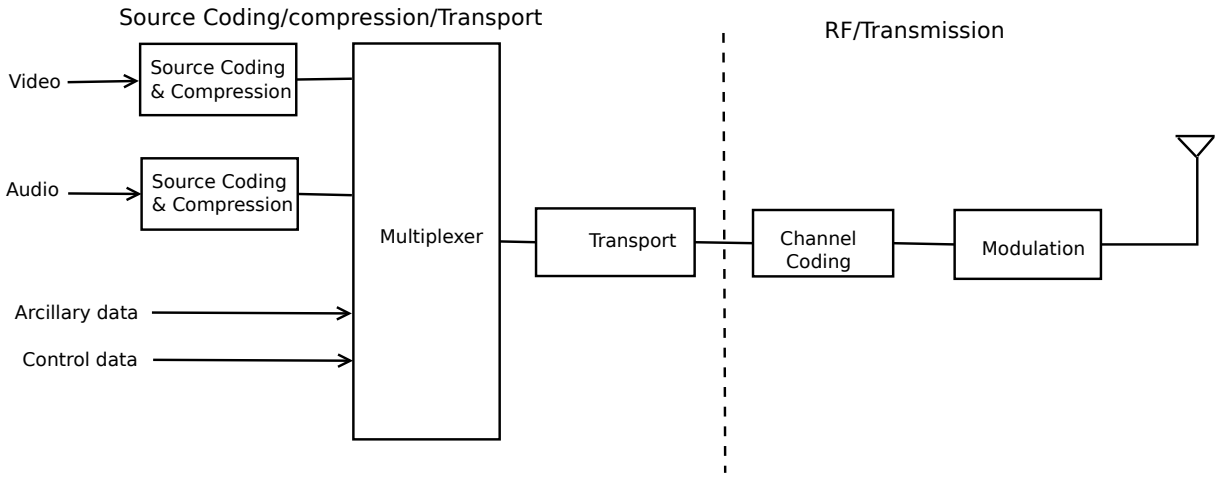



Fig. 2. transport stream [1]

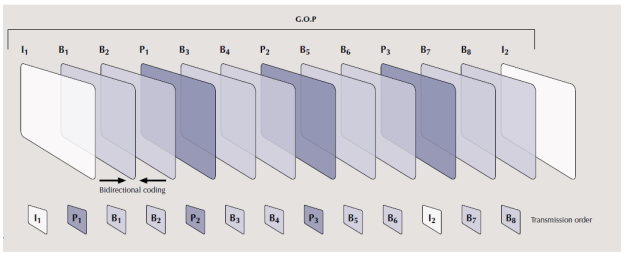



Fig. 3. GOP MPEG-2 [3]

## II. Statistical Multiplexing

The statistical multiplexing is based on rate control algorithms used the feedback concept; this is produced by the encoders through the compression changes in the information bitstream [2]. The generated statistical are used as input parameters in the encoders control process before the picture compression. This statistics codification together with the buffer state information from channel, are used to dynamic process the bit rate allocation in each encoder [2]. The programs bit rate is proportional to the relation between the complexity of any program and the sum of the complexity for all programs [2].

$$R_t = R_channel \frac{X_i}{\sum X_i} \tag{1}$$

Where $R_i$ is the programs bit rate $i$, Rchannel is the channel rate, and $X$ is the complexity of program $i$.[2]

### A. Complexity Compression MPEG-2 y MPEG-4

The made bit allocation is used to estimate the necessary bits number in the each imagen generation, through the use of statistical caracteristics from the previous pictures. the bit number in to the I, P, B frames in the groups of pictures (GOP) is allotted using the ISO 13818 codifications mode considerations [3]

The complexity MPEG-2 calculated used the distortion (D) and Compression parameters (m,n) [2]

$$D = 10^{m-nR} \tag{2}$$

$$R_i = \frac{R_t - \sum_{j=1}^{N} [(m_j - m_i) + (log\alpha_j - log\alpha_i)]}{n_i \sum_{j=1}^{N} \frac{1}{n_j}} \tag{3}$$

(4) Shows the complexity equation for a MPEG-4 frame.

$$T_{RegularFrame}(i,j,l) = \frac{X(i,j,l)}{\sum_{l=1}^{L} X(i,j,l)} T_{SuperFrame}(i,j) \tag{4}$$

### B. Transport Stream Analysis in Colombian public channels

This analysis used the ETSI TR 101 209 norm, under which the Rohde Schwarz ETL TV analyser works, that is a universal analyzer for analog TV , DTT, mobile and radius, the equipment allows the Transport Stream (TS) capture, the video and audio decoding and the measure of some quality parameters in the transmission contents (figure 4)

A study was conducted about ten services in a TS, for a time of 100 seconds. The video contents were compress under MPEG-2 and MPEG-4 (table 1), the measures focused in the Canal Uno, Canal Institucional and Seal Colombia contents; this due to the simultaneous transmission from this channels in standards DVB-T and DVB-T2. The bit rate for these was generated through the use of statistical multiplexing. in the figure 5 can observed the bit rate variation and comparison for this in a Canal Uno contents for MPEG-2 and MPEG-4.The audio information not was analyzed because the low bit rate and low changes for the same, the figure 6 shows the differences between audio and video contents.

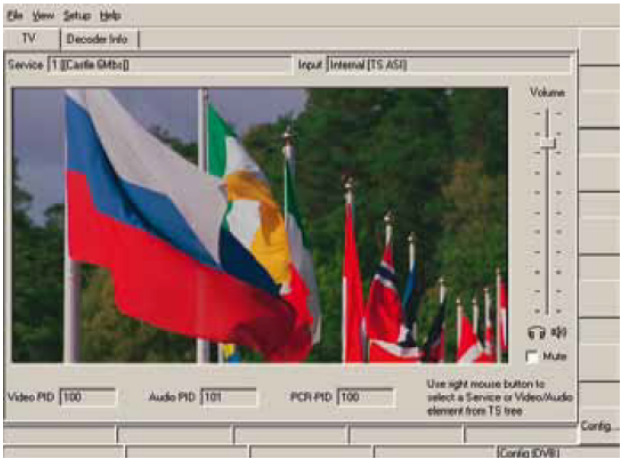


Fig. 4. Transport Stream Rohde Schwarz [3]

| Servicio | Video | |
|---|---|---|
| Canal 1 | V S I | MPEG 2 |
| Canal Institucional | Height | 480 |
| Senal Colombia | width | 740 |
| TV Andina | Aspect Radio | 4 : 3 |
| Canal Capital | San Type | Interlaced |
| Canal Congreso | Frame rate | 29,9 fps |
| Canal UNO | V S I | H-264 |
| Canal Institucional | Height | 480 |
| Senal Colombia | width | 740 |

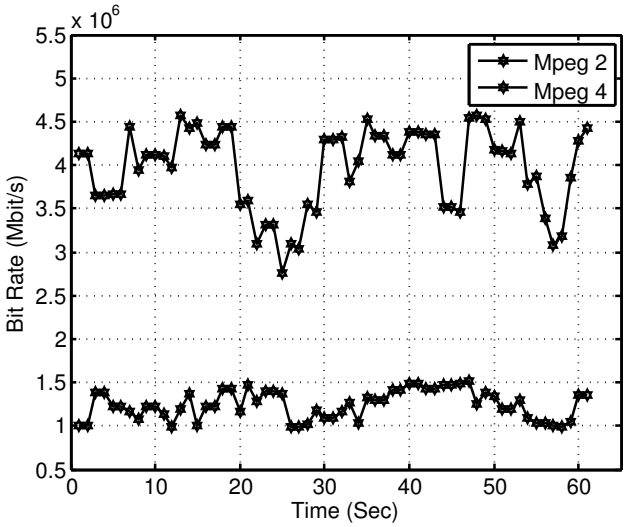



Fig. 5. Bit Rate comparasion

The analysed TS had a total bit rate ($\mu$) of 24.26 Mbps, distributed for ten video services, were grouped the contents to analyse according to the compression system used and were calculated the bit rate average of each group, also the variation of average in the time. Was observed a mayor variation in the average bit rate of the MPEG-2 system, the variation in the average indicates a statistical multiplexing. The entropy was calculated in time funtion using the ecuation (5) and (6), in the

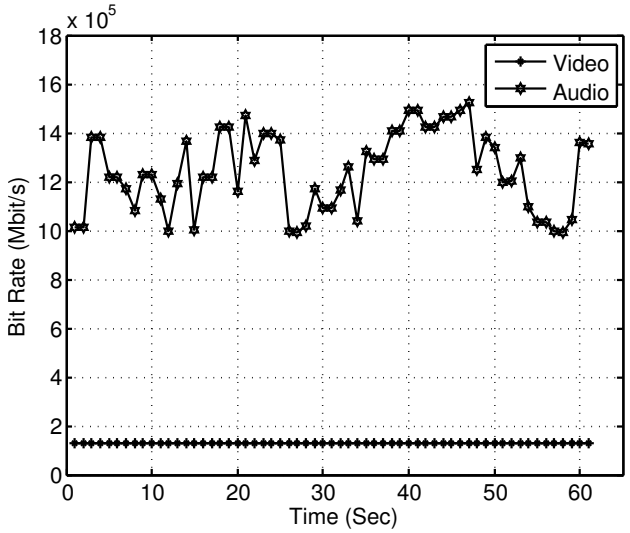



Fig. 6. Service Video and Audio

figure 7 we observed a relation between the average bit rate and the calculated entropy for the Compressed video MPEG-2 , if compared a entropy of video services MPEG-2 and MPEG-4, found a big difference, however, we must considered the efficency of the MPEG-4 system.

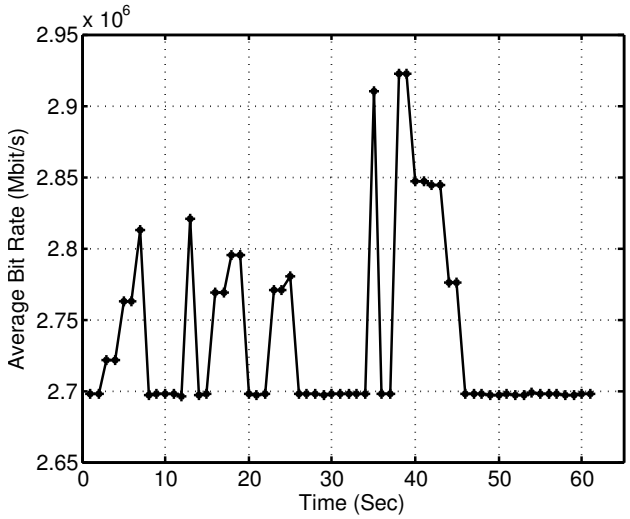
$$H_i = \frac{1}{\mu}\sum_{i=1}^{6}\lambda_i log2\left(\frac{\lambda_i}{\mu}\right) \tag{5}$$

$$H_i = \frac{1}{\mu}\sum_{j=1}^{4}\lambda_j log2\left(\frac{\lambda_j}{\mu}\right) \tag{6}$$

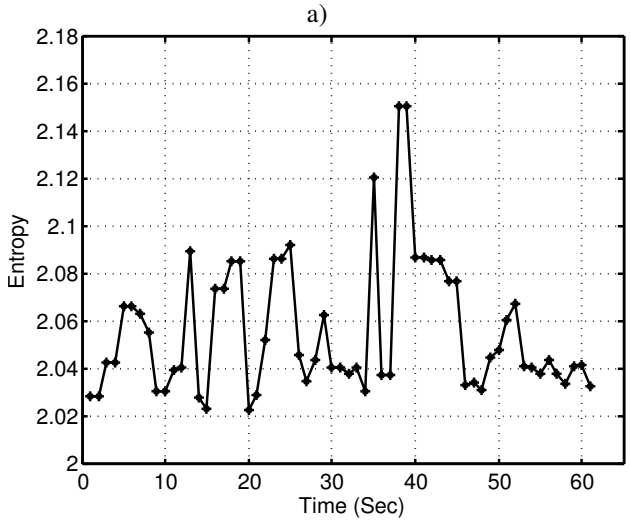
Finally we revised the relation between the average bit rate and entropy calculated, the results are located in the figures 8 and 9, and we observed a lineal variation in the relation for a same bit rate. In MPEG-4 observed a lineal variations for bit rate more high (in MPEG-2 this relation is less evident).

## III. Conclusion

- The multiplexing statistical is an excellent technical for signal digital proceeding , that it permits better spectrum efficiency in the television standards.
- Was Performed an analysis through the ETSI TR 101290 norm to 10 colombian public channels with compression MPEG-2 y MPEG-4 where is applied statical multiplexing and were divided according to the compression type and were determined the bit rate and entropy for the same content with different dispersion complexity.
- With the average measurement of entropy and bit rate, was identified less information in the contents of MPEG-4 for the same quality of MPEG-2 video into a transport stream; this allows better video quality or more contents in a transport stream.




a)




b)

Fig. 7. a) Service MPEG-2 video average, b) Service MPEG-2 entropy

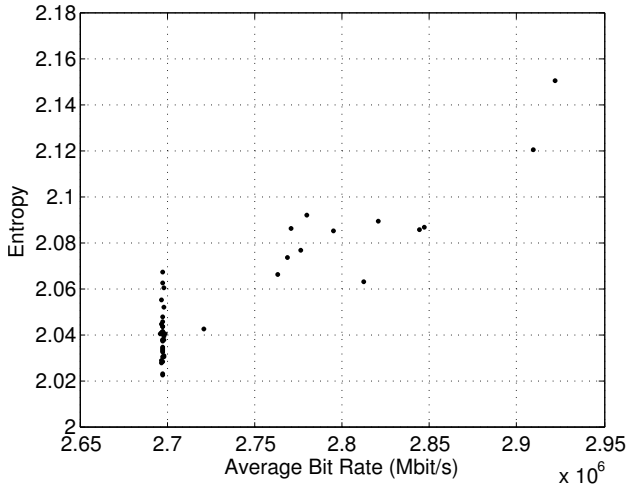



Fig. 8. Relation beetwen Entropy and Bit rate for MPEG-2

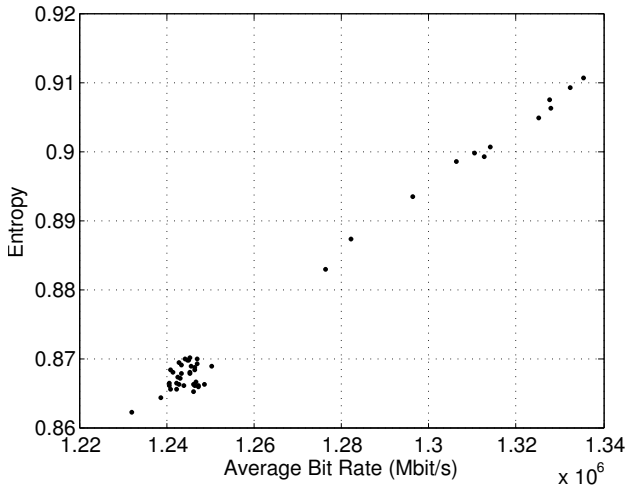
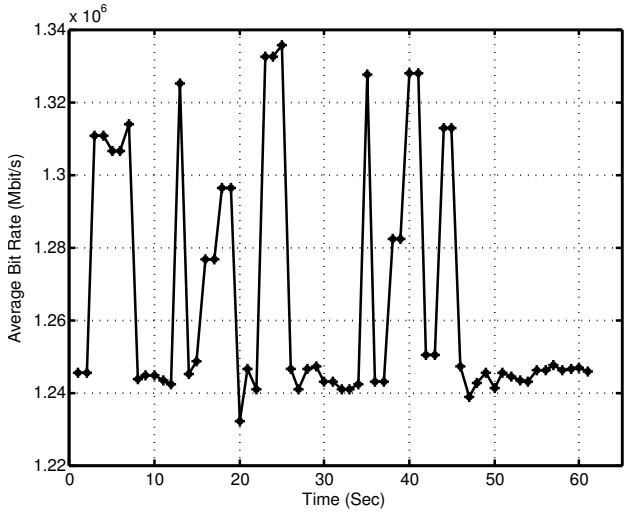



Fig. 9. Relation beetwen Entropy and Bit rate for MPEG-4

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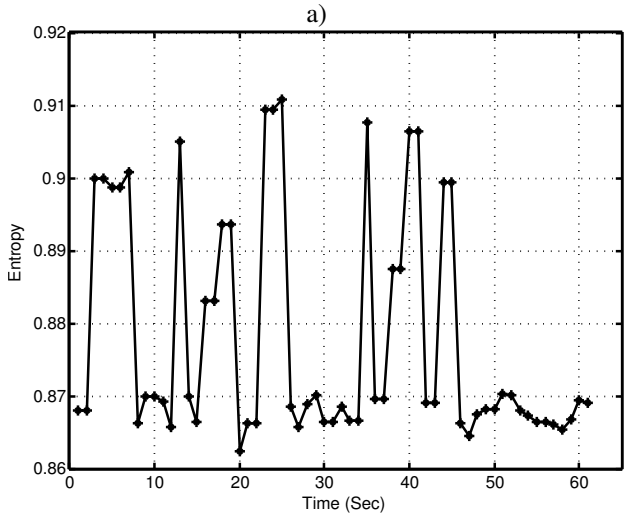


b)

Fig. 10. a) Service MPEG-4 video average, b) Service MPEG-4 entropy

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[1] G. W. Collins, *Fundamentals of Digital Television Transmission*. John Wiley & Sons, 2000.

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