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SMPTE ENGINEERING GUIDELINE

MPEG-2 Operating Range Applications



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1 Scope and application

1.1 Scope

The aim of this document is to provide practical guidelines to users of MPEG-2 in studio and in other professional applications.

This guideline provides a system overview, detailing the elements to be considered when choosing an MPEG-2 operating range.

This guideline describes how the structure and parameters defined in SMPTE RP 213 may be configured to meet a selected operating point. This is achieved by giving specific, but representative, implementation examples planned or in use around the world.

Examples are included from both intraframe and temporal predictive coded MPEG-2 for both 4:2:2 profile at main level and high level.

1.2 Application

The picture quality obtained when decoding an MPEG encoded signal is largely dependent upon the combination of bit rate and GoP structure. The results of tests made by the SMPTE and EBU are shown in figure 1 and are as reported in the EBU/SMPTE task

force report (for full details of the test procedures please refer to the report).

Figure 1 illustrates that for a given sequence of images, the same image quality can be obtained by various combinations of bit rate and GoP structure.

The curves shown in figure 1 should be taken as an indication of first-generation performance within the wide span of MPEG-2 encoding options only. Taking signal differences as a measure of picture quality only allows coarse evaluation of actual quality performance. The variance of encoding parameters allowed in MPEG-2 encoding structures to achieve the desired flexibility will require subjective testing of each individual encoder design to determine the actual quality performance at a given data rate and GoP structure. The arrows indicate possible members of the MPEG-2 4:2:2@ML compression family envisaged for mainstream broadcasting, news and sports, and for contribution, as implemented in current industrial designs.

Since this figure was produced, for example, temporal predictive coding efficiency has improved allowing lower data rates than those given in figure 1.

A specific operating point for mainstream production has been defined at 50 Mb/s and this is described in SMPTE 356M.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this guideline. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this guideline are encouraged to investigate the possibility of applying the most recent edition of the standards indicated below.

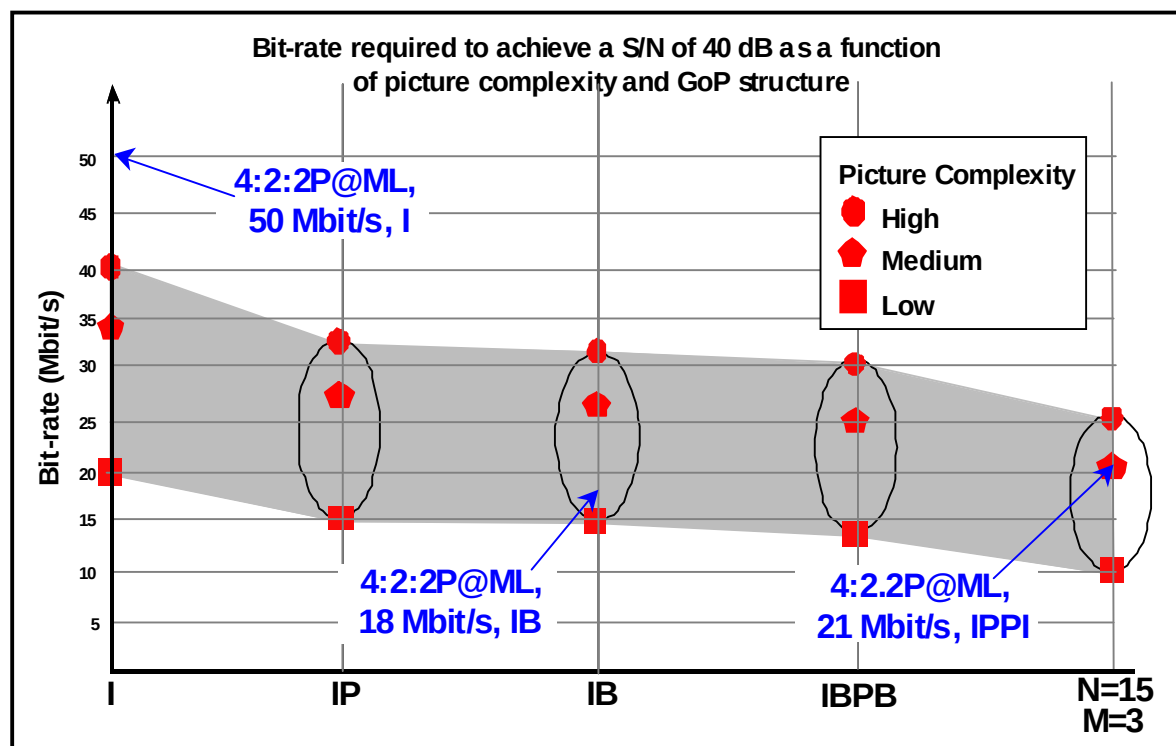


Figure 1 – Basic characteristics of compression for news and sports — MPEG-2 4:2:2P@ML

SMPTE 312M-2001, Television — Splice Points for MPEG-2 Transport Streams

SMPTE 327M-2000, Television — MPEG-2 Video Recoding Data Set

SMPTE 356M-2001, Television — Type D-10 Stream Specifications — MPEG-2 4:2:2P @ ML for 525/60 and 625/50

SMPTE RP 202-2000, Video Alignment for MPEG-2 Coding

SMPTE RP 213-2001, MPEG-2 Operating Ranges

3 Introduction to operating points

SMPTE RP 213 defines the MPEG-2 operating ranges. These ranges constrain characteristics of the MPEG-2 4:2:2 profile to ensure bitstream interchange in the professional environment.

The operating ranges are subsets of ISO/MPEG profiles and levels. SMPTE RP 213 defines two operating

ranges for standard-definition television and three operating ranges for high-definition television. It also defines a hierarchical relationship among the ranges.

This guideline analyzes the production system data flow, describes the operating range applicable for each main production stage, and gives examples of operating points. For each stage in the production system data flow, the guideline discusses considerations that influence selection of an operating range and within it an operating point or points. Specific considerations include quality of video and audio, efficiency, technology, and existing equipment and services.

This guideline elucidates choice of operating points to enable bitstream interchange within professional applications. It enhances the user's ability to specify equipment and set application-specific parameters. The clauses that follow will inform and help guide the users to an optimum choice for their applications.

Clause 4 describes the production system data flow and defines its stages.

Clause 5 gives, for each stage, example data rates and operating ranges. This is done separately for SDTV and HDTV. Further considerations for each stage follow.

Clause 6 lists applications that use the production system described in clauses 4 and 5 and identifies issues that need to be considered when implementing a system.

3.1 Nomenclature

The following definitions will be used in the clauses that follow:

3.1.1 acquisition data rate: The (net or total) data rates used in field acquisition recording.

3.1.2 contribution data rate: The (net or total) data rates used to back-haul signals to a network center or station operating facility.

3.1.3 distribution data rate: The (net or total) data rates used to pass network signals to regional or local stations.

3.1.4 editing data rate: The (net or total) data rates used for a reasonable number of post-production generations, not including the most demanding high-end post-production applications.

3.1.5 emission data rates: The (net or total) data rates used in digital television broadcasting, either by terrestrial or satellite paths.

3.1.6 headroom: The additional data rate necessary to permit a naive transcode or naive compressed family conversion while retaining an acceptable picture quality.

3.1.7 intelligent compression family conversion: The conversion between the MPEG and non-MPEG (DV, JPEG, etc.) families of compression using nonessence data (such as bit-rate allocation and quantization) in the recompression to minimize quality loss.

3.1.8 intelligent transcoding: The conversion between two MPEG-2 formats using MPEG-2 recoding data set in the recompression to maximize quality. The formats may differ in GoP structure, bit rate, frame rate, or frame size.

3.1.9 naive compression family conversion: The conversion between the MPEG and non-MPEG families (DV, JPEG, etc.) of compression using only uncompressed video and audio in the recompression.

3.1.10 naive transcoding: The conversion between two MPEG-2 formats using only uncompressed video and audio in the recompression. The formats may differ in GoP structure, bit rate, frame rate, or frame size.

3.1.11 net data rate: The data rate of the video elementary stream.

3.1.12 on-air operations data rates: The (net or total) data rates used for local storage prior to master control in an on-air playout facility, and may be subsequently recoded for analog transmission or lower bit-rate digital transmission.

3.1.13 total data rate: The net data rate plus audio, data, and any system overhead.

3.1.14 transcoding: The process of converting one MPEG-2 format to another.

4 Professional production system data flow

Figure 2 illustrates the various strategies available to broadcasters when designing a compressed video production flow process. In this example, the split between long GoP and I-frame-only systems at 30 Mb/s reflects the point of approximately equal performance for long GoP systems at 30 Mb/s and I-frame-only systems at 50 Mb/s.

Acquisition: The program may be captured in I-frame only or using long GoP MPEG-2 to provide higher storage capacities (principally camcorders).

Contribution: Where there is a need to electronically transmit the captured information over a network (satellite/telco/wireless camera), the long GoP MPEG-2 format is more likely to be used as this provides for higher transmission efficiency.

Source storage: Ideally the signal should be stored in its received format, that is I-frame-only for I-frame-only systems and long GoP for long GoP systems to maintain the highest possible quality. It is also possible to transcode the incoming feed to permit a standard