REPORT 1223

A LAYERED MODEL APPROACH FOR DIGITAL TELEVISION

(Question 46/11)

(1990)

1. Introduction

A description of the basic functions of a television information transfer may be performed in terms of a layered architecture complying with the one defined by ISO and CCITT in the OSI framework [Miceli, 1986; Fierro and Miceli, 1987]. Such an approach may be helpful also in the future, when television signals are going to be transmitted across a broadband ISDN. Furthermore it allows a clear separation of the various problems concerning the definition of a new standard. In particular the information path from the 7th layer to the first may be considered also as an ordered way to face these problems.

In Figure 1, the information transfer at a television interconnection is symbolically expressed in terms of the layered architecture.

This has to be considered as a tentative solution to the problem of putting typical television signals into the abstracted functions of the ISO model.

Particularly, problems may arise as far as the 5th layer is concerned, because it is not totally clear whether the "picture rate" and the "pictures per frame" may be considered at the 5th or as a sub-layer of the 6th level. However, this is a theoretical problem only; what is important is the order or, in other words, the priority of the various functions in the television interconnection. For this purpose a valid assignment of parameters is given in Figure 1.

2. Description of layer functions

A short description of some layer functions is necessary for the sake of clarity.

2.1 The 6th layer

In the layered architecture the 6th layer is concerned with the presentation of the information being transferred from the source to the destination. In the case of a video system, therefore, it deals with the colorimetric aspects of the pixel data and with the geometrical structure of the screen (number of active lines, number of active pixels per line, aspect ratio).

2.2 The 5th layer

The 5th layer is concerned with the number of pictures per second (whose format has been already discussed in the 6th layer) flowing through the system. In order to allow some spatio-temporal processing at the 4th layer (as explained later), it is preferable to consider pictures grouped in "frames". Therefore the same group of pictures, can be considered as a whole and can be coded accordingly. Obviously, the product of the number of pictures per "frame" and the "frame" rate equals the number of pictures per second being processed in the television system.

The "frame" so defined can be interpreted also as a time slot in which a typical periodicity of the video signal can be shown. This periodicity has to be specified in terms of an integer number of pictures, also considering the limit case of one picture per "frame". In a sense this concept can be considered as a generalization of the original meaning of the television frame. In fact, the case of an interlaced system can be interpreted as having 2 pictures per "frame" each coded in a particular way (transmission of one line out of two). In this case the "frame" rate is obviously half the field rate and is also the basic periodicity of the video signal.

2.3 The 4th layer

This layer is concerned with coding and formatting the video information. In that sense it deals with bandwidth compression methods, in order to adapt the video bit rate to the channel bandwidth.

In terms of the layered architectures, interlaced methods of picture transmission should involve typically the 4th layer. In fact it is theoretically possible to obtain an interlaced television signal by vertical subsampling a progressively scanned picture: in a sense, interlacing may be considered as a very simple method for coding pictures at reduced bandwidth.

2.4 The lowest layers (transmission standard)

The lowest layers deal with interface problems as shown in Figure 1.

Interfaces define the physical and logical ways for the information transport across the video chain. Their definition should not have any implication on the main system parameters and may be studied separately. Different interfaces may be defined for various nodes of the video chain in order to comply with local transmission requirements, while a common interface should be adopted for studio interconnections, see Figure 2.

3. OSI versus Recommendation 601 approach to compatibility

The most important characteristic of the OSI model is that the information transfer is transparent as far as the higher layers are concerned. If a standards conversion is necessary it will take place at the lower layers, as for example in Figure 2. Hence, the approach to compatibility is obtained starting from the highest layers and proceeding downwards.

This is the fundamental difference with Recommendation 601 philosophy. In fact, in this case the compatibility is obtained at the lowest 2 layers, while a standards conversion process is necessary for the highest layers, (625 to 525 line conversion and vice versa).

4. An example of a possible application

[CCIR, 1986-90] outlines a possible application of the approach described in section 2. According to the above structure an "asynchronous transport system" can be defined which allows to easily accommodate different scanning formats, such as 50 Hz television, 60 Hz television and motion picture films. Assuming that a commonality on the screen format has been reached at the 6th layer (using an interlaced-to-progressive conversion where required), the next step, at the 5th layer, is the definition of a "frame duration" as a time period that includes an integer number of pictures for all kinds of sources.

In order to accommodate into a "frame", regardless of the original picture frequency, an integer number of pictures, a "frame frequency" is considered, which is the greatest common divisor among the various picture rates, i.e. 2 Hz. Therefore, if the source is represented by a motion picture at 24 pictures per second, 12 pictures will be contained in the "frame period" (T = 0.5 sec). On the other hand, in the cases of 50 and 60 Hz television systems, the number of pictures included in a "frame" will be 25 and 30 respectively (Figure 3).

As far as the data formatting is concerned (4th layer), the "frame" has to be organized in a structure able to carry in the order, the information related to the frame itself, the pictures carried in it and the pixels; overhead data is required for labelling, data protection and synchronization purposes.

As shown in Figure 4 (in the case of a 50 Hz television system) a "frame" can be structured as follows:

- a "frame marker record" (FMR) placed at the beginning of each transmission frame;
- an optional "encryption record" (ER) where a conditional access to the transmitted data is required;
- a "picture marker record" (PMR) for each picture;
- a "pixel data record" (PDR) for each group of pixels (e.g. 8 x 8 square blocks where this is allowed by the screen format);
- a "padding record" (PR) to grant a fixed data rate in all cases.

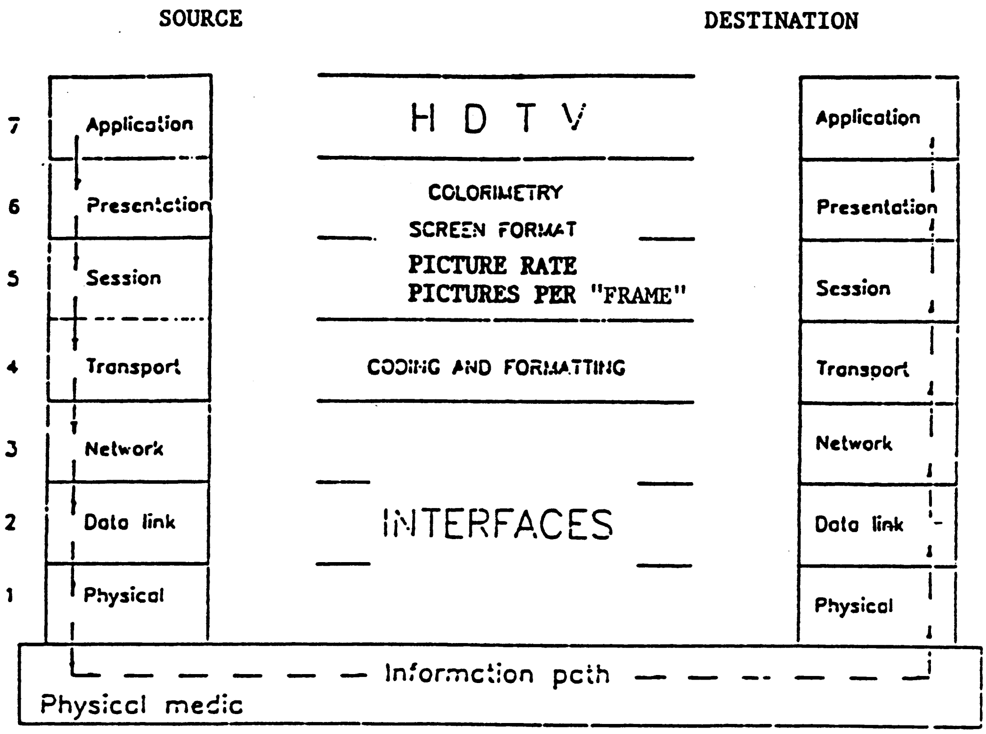


FIGURE 1

Layered architecture for the digital television

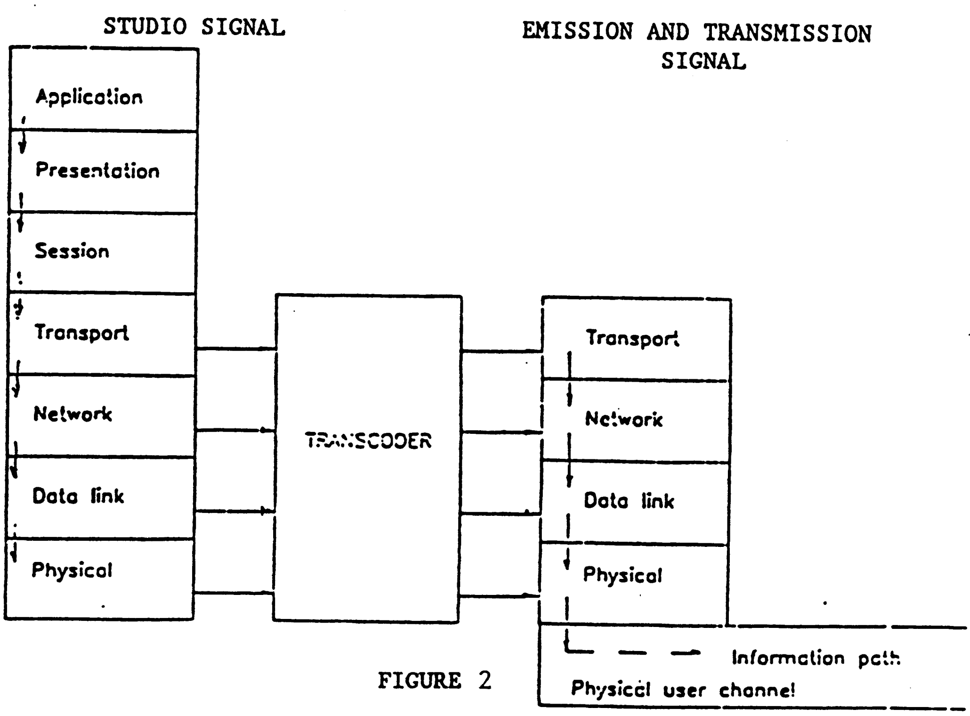


FIGURE 2

Transmission and emission standard generation

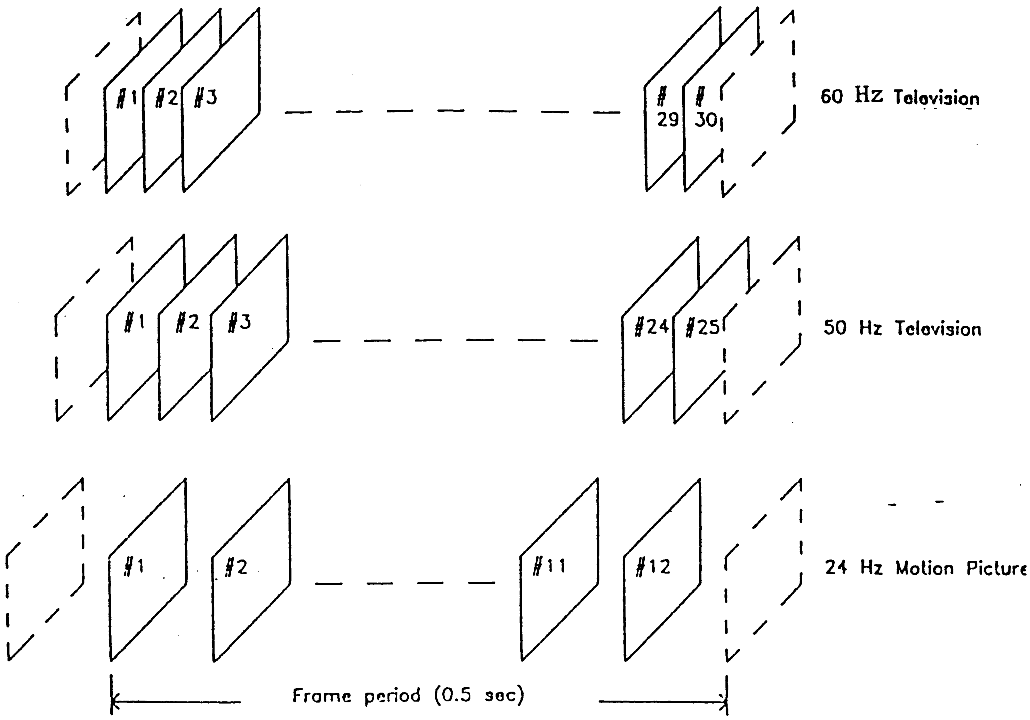
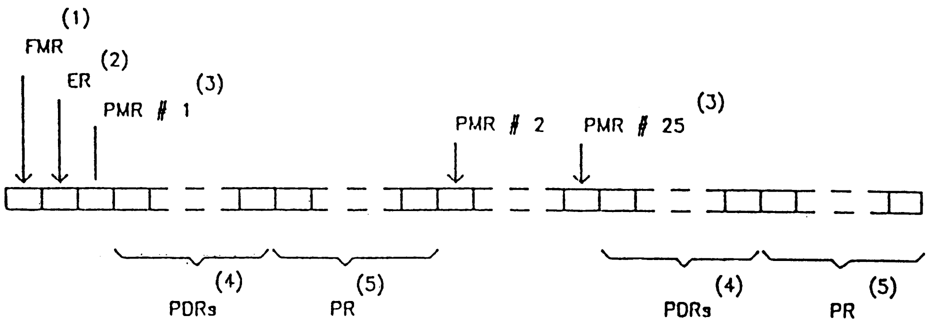


Fig. 3 – Definition of the frame period for the three most used picture rates



(1) Frame Marker Record
(2) Encryption Record
(3) Picture Marker Record
(4) Pixel Data Records
(5) Padding Records

Fig. 4 – Tentative definition of the frame structure (the figure refers to 50 Hz television case)

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FIERRO, G., MICELI, S. [September 1987] - "Frame based HDTV system", Proceedings of the "International Symposium on Broadcasting Technology", Beijing.

MICELI, S. [1986] - "Basic structure for a future television system", Proceedings of the EURASIP Workshop on Coding of HDTV, L'Aquila, **12-13 November.**

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[1986-1990]: 11/502 (Italy).

REPORT 1212*

MEASUREMENTS AND TEST SIGNALS FOR DIGITALLY ENCODED COLOUR TELEVISION SIGNALS

(Question 25/11, Study Programme 25M/11)

1. Introduction (1990)

Digital television systems operate in very different ways from analogue systems with the consequence that a quite different set of picture impairments may be introduced. Impairments may occur both from the conversions to and from the digital domain (which include filtering, sampling and quantization processes, see Reports 629, 962 and Recommendation 601) and by degradations of the digital signal itself (such as individual digit errors, timing jitter or loss of frame synchronization). In the conversion processes, the impairments may be picture dependent, while errors in the digital domain may be bit-sequence dependent. In the digital domain, an increase in noise or distortion above a certain threshold level can result in a rapid increase in the number of digit errors. Before that level is reached, the error performance can be improved significantly by the use of error correction techniques.

Picture impairments may thus arise from several sources:

a) distortions in the conversion processes from analogue to digital form and from digital to analogue form;

b) errors in the digital channel;

c) distortions introduced by digital signal processing.

Test and measurement methods for the digital television system must therefore include consideration of these separate factors and of the need for both off-line (acceptance and maintenance testing) and on-line (monitoring and diagnostic) requirements.

In the case of picture impairments, either subjective or objective tests may be used. Section 2.1 of this report contains information on subjective test methods and section 2.2 considers objective testing. In either case, care must be taken to consider the effect of two- or three-dimensional signal processing techniques which render many current analogue test signals of little use (in that case because of their line-repetitive nature). Section 2.3 of this report considers the testing of signals in digitally encoded form. In this case,

* This Report should be brought to the attention of the CMTT and of the IEC.