A Review of Second Generation of Terrestrial Digital Video Broadcasting System

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Abstract

Digital broadcast systems have increasingly been deployed for various services such as Digital Video Broadcasting (i.e. DVB-S, DVB-T, etc.) and Digital Audio Broadcasting (DAB). Classical digital broadcast systems were designed with fixed modulation guarantee reliable communication even with very hostile channel environment. DVB-T2 terrestrial television standard is becoming increasingly important. The emergence of it is motivated by the higher spectral efficiency and adopting transition from analogue TV to DVB-T2, or transition from DVB-T to DVB-T2. It can reduce the transmission cost per program and deliver HD services economically viable. It introduces a new technique to improve performance in channels with frequency selective fading. If in addition improved source coding (MPEG-4) is employed, the gain in broadcast transmission is remarkable.

Keywords: DVB-T, DVB-T2, Digital video broadcasting

I. Introduction

DVB-T2 is the second generation standard for digital terrestrial TV, offering significant benefits compared to DVB-T. IT is the world's most advanced digital terrestrial transmission system offering highest efficiency, robustness and flexibility. It introduces the latest modulation and coding techniques to enable highly efficient use of valuable terrestrial spectrum for the delivery of audio, video and data services to fixed, portable and mobile devices. These new techniques give DVB-T2 a 50% increase in efficiency over any other DTT system in the world. DVB-T2 will coexist for some years with DVB-T transmission. Similarly to the first generation standard (DVB-T, ISDB-T, DAB), DVB-T2 uses OFDM (Orthogonal Frequency Division Multiplex) modulation, with a large number of sub- carriers delivering a robust signal, the new specification offers a range of different modes making it a very flexible standard. DVB-T2 uses the LDPC (Low Density Parity Check) codes offering excellent performance in the presence of high noise levels and interference. Transmission quality and reliability is improved by the introduction of advanced clipping functions, named PAPR techniques.

II. DVB-T2 Key Concept

DVB-T2 is a complex standard which is built with more than 30 building blocks. The new advanced signal processing techniques such as rotated constellation, ACE (Active Constellation Extension) and TR (Tone Reservation) PAPR reduction techniques, MISO (Multiple Inputs Single Output), Flexible time interleaver, FEF, scalable frame structure are good examples of how to bring added value to a broadcast technology.

Four main guidelines of DVB-T2 are:

A. Capacity increase

In DVB-T2, benefiting from higher modulation order (256QAM) and more efficient DVB-S2, LDPC FEC, up to 50% capacity gain is achieved compared to DVB-T performances.

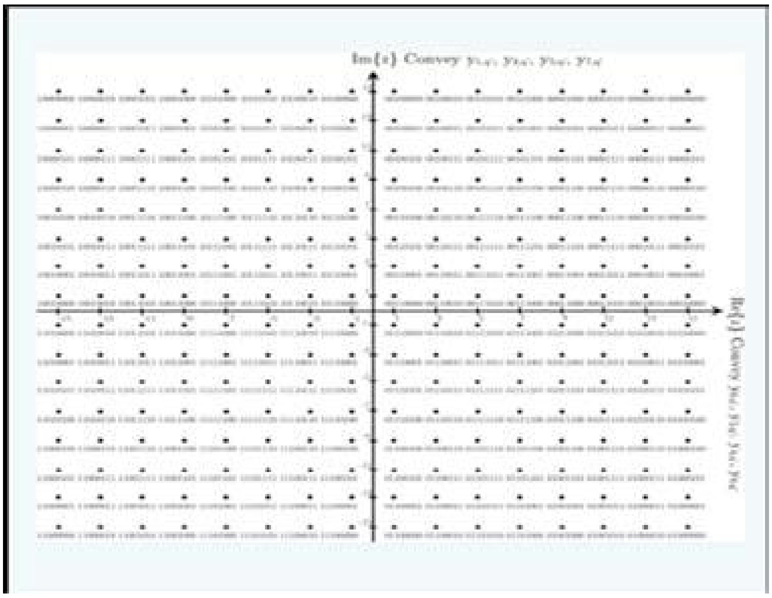

Figure 1: 256 QAM modulation

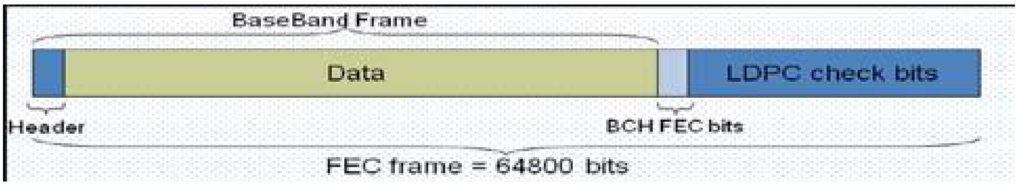

Figure 2: baseband frame

B. Efficiency increase with Tone reservation or ACE

Lower PAPR achieved with tone reservation or Active Constellation Extension. The goal of these techniques is to achieve better RF performances and increase overall efficiency of the RF power amplifiers. With this technique, the purpose is to achieve Peak to Average Power Ratio below 10dB.

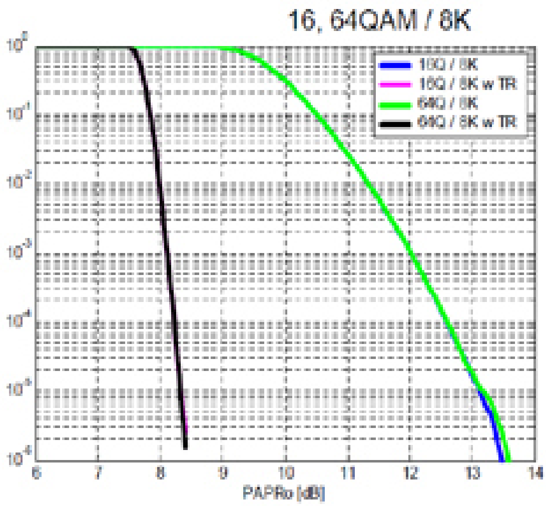

Figure 3: PAPR reduction

ISSN 2224-610X (Paper) ISSN 2225-0603 (Online)
Vol.6, No.2, 2016

C. Flexible and robust system based on innovative frame structure

New T2 frame structure: A T2 frame is based on P1 preamble, P2 preambles followed by data symbols. P1 preamble is used for fast parameters detection and raw equalization while P2 preamble symbols are used to discover the subsequent T2 frame parameters.

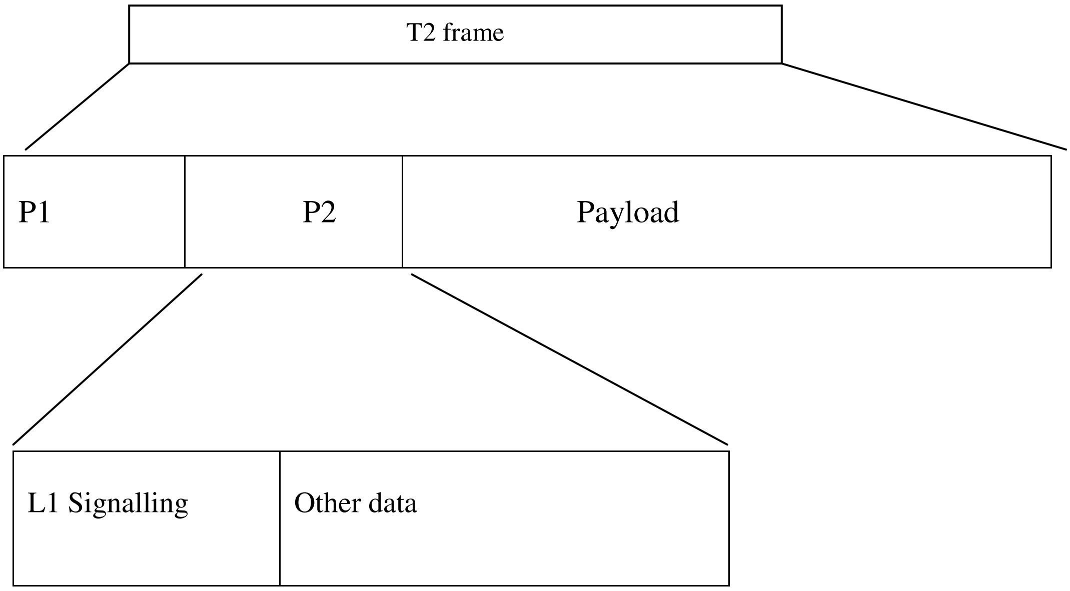

Figure 4: Frame Structure

T2 frame is based on the same DVB-T frames using guard interval OFDM data symbols

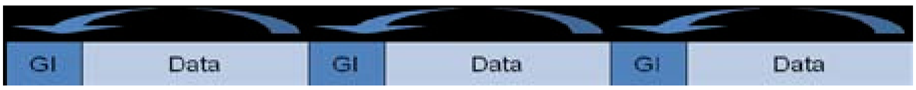

Figure 5: Guard interval

MPLP mode offers a Service specific robustness while SPLP mode can be used in existing distribution network based on MPEG2-TS.Time interleaver combined with Cell interleaver can be adjusted for each PLP and the depth of the interleaver can be adjusted on 1 or several consecutive frames. This makes time interleaver really robust against impulse noise. Rotated constellation combined with cell interleaver improves signal robustness in corner reception scenarios by de-correlating I & Q components of regular grey mapping scheme.

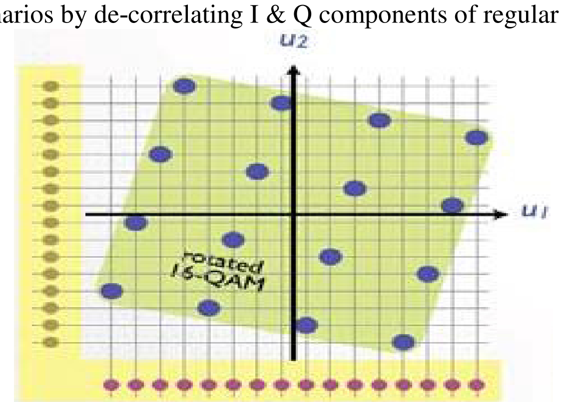

Figure 6: Rotated constellation

D. T2 lite

The mobile configuration of the DVB-T2 standard, also called T2-Lite, uses a limited number of available modes which are optimized for mobile transmission and minimize the requirements for the receiver.

- Maximum bitrate of 4 Mb/s per PLP
- Limitation of the FFT size to exclude 1K and 32K carriers mode
- Allows only short FEC frames (Nldpc = 16200)
- Limitation of the size of the time interleaver memory to approximately half the size of normal DVB-T2 transmission
- Reduces set of combinations of FFT size, guard interval and pilot pattern. PP8 pilot pattern is not allowed
- Prohibition of the use of rotated constellations in 256-QAM and addition of two new more robust code rates (1/3 and 2/5)

III. System Overview

Like many modern terrestrial broadcasting and radio communication systems DVB-T2 uses OFDM (orthogonal frequency division multiplex) modulation. DAB (Digital Audio Broadcasting) and DVB-T were in the nineties the first digital terrestrial broadcasting standards that made use of this technique. Since the introduction of the first DVB based DTT standards, many other wireless communications systems like IEEE 802.11, IEEE 802.16 and LTE have finally adopted OFDM as transmission technique. The DVB-T2 standard was originated by the demands to increase the spectral efficiency of digital terrestrial systems in the UHF/VHF bands. The standard provides high flexibility in multiplex allocation, coding, modulation and RF parameters. The DVB-T2 transmission chain is depicted in Fig. 7 where the main processing blocks are represented. In comparison with DVB-T, DVB-T2 adds new elements which is connected to the modulator, or modulators in a SFN configuration, by an interface named T2-MI (T2 Modulator Interface) . The T2-Gateway performs the needed tasks to ensure that all the modulators belonging to the same SFN generate the same signal, or the two possible signals in case of MISO SFN.

A. Input Processing
The DVB-T2 standard allows the following input formats:
1) Transport Stream (TS). Stream with constant packet length, as in DVB-T.
2) Generic Encapsulated Stream (GSE). Constant or variable length packets, where the format is known by the modulator. This format is intended to broadcast IP content without using TS-MPE (Multi-Protocol Encapsulation)
3) Generic Continuous Stream (GCS). Variable length packets. Modulator does not know the actual length.
4) Generic Fixed-length Packetized Stream (GFPS). For compatibility with DVB-S2. Not expected to be used.
TS can still be used as in DVB-T. However, some optional mechanisms are designed to decrease the overhead that TS format introduces:
1) Null Packet Deletion. Remove most of the null packets of the TS.
2) High Efficiency Mode (HEM). Remove the SYNC (synchronization) byte of the TS. Also used with GSE format.

The receiver at the output will be able to replace the removed parts again. If TS format is going to be used, these options should be selected, because in general no drawbacks are present. These types of streams are allocated to T2 baseband frames (BBframes). Sometimes padding could be needed to adjust the input stream packets to the BBframes. Then the contents of the BBframe are scrambled.

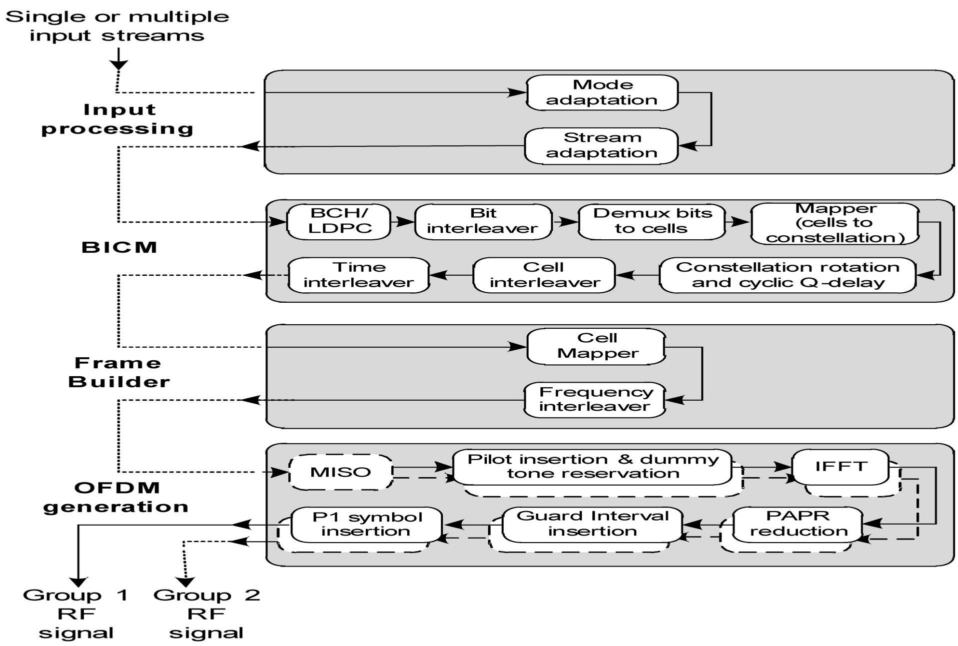

Figure 7: DVB-T2 Block diagram

B. BICM

The BICM (Block Interleaving and Coding Modulation) includes all the interleaving, coding and modulation steps carried out over each BBframes of a given T2 PLP (Fig. 7). According to the BICM, the input BBframes of a PLP to be transmitted are first coded by an outer encoder (BCH) and an inner encoder (LDPC). The use of the LDPC is responsible for the robustness increase compared with other systems like DVB-T, and is a common characteristic of the DVB second generation standard family (DVB-S2, DVB-T2 and DVB-C2) while the outer BCH encoder is intended to reduce the error floor of the LDPC . Six code rates (CR) or protection levels are defined: 1/2, 3/5, 2/3, 3/4, 4/5 and 5/6 (from more protected to less protected), and two sizes for the LDPC FEC frames, 16K and 64K. Short FEC frames are slightly less robust (about 0.2 dB), but allow an easier scheduling, especially for low data rates. Since the encoding scheme of DVB-T2 greatly out performs the Convolutional and Reed Solomon codes used in DVB-T, DVB-T2 introduces the higher order constellation 256-QAM which increases the spectral efficiency and bit rate.

C. Frame builder

The function of frame builder is to assemble the cells produced by the time interleavers for each of the PLPs and the cells of the modulated L1 signalling data into arrays of active OFDM cells corresponding . Frame builder works according to the information generated by the scheduler and the configuration of the frame structure.

The function of the OFDM generation module is to take the cells produced by the frame builder, as frequency domain coefficients, to insert the relevant reference information, known as pilots, which allow the receiver to compensate for the distortions introduced by the transmission channel. It then insert guard intervals and, if relevant, applies PAPR reduction processing to produce the completed T2 signal. A block diagram of this module is found in figure

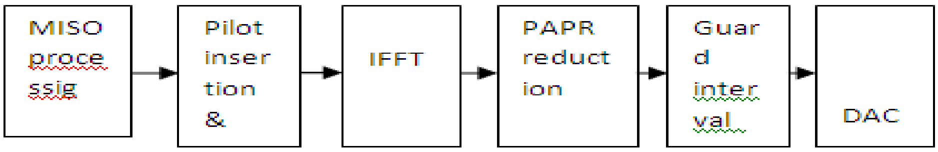

Fig 8: OFDM generation block diagram

The DVB-T2 frame structure is shown in figure 9. At the top level, the frame structure consists of super-frames, which are divided into T2-frames. The super-frame may in addition have FEF parts into super frames, T2 frames and OFDM symbols.

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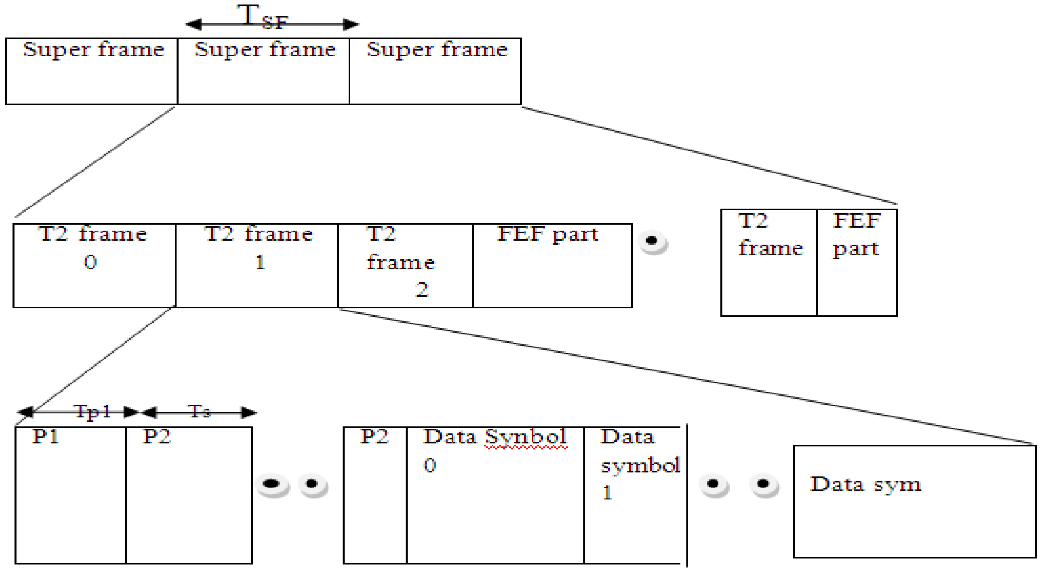

Fig 9: The DVB-T2 frame structure, showing the division

D. OFDM generation

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IV. Conclusion

DVB-T2 provides data rates between 50% and 90% higher than DVB-T for the same level of robustness. The increase results from the following advances:

- Improved FEC
- Rotated Constellation and Q-delay
- Greater choice for guard interval
- Higher FFT modes (number of carriers)
- larger SFNs
- Flexible Pilot Pattern
- MISO

This definitely makes it the first choice when introducing DTT or adding HD services to the terrestrial platform. However, accurate definition of the key parameters of the DVB-T2 system is more critical in planning DVB-T2 networks than it is for DVB-T. The configuration of the system for receiving fixed services with roof top antenna is the simplest one and the objective is to maximize the capacity at the lowest possible C/N value. In the case of mobile and portable reception many factors are present, like Doppler spread, delay spread or power variations. At

Present DVB-T2 has been officially adopted and commercially launched in more than 50 countries world wide. Some of them are India, Indonesia and Russia which are highly populated. This may lead to an important growth in the DVB-T2 equipment manufacturing industries and c increasing availability of low cost receivers. This is a key factor to ensure the success of any new broadcasting standard.

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