



AIRLINE PASSENGER EXPERIENCE ASSOCIATION

APEX SPECIFICATION 0403 “DIGITAL CONTENT DELIVERY METHODOLOGY FOR AIRLINE IN-FLIGHT ENTERTAINMENT SYSTEMS” VERSION 1.4

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TABLE OF CONTENTS

FOREWORD	5
1 INTRODUCTION	5
2 SYSTEM REFERENCE MODEL	6
3 REFERENCES	8
3.1 NORMATIVE REFERENCES	8
3.2 INFORMATIVE REFERENCES	9
4 VIDEO COMPRESSION	9
5 AUDIO COMPRESSION	13
6 MPEG SYSTEM	14
7 SECURITY	14
7.1 SECURITY INTRODUCTION	14
7.2 SD CONTENT SECURITY	14
7.3 HD CONTENT SECURITY	14
8 OTHER CONSIDERATIONS	15
8.1 METADATA	15
8.2 CONTENT SOURCE MEDIA	15
8.3 QUALITY	16
8.4 INTELLECTUAL PROPERTY DISCLAIMER	16
8.5 SUBTITLES AND CLOSED CAPTIONS FOR VIDEO FILES	16
8.5.1 <i>Closed Caption and Subtitle Feature Overview</i>	16
8.5.2 <i>Display Schedule File Format</i>	18
8.5.3 <i>Image File Format</i>	18
8.5.4 <i>Timing Validation</i>	19
8.6 SAMPLE SUBTITLE AND CAPTIONING DISPLAY SCHEDULE FILE	20
9 INFORMATIVE ANNEX: MEDIA ACCESSIBILITY OVERVIEW	21
9.1 INTRODUCTION	21
9.1.1 <i>Captioning</i>	21
9.1.2 <i>Descriptive Narration</i>	21
9.1.3 <i>Accessible Navigation</i>	21
9.2 CAPTIONING IN IFE	21
9.2.1 <i>Parallel Content</i>	21
9.2.2 <i>Closed-Captioned Content</i>	22
9.2.3 <i>Subpicture Stream Technology</i>	22
9.3 DESCRIPTIVE NARRATION IN IFE	22
9.3.1 <i>Parallel Content</i>	22
9.3.2 <i>Multiple Audio Tracks</i>	22
9.4 ACCESSIBLE NAVIGATION IN IFE	22
9.4.1 <i>Tactile Controls</i>	22
9.4.2 <i>Audible Feedback</i>	22
9.4.3 <i>Speech Control</i>	22
10 INFORMATIVE ANNEX: ACRONYMS AND ABBREVIATIONS	23
11 INFORMATIVE ANNEX: LIST OF PARTICIPANTS	24

TABLE OF FIGURES

Figure 1: System Reference Model with Manual Content Loading to Aircraft	7
Figure 2: Captioning and Subtitling Process Flow	17
Figure 3: Pixel View of Captioning and Subtitle Characters	19
Figure 4: Example of Full Screen Caption Image	19

TABLE OF TABLES

Table 1: Coded Picture Format and Video Encoding Resolution	10
Table 2: Parameters For MPEG-4 Settings	13
Table 3: Audio Formats and Data Rates	13
Table 4: HD Content Security Requirements	15

FOREWORD

The Digital Content Management Working Group (DCMWG) is a working group established by the Airline Passenger Experience Association (APEX), formerly the World Airline Entertainment Association (WAEA), Technology Committee to develop and publish technical specifications for delivery of digital content to in-flight entertainment systems (IFES). The DCMWG membership includes representatives of in-flight entertainment (IFE) equipment manufacturers, content providers, post-production laboratories, service providers, airlines and experts in the fields of digital video and audio compression, security, metadata and Internet technologies.

The work of the DCMWG was expanded to the development of this specification in 2003, following nearly three years during which the DCMWG functioned as an educational entity for APEX (formerly WAEA). A call for contributions from technology companies was widely distributed in January and February 2004. There were regular DCMWG meetings and discussions on the resulting contributions, leading to the development of this specification.

In response to changing requirements, APEX (formerly WAEA) in 2009 began a review of the standards adopted May 1, 2009 as Version 1.1 of this document. Member surveys and teleconferences were conducted, and input regarding potential changes to the document was discussed at the APEX Technology Committee Meeting in March 2010, and regular conversations and teleconferences were held in June and July 2010 leading to version 1.2.

Following a mandate to embrace HD content that was proposed and adopted at the February 2011 APEX-TC meeting, the High Definition Working Group (HDWG) was formed. Weekly Internet based meetings and several in person meetings were held. Much education and discussion led to the consensus that is expressed in this document. The results were presented at the November 2011 APEX-TC meeting.

The key concerns, purposes and objectives of the DCMWG in establishing this specification are:

- The development and publication of an open, voluntary technical specification that encourages a common digital content delivery methodology for IFES
- The interoperability of content across multiple IFES implementations
- The utilization of efficient encoding methods for high quality image and sound, helping to ensure a quality airline passenger experience
- Non-proprietary and interoperable system components
- A secure IFE system infrastructure with secure content preparation and delivery
- Low complexity, high efficiency and effectiveness
- The establishment of an encoding parameter set that a) achieves the highest visual quality on IFE screens, b) eases the positioning of the Trick Modes, and c) decreases the load on the seat decoding CPUs.

The scope of work for this specification includes the interfaces, delivery processes, security and key management between content point of origin and delivery to the onboard IFES. Content storage archives and onboard playback systems that were outside the scope of this specification (still true for SD content) are now being addressed for HD content only. SD content storage archives and SD onboard playback systems have been addressed in APEX Specification 0395.

1 INTRODUCTION

The DCMWG recognizes that the commercial and consumer industries have created broad standards for creating, formatting and delivering digital content. This specification draws from those standards and applies them to IFES content. Other specifications generally allow a wide range of options to be utilized. However, there are certain requirements that are unique to IFES, e.g., IFES are generally constrained with respect to processing, bandwidth and screen resolution as a result of requirements for very low power, size and weight. By agreeing in this specification to constrain the use of digital content to a subset of these broader standards, greater interoperability will be achieved for digital content destined for IFES.

As a result of wide-ranging emerging compression technologies for the commercial and consumer industries that require decoding compatibility with MPEG-2 and MPEG-4, integrated circuit (IC) manufacturers are designing decoders that support at least these formats. Many decoders are implemented with a digital signal processor where code can be downloaded for support of additional types of audio/video (A/V) codecs.

The DCMWG acknowledges that the short-term future includes MPEG-1 and MPEG-2, already in use in IFES, but that the adoption of the MPEG-4 part 10 codec has now begun and will have primacy in the long term. Consequently the DCMWG, in recognition of these trends, sets forth parameters in the following areas in this specification:

- Implementations of MPEG-4 Part 10.
- A security system for these new codecs that encourages the provisioning of early-window release content to aircraft IFES.
- Simplification of the process of content distribution, including enhanced automation of the supply chain between content providers, postproduction laboratories, service providers, security entities, IFES content integrators, IFES providers and airlines.

The DCMWG intends, as a separate initiative, to examine the evolving high-speed Internet access technologies. This includes automated content delivery through the entire supply chain. The passage from manual delivery to automated delivery will facilitate migration from monthly delivery to on demand delivery of content and data. Also, when aircraft have high-speed Internet access on the ground, it is contemplated that content, keys, metadata and other required elements can be delivered directly to the aircraft, potentially bypassing the need for physical media delivery.

2 SYSTEM REFERENCE MODEL

This specification is primarily intended for third and future generations of cabin networks that are compliant with ARINC Specifications 808, 809 and 820. Present IFE systems compliant with ARINC Specification 628 may not be able to accommodate this specification.

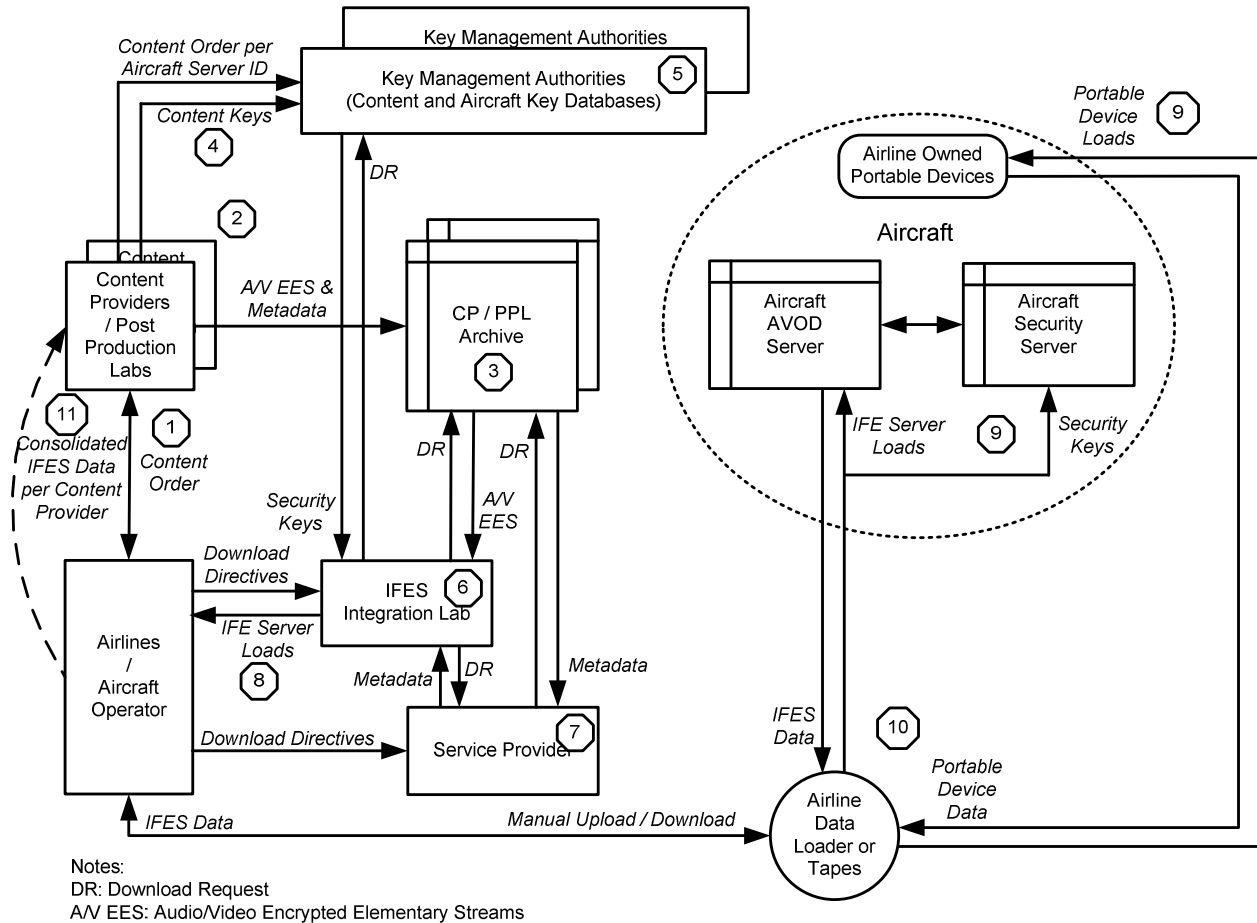


Figure 1: System Reference Model with Manual Content Loading to Aircraft

The system reference model addressed by this specification is illustrated in Figure 1. With respect to Figure 1, the following workflow descriptions and key components apply, with the numbers in the figure corresponding to the numbered items below:

1. A content provider accepts an order from an airline or from an airline's authorized agent.
2. Content is delivered to a postproduction laboratory (PPL). The content provider elects to encrypt the content or to provide it in the clear.
3. The PPL provides the A/V encrypted elementary streams and, with metadata (as required), stores the A/V encrypted elementary streams in an Internet accessible archive.
4. Content providers and/or PPLs generate security keys that are provided to a Key Management Authority (KMA) with the content orders (and aircraft specific identification in the future).
5. The content provider and/or PPL authorize a KMA to distribute keys.
6. Based on airline requests, encrypted content and keys are accessed or delivered accordingly by or to an IFE integration laboratory.
7. Metadata is accessed by the service provider, which customizes the metadata to airline graphical user interface (GUI) style.
8. The IFE integration laboratory produces IFE server loads that contain encrypted content, security keys and electronic program guide (seat GUIs) on a transport media.

9. These IFE server loads are sent encrypted to the airline, which loads them onto onboard servers with portable or embedded data loaders. The onboard servers play out the content for use by passengers. Alternatively, similar encrypted IFE server loads are transferred onto airline owned portable devices for use by passengers. Passenger-owned notebook computers, personal digital assistants and personal electronic devices are outside the scope of this specification.
10. IFES data and portable device data, consisting of passenger usage and maintenance information, are downloaded to the airline data loader for further processing by the airline. As agreed between the necessary parties, passenger content usage data may be shared to enable better content customization.

3 REFERENCES

3.1 Normative References

The following international and industry standards contain provisions that, through reference in this specification's text, constitute provisions of this specification. At the time of publication, the editions indicated were valid. All of these referenced standards are subject to revision, and parties to agreements based on this specification are encouraged to investigate the possibility of applying the most recent editions of the referenced standards indicated below.

Cable Television Laboratories, Inc., (CableLabs) Asset Distribution Interface Specification, Version 1.1, 2006. Available from <www.cablelabs.com>.

Cable Television Laboratories, Inc., (CableLabs) Video-On-Demand Content Specification, Version 1.1, 2006. Available from <www.cablelabs.com>.

ISO/IEC 11172-3:1993, "Information Technology – Coding of Moving Pictures and Associated Audio for Digital Storage Media at Up to About 1,5 Mbit/s – Part 3: Audio", 1993. Available from <www.iso.ch>.

ISO/IEC 13818-1:2000, "Information technology – Generic Coding of Moving Pictures and Associated Audio Information: Systems", 2000. Available from <www.iso.ch>.

ISO/IEC 14496-1:2004, "Information Technology – Coding of Audio-Visual Objects – Part 1: Systems", 2004. Available from <www.iso.ch>.

ISO/IEC 14496-3:2009, "Information Technology – Coding of Audio-Visual Objects – Part 3: Audio", 2006. Available from <www.iso.ch>.

ISO/IEC 14496-8:2004, "Information Technology – Coding of Audio-Visual Objects – Part 8: Carriage of ISO/IEC 14496 Contents Over IP Networks", 2004. Available from <www.iso.ch>.

ISO/IEC 14496-10:2005, "Information Technology – Coding of Audio-Visual Objects – Part 10: Advanced Video Coding", 2005. Available from <www.iso.ch>.

ISO/IEC 14496-14:2003, "Information Technology – Coding of Audio-Visual Objects – Part 14: MP4 File Format", 2003. Available from <www.iso.ch>.

ISO/IEC 15938, Parts 1-11, "Information Technology – Multimedia Content Description Interface", 2002-2005. Available from <www.iso.ch>.

ISO/IEC 21000, Parts 1-17, "Information Technology – Multimedia Framework (MPEG-21)", 2003-2006. Available from <www.iso.ch>.

ITU-R Recommendation BT.601-5, "Studio Encoding Parameters of Digital Television for Standard 4:3 and Wide-screen 16:9 Aspect Ratios", October 1995. Available from <www.itu.int>.

ITU-R Recommendation BT.709-5, "Parameter values for the HDTV standards for production and international programme exchange", April 2002. Available from <www.itu.int>.

WAEA Specification 0395, Version 2.0, "Content Delivery for In-Flight Entertainment", 6 November 2001. Available from <www.apex.aero>.

WAEA Specification 1289-2, Revision 3, “Specification for Mastertape Recording, Tape Duplication, Compact Disc Replication, and Digital Encoding for Airborne Audio Entertainment Systems”, 20 January 2005. Available from <www.apex.aero>.

Worldwide Web Consortium Recommendation: Extensible Markup Language (XML) 1.0, Fourth Edition, 16 August 2006. Available from <www.w3c.org>.

FIPS Publication 197, “Specification for the Advanced Encryption Standard (AES)”, 26 November 2001. Available from <www.csrc.nist.gov>.

R.L. Rivest, A. Shamir, and L. Adleman. “A method for obtaining digital signatures and public-key cryptosystems.” Communications of the ACM, 21(2):120-126, February 1978.

3.2 Informative References

The following references contain information that relates to this specification, but are not provisions of this specification. At the time of publication, the editions indicated were valid.

ARINC Project Paper 809, Draft 9, “3rd Generation Cabin Network, Seat Distribution System”, November 2006. Available from <www.arinc.com>.

ARINC Project Paper 820, Draft 2, “3rd Generation Cabin Network, Wireless In-Flight Entertainment System”, November 2006. Available from <www.arinc.com>.

ARINC Specification 628, “Cabin Equipment Interfaces”, Parts 0-9, 1999-2006. Available from <www.arinc.com>.

ARINC Specification 808, “3rd Generation Cabin Network, Cabin Distribution System”, November 2006. Available from <www.arinc.com>.

Consumer Electronics Association (CEA) Standard 608-D, “Line 21 Data Services”, 2006. Available from <www.global.ihs.com>.

CEA Standard 708-C, “Digital Television Closed Captioning”, 2006. Available from <www.global.ihs.com>.

MovieLabs Specification for Enhanced Content Protection v1.0, 2013

4 VIDEO COMPRESSION

To ensure visual quality on a wide array of screen sizes and the interoperability of content, the following video codec meets the requirements of this specification:

- MPEG-4 Part 10 (ISO/IEC 14496-10:2005)

Image data parameters shall be as specified in Table 1.

Coded Picture Format	Video Encoding Resolution
Full-frame (4:3) SDTV	720 x 480 (NTSC, non-square pixels)ITU-R Recommendation BT.601-5
Widescreen (16:9) SDTV	720 x 480 (NTSC widescreen, non-square pixels) ITU-R Recommendation BT.601-5
Widescreen (16:9) HD 720P	1280 x 720 (square pixels) ITU-R Recommendation BT.709-5
Widescreen (16:9) HD 1080P	1920 x 1080 (square pixels) ITU-R Recommendation BT.709-5

Table 1: Coded Picture Format and Video Encoding Resolution

Support for 4:3 content to be displayed in 16:9 screens without distortion and support for 16:9 content to be displayed in 4:3 screens without distortion are required. While systems may be technologically capable of automatically converting 4:3 content into 16:9 displays, or 16:9 content into 4:3 displays, the execution of this capability may be bound by private agreements. Implementers are cautioned to read and understand all applicable agreements. IFES manufacturer and content provider migration to 16:9 content and 16:9 displays is encouraged.

These specifications are for displays on the IFE system. This specification is not a definition for source files that can be transcoded into different bitrates and resolutions (e.g. use the 1080 file as a source for a 720 encode). This is a specification for "Play-out files" (intended to define a format to be rendered on the playback device) as opposed to "Master Files".

Video editing may be performed prior to encoding; these processes are outside the scope of this specification.

The parameters for MPEG-4 settings shall be as specified in Table 2.

FEATURES	CONFIGURATION FOR STANDARD DEFINITION	CONFIGURATION FOR HD 720P	CONFIGURATION FOR HD 1080P
Objective of encoding parameters	The objectives of the encoding Parameter Set shall be: a) To achieve the highest visual quality on IFE screens; b) to ease the positioning of the Trick Modes; and c) to decrease the load on the seat decoding CPUs.	The objectives of the encoding Parameter Set shall be: a) To achieve the highest visual quality on IFE screens; b) to ease the positioning of the Trick Modes; and c) to decrease the load on the seat decoding CPUs.	The objectives of the encoding Parameter Set shall be: a) To achieve the highest visual quality on IFE screens; b) to ease the positioning of the Trick Modes; and c) to decrease the load on the seat decoding CPUs.
Video Input	Progressive	Progressive	Progressive
Resolution	720 x 480	1280 x 720	1920 x 1080
Differentiate by screen size	No size Limitation	For displays up to and including 50 inches measured diagonally	No Size Limitation

FEATURES	CONFIGURATION FOR STANDARD DEFINITION	CONFIGURATION FOR HD 720P	CONFIGURATION FOR HD 1080P
Frame Rate	The reference to Frame Rate and the reference to Progressive video input shall mean that when the source content to be encoded originates in 24fps film, the appropriate frame rate is 23.976fps (24P), and when the content to be encoded originates in 30fps NTSC video, the appropriate frame rate is 29.97fps (30P). If the content to be encoded originates in 24fps film, but has been converted to 30fps NTSC, the Best Practice is to reverse telecine the 30fps NTSC video back to the original 24fps and encode as 24P.	The following Frame Rates are acceptable for video encoded to this specification, 23.976 fps, 25 fps, and 29.97 fps. Content originated at film rates should be available as 23.976 HD masters, and shall be encoded at that rate. Content mastered at 25fps shall be encoded as 25P or converted to 23.976P. Higher frame rates, such as 50P, 50i, 60P and 60i shall be reduced to a frame rate available in the standard. When the content to be encoded is presented as 29.97 fps or 59.94 fps video, best practice is to, if possible, reverse telecine down to a film frame rate and encode as 23.976. In any event the source shall be de-interlaced before encoding.	The following Frame Rates are acceptable for video encoded to this specification, 23.976 fps, 25 fps, and 29.97 fps. Content originated at film rates should be available as 23.976 HD masters, and shall be encoded at that rate. Content mastered at 25fps shall be encoded as 25P or converted to 23.976P. Higher frame rates, such as 50P, 50i, 60P and 60i shall be reduced to a frame rate available in the standard. When the content to be encoded is presented as 29.97 fps or 59.94 fps video, best practice is to, if possible, reverse telecine down to a film frame rate and encode as 23.976. In any event the source shall be de-interlaced before encoding.
Reverse Telecine	Yes	To be used before encoding in the case where telecine pull-down is present in the source	To be used before encoding in the case where telecine pull-down is present in the source
Codec(s)	MPEG-4 Part 10 (H.264)	MPEG-4 Part 10 (H.264)	MPEG-4 Part 10 (H.264)
Profile	Main Profile	High Profile	High Profile
Level	3.1	3.1	4.1
Aspect Ratios Supported	4:3, 16:9	16:9 only HD content shall be encoded as 16:9 display aspect ratio. HD content with an Original Aspect Ratio (OAR) other than 16:9 shall be framed in a 16:9 presentation. HD content that is in 4:3 shall be pillar-box matted. HD content with an aspect ratio wider than 16:9 shall be letterbox matted.	16:9 only HD content shall be encoded as 16:9 display aspect ratio. HD content with an Original Aspect Ratio (OAR) other than 16:9 shall be framed in a 16:9 presentation. HD content that is in 4:3 shall be pillar-box matted. HD content with an aspect ratio wider than 16:9 shall be letterbox matted.
Bit Rate Mode	CBR	CBR or VBR	CBR

FEATURES	CONFIGURATION FOR STANDARD DEFINITION	CONFIGURATION FOR HD 720P	CONFIGURATION FOR HD 1080P
Bit Rate	<p>Standard definition (SD) video shall be encoded in a range from 1.5Mb/s to 2.0Mb/s with a default value of 1.5Mb/s.</p> <p>When visual quality requires it, encoding may deviate from the default value with the consent of the stakeholders, who may include the compressionist, the content provider, the system provider and/or the airline. This bit rate refers to the video elementary stream only without audio.</p>	<p>High definition (HD) in 720P format shall be encoded within a range from 4.0 Mb/s to 8.0 Mb/s, depending on the application and rate control method. Constant bit rate (CBR) default will be 4.0 Mb/s with a maximum of 8.0 Mb/s. When supported by the IFE system, a variable bit rate (VBR) may be used with peak bit rates that shall be in the same range with 6.0 Mb/s as the default value. When visual quality requires it, encoding may deviate from the default value with the consent of the stakeholders, who may include the compressionist, the content provider, the system provider and/or the airline. This bit rate refers to the video elementary stream only without audio.</p>	<p>High definition (HD) in 1080P format at constant bit rate (CBR) shall be encoded within a range from 6.0 Mb/s (default) to 8.0 Mb/s (max.), depending on the application.</p> <p>Variable Bit Rate (VBR) is not specified here.</p> <p>When visual quality requires it, encoding may deviate from the default value with the consent of the stakeholders, who may include the compressionist, the content provider, the system provider and/or the airline. This bit rate refers to the video elementary stream only without audio.</p>
Slice	1, 2 or 4	4	4
Pixel Accuracy	1/4	1/4	1/4
Reference B-frames	No	No	No
Number of Reference Frames	2	3	3
Min/Max GOP Size	<p>GOP size shall be set at:</p> <ul style="list-style-type: none"> - 15 frames for 30fps media - 12 frames for 24 or 25fps media <p>but may be shortened if an I-Frame is triggered by a scene change</p>	<p>GOP size shall be set at:</p> <ul style="list-style-type: none"> - 15 frames for 30fps media - 12 frames for 24 or 25fps media <p>but may be shortened if an I-Frame is triggered by a scene change</p>	<p>GOP size shall be set at:</p> <ul style="list-style-type: none"> - 15 frames for 30fps media - 12 frames for 24 or 25fps media <p>but may be shortened if an I-Frame is triggered by a scene change</p>
Number of B-frames	2	3	3
IDR Frequency	1 on every key frame	1 on every key frame	1 on every key frame
Access Unit Delimiters	The Parameter Set shall include Access Unit Delimiters	The Parameter Set shall include Access Unit Delimiters	The Parameter Set shall include Access Unit Delimiters

FEATURES	CONFIGURATION FOR STANDARD DEFINITION	CONFIGURATION FOR HD 720P	CONFIGURATION FOR HD 1080P
Sequence End Code	No	No	No
Timestamp	No	No	No
Timestamp Offset	No	No	No
Deblocking Filter	The Parameter Set shall include a Deblocking Filter	The Parameter Set shall include a Deblocking Filter	The Parameter Set shall include a Deblocking Filter
Entropy	CABAC	CABAC	CABAC
Weighted Prediction	No	Yes	Yes
Key Frame Insertion on Scene Cut	Yes	Yes	Yes

Table 2: Parameters For MPEG-4 Settings

5 AUDIO COMPRESSION

To ensure aural quality and interoperability of content, the following audio codecs meet the requirements of this specification:

- MPEG-4, Part 3 – High Efficiency Advanced Audio Coding (HE-AAC) (ISO/IEC 14496-3:2009)
- MPEG-4, Part 3 – Low Complexity Advanced Audio Coding (LC-AAC) (ISO/IEC 14496-3:2009)
- MPEG-1 Audio, Layer 2 (MP2) (ISO/IEC 11172-3:1993)

Audio content shall be encoded at the data rates specified in Table 3.

Audio Formats	HE-AAC CBR in Kb/s	LC-AAC & MP2 CBR in Kb/s
Joint Stereo	64	128
Dual Channel or Independent Stereo	128	256
Single Channel Monaural	64	128

Table 3: Audio Formats and Data Rates

Audio quality shall comply with APEX Specification 1289-2, Revision 3, “Specification for Mastertape Recording, Tape Duplication, Compact Disc Replication, and Digital Encoding for Airborne Audio Entertainment Systems”.

Frequency response shall be 20 Hz to 20 kHz at ± 3 dB (“Hi-Fi”). Sampling frequency shall be 44.1 kHz for all audio content.

Audio editing may be performed prior to encoding; these processes are outside the scope of this specification.

6 MPEG SYSTEM

MPEG system multiplexing is required for the delivery of elementary encoded video and audio, data and metadata. PPLs provide the required encrypted elementary streams and each IFES manufacturer or their agent multiplexes them pursuant to their unique IFES MPEG systems requirements. This allows for cross-utilization of the same encoded content with different IFES architectures.

The following systems multiplexing meet the requirements of this specification:

- MPEG-4, Part 14 (ISO/IEC 14496-14:2004)
- MPEG-4 over MPEG-2 as specified in MPEG-2 Systems (ISO/IEC 13818-1:2000)
- MPEG-4 over IP networks (ISO/IEC 14496-8:2004)
- MPEG-4 over http as specified in MPEG-4 Systems (ISO/IEC 14496-1:2004)

Precise synchronization of multiplexed elementary video and audio streams is required to prevent noticeable and objectionable lip-sync problems. It is a synchronization requirement of this specification that video shall lag audio no more than 20 ms and video shall lead audio no more than 40 ms.

7 SECURITY

7.1 Security Introduction

IFES must be capable of protecting intellectual property from unauthorized access. It is desirable that security systems have minimum impact on the operations of airlines for handling protected content. Both plain text and secure content shall be accommodated throughout the content delivery process. Not all content need be made secure. The content provider shall determine if a particular item or class of intellectual property must be protected, and if a particular security implementation offered by an IFE vendor is acceptable.

7.2 SD Content Security

Security of content in Standard Definition (SD) is specified in WAEA Specifications 0395, "Content Delivery for In-Flight Entertainment", version 2.0, As Amended and Approved by the World Airline Entertainment Association Technology Committee, November 6, 2001. (Original Version 1.1 Approved June 7, 1996.)

7.3 HD Content Security

The following requirements are in addition to the above already required APEX SD Content Security and apply to content in High Definition (HD) when requested by Content Providers.

Content Security	Security Requirements
HD Video Protection	HD Video content shall be maintained encrypted while on board except during playback
Audio, CC & Subtitle Protection	Same as APEX 0395
Content Encryption Strength	The encryption algorithm for HD Video shall be at least as strong as the Advanced Encryption Standard (AES), 128-bit Symmetric Key with Cypher Block Chaining (CBC)

Key Encryption Strength	The symmetric key used to encrypt/decrypt HD content shall be encrypted using a public key encryption algorithm at least as strong as RSA with a 2048-bit key
Export of Encryption Algorithms	All selected encryption/decryption algorithms shall be exportable from the U.S. by complying with currently applicable U.S. export regulations (e.g., ITAR, EAR)
Symmetric Key Encryption	The encrypted symmetric key shall be maintained encrypted in the IFEC system except during playback
Private Key	The airline or their agent shall be responsible for maintaining the secrecy and security of their Private Key in the IFEC system
Security Breach Response	If a security breach is discovered, the airline or their agent shall be responsible for providing a key revocation process acceptable to the content provider
Key Management System	The content provider shall determine if a particular KMS implementation offered by the airline or their agent is acceptable

Table 4: HD Content Security Requirements

8 OTHER CONSIDERATIONS

8.1 Metadata

To allow automated generation of passenger GUIs, A/V content attribute metadata should be provided for, at a minimum, title, credits, synopsis, ratings, promotional material, and key art. Audio only content attribute metadata should be provided for, at a minimum, title, credits, lyrics, ratings and key art.

The following metadata formats are applicable to content meet the requirements of this specification:

- MPEG-7 (ISO/IEC 15938, Parts 1-11), including XML (Worldwide Web Consortium Recommendation: XML 1.0, Fourth Edition)
- MPEG-21 (ISO/IEC 21000, Parts 1-17)
- Cable Television Laboratories, Inc., (CableLabs) Video-On-Demand Metadata Specifications, Version 1.1 (CableLabs Asset Distribution Interface Specification, Version 1.1, and CableLabs Video-On-Demand Content Specification, Version 1.1)

All files and metadata associated with particular content should include a corresponding UUID content identifier and/or an ISAN content identifier. ISAN has a dedicated field in MPEG-4.

8.2 Content Source Media

Recommended source media for the A/V content encoding process include:

- One content release, HD 1920 x 1080 resolution, language tracks with digital audio,
- One content release, HD 1280 x 720 resolution, language tracks with digital audio,
- One content release, Full D-1 resolution, widescreen (16:9, 4:3) SDTV format, language tracks with digital audio,
- Promotional material, Full D-1 resolution, widescreen (16:9, 4:3) SDTV format, language tracks with digital audio,

- Key art files, JPEG format,
- A metadata file containing content description information (e.g., title, credits, synopsis, ratings and other metadata).

Recommended source media for the audio only content encoding process include:

- Audio programs with Hi-Fi audio,
- Key art files, JPEG format,
- A metadata file containing content description information (e.g., title, credits, lyrics, ratings and other metadata).

8.3 Quality

Compliance with this specification does not guarantee acceptable quality of the encoded media, and does not replace the need for skill and judgment in the art and science of motion picture and video postproduction laboratory practices. Nothing in this specification is intended to replace normal content provider quality assurance processes.

8.4 Intellectual Property Disclaimer

The intention of this specification is to only require the use of intellectual property that meets the ISO/IEC/ITU guidelines for inclusion of intellectual property in international standards, which, paraphrased, requires licensing of intellectual property on a fair, reasonable and non-discriminatory basis. It is the responsibility of parties implementing this specification to ensure they obtain necessary licenses for use of intellectual property used in their implementation.

This specification is based on material submitted by various participants during the drafting process. APEX has not made any determination whether these materials could be subject to valid claims of patent, copyright or other proprietary rights by third parties, and no representation or warranty, expressed or implied, is made in this regard. Any use of or reliance on this document shall constitute an acceptance thereof “as is” and be subject to this disclaimer.

8.5 Subtitles and Closed Captions for Video Files

This document describes the proposed standard digital media encoding requirements for interchange of Subtitles and Closed Captions for caption-capable IFE systems.

8.5.1 Closed Caption and Subtitle Feature Overview

Closed Captions and Subtitles for IFE systems will be provided in the Scenarist DVD authoring format for subtitling. This format consists of a combination of TIFF images and a display schedule file with time-on/off for each CC/Subtitle image. The requirements for this delivery or interchange format are outlined in this section.

It is expected that an IFE system will post-process this interchange format into another format usable internally. The use of this interchange format makes the delivery of Captions and Subtitles independent of the encoding format (refer to Section 4) and transport format (Section 6) of the ultimate video file or stream.

Future: Closed Captions and Subtitles may be provided in DVB compliant TS file format; where the TS file includes the final versions of video, audio tracks and textual tracks. The requirements for this delivery format may be found in a future revision of this document, but would only be specific to one of the four Systems choices listed in Section 6.

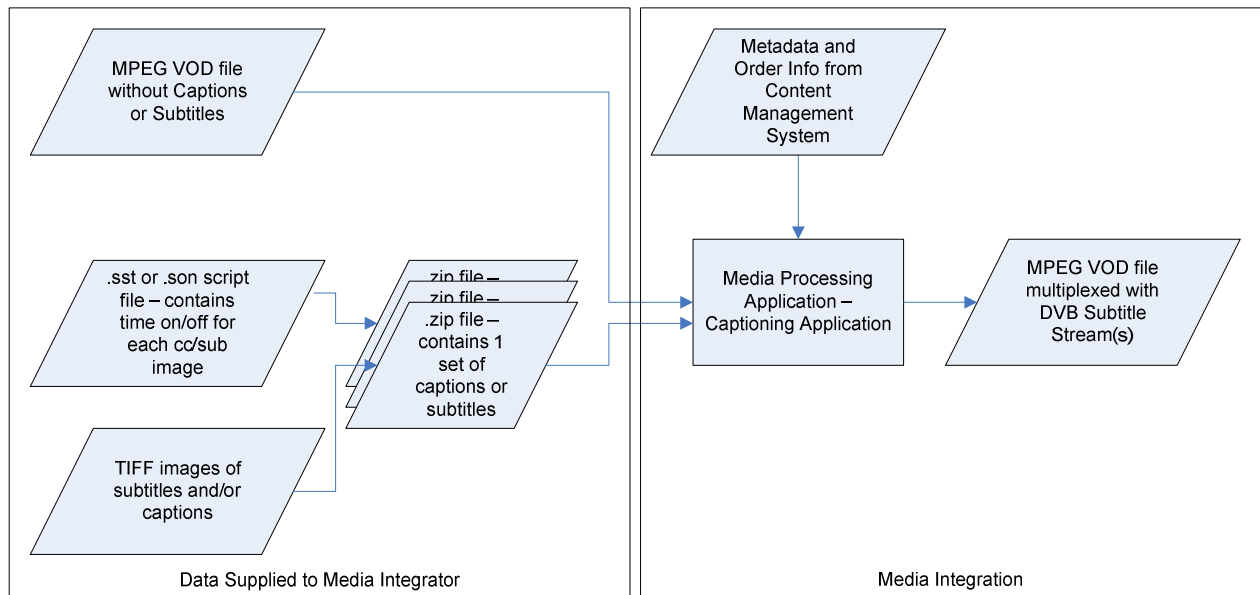


Figure 2: Captioning and Subtitling Process Flow

8.5.1.1 The supported subtitle and captioning streams may contain any language and any font. Since input requirement for captioning and subtitle streams is image-based, the IFE system will support captioning and subtitles in any language, including Asian character sets, languages that read right-to-left as well as Western languages.

8.5.1.2 Up to 12 independent subtitle streams and closed caption streams shall be supported in a single file. For example, a single VOD file may contain 3 streams of captioning for the hard of hearing and 9 streams of subtitles for language translation purposes.

8.5.1.3 When supplying captioning and subtitles in the DVD subtitle authoring format, they shall be provided as a separate archive containing the timing and associated subtitle/closed caption images. The Media Integrator must provide the ability to integrate the DVD formatted captioning and subtitles stored in a Scenarist DVD authoring format into the multiplexed VOD file. The following sections describe the accepted Scenarist DVD authoring format.

8.5.1.4 Closed Captions and Subtitles File Format Specifications

8.5.1.4.1 The basic requirement for delivery of Closed Captions and Subtitles is the Scenarist DVD authoring format. It is a combination of TIFF images and a display schedule file with time-on/off for each CC/Subtitle image.

8.5.1.4.2 A separate zip file shall be required for each CC/Subtitle stream. The display schedule file and all corresponding images shall be compressed into a single zip file. In other words, if 3 languages are required, there shall be 3 separate zip files each with the complete set of files for one language.

8.5.1.4.3 The zip file shall be named as follows: <VOD_File_Name>_<CC/Sub_Language><Caption_Type>.zip; where:

<VOD_File_Name> = the base name of the corresponding mpeg video file.

<CC/Sub_Language> = the ISO 639 3-letter code for this language

<Caption_Type> = CAP for captions for hard of hearing persons, SUB for subtitles for language translation

Example: AA0123M2_ENG_CAP.ZIP

8.5.2 Display Schedule File Format

The display schedule file shall be provided in a Scenarist compliant script file format, also known as “.sst” or “.son” files; a st_format 2 file type. Section 8.6 includes a sample of a display schedule file. Although other Scenarist fields/parameters may be included in the display schedule file, only the Base_Time and Tape_Type parameters are processed by the integration tools at this time.

8.5.2.1 Base_Time

Base_Time is a required parameter in the display schedule file. It represents the PTS of the start of the mpeg file and can be used to offset the display of the captions from the time codes shown in the schedule file. This value is specified as follows:

hh:mm:ss:ff

Where:

hh = 2-digit hours value of the PTS at the start of the video stream

mm = 2-digit minutes value of the PTS at the start of the video stream

ss = 2-digit seconds value of the PTS at the start of the video stream

ff = 2-digit frame number value after the start of the above specified second within the video stream (non-drop frame count)

Note: Typically, it is expected the Base_Time and PTS in the mpeg file will be 01:00:00:00 at the start of the mpeg file. In this case, the Time-On and Time-Off values, in the display schedule file, shall include this offset.

8.5.2.2 Tape_Type

Tape_Type is a required parameter in the display schedule file. It represents the type of timing used in the display schedule. Possible values are DROP for Drop Frame Time Code and NON_DROP for Non Drop Frame Time Code. Proper timing of the subtitles will depend on this parameter being defined properly; it must correspond with the type of time code used in the control file. An error in the value of this parameter will lead to a drift in the subtitle timing of 3.58 seconds per hour of video!

8.5.3 Image File Format

Both TIFF and BMP file formats are accepted. The following are specific image file parameter requirements:

- Width = 720 pixels, Height = 480 pixels. Note that the bitmaps will be stretched beyond the 3:2 aspect ratio to fit a given display. The fonts may be rendered with that in mind; however, in most cases one rendering should view fine both when display aspect ratio is 4x3 and when it is 16x9.
- Color Depth (bit depth) = 4bit (recommended) or 8bit
- Number of unique colors: 4 colors or less For example, 8 bit TIFF images can be accepted, as long as the color pallet includes 4, or less, colors.
- Color Representation = Palletized and RGB are both acceptable
- Compression = RLE and other similar TIFF compression types are supported
- The background color must be different from the other colors used for the fonts; all pixels equal to the background color will be made transparent when the image is displayed on the IFE system.

Font sizes shall be based on a 32pixel height for a full size character, e.g. “[“.

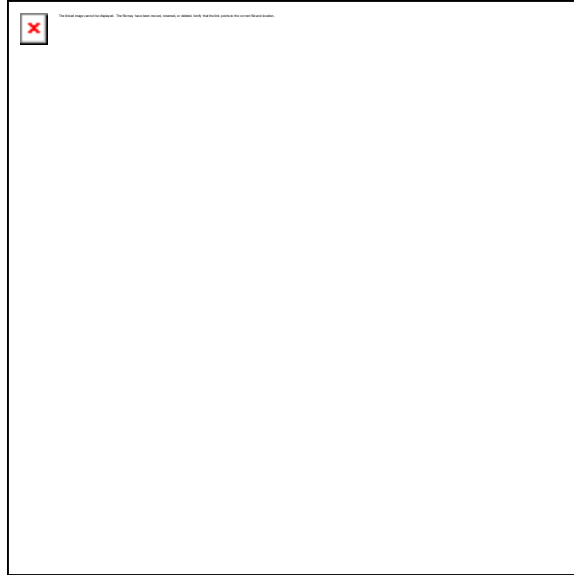


Figure 3: Pixel View of Captioning and Subtitle Characters



Figure 4: Example of Full Screen Caption Image

8.5.4 Timing Validation

It is expected that incoming media shall be validated for proper video-captioning synchronization prior to receipt by the Media Integrator.

- 8.5.4.1 For each image identified in the display schedule file, the Time On must be less than the Time Off.
- 8.5.4.2 For each image identified in the display schedule file, the preceding Time Off value must be less than the Time On value of the next image.
- 8.5.4.3 For each image identified in the display schedule file, the Time Off value must be at least 20 frames greater than the Time On value. That is, a minimum duration for a single subtitle is 20 frames. Durations less than 20 frames may not be displayed.
- 8.5.4.4 If the caption display schedule file was produced for DVD production, care is required to provide an adjusted Base_Time to align the timing to a new MPEG encoded movie file. Two common elements that introduce an offset are described in the following subsections, but others may be considered.

- 8.5.4.4.1 The file produced for a DVD may have the first subtitle cued in at 01:00:43:11, whereas the cue time in the new MPEG file will be 00:00:43:11. For example, where the DVD file lists the first subtitle in hour=1, instead of hour=0, a Base_Time of 01:00:00:00 will correct the misalignment.
- 8.5.4.4.2 The new MPEG encoded file might have 5 seconds of Black appended at its head or a content warning for example. For example, if the newly encoded file has 12 seconds of added footage then the Base_Time becomes 00:59:48:00 (1 hour minus 12 seconds)
- 8.5.4.5 In the absence of the ability to play the MPEG file and display or overlay the subtitles and verify synchronization, the following steps shall be followed to verify video-caption synchronization:
- Look at the first caption image file (.tif file) with a viewer.
 - From the display schedule take the start time for that image and subtract the Base_Time (to arrive at the actual display time).
 - Using a software media player, check the video and audio at the same point in the media file.
 - Verify the initial caption is correctly aligned with the video.

8.6 Sample Subtitle and Captioning Display Schedule File

```
st_format 2
#####
# Title :
#
# English Subtitle File
#
# Edited by :
# Date : 070403
#
#####
# BG = Background color
# PA = Text foreground color (letter body)
# E1 = Antialiasing color
# E2 = Text border color
#####
Subtitle ERCH
Tape_Type DROP
Display_Start non_forced
Pixel_Area (2 479)
Display_Area (0 2 719 479)
Color (3 3 7 4)
Contrast (15 2 15 0)
BG (0 255 0 = = = )
PA (255 255 255 = = = )
E1 (0 0 0 = = = )
E2 (0 0 255 = = = )
directory C:\media\movie1
```

```

Base_Time      00:59:58:00
#####
SP_NUMBER      START          END          FILE_NAME
0001 01:00:30:12 01:00:35:08 eng0001.tif
0002 01:00:35:13 01:00:40:07 eng0002.tif
0003 01:00:41:17 01:00:44:08 eng0003.tif
0004 01:00:44:13 01:00:48:02 eng0004.tif

```

9 INFORMATIVE ANNEX: MEDIA ACCESSIBILITY OVERVIEW

9.1 Introduction

9.1.1 Captioning

There are millions of people worldwide that have a hearing loss so acute that they cannot fully understand the audio portion of A/V content. This is especially true of the elderly, the fastest growing category of individuals who are deaf and hard of hearing. Text captions enable viewers who are deaf and hard of hearing to understand the audio portion of A/V content. Captions can also benefit adults and children learning to read, as well as people learning second languages.

Like subtitles, captions display spoken dialogue as printed words on the screen. Unlike subtitles, captions are specifically designed for viewers who are deaf and hard of hearing. Captions are carefully placed to identify speakers, on-screen and off-screen sound effects, music, and laughter. Closed-captions are hidden as data within the A/V content’s data package, and they must be decoded in order to be displayed. Open captions are imprinted as part of the A/V content’s visual display and cannot be turned on or off.

9.1.2 Descriptive Narration

Descriptive narration is a service that makes A/V content accessible to people who are blind or who have low vision. Descriptive narration consists of a script written to highlight key visual elements that a viewer who is blind or who has low vision would ordinarily miss in the content (e.g., action, settings, costumes, gestures, and scene changes). The script is then voiced by a professional narrator, interspersing the descriptions between dialog so as not to interfere with the audio or dialog of the content. The descriptive narration track is then mixed with the original content audio track to create a new audio track that includes the descriptions. Such descriptive narration audio is delivered to users via a variety of technologies, depending on the platform: stereo television’s secondary audio program for broadcast and cable distribution, selectable audio tracks for DVD distribution, and via infrared or frequency modulation systems in motion picture theaters.

9.1.3 Accessible Navigation

People who are blind or who have low vision have difficulty navigating on-screen menus, particularly those which employ touch screens. Solutions to overcome these difficulties are proposed in this annex that may help create a better passenger experience for those with visual impairments.

9.2 Captioning in IFE

There are several techniques that can be employed to provide captioning in IFES:

9.2.1 Parallel Content

For A/V content that is provided to IFE passengers, it is possible to provide a parallel content library with open captions imprinted in the A/V content, allowing the deaf and hard of hearing to select from the library of captioned material.

If open captions are offered, they should be readable at a distance of 4.25 times the diagonal size of the display. Given the limitations of most IFE screens (i.e., their limited size and close distance to the viewer), open captions

should use the same process as subtitling, which provides readable characters while keeping most of the picture visible. This implementation also interferes less with the appearance of the A/V content.

9.2.2 Closed-Captioned Content

Alternatively, A/V content may be made available with closed-caption data. This data can take the form of line-21 data for analog content (CEA 608-D, “Line 21 Data Services”) or digital television closed-caption data for digital content (CEA 708-C, “Digital Television Closed Captioning”). Line 21 closed-caption decoder technology is widely available as integrated circuits or software. Decoding could happen at the seatback, or could be centralized at an onboard server and accomplished in software for each passenger.

9.2.3 Subpicture Stream Technology

Captions are commonly provided for DVD titles as subpicture streams specifically authored for the needs of deaf and hard-of-hearing viewers. Similarly, an IFES could utilize such captions as subpicture streams and provide a passenger interface to allow for the selection of a given subpicture stream. The MPEG-4 format also supports text data in the stream file.

9.3 Descriptive Narration in IFE

Care should be taken to provide descriptive narration audio that can contend with a noisy airborne environment by utilizing WAEA Specification 1289-2, Revision 3. Like captioning, several techniques can be employed to provide descriptive narration in IFES:

9.3.1 Parallel Content

For A/V content that is provided to IFES, it is possible to provide a parallel content library with descriptive narration, allowing the blind or low vision passenger to select from the library of described material.

9.3.2 Multiple Audio Tracks

A/V content may be made available for IFES with multiple audio tracks, such as alternate languages or a descriptive narration audio track. The IFES provides a user interface allowing for the selection of a given alternate audio track, including the descriptive narration.

9.4 Accessible Navigation in IFE

Most IFES rely on graphical user interfaces, which typically include hierarchies of onscreen menus not readily usable by people who are blind or who have low vision. Accommodation of these users can be accomplished in a number of ways, or more often, using a combination of the following methods:

9.4.1 Tactile Controls

User handsets have tactile indicators (“nibs”) on essential keys and differentiated key shapes (square, triangle, round) so that different functions are readily discernable.

9.4.2 Audible Feedback

The IFES user interface can be programmed to provide audible feedback. Key elements include descriptions of positioning within the menu structure, available choices, navigation instructions, audible prompts, and audible versions of other key information on the screen that is otherwise only available to sighted users. When this feature is enabled as an option by user choice, audio files that enunciate the name or function of a menu, button or key press are automatically triggered as the user navigates the GUI. Such techniques are commonly referred to as “talking menus”.

9.4.3 Speech Control

Where there are no tactile controls for IFES navigation, speech-to-text solutions, if practicable and available, may allow the passenger to speak commands to the system to accomplish such tasks as moving the cursor and selecting menu items.

10 INFORMATIVE ANNEX: ACRONYMS AND ABBREVIATIONS

A/V	Audio/Video
AES	Advanced Encryption Standard
APEX	Airline Passenger Experience Association <i>formerly</i> World Airline Entertainment Association [WAEA]
ARINC	Aeronautical Radio, Inc.
AVOD	Audio/Video On-Demand
CBC	Cipher-Block Chaining
CBR	Constant bit rate
CEA	Consumer Electronics Association
CP	Content Provider
dB	Decibels
DCMWG	Digital Content Management Working Group
DES	Data Encryption Standard
DR	Download Request
DVD	Digital Versatile Disc
FIPS	Federal Information Processing Standards
GUI	Graphical User Interface
HE-AAC	High Efficiency Advanced Audio Coding, now version 2
Hi-Fi	High-Fidelity audio with a frequency response of 20 Hz to 20 kHz at ± 3 dB
http	Hypertext Transfer Protocol
Hz	Hertz (cycles per second)
IC	Integrated Circuit
ID	Identifier
IEC	International Electrotechnical Commission
IETF	Internet Engineering Task Force
IFE	In-Flight Entertainment
IFEC	In-Flight Entertainment & Connectivity
IFES	In-Flight Entertainment Systems
IP	Internet Protocol
ISO	International Organization for Standardization
ITU	International Telecommunication Union
ITU-R	International Telecommunication Union - Radiocommunication
JPEG	Joint Photographic Experts Group
Kb	Kilobit
kHz	Kilohertz (one thousand cycles per second)
KMS	Key Management System
LC-AAC	Low Complexity Advanced Audio Coding
Mb/s	Megabit per second
MP2	MPEG-1 Audio, Layer 2

MPEG	Moving Picture Experts Group
OAR	Original aspect ratio
PPL	Postproduction Laboratory
RSA	A cryptographic algorithm invented by R. Rivest, A. Shamir and L. Adleman
RTC	Real-Time Clock
SAMI	Synchronized Accessible Media Interchange
SDTV	Standard Definition Television
SMPTE	Society of Motion Picture and Television Engineers
VC	Video Codec
WAEA	World Airline Entertainment Association (now the Airline Passenger Experience Association [APEX])
XML	Extensible Mark-Up Language

11 INFORMATIVE ANNEX: LIST OF PARTICIPANTS

This specification could not have been produced without the dedicated involvement of many individuals and companies. The following persons participated in the creation of this document by attendance at one or more meetings of the WAEA DCMWG. Their company affiliation at the time of their participation is also given.

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