

0 Introduction

The vast increase in content throughput caused by the advent of multi-channel program release together with the ever increasing pace of television program production mandate the exclusive use of digital production technology. These trends require the development of improved production tool functionality and the application of optimized workflow-concepts for the total production chain.

Manufacturers of professional television equipment as well as the computer industry are currently developing radically new system concepts to meet these requirements. These pivotal concepts include:

1. program data transport in the form of compressed bit streams,
2. non-real-time data transfer,
3. simultaneous, multi-user access to random program segments stored on servers,
4. inter-networking on open platforms of all production tools within the post-processing chain, and
5. hierarchical storage concepts based on tape, disk, and solid state media.

In this context, questions of end-to-end interoperability as well as technical quality have to be considered.

Functional interoperability and exchange of video material between equipment of different manufacturers, employing different and incompatible compression algorithms, currently can be achieved by decoding and re-encoding. The accumulation of compression algorithm artifacts within the long chain of production, post production, and distribution can introduce unpredictable, detrimental effects to the quality of the final output product. Concern about this topic has been expressed at all levels up to the International Telecommunications Union (ITU) and various government agencies.

It has been proposed that these detrimental effects be mitigated by limiting the number of generations of decoding and re-encoding and by employing compression algorithms that provide adequate post-production headroom for the end-to-end production chain. With few exceptions, the processing and editing of compressed program material will require decoding to the high bit rates of uncompressed rasters and baseband audio. Editing material based on different compression methods and data rates clearly demands the development of "agile" decoders, with special attention to codec symmetry and delay (or latency). The use of compression schemes which allow users to retain the potential for high quality post production throughout the production process can alleviate the quality problem but may lead to penalties in the area of storage efficiency and network bandwidth sharing.

Metadata is a major new class of enablers of systems using

bit streams for program material exchange. Metadata is a generic term for all sorts of data captured that relates in one way or another to program material. It ranges from time code and details of technical conditions when material was created, to the scripts used, the publicity materials created, and descriptions of shooting locations. It can include standardized descriptive data to help in locating the material through various database entries. This can aid in the re-use of material, thereby significantly increasing its value.

Wrappers and file formats are inextricably linked with metadata in that they contain program content and its associated metadata in ways that it can most easily be transferred and most beneficially be used. This means that the metadata may need to be accessible from the outside of containers so that the contents of the containers can be properly identified and processed. The need to both contain and provide access to the metadata requires that the form of the metadata and of the containers be considered together.

With regard to **networks and program file transfers**, users require the ability to exchange audio, video, and associated data easily and reliably between different systems. Agreed methods to move content within the production chain are therefore essential, will provide a stable basis for user choice, and will encourage a variety of solutions without putting limits on innovation in product design.

In general, users in the analog world have not had to deal with the complexities and characteristics of digital public carrier distribution systems and of networking through them. In an all-digital environment, the selection of one or more compression schemes and their associated bit rates should take into account the desired level of technical quality to be retained in the final output product of a given application. This will minimize cascading errors, fully exploit the bandwidth of the interconnection, and place economic utilization of any interconnecting networks and storage devices under user control.

In this report, the Task Force seeks to provide users and manufacturers alike with a document that addresses these issues in a complete and informative manner.

0.1 Open Standards

Users are asking that the future of digital video be based on the research and adoption of standards, such as those of the International Telecommunications Union (ITU), the Society of Motion Picture and Television Engineers (SMPTE), and the European Broadcasting Union (EBU). It may be useful to consider standards as providing "90% solutions." Users and user groups may then need to specify "profiles" that adjust basic standards to meet the last 10% of functionality that broadly based commercial systems were never designed to meet. Lastly, users may have to specify "re-

ommended practices" and/or "engineering guidelines" to facilitate final and specific technical interoperability. An example of the need for clearly defined recommended practices is the case where standards may broadly define a capability that maximizes flexibility but does not guarantee interoperability. By carefully selecting "nominal" values from the ranges of choices within a standard, users can better shape interoperability for their classes of applications.

As a general design philosophy, user organizations should attempt to choose Open Standards to which all qualified vendors can design and field systems. The EBU has recently published a Statement on Open Standards which emphasizes this requirement. By selection of international standards wherever possible, global competition can be maintained, providing all international players with opportunities to contribute their technologies to common systems and data exchange.

0.2 Scope of Activities

Users are well aware that the technology to treat television programs as bit streams is developing at a rapid pace. They also understand that within the wide gamut of system proposals advocated today, only the careful matching of technical options offered for system components involved in the total production chain will deliver the desired results. The provision of a single option, or at least a transparent gateway between different options within each subsystem is therefore of vital importance to users.

The Task Force has identified the following elements as critical for both interoperability between systems of different vendors and the overall performance of program transfers based on bit streams:

The digital encoding (compression) format.

Wrappers and file formats that are used to contain program elements and other data in ways so that they can be stored, retrieved, and transmitted as identifiable objects.

Metadata – a major new class of enablers of systems

using bit streams for program material exchange. Metadata is a generic term for all sorts of data that relates to program material but is not directly content. It can be used to locate and identify content, help in its use and interpretation, and support its exchange between systems of differing characteristics.

Interfaces suitable for program data transfers.

The physical link and transport layers that provide mechanisms that allow the movement of compressed video and audio streams and files from one place to another.

These components have been carefully studied, and conclusions about them in this report are contained within individual chapters on the subjects of:

Compression Issues (the digital encoding format),

Wrappers and Metadata (methods for collecting and describing program content and other elements),

File Management, Transfer Protocols, and Physical Connections (the combination of data transport mechanisms and interfaces).

Each of these chapters is largely independent of the others, although the topic of compression underlies the whole document.

Note that it is not the intention of the Task Force to include all possible compression formats but to limit the range initially to:

- 525 line and 625 line interlaced systems,
- Video Compression schemes using bit rates of 50Mbit/s or less (excluding audio), and
- Coding resolution of one frame or more.

The considerations discussed, however, are broadly applicable to advanced television systems, such as those being implemented in North America.