Teletext — in digital television

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IRT

Teletext is about 25 years old and is currently being brought into the digital broadcasting environment by the DVB project. This article looks at some of the key issues involved in offering teletext and subtitling to DVB viewers.

The digital transmission of television programmes has become a reality more quickly than was ever imagined. This is a result of the enormous progress made over the last few years in reducing the quantity of data in digital video signals. The advantages are obvious: smaller bandwidths offer savings in energy which in turn reduce the transmission costs, thereby enabling a larger number of programmes to be fed into cable network and satellite channels. For the viewer, this means even more programmes than before, plus the fact that more space is available for ancillary data services of all kinds. For these services, including teletext, the changeover to digital transmission has been little short of a revolution. Gone are the days of low data-rates in the vertical blanking interval of the analogue television signal. With digital television there is a choice of bandwidths and the data-rates can now easily be increased.

Use of partial capacities in the MPEG transport stream also provides the opportunity for new types of services. The buzzword here is *multimedia applications*. The key to this procedure is *flexible scaling* which offers a vast potential for new applications, the enormity of which cannot even be grasped. In Europe, most of the research in this area is being carried out at the EBU. In co-operation with DVB, MHP and standardization committees such as ETSI, the EBU is in the process of standardizing a Java-based procedure for ancillary data services. This specification work will probably be completed during 2001. It relates mainly to ancillary data such as EPGs and other information services similar to teletext but closer in form to the online services found on the Internet. In this connection, the return channel from the viewer to the transmitter or broadcaster represents a great leap forward, enabling totally new types of interactive applications to be introduced.

It should also be mentioned that in anticipation of these open standards, various proprietary procedures are now already "on the air"; for example, the ARD online service

based on OpenTV and the service provided by ZDF (ZDF.vision). However, not all digital receivers (known as set-top boxes) or integrated receiver-decoders (IRDs) are able to read this type of additional information yet.

Teletext in DVB

In spite of – or perhaps because of – the astounding new dimensions offered by digital television, the viewers want more. They are keen to obtain quicker and more accurate information, similar to that which has been available in Europe on teletext since around 1980. A look at the number of hits per day – approx. 9.5 million viewers for ARD and ZDF's teletext pages – illustrates the significance of this service. On average, each broadcaster offers more than 500 pages and these can also be updated for analogue television within 20 to 30 seconds. Modern teletext decoders can also store these pages on a permanent basis, enabling the viewer to consult them immediately without having to wait for them to download.

DVB also wants to use this teletext service. After all, viewers expect to be able to find their usual services in digital bouquets too. Until the new technology offers an equivalent service with digital improvements, viewers will be missing out.

Abbreviations

BAT	(DVB) Bouquet Association Table
CLUT	(DVB) Colour Look Up Table
DVB	Digital Video Broadcasting
DVB-C	DVB - Cable
DVB-S	DVB - Satellite
DVB-SI	DVB - Service Information
DVB-T	DVB - Terrestrial
EIT	(DVB) Event Information Table
ETSI	European Telecommunication Standards Institute
IRD	Integrated receiver/decoder
MHP	(DVB) Multimedia Home Platform
MPEG	Moving Picture Experts Group
NIT	(DVB) Network Identification Table
PES	(MPEG) Packetized Elementary Stream
PID	(MPEG) Packet Identification Number
PMT	(MPEG) Programme Map Table
PTS	(DVB) Presentation Time Stamp
ROM	Read-only memory
SDT	(DVB) Service Description Table

DVB uses the MPEG-2 standard which the MPEG organization defines as a (digital) transport stream. *Fig. 1* illustrates the location of teletext alongside MPEG-2 – video and audio – and the data channel. It is embedded into what is known as a Packetized Elementary Stream (PES), which forms packets from the individual streams. In the case of teletext, these packets contain 45 bytes so that a complete teletext line can be transferred in one packet. One byte represents one character. A teletext page consists of 23 visible lines, each containing 40 characters. The remaining five bytes are required for the teletext control information, such as the language and character set, and these are taken from the teletext specification. So each teletext PES packet that is transmitted in DVB contains a complete line of teletext.

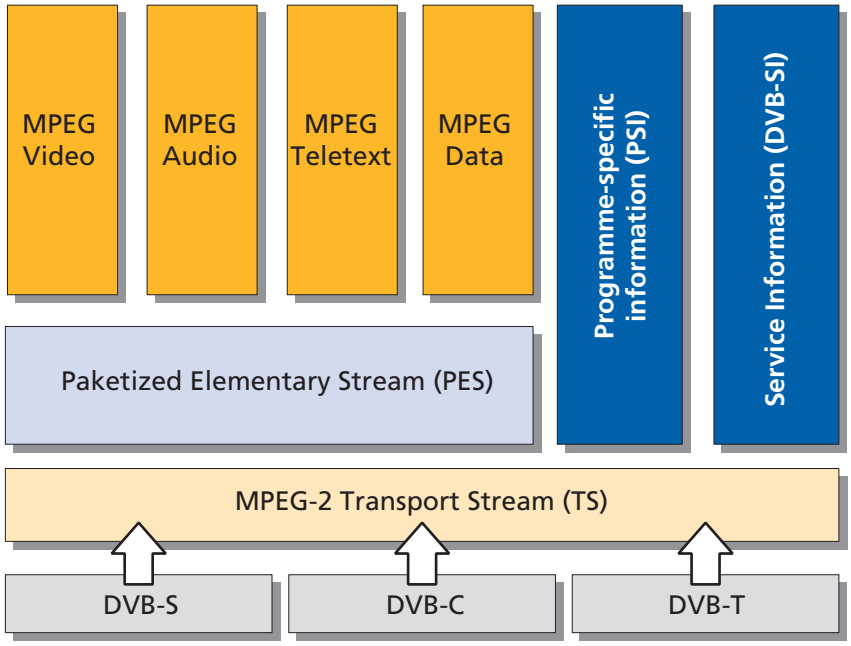

Figure 1
Components of MPEG and DVB.

However, for transmission at the transport level, much larger packets of 188 bytes are used (known as transport packets). Each transport packet contains an identifier (PID) of a few bytes which identifies a specific data group (e.g. the video components of a programme or the teletext components). Added to this are periodically-repeated components such as the DVB Service Information (SI). These are based on a table containing important additional information on the type of programme being transmitted [1].

In the past, due to the transmission capacity of the analogue television signal's VBI, the teletext bandwidth was limited to around 100-150 kbit/s. In principle, this limit can now be exceeded in DVB transmissions. However, due to problems of (i) compatibility with existing receivers, (ii) generation of the data and (iii) connections to existing uplinks, it is probable that the existing teletext bandwidth will not be exceeded, at least for the foreseeable future. So, at a typical data-rate of 2 to 12 Mbit/s, a total bit capacity of 150 kbit/s for teletext is entirely appropriate.

For the transmission of teletext, DVB offers a procedure which is described in the ETSI standard, **ETS 300 472**, and is examined in more detail below.

1. There is no need to go into further detail on SI in connection with teletext. It should just be mentioned that SI is further divided up into tables. Examples of these are Network Identification Tables (NIT), Service Description Tables (SDT), Bouquet Association Tables (BAT) and Event Information Tables (EIT).

Transmission of teletext in digital television — in accordance with ETS 300 472

As described above, teletext data is transmitted in PES packets which each contain 45 bytes. The packet identifier (PID) assigned to teletext is defined in the Program Map Table (PMT) as 0 x 26. The PES themselves are embedded in descriptors which are a another special feature of DVB (see *Fig. 2*). These contain important information for the reconstruction of the original teletext pages upon receipt. For example, the information about which magazine is contained in a PES packet and in which lines. In addition, the descriptors provide information on the television line and field in which the original (analogue) teletext signal was sent, and much more. The framing code – a relict from teletext's analogue past, used for synchronization of the receiver – is also contained in the descriptor.

```
PES_data_field(){
        data_identifier
        for(i=0;i<N;i++){
                data_unit_id
                data_unit_length
                data_field(){
                        reserved_for_future_use
                        field_parity
                        line_offset
                        framing_code
                        magazine_and_packet_address
                        data_block}
    }
}
```

Figure 2
Structure of a DVB descriptor for teletext.

When all the information required to restore the original teletext signal is properly transmitted, a complete analogue teletext signal is produced in the receiver. This is necessary because many of the digital receivers available on the market are unable to decode teletext. At present, many of the receivers on sale can only pass on this information to a television set once they are connected up to it. In so doing, it is assumed that each receiver already has a teletext decoder. No distinction is made for analogue reception and the teletext pages appear exactly as they would with analogue reception.

Having said that, manufacturers of digital receivers are increasingly producing receivers which can decode teletext pages and overlay them on top of the video image. This procedure avoids the problem of teletext decoders in television sets having a very small buffer memory. For the most part, the IRDs have a very large memory which can easily store and process up to 1,000 pages of extended teletext data.

Finally, it should be pointed out that there are older DVB digital receivers on the market which cannot recognize teletext at all. In these receivers the PID contained in the MPEG transport stream is simply ignored. So when buying a digital receiver, even a newer model, you should always make sure that it is teletext compatible.

Transmission of subtitles to digital television — in accordance with ETS 300 743

In Germany, subtitles are transmitted on a teletext page specially reserved for this purpose, usually page 150. In Europe, page 777 is often used which is why ZDF has now begun transmitting subtitles on both pages. The unusual feature with subtitles is the fact that they can be processed with split-second accuracy. The other teletext pages have a transmission delay of approximately 20 to 30 seconds [2]. For pages containing subtitles this would be too slow. The overlay of pictures and text is made possible using transparency mode. This mixes the analogue picture signal with the teletext signal or subtitle which is changed to analogue before being fed to the picture display. This is the mode required for subtitling. The decision as to whether to display in transparent (i.e. with video images) or text-only mode is taken by the editor. A special control bit is then inserted into the top of the teletext line [3].

In addition to simple text display, DVB subtitles also offer the possibility for accurately-timed insertion of graphics [4] such as station identifiers (known as logos). Moreover, a film can be subtitled in several languages. If desired, the cinefilm widescreen format, 16:9, is also available, for which a proprietary DVB specification has been developed – **ETS 300 743**.

DVB subtitles are also transmitted as PES packets in the MPEG transport stream, with these being filtered out by a PID built into the receiver. Time is marked by Presentation Time Stamps (PTS) which are used to control the appearance of the subtitles on the screen. In order to ensure that all objects appear at the same time, where possible these should be transmitted in a PES packet of 64 KB maximum. However, it is

2. One exception is the entry page, 100, which must be transmitted more frequently, i.e. at shorter time intervals.

3. There are, however, receivers which allow the viewer to set the transparency mode, although the corresponding bit is not transmitted.

4. Not to be confused with the new teletext graphic possibilities in Level 2.5.

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possible to use several packets carrying the same time information (Presentation Time Stamp).

If, instead of text, a graphic field is to be inserted, the specification also allows for this, on the condition that the graphic does not exceed 60,000 pixels. This corresponds to a picture area of 200 x 300 pixels, or approximately one quarter of a television screen, with a total resolution of 720 x 576 pixels [5]. This is linked to the fact that the PES packets cannot exceed 64 KB. Unfortunately, however, this 60,000 pixel size cannot actually be realized in its entirety as, in its present form, the specification does not allow for a one-bit mode enabling two-colour representation (e.g. in black and white, the Colour Look Up Table (CLUT) would be particularly simple for digital-to-analogue conversion) [6]. Having said that, a 2-, 4- or 8-bit mode is possible, meaning a colour depth of four, sixteen or 256 colours. However, the number of pixels which can be represented is reduced accordingly, as each graphic point displayed requires some of the 64 KB of memory available to describe the colour. By way of example, in 8-bit mode, 256 colours can be depicted but the picture size is limited to 7,500 pixels. This is equivalent to a field of no more than 80 x 90 pixels.

In addition, the specification allows different CLUTs to be used in different regions of the screen [7]. A composition page is used to define and control these regions. There can also be different composition pages [8] and these, in turn, are administered by an ancillary page. Fortunately, this complicated scenario enables the same CLUTs and objects [9] to be used in different layouts. For example, different texts can be seen in different languages with the same station logo. A further special feature of DVB subtitles is that objects can also be held in ROM [10] in the receiver. This saves transmit latency and is especially useful in the case of station identifiers (logos).

5. This statement only applies to a 4:3 screen.
6. It is unclear why this important two-colour mode is not contained in the specification, even though it would have been easy to implement.
7. Here there is already a potential conflict for future applications: for example, how can a 16-colour picture receiver process a subtitle transmitted with 256 colours?
8. Although only one composition page can be active at any one time, several can be transmitted at the same time in the bit stream.
9. Object implies both text and graphics.
10. Resident storage capacity with unchangeable data available in the receiver decoder.

Fig. 3 shows the structure of a DVB descriptor for subtitles.

```
PES_data_field(){
        data_identifier
        subtitle_stream_id
        while nextbits()=='00001111'{
                Subtitling_segment(){
                        sync_byte
                        segment_type
                        page_id
                        segment_length
                        segment_data_field()
                }
        end_of_PES_data_field_marker
    }
}
```

Figure 3
Structure of a DVB descriptor for subtitles.

Prospects for teletext in the digital environment

In the age of digital TV, the level of editorial input will be the same. Only the technology will change – although the content too is being modified by new technical features. Moreover, the viewers, users, customers, clients – whatever the fashionable phrase may be for referring to them these days – are only interested in the content anyway. And this content needs to be broadcast via a TV channel in order to reach them. This is why teletext, now almost twenty-five years old, looks set to continue as a content provider – both in analogue and digital mode – for a long time to come.

Fig. 4 shows typical screen-shots of entry-level teletext from various European digital broadcasters.

Figure 4
Typical screen-shots of entry-level teletext, from various European digital broadcasters.