EBU – R 114

User Requirements for non tape-based camcorders for broadcast production

Project Group P/AGTR
Advisory Group on Television Recording

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Foreword

This document outlines the user requirements of EBU members for a future generation of non-tape based recorders for broadcast production of standard definition television. It is nevertheless intended that these requirements will also apply (with minor modification) to HD equipment as soon as the situation within Europe has been clarified and stabilised. In particular, the user's requirements of portable digital camcorders for use in ENG as part of a larger recorder family are addressed.

At the time of preparation of this document, three different recording techniques and media were considered; hard disk, optical disk and solid-state memory recorders.

This document has benefited both from the considerable experience gained by EBU members in operating ENG equipment in recent years and the rapid technological progress in the field of IT-based programme production.

EBU Technical Statement D86-1999 [1] and EBU Technical Statement D94-2002 [2] were taken into account in writing the present document.

The Metadata requirements for such non tape-based camcorders are defined in EBU Technical Document Tech 3301 [3].

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1 Introduction

The EBU is aware that the next generation of digital recorders will employ new recording techniques and new media such as optical disks, solid-state memories and hard disks. These systems have the potential for widespread use beyond acquisition, enabling attractive solutions for TV programme production. Future television production is expected to be oriented more towards networking and operation on different storage platforms.

These new systems will need to compete with tape-based systems in terms of media cost, media lifetime, video/audio quality and non-linear editing options. In terms of function these new systems must, for example, record and handle Metadata, provide streaming and file data-transfer, provide interfaces for the exchange of compressed signals and accommodate faster-than-real-time (compressed) data-transfer.

As with most new technology introductions into consumer and professional markets, the risk of a variety of different standards appearing is present. This risk is already materialising as competing but differing prototype technologies have been demonstrated for the storage media. Considering the likely widespread use of these new media within an IT-based infrastructure, the EBU encourages manufacturers to co-operate to create a single standard for each medium in order to avoid incompatibilities and the inevitable format wars that ensue. In this document, the EBU represents Broadcasters concerned to guide the market to universal standards.

2 System requirements for interoperability

In principle, these new recording systems must be designed to support recording and replay of digital video and audio signals, Metadata, data Essence (with access to them independently from each other) and the time-code.

It is to be hoped that competition between different manufacturers' products will only take place in areas that are not essential for interoperability purposes. A high degree of interoperability between different manufacturers' products will be of great advantage to all manufacturers, as it will stimulate widespread acceptance of these new technologies. Therefore, the EBU expects that these new storage media can be used with common operating systems, e.g. Windows, Linux, etc, using open standardised means of mounting them.

Each physical medium must be capable of being exchanged between different TV production platforms. To achieve this it is essential that the relevant parameters of each new recording format are open (standardised) or at least must be available to third parties on fair and equitable terms.

This is not in itself sufficient to ensure full portability of Content between systems. Because of this, users should be aware that they might be confronted with different levels of interoperability.

2.1 Interoperability

The Annex of SMPTE RP 213M [4] defines four levels of interoperability. The lowest level of interoperability is determined by interoperation at the physical layer. The next level is determined by interoperation at the link layer. The next highest level is determined by interoperation at the transport layer and the highest level of interoperation is about interchange at the presentation and application layers. This approach assumes that interoperability is about the interconnection of a sender and a receiver connected by a transport mechanism. Thus, levels of interoperability may be changed by altering the capabilities of any of these components.

It concludes that the highest level of interoperability, level 4, is only achieved when all the Essence and Metadata are available to be used. However, it also points out that level 4 is the area that causes most of the difficulty when building systems and therefore must be part of a user requirement. In order to meet the requirement for a minimum predictable picture quality and to guarantee full interoperability through a chain of different equipment, specifications may be required which are located in interoperability level 4 as well as levels 3, 2, and 1.

The EBU prefers the highest level of interoperability that delivers the required benefits of new recording systems as described in paragraph 2.1. The EBU warns that operational limitations must be considered if a limited level of interoperability is accepted as described the Paragraph 2.2.

2.2 Comprehensive interoperability

The recorded Essence, Metadata and data Essence should be directly accessible from different computer platforms (different operating systems) via open (standardised) interfaces if necessary. Put another way, third party post-production systems must be able to exploit all editing functions (random access, integration into time-line) via appropriate interfaces. This is the level of interoperability preferred by the EBU and can be denoted as the ***comprehensive interoperability level***.

> **Note:** A representative example for this is the way in which files are organised on the storage medium. It is determined by the file system, which defines, for example, the number of levels in a directory tree or the length and format of the file names. Only open file systems can enable open access to the stored data from different computer platforms and operating systems. It is required that new recording systems should use a file system, which must be open (standardised) and which should be compatible with as large a variety of operating systems (existing and near future) as possible.

2.3 Limited interoperability

If EBU Members are confronted with proprietary implementations of these new recording systems a variety of interoperability problems will arise preventing their full exploitation within IT based production platforms.

Access to the recorded material may only be possible after the material has been transferred from one system to another system (storage). This will waste time and detract from many of the advantages of these new technologies.

Even in this case the standardised file format, MXF, must be used and the disclosure of Essence type, Browsing format and Metadata is absolutely necessary. In addition, common mechanisms for the file transfer must be provided.

This ***limited interoperability level*** is not endorsed. Only the ***comprehensive interoperability level*** – as stated in 2.1 above – will deliver the required benefits.

3 Specific requirements for camcorders and recording media

A new generation of non tape-based recorders must provide the functionalities necessary to permit an economical integration into IT based production platforms. Particular importance is placed on the availability of non-linear operations and the support of special recording and replay functions for broadcast use.

The requirements listed below represent the most business-critical needs of users for a new generation of camcorders. However, the EBU is aware that products available at this time may not yet satisfy all of these requirements. Nevertheless, the broadcasters should use the list for the evaluation of such camcorders and manufacturers are requested to take all of the requirements into account when developing products.

3.1 Basic properties

a Compression standard DV based compression at 25 Mbit/s and 50 Mbit/s according to SMPTE Standard 314M [5], or MPEG-2 4:2:2P@ML at 50 Mbit/s according to D94. DV compression with a sampling raster of 4:2:0 according to EBU Recommendation R116-2005 [6].

b Must support 4:3 and 16:9 aspect ratios, e.g. lens, target, viewfinder, etc.

c Digital video processing shall still be based on the 13 MHz family of ITU-R BT.601 [7].

d A minimum of two and, preferably four digital audio channels, with a minimum resolution of 16 bit linear and a sampling frequency of 48 kHz

e In addition to these audio channels an audio cue channel (possibly with lower quality) shall be provided

f Automatic generation of technical Metadata and material identifier (UMID) [8] [9] (Also see [3] EBU Tech 3301).

g Metadata input and output via RAM device or wireless LAN or USB

h Recording of Metadata (see [3] EBU Tech 3301).

i Automatic generation of key-frames (thumbnails) and, preferably, automatic generation of a LowRes (Browsing) version.

j HighRes, key-frames and LowRes shall be accessible independently from each other via standardised interfaces.

k SDI Streaming output for Essence.

l Open standardised interface for file transfer of Essence and Metadata, e.g. IEEE1394, USB, Ethernet

m Output file format shall be MXF.

n Continuous and non-interrupted recording time with a minimum of 20 minutes and, preferably, more than 30 minutes

3.2 Recording, replay and editing functionality

a Loop recording and playback, Skip-back recording, Frame capture recording, Time-lapse recording

b Deletion of any unwanted shot and reuse of this storage area

c Variable speed video and audio replay, e.g. range from -1 to +1

d Continuous replay based on marking information, for a minimum marked duration of 1s at least

e Over-write protection of recorded shots

f "Good shot" indication

g "Event marker", e.g. initiated by an accompanying person, e.g. via remote operation, or by camera operator's pushbutton, recorded as Metadata and as a key frame onto the media

h Provision of independent access on a frame-by-frame basis to the recorded Content, e.g. video Essence, audio Essence, data Essence and Metadata

3.3 Items for general consideration

a Reliability of device and medium, e.g. work under vibration, abrupt changes in temperature and/or humidity, a dusty or otherwise hostile environment

b Durability of medium

c Operating temperature range for the device, including storage media, shall be -20°C to +50°C, in a humidity range from 10% to 90%

d The medium must be protected against bending and impact forces

e A label area must be available on the medium housing in order to allow simple manual annotation

f Appropriate self-monitoring and reporting tools for two categories: unambiguous signalling of malfunctions for the camera operator in the field and precise information about the state of the system for the service personnel at home.

***NOTE**: This information should be available as a malfunction report. Using common messages built on MIBs (Management Information Base) could be a promising solution.*

g Security management of the Content which is recorded and stored on the removable media

h Low acoustic noise generated in recording mode, lower than tape based camcorders, i.e. lower than 31 dB(A) measured 5 cm from each side

i 12V output connector for lighting equipment

j Possibility to record external video and audio signals via digital interfaces and the possibility to record at least two audio channels via analogue interfaces.

k Picture stabilisation circuits shall be provided and switchable ON/OFF

l Viewfinder indications shall include remaining recording time, battery level, white balance settings, zoom and a minimum of two audio-level indicators

m Additional continuous auto white balance alignment function for camera on the move, which shall be switchable ON/OFF

n Usage counter for the storage medium

4 Technical explanation and consequences of the requirements

4.1 Video signal standard and video processing

The main application is SDTV in 625/50 and 525/60 television systems. If there are economic advantages there should be as much commonality as possible between equipment operating in these different standards. Systems must support both 4:3 and 16:9 aspect ratios, and camcorders should have a pick-up device that is switchable between 4:3 and 16:9 aspect ratios.

The digital video processing shall be based on the 13 MHz family of ITU-R BT.601 [7].

4.2 Video compression

In Technical Statement D86-1999 [1] the EBU accepts that new camcorders will use video compression (bit-rate reduction schemes). However, the EBU strongly recommends that future networked television production should focus on **DV-based compression** and **MPEG-2 422P@ML compression,** which have been identified as being appropriate for television production operations according to the following specifications:

a) DV-based compression at 25 Mbit/s and 50 Mbit/s according to SMPTE Standard 314M [5], and

b) MPEG-2 4:2:2P@ML compression at 50 Mbit/s according to EBU Technical Statement D94-2002 [2] in which the SMPTE Standards 356M [10], 328M [11] and the SMPTE Recommended Practice RP202 [12] are concerned.

For certain applications, the use of DV compression with a sampling raster of 4:2:0 according to the constraints in EBU Recommendation R116-2005 [6] can be considered.

4.3 Video interfaces

Depending on the intended area of application the individual device concerned shall provide sufficient I/O interfaces. The following possibilities should be considered:

a For digital baseband I/O, SDI interfaces shall be supported.

b For digital I/O in the compressed domain, SDTI interfaces and other IT-based interfaces, e.g. IEEE 1394, USB2 should be supported.

c The access and exchange of video signals via relevant IT interfaces, e.g. Ethernet, must be supported.

d In order to allow easy integration into current production environments, appropriate analogue interfaces shall be provided.

4.4 Audio

a The digital audio processing shall be based on the International Standard ITU-R BS. 646-1 [13].

b The recording system must provide a minimum of two and, preferably, four digital audio channels, with a minimum resolution of 16 bit linear and a sampling frequency of 48 kHz.

c In general, no pre-emphasis shall be applied.

d According to EBU Technical Recommendation R68 [14], audio headroom of 9 dB shall be applied (corresponding to an alignment level of -18 dBFS) for all audio channels.

e Audio level monitors should be designed for 9 dB headroom with markers at –9 dBFS for maximum programme level and –18 dBFS for alignment level.

f The alignment level of the analogue domain which corresponds to the digital alignment level of –18 dBFS shall be selectable for national purposes: 0 dBu, -3 dBu / -5 dBu / - etc.

g Depending on the intended area of application the individual recording device concerned shall provide sufficient I/O interfaces. The following possibilities should be considered:

  i For digital I/O, AES/EBU interfaces shall be used and auxiliary data, e.g. channel-status, user, validity and parity bits, shall be supported. The digital audio signals at the AES/EBU interfaces shall comply with the A/V timing relations given in EBU Technical Recommendation R83-1996 [15] (for a digital audio signal sampled at 48 kHz the tolerance is ±1 µs).

  ii The AES/EBU digital interface should support compressed audio data according to EBU Tech 3250 [16]

  iii Embedded audio must be supported for SDI according to SMPTE 272M [17], levels of operation A, B and C as well as for SDTI according to the compression system applied.

  iv The access and exchange of audio signals via relevant IT interfaces must be supported.

  v In order to save space and increase operational flexibility the AES/EBU sockets should be switchable between digital and analogue operation.

  vi Cue channel.

The utilisation of an additional audio (cue) channel, possibly at lower quality, must be possible. The purpose of this channel is to provide means for commenting on the content of the shots or for storing instant markers during acquisition, for example.

4.5 Time code

Recorders must be able to record IEC 60461 [18] time code. Depending on the specific device, there shall be input and output terminals for time-code signals according to this standard.

The implementation of the relevant standards must support the import and export of time-code signals that are embedded in other signals or data streams, e.g. in the ancillary data space of a digital television data stream, in the SDI payload or in the MXF file format.

The recording and processing of two independent time codes representing both the “Time of the day” and the “Elapsed time” should be possible.

4.6 Key-frames and Browsing

The generation and recording of key frames (or Thumbnails) at the start and end of each shot is mandatory. In addition to that, key frames may be generated automatically at selectable fixed intervals, based on picture changes or based on manual mark up.

The generation and recording of a low-resolution video (browsing) copy should additionally be possible.

The browsing standard used must be fully described (open) in order to be completely usable in a production environment.

5 Access to, and exchange of Content

In general, subsequent systems must be able to use the recorded Essence without re-encoding (transcoding).

5.1 Random access

The signals and data recorded on the recording medium must be directly accessible via appropriate interfaces, e.g. SCSI-2. In particular, this must be assured for third-party post-production systems, for example, to be able to, e.g. perform full real time editing functions (independent random access to all data or direct editing [hard cuts] on the recording medium).

5.2 File Format and File Transfer

The file format for the import and export of Content shall be MXF. Constraints such as operational patterns or additional constraints concerning index tables or the storage multiplex needs still to be specified. It is mandatory that the Essence, Data and Metadata formats (including browsing formats) that are wrapped in MXF use standardised specifications.

For successful file transfer and file access over a network the implementation must support the setting of Quality of Service parameters. This will ensure that, for example, the file transfer rate can be aligned to the capabilities of the network in order to avoid congestion or blocking of other services on the same network. Factors such as network bandwidth and network protocols (which influence round-trip-delay) should not affect the performance of the overall system.

5.3 Streaming

The streaming exchange of Content in the compressed and packetised domain shall be provided by either SDTI (Serial Data Transfer Interface) according to SMPTE 305.2M [19] or via IEEE1394, USB2 or other standardised interfaces that support the appropriate quality of service requirements. In any case the Content shall be transferred in its native form and the transport protocol and binding shall be openly documented and preferably standardised.

If a SDTI interface is provided it shall be switchable between SDI/SDTI for monitoring purposes.

References

[1]	**EBU Technical Statement D86-1999**	Video compression systems for new disc based camcorders for television
[2]	**EBU Technical Statement D94-2002**	Use of MPEG 4:2:2 P@ML compression standards and specific application ranges in mainstream television production
[3]	**EBU Tech. Doc. 3301-2005**	Metadata for non tape-based camcorders for broadcast production
[4]	**SMPTE RP213**	MPEG-2 Operating Ranges
[5]	**SMPTE Standard 314M**	Data Structure for DV based Audio, Data and Compressed Video – 25 and 50 Mbit/s
[6]	**EBU Technical Recommendation R116-2005**	Recommendation on the use of DV compression with a sampling raster of 4:2:0 for professional acquisition
[7]	**ITU-R Recommendation BT.601**	Studio encoding parameters of digital television for standard 4:3 and wide-screen 16:9 aspect ratio
[8]	**SMPTE Standard 330M**	Unique Material Identifier (UMID)
[9]	**SMPTE Recommended Practice RP205**	Application of Unique Material Identifiers in Production and Broadcast Environments
[10]	**SMPTE Standard 356M**	Type D-10 Stream Specifications – MPEG-2 4:2:2 P@ML for 525/60 and 625/50
[11]	**SMPTE Standard 328M**	MPEG-2 Video Elementary Stream Editing Information
[12]	**SMPTE Recommended Practice RP202**	Video Alignment Level for MPEG-2 Coding
[13]	**ITU-R Recommendation BS.646-1**	Source encoding for digital sound signals in broadcast studios
[14]	**EBU Technical Recommendation R68**	Alignment level in digital audio production equipment and digital audio recorders
[15]	**EBU Technical Recommendation R83-1996**	Synchronisation of digital audio signals in a television environment
[16]	**EBU Tech. Doc. 3250-2004**	Specification of the Digital Audio Interface (The AES/EBU interface)
[17]	**SMPTE Standard 272M-2004**	Formatting AES Audio and Auxiliary Data into Digital Video Ancillary Data Space
[18]	**IEC International Standard 60461-2001**	Time and control code for video tape recorders
[19]	**SMPTE Standard 305.2M-2000**	Serial Data Transport Interface