**A&QT-R2004 (THETA 14)**
**2004 IEEE-TTTC International Conference on Automation, Quality and Testing, Robotics**
**May 13-15, 2004, Cluj-Napoca, Romania**

# A LOW COST TRANSPORT STREAM (TS) GENERATOR USED IN DIGITAL VIDEO BROADCASTING EQUIPMENT MEASUREMENTS

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Abstract
This paper describes a methodology to generate Transport Streams using low cost domestic equipment, in some experiments involving DVB (Digital Video Broadcasting). First the basic aspects of DVB are described followed by a short description of the equipment used to build the DVB TS generator. The results allowed building a TS generator which can be used for near full functional tests in DVB technology before this technology being completely installed and active in Romania.

Keywords: Digital Video Broadcasting, Transport Stream, MPEG2

## 1.INTRODUCTION

The current generation of TV signal broadcast standards based on digital data compression and digital data transmission ensures both higher image quality and better bandwidth utilization than classic analog color TV broadcasting standards such as PAL, NTSC, and SECAM.

In January 1995, the Digital Video Broadcasting (DVB) project organized by the European Broadcasting Union (EBU) has published the first set of standards, which defined the new Digital Video Broadcast system. These DVB standards are the technical basis for implementing digital TV transmission in Europe, Asia, Australia, and many others regions of the world. DVB is proved to be the best candidate for a single global digital TV broadcasting standard. DVB-T broadcasting started in some countries of Europe (Germany, UK) and is considered for adopting in other (including Romania).

The active standards (ATSC, DSS) used in other countries are in general based on the same technology as DVB , this allowing the re-use of most components.

Future updates of the standards have improved the specifications, but the main lines remained the same.

Current DVB standards describe digital TV transmission over satellite and cable and modulation standards for terrestrial broadcast. DVB standards cover the system design and the modem standards for high bandwidth video data transmission as well as several auxiliary functions like Teletext, electronic program guides, and conditional access. The compression technique used by the DVB system is the ISO MPEG-2 algorithm.

The block diagram of a DVB receiver (generally called "set-top box") is presented and will be detailed in figure 3. The block schematic is almost the same for terrestrial, satellite or cable receivers, the main difference being in the RF stages of the diagram.

There are three basic standards of DVB:

- DVB-C is designated for TV and data transmission via cable
- DVB-S is used for transmission via satellite
- DVB-T is used for terrestrial TV transmission

### *1.1. DVB-S*

DVB-S ([1],[2],[4]) is a satellite-based delivery system designed to operate within a range of transponder bandwidths (26 to 72 MHz) accommodated by many European satellite organizations [3]. DVB-S is a single carrier system, with the payload (the most important data) at its core. Surrounding this core are a series of layers intended not only to make the signal less sensitive to errors, but also to arrange the payload in a form suitable for broadcasting. The video, audio, and other data are inserted into fixed-length MPEG transport-stream packets. This packetized data constitutes the payload. A number of processing stages follows:

• The data is formed into a regular structure by inverting synchronization bytes every eighth packet header.
• The contents are randomized.
• Reed-Solomon forward error correction (FEC) overhead is added to the packet data. This efficient system, which adds less than 12 percent overhead to the signal, is known as the outer code. All delivery systems have a common outer code.
• Convolutional interleaving is applied to the packet contents.
• Another error-correction system, which uses a punctured convolutional code, is added. This second error-correction system, the inner code, can be adjusted (in the amount of overhead) to suit the needs of the service provider.
• The signal modulates the satellite broadcast carrier using quadrature phase-shift keying (QPSK).

### *1.2. DVB-C*

The cable network system, known as DVB-C, has the same core properties as the satellite system, but the modulation is based on quadrature amplitude modulation (QAM) rather than QPSK, and no inner-code forward error correction is used [3]. The system is centered on 64-QAM, but lower-level systems, such as 16-QAM and 32-QAM, also can be used. In each case, the data capacity of the system is traded against robustness of the data.

Higher-level systems, such as 128-QAM and 256-QAM, are possible, but only when the quality of the network will allow the lowering of the decoding margin. In terms of capacity, an 8 MHz channel can accommodate a payload capacity of 38.5 Mbits/s if 64-QAM is used, without spillover into adjacent channels.

### *1.3. DVB-T*

DVB-T [3] must fulfill the requirements working in the following conditions:

- very variable signal-to-noise ratio
- large-scale multi-path effects (reflections from nearby
- house walls, etc. attenuate certain frequencies)

- a very populated frequency spectrum, interference from nearby TV channels, or remote stations on the same frequency band.

The selected DVB-T modulation scheme, called COFDM (Coded Orthogonal Frequency Division Multiplex), has the following characteristics:

- multiple mutually orthogonal QAM modulated carriers. A single symbol carries therefore several kilobits of information. A guard interval between symbols allows echos to pass by before the receiver starts the detection of the next symbol.
- 8192 or 2048 carrier frequencies, each modulated using a QAM with between 4 and 64 Symbols
- 8 MHz bandwidth
- outer FEC: Reed Solomon FEC RS(204, 188, T=8)
- outer convolutional interleaving
- inner FEC: Convolutional Code (1/2, ..., 7/8)
- inner interleaving

## 2. TRANSPORT STREAM GENERATION

### *2.1. TS encoder*

One of the most important aspects related to DVB experiments is test sequences delivery. This requires an expensive and rather complicated TS generator [7], with a limited set of test patterns. The required structure of the test generator is almost the same compared with a broadcast encoding module. The block schematic of the encoder for DVB is presented in figure 1.

Modulation and RF part are difficult to implement, but in most cases TS generation for Source Decoder functions verification is sufficient. The packet structure of the TS can be illustrated by figure 2.

### *2.2. Transport stream – short description*

The transport stream is composed from time-multiplexed packets from different

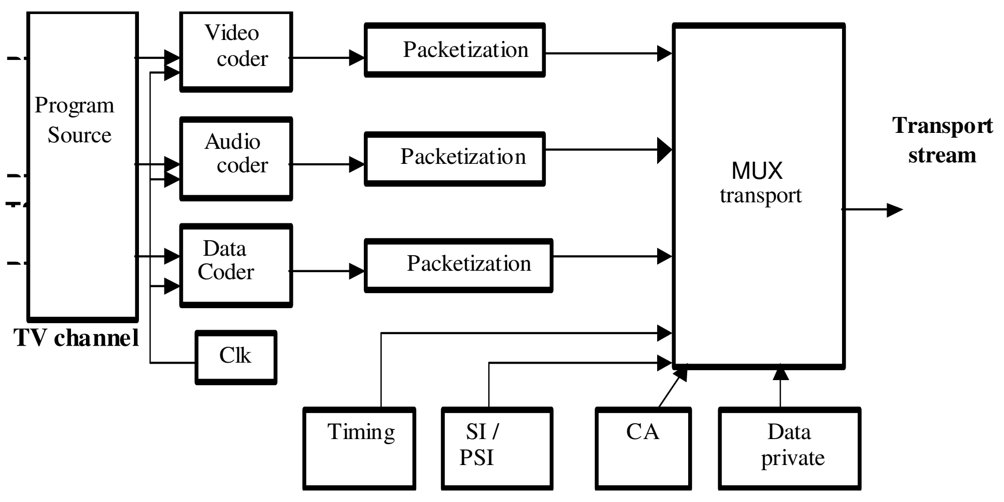
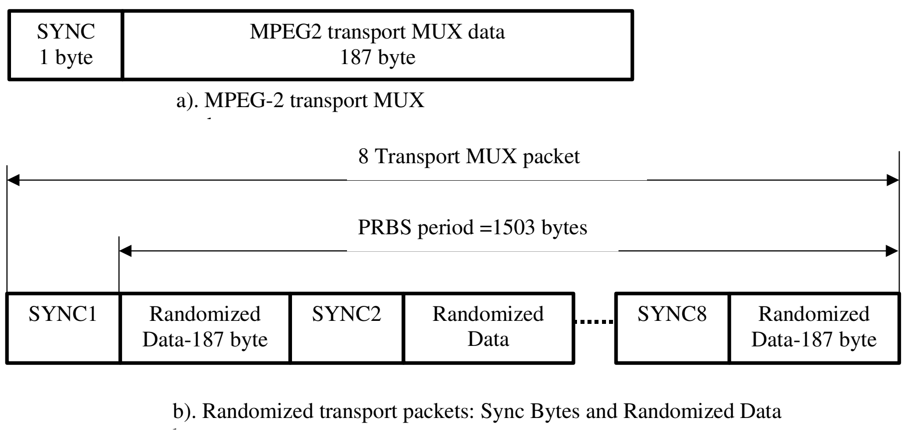



*Fig.1. DVB TS coding process*

streams. The MPEG-2 packet is a 188-byte packet, consisting of a 4-byte header leaving 184 bytes for payload, as shown in figure 2a. The small packet length is more suited for high error mediums as the errors thus affects less data, although the header represents a higher overhead for such a packet size. The header, as shown in figure 2, contains a Sync byte used for random access to the stream. It also contains a Program ID (PID), which allows for the identification of all packets belonging to the same data stream, or alternatively it provides a mean for multiplexing data streams within transport streams.




a). MPEG-2 transport MUX

b). Randomized transport packets: Sync Bytes and Randomized Data

*Fig.2. Packet structure in DVB*

## 3.IMPLEMENTATION

The basic idea of this low-cost TS generation is to use a regular DVB receiver, preferable a DVB-S receiver, and to build inside an interface capturing the internal TS, which is amplifying and delivering the data serial or parallel to the tested device. The

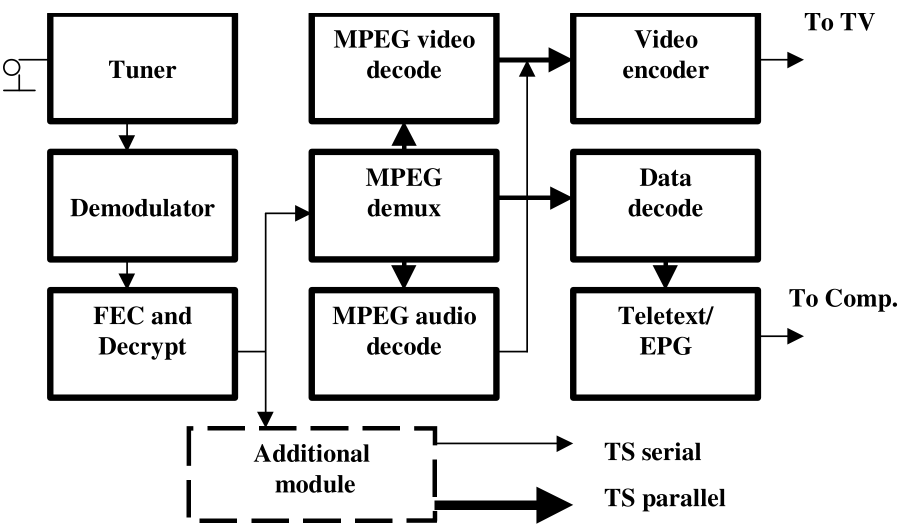



*Fig. 3. Block diagram of DVB receiver*

reason to choose a DVB-S receiver is that DVB-S is the most common way to deliver digital television and it is accessible practically every ware. Using DVB-S technology allows the possibility to deliver either "natural" images or static (test pattern) signals. To illustrate the basic idea of the test generator, figure 3 presents the block diagram of the DVB receiver. This schematic is practically the same for any of the DVB technologies. The TS delivered from the demodulator after FEC calculation, is available in most receivers both in serial or parallel form. These signals need to be amplified and the most convenient way to transport them is to use a LVDS transceiver, allowing less RF radiated perturbations, and a better reliability.

This TS extraction is performed by the additional module presented in figure 3. A more detailed block diagram of this module is presented in figure 4. The source decoder used in the proposed DVB-S receiver [6] is based on Sti5518 source decoder IC.

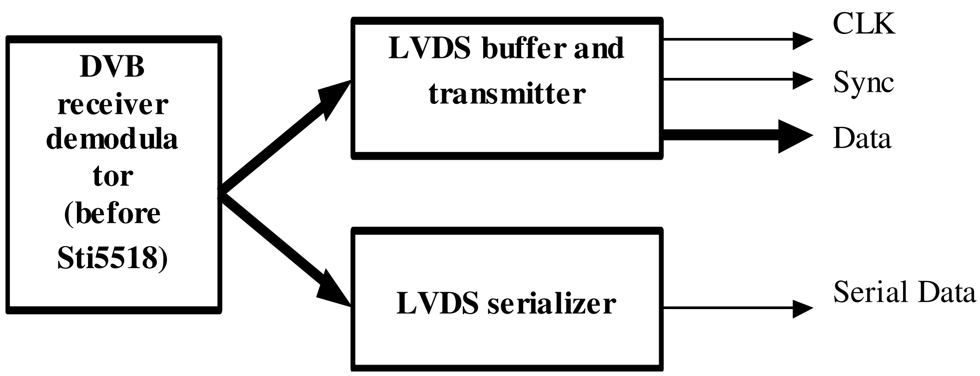



*Fig. 4. Block diagram of the additional module*

## 4.CONCLUSION

This simple technique allows TS generation for test purposes in small laboratory [5], without spending thousands of dollars for a professional TS generator.

The quality of the generated signal is guaranteed, unless of the most low-cost TS generators that makes compromises in DVB standard implementation. The only weakness of this solution is that the generated images are "natural" ones and some objective measurements need standard fixed test charts to obtain results comparable with other equipment.

The next step in this practical research would be to implement the RF part of the modulation for the three DVB standards.

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