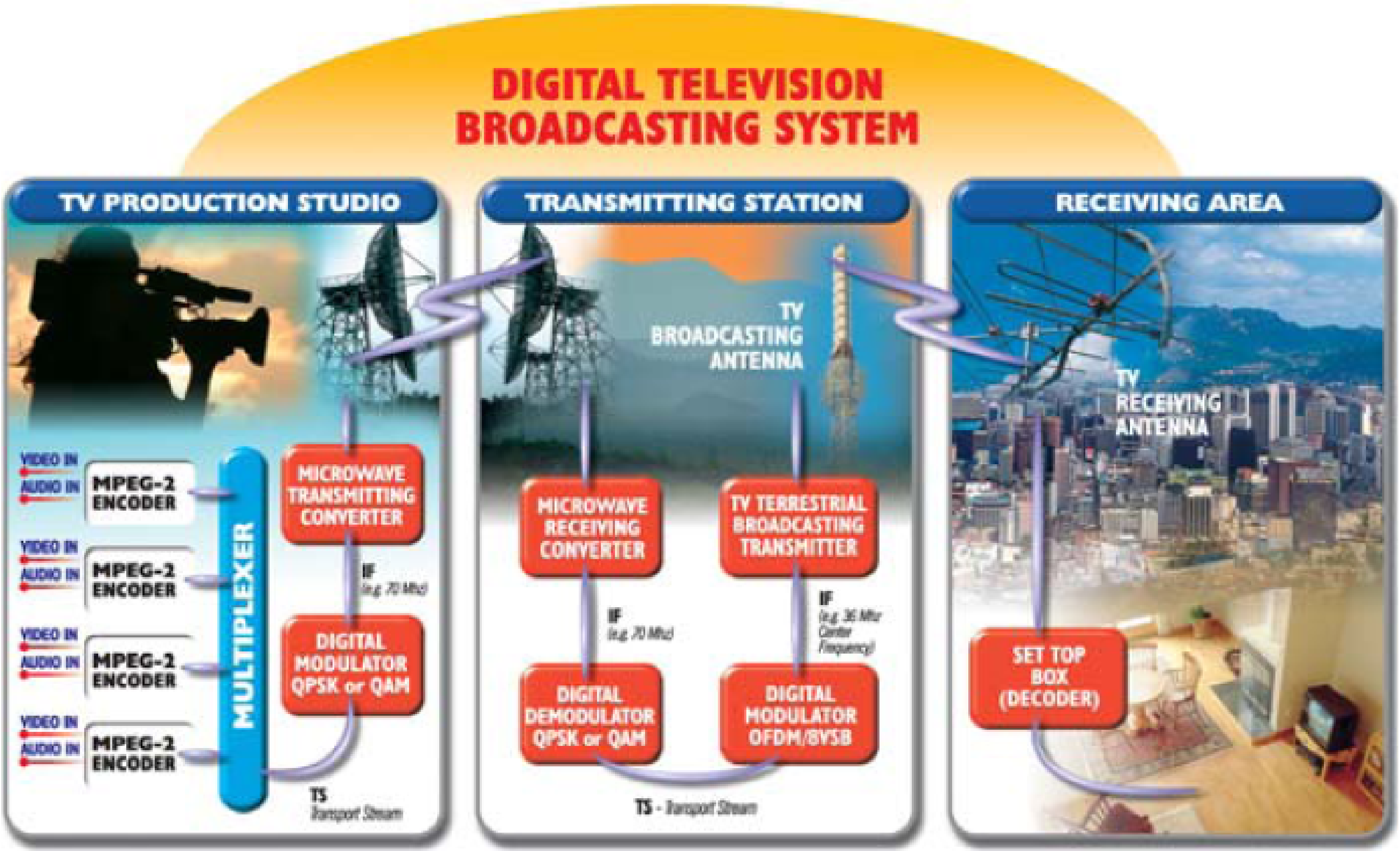
TS 102 005 V1.2.1 “Specification for the use of Video and Audio Coding in DVB services delivered directly over IP protocols”

The advantages of digital TV transmission, in comparison with analog, considering both microwave links and actual broadcasting, are notable and evident from the following:

- more TV programs may be transmitted in a given RF spectrum (typically at least four times as many, that is, in a single RF channel it is possible to broadcast 4 or more digital TV programs instead of a single analog one)
- lower transmission power will cover the same distance (that is, greater immunity to noise and interference)
- better picture/sound quality
- possibility of Isofrequency Terrestrial Broadcasting Networks, that is to have more transmitters in operation, broadcasting the same program, on the same frequency, covering adjacent areas. Practically, it is possible to use the same channel on large areas using more transmitters without having interference problems among them (OFDM emission with SFN – Single Frequency Network)
- possibility of mobile reception without having the typical problems of analog systems, that is double images, reflections, distortions, etc. (OFDM modulation)
- possibility for simultaneous transmission of auxiliary data

Example: Structure of a Digital TV Broadcasting multiprogram system



TV Production Studio:

•The TV production studio generates more audio/video programs (in the example are 4) that are digitally codified according to the MPEG-2 standard and multiplexed (that is aggregated to make a single digital data stream called a transport Stream).

•The Transport Stream digitally modulates an IF (Intermediate Frequency) carrier (usually at 70MHz), according to the QPSK or QAM modulation scheme. The IF carrier is converted into microwave frequencies and transmitted to the broadcasting station directly (terrestrial microwave link) or through a satellite or terrestrial transponder.

Transmitting station:

•The microwave received signal is converted at IF (Intermediate Frequency – 70MHz) and digitally demodulated so to get the Transport Stream that contains the four programs.

•The demodulator can eventually also decode the four programs, so as to have them separately available both in analog and/or in digital format, for other purposes (i.e., to be broadcasted with analog TV transmitters).

•The Transport Stream, at this point, digitally modulates an IF carrier(usually at 36 or 44MHz) according to the digital terrestrial broadcasting standard OFDM (DVB-T) or 8VSB (U.S. ATSC).

•The IF carrier is then converted to the VHF or UHF band, amplified and radiated through the broadcasting antenna, to be available in the receiving area.

Receiving area:

The digital broadcast signal is received through the viewer's antenna and feeds to a proper receiver /decoder (usually called settop-box or IRD) connected to the TV set (functioningas a video / audio monitor).

Transport Stream, interfaces (ASI/SPI)

•In the Transport Stream (data stream containing video / audio / data programs) to be carried from the generating/broadcasting equipment to the users/viewers), data have a constant bit rate and are organized in a continued sequence of “packets.” These packets have fixed length of 188 bytes (204 bytes if data for Reed Solomon correction algorithm are present).

•To maintain the bit rate of the Transport Stream constant, also when there are no data packets to be sent, valid packets with null content are generated and inserted (this procedure is called “Bit Stuffing”). These “null packets” will be recognized and eliminated during processing.

•Each packet is composed of a header (that has a standard dimension of 4 bytes, except for particular cases), which includes a sync byte, the PID (Program Identifier – a number that identifies the video / audio / data program to which the packet is referred) and other information, followed by the “payload”: the data of the real program to be “transported.”

Commonly used Transport Stream interfaces are:

•*Synchronous Parallel Interface SPI:* This interface is made by 11 contemporaneous signals: 8 data signals (Parallel Data Path), 1 clock signal, 1 synchronism signal (Psync) and 1 signal which identifies when valid data are transmitted (Dvalid). The Bit Rate is variable (Max 108 Mbit/s on Data Path) and the standard connector for this interface is 25 pins. Electrical levels may be LVDS (Low Voltage Differential Signal) for external, short connections, between different pieces of equipment or may be LVTTL (LowVoltage TTL) for short connections among the same equipment.

•*Asynchronous Serial Interface (ASI):* This is the most commonly used interface, which has a constant bit rate at 270 Mbit/s working on a single unbalanced coaxial line (75 Ohm impedance). Its standard connector is BNC. The difference between available Transport Stream Bit Rate and 270 Mbit/s is filled by stuffing bytes, which will be discarded during the deserialization process.

This interface is used for connections between different pieces of equipment, even

when separated by long distances.

Multiplexing

•The Multiplexer is a device that aggregates several Transport Streams (coming, for example, from different encoders) into a single Transport Stream, which includes all the streams.

•In addition, the Multiplexer (Re-Multiplexing function) can modify Transport Streams, adding data and tables (for example NIT, Network Information Table, into which it is possible to edit transmitted program's names that will appear to the user).

Some Multiplexer considerations, settings and tests:

• Multiplexer output Transport Stream Bit Rate must be set to be equal or greater to the sum of the input Transport Streams Bit Rate + data + tables.

• Data/tables to be inserted and/or modified may be several (NIT data, EIT Event Information Table that describe programs transmitted, etc.). Some multiplexers can add TELETEXT that, since it is not part of the video active lines, cannot be encoded by MPEG-2 encoders.

• If serious errors are present in the Transport Stream decoders will not work or will generate errors.

• To function, some decoders require data or tables (for example the NIT) in the Transport Stream, while for other decoders, these data aren't essential.

• For a correct and complete analysis of the Transport Stream there are dedicated instruments able to indicate errors or nonconformities (Transport Stream errors are classified with three priority levels - see

ETSI technical report TR 101 290, ex ETR 290).

Digital TV broadcasting terrestrial transmitters:Specifications, advantages, measurements, differences and upgrading from analog operation

•Nowadays, even when transmitters are not supplied as "digital," thanks to all improvements introduced with the development of digital technologies, they are "digital ready," meaning that they can be easily converted into digital transmitters with minimum economic and technical impact.

•Here are main differences and possible modifications with respect to analog transmitters.

- *IF Modulator*

The 36 or 44 MHz (center frequency of the bandwidth) IF analog Modulator has to be replaced by a suitable digital OFDM or 8VSB Modulator having the same IF and compatible output level and impedances (e.g., the ABE DME 1000 that is also equipped with one or more MPEG-2 encoders and multiplexer).

-*IF/RF Bandwidth*

information capacity – considerations about settings – the guard interval The occupied bandwidth (channel) is exactly the same of the analog transmitters: 6, 7 or 8 MHz.

The input Transport Stream Bit Rate with 8VSB transmitters is fixed at 19.28 Mb/s or depends on bandwidth setting (6,7 or 8 MHz), modulation scheme (QPSK, 16 or 64 QAM), Code Rate setting (from 1/2 to 7/8) and guard interval setting with OFDM transmitters (DVB-T standard) and may vary from around 4 to nearly 32 Mb/s.

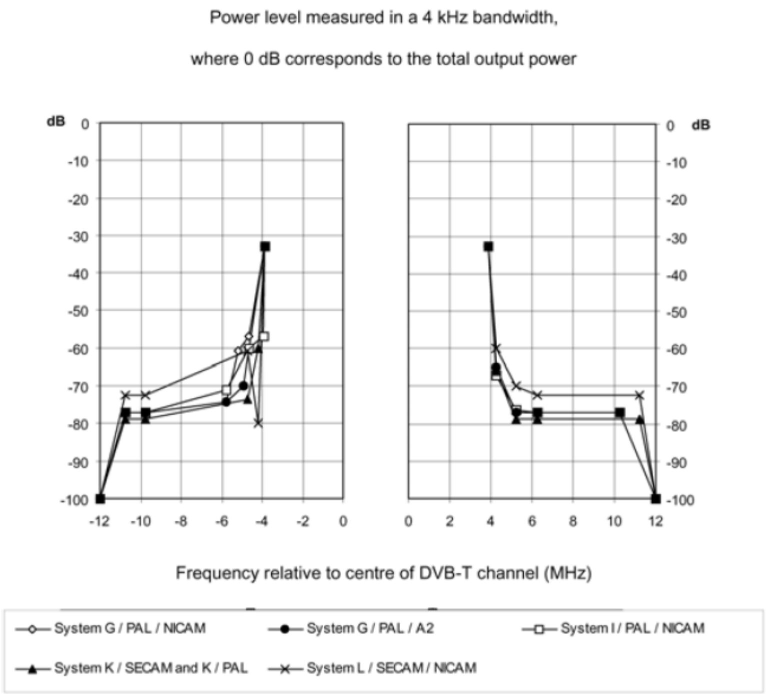
Since in a standard application it uses an input Bit Rate to the modulator of 19 to 24Mb/s, it is possible to transmit 4 video programs, each with double audio, with excellent broadcast quality, in a single TV channel (around 5 – 6 Mb/s per TV program).

Power amplifiers: phase and amplitude linearity – RF power and output spectrum measurements

•Digital modulators (and especially OFDM) require extremely linear amplification.

•Transmitters' power amplifiers should be made with high efficiency and linear solid state technology, thanks to last generation MOSFET and LDMOS and to the use of pre correction techniques.

•Output spectrum mask required for a DVB-T OFDM transmitter operating on a lower or a higher adjacent channel to a co-sited analog television transmitter (the specification is normally compiled using a proper filter at the output of the transmitter).



Phase noise of local oscillators – frequency stability

•In the digital TV transmitters, local oscillator phase noise must be very low, much lower than what is needed for analog TV transmission.

•Usually, synthesized local oscillators with excellent performance and low cost, which are now currently

employed in the analog transmitters. Please note that, especially with OFDM transmitters (up to 6817 carriers), the oscillator's phase noise is added 6817 times into the emission channel!

•The local oscillator's low phase noise is crucial because otherwise it may cause deterioration of some qualitative parameters (first of all the Modulation Error Ratio – MER).

•Frequency precision/stability (that for standard applications is required to be 500Hz) is a parameter that has great importance in case of OFDM transmission in SFN (Single Frequency Network – that is, a network of transmitters with a single frequency). In this case all transmitters must be synchronized to a single reference signal: the GPS (Global Positioning System) has been chosen for this purpose.

Digital TV transmitter's main measurements – MER

•MER (expressed in dB) is a function of the ratio between the theoretical vector amplitude of a symbol and the amplitude of the shift vector from the theoretical position of the symbol in the constellation and the effective position, averaged for a certain number of symbols. The higher the MER, the more precise the constellation generated from the transmitter and the lower the errors made by the receivers demodulating it.

•In order to give some practical figures, it has to be considered that to demodulate a QPSK modulation scheme, MER cannot be lower than 5dB; for a 16QAM it needs to be at least 11dB MER and for a 64 QAM it needs to be at least 19dB. Moreover it has to be considered that a commercial receiver generally cannot take advantage from MERs higher than 30dB; so a reasonable requirement for a MER value at the output of a transmitter, for OFDM/64QAM emission, can be 30/32dB.

Comparison between performances of digital and analog TV transmitters

•With an analog TV transmitter, with amplitude modulation, as the level of received signal reduces below a certain threshold, the video and audio quality deteriorates progressively. In practice, the minimum acceptable signal is about 0.5/1 mV.

•In contrast, the audio and video quality of a digital receiver is not degraded and, moreover, remains constant as the received input signal level is reduced, right down to a threshold (generally around 20dB under analog threshold), below which the signal is lost.

•The exact threshold level depends by various factors/settings: Code Rate, Symbol Rate, receiver noise figure etc.

•Summarizing, digital operation confers many notable advantages:

• A single transmitter may be used to carry 4 (or more) video/audio/data program channels.

• Received signal quality is higher and does not degrade progressively as the receiver input reduces but remains constant down to a very low threshold (the receiver input range is increased by around 20dB with respect to the level needed for a good analog reception). *So it is possible to use lower RF power or smaller antenna size to broadcast over the same area.*

• The DVB-T standard allows mobile reception without the typical problems associated with analog systems (reflections, distortions, double images, and so on), and Single Frequency Network operation.

DVB Internet Protocol TV

Broadcast to Broadband – IPTV Solutions

What is DVB-IPTV?

DVB-IPTV is the collective name for a set of open, interoperable technical specifications, developed by the DVB Project,

that facilitate the delivery of digital TV using Internet Protocol over bi-directional fixed broadband networks. The work is

taking place in two phases, with the first phase nearing completion. Two specifications have already been published as

formal ETSI standards along with a Guidelines document:

- TS 102 034 : Transport of MPEG-2 TS-Based DVB Services over IP Based Networks

- TS 102 539 : Carriage of Broadband Content Guide (BCG) Information over Internet Protocol

- TR 102 542 : Guidelines for DVB-IP Phase 1 Handbook

NEW STANDARDS

TS 102 005 V1.2.1 “Specification for the use of Video and Audio Coding in DVB services delivered directly over IP protocols” (06/05/06)

EN 300 468 V1.7.1 “Specification for Service Information (SI) in DVB systems” (23/05/06)

EN 302 307 V1.1.2 “Second generation framing structure, channel coding and modulation systems for Broadcasting, Interactive Services, News Gathering and other broadband satellite applications (DVB-S2)” (13/06/06)

TR 101 790 V1.3.1 “Guidelines for the Implementation and Usage of the DVB Interaction Channel for Satellite Distribution Systems” (14/09/06)

TS 102 034 V1.2.1 “Transport of MPEG-2 Based DVB Services over IP Based Networks” (28/09/06)

TS 102 523 V1.1.1 “Portable Content Formats (PCF)” (05/10/06)

TR 102 542 V1.1.1 “Guidelines for DVB IP Phase 1 Handbook” (14/11/06)

TS 102 539 V1.1.1 “Carriage of Broadband Content Guide (BCG) information over Internet Protocol (IP)” (14/11/06)

TS 102 471 V1.2.1 “IP Datacast over DVB-H: ESG” (17/11/06)

EN 300 743 V1.3.1 “Subtitling systems” (29/11/06)

TS 102 472 V1.2.1 “IP Datacast over DVB-H: Content Delivery Protocols” (13/12/06)