Essence (10E)

Co-Chairs: Annie Chang and Edward Reuss

Overview

The scope of the 10E technology committee applies to electronic capture, generation, editing, mastering, archiving, and reproduction of image, audio, subtitles, captions, and any other master elements required for distribution across multiple applications.

Organization

The 10E technology committee is organized into drafting groups and study groups covering specific tasks and areas of activity. Typically, more than 20 projects have been active throughout the year. All project groups report directly to the technology committee.

Recent Publications

Over the past 12 months, 10E has published the following engineering documents and registered disclosure documents (RDDs):

- Amendment 1:2016 to SMPTE ST 2048-1:2011, 2048 × 1080 and 4096 × 2160 Digital Cinematography Production Image Formats FS/709—Amendment 1
- SMPTE OV 2073-0:2016, VC-5 Video Essence—Overview for the SMPTE VC-5 Document Suite
- SMPTE RP 2073-2:2015 (Revision on SMPTE RP 2073-2:2014), VC-5 Video Essence—Part 2: Conformance Specification
- SMPTE ST 2073-3:2015, VC-5 Video Essence—Part 3: Image Formats
- SMPTE ST 2073-4:2015, VC-5 Video Essence—Part 4: Subsampled Color Difference Components
- SMPTE ST 2085:2015, Y′ $D'_Z D'_X$ Color-Difference Computations for High Dynamic Range X′Y′Z′ Signals
- SMPTE RDD 34:2015, LLVC—Low Latency Video Codec for Network Transfer
- SMPTE RDD 35:2016, TICO Lightweight Codec Used in IP Networked or in SDI Infrastructures
- SMPTE RDD 36:2015, Apple ProRes Bitstream Syntax and Decoding Process
- SMPTE RDD 37:2016, Uncompressed Video Transport Over MPEG-2 Transport System
- RP 2047-3, Level 65 Compression of High Definition Video Sources for Use with a Standard Definition Infrastructure
- SMPTE ST 2019-1:2014, VC-3 Picture Compression and Data Stream Format
- SMPTE RP 2019-2:2014, VC-3 Decoder and Bitstream Conformance
- SMPTE ST 2019-4:2016 (Revision of SMPTE ST 2019-4:2014), Mapping VC-3 Coding Units into the MXF Generic Container
- RP 219-2 2002, Ultra High-Definition, 2048 × 1080 and 4096 × 2160 Compatible Color Bar Signal
- Study Group Report on High Dynamic Range (HDR) Imaging Ecosystem
- SMPTE ST 2094-1:2016, Dynamic Metadata for Color Volume Transform—Core Components
- SMPTE ST 2094-10:2016, Dynamic Metadata for Color Volume Transform—Application #1

By September 2016, the following may have been published:

- SMPTE ST 2094-20:2016, Dynamic Metadata for Color Volume Transform—Application #2
- SMPTE ST 2094-30:2016, Dynamic Metadata for Color Volume Transform—Application #3
- SMPTE ST 2094-40:2016, Dynamic Metadata for Color Volume Transform—Application #4
- ST 2087:2016, Depth Map Representation
- RP 219-2:2016, Ultra High-Definition, 2048 × 1080 and 4096 × 2160 Compatible Color Bar Signal

Work in Progress

VC-2 Video Compression

VC-2 mezzanine video compression is based on the BBC's Dirac pro. Work has been progressing on the revisions for SMPTE ST 2042-1, VC-2 Video Compression and SMPTE ST 2042-2, VC-2 Level Definitions. Supporting conformance documentation awaits the availability of new bitstreams in the form of an amendment to RP 2042-3, VC-2 Conformance specification. A revision of RP 2047-3, Level 65 Compression of High Definition Video Sources for Use with a Standard Definition Infrastructure, has been published. Work is under way on RP 2047-5, Level 66 Compression of UHD for Use with HD Infrastructure.

VC-3 Video Compression

VC-3 is based on AVID's DNxHD technology. A revision of SMPTE ST 2019-1:2014, VC-3 Picture Compression and Data Stream Format, which has been published, adds image resolution independence capability in a way that is fully backward compatible with the existing standard. A revision of SMPTE RP 2019-2:2014, VC-3 Decoder and

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Date of publication: 10 October 2016

Bitstream Conformance, has also been published, which includes new bit patterns to enable testing of the updated ST 2019-1 implementations. This project has completed its work.

VC-5 Video Essence

VC-5 is based on the Cineform/GoPro video compression system. The document suite plan currently consists of the following:

- Part 1: VC-5 Elementary Bitstream (Published)
- Part 2: VC-5 Conformance Specification (Published; includes a reference decoder, a sample encoder, and sample bitstreams)
- Part 3: VC-5 Image Formats (Published)
- Part 4: VC-5 Subsampled Color Difference Components (Published)
- Part 5: Layers (extensions to support the representation of multiple images in a single VC-5 bitstream)
- Part 6: Sections (a mechanism for implementing special functions without disturbing standard decoders)
- Part 7: Metadata.

A revision of RP 2073-2:2014, VC-5 Conformance Specification, is being prepared, which will add test materials and features to the source code to enable testing of Parts 3 and 4. Both ST 2073-3 VC-5—Part 3: Image Formats and ST 2073-4:2015 VC-5—Part 4: Subsampled Color Difference Components have been published. Part 5: Layers and Part 6: Sections are nearly complete. Work is continuing on Part 7: Metadata.

Reference Display and Environment for Critical Viewing of Television Pictures

This project group is developing a suite of documents dealing with the use of fixed pixel matrix reference displays. This is currently planned to consist of the following:

- ST 2080-1: Reference White Luminance Level and Chromaticity (Published)
- RP 2080-2: Measurement and Calibration Procedure for HDTV Displays (Published)
- ST 2080-3: Reference Viewing Environment for Evaluation of HDTV Images (In process)
- ST 2080-x: Reference Display Characteristics (On hold)
- RP 2080-x: Full Measurement/Calibration (In process)
- EG 2080-x: Engineering Guideline to provide context and background (On hold).

Recent drafting work has been on Part 3, with attention now turning to reference display characteristics.

Depth Map Representation

This project is defining a standard for a data representation of depth maps in multiview production and post-production to support interoperability and exchange. The new standard ST 2087, Depth Map Representation, has been published, and this project has completed its work.

UHDTV Color Bar Signal

A new RP 219-2:2016, Ultra High-Definition, 2048 × 1080 and 4096 × 2160 Compatible Color Bar Signal, which has been published, specifies color bar patterns compatible with a range of image formats: 2048 × 1080, 3840 × 2160, 4096 × 2160, and 7680 × 4320.

Dynamic Metadata for Color Transforms of HDR and WCG Images

This project has developed multipart standards to specify the semantics and representation of content-dependent metadata needed for color volume transformation of high dynamic range (HDR) and wide color gamut (WCG) imagery to smaller color volumes in mastering applications. A core metadata standard has been published, in conjunction with a number of application standards, to define particular approaches to color volume mapping. The 10E chairs would like to highlight the amazing work that the project group chair, document editor, and group have done to draft, ballot, and publish all the documents within a year. The following suite of documents have been, or will soon be, published:

- SMPTE ST 2094-1:2016, Dynamic Metadata for Color Volume Transform—Core Components
- SMPTE ST 2094-10:2016, Dynamic Metadata for Color Volume Transform—Application #1
- SMPTE ST 2094-20:2016, Dynamic Metadata for Color Volume Transform—Application #2
- SMPTE ST 2094-30:2016, Dynamic Metadata for Color Volume Transform—Application #3
- SMPTE ST 2094-40:2016, Dynamic Metadata for Color Volume Transform—Application #4

A project is under way, under the 31FS Technology Committee, for the Material Exchange Format (MXF) mapping and key-length-value (KLV) encoding of the dynamic metadata. Liaisons with the Consumer Technology Association (CTA) and the Motion Picture Experts Group (MPEG) have been formed for the exchange of information regarding the dynamic metadata standards.

Study Group on HDR Ecosystem

The study group concluded its research and published a report on its findings, which included the implementation of HDR and WCG in professional media workflows. The report includes a glossary of HDR-related terms, a look at current HDR technology proposals, implementation issues, and requirements across both linear and home entertainment distribution platforms. The report also identifies existing standards that are impacted and standards gaps that need to be addressed. This report is available on the SMPTE website at https://www.smpte.org/standards/reports.

Television Lighting Consistency Index

Work is continuing on the drafting of RP 2093, Lighting Consistency, to define the measurement procedure for assessing the colorimetric quality of lighting when used in television production.

Coding of Tactile Essence

This project is dealing with technology to allow a remote viewer to receive and experience the haptic or tactile "feeling" and "impact" of an event, regardless of the transmission means. The group is restarting and continuing the development of the proposed standard ST 2100-1, Definition and Representation of Haptic-Tactile Essence.

1080-line and 2160-line Digital Cinematography Production Image Formats FS/709

A number of additional higher frame rates are included in a published Amendment SMPTE ST 2048-1:2016, 2048 × 1080 and 4096 × 2160 Digital Cinematography Production Image Formats FS/709. The project has completed its work.

RDD 34: Sony LLVC—Low Latency Video Codec for Network Transfer

This published RDD describes the Low Latency Video Codec (LLVC) and describes an example decoder implementation with subsampling schemes of 4:2:2 and 4:4:4. The project has completed its work.

RDD 35: IntoPIX TICO Lightweight Codec Used in IP Networked or SDI Infrastructures

This published RDD describes the architecture and mezzanine compression scheme of the TICO codec designed to support multiple high-definition and ultra-high-definition television streams across the Internet Protocol (IP) network or across the existing 3G-SDI infrastructure. The project has completed its work.

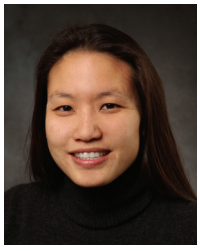
RDD 36: Apple ProRes Bitstream Syntax and Decoding Process

This published RDD includes specifications for the Apple ProRes bitstream syntax, the bitstream element semantics, and the decoding processes used to decompress images. The project has completed its work.

Future Work

Other video-related new projects can be anticipated to emerge over the coming months.

About the Authors



Annie Chang is the vice president of technology standards and strategy for The Walt Disney Studios. Chang harmonizes the Studio's content technology strategies with industry standards efforts from feature production through consumer distribution. She is the co-chair of the 10E Essence Technology Committee at SMPTE and was the chair of the Interoperable Master Format at SMPTE for five years. Chang represents Disney as a Board Member in the Avid Customer Association and as a Board Director in the UHD Alliance. In October 2015, Chang became an SMPTE Fellow and received the Workflow Systems Medal Award for her research, implementation, and participation in file-based technologies, and in 2016, she became a member of the Academy of Motion Picture Arts and Sciences Members-At-Large branch. During her eleven years at Disney, Chang has helped research and implement new technologies into Disney's feature post-production and mastering pipelines, helped the studio transition from tapes to files, and helped launch feature iTunes and 2-D/3-D Blu-ray. Prior to Disney, she spent six years at THX Ltd. as the senior engineer for the Digital Mastering Program and three years in DVD authoring and compression. Chang holds a BS in engineering technology from Texas A&M University.

Edward Reuss serves as a senior systems engineer and a hardware architect for Doppler Labs. He specializes in video, audio, and Wi-Fi networks, particularly for very low-latency applications. Earning his MSEE at Colorado State University, Reuss started in test and measurement for Hewlett Packard (Agilent), Tektronix, and Wavetek. He worked at General Instrument on the Eurocypher project for the British Satellite Broadcasting. After several years developing scientific instruments at the Scripps Institution of Oceanography, he was a director of systems engineering at Tiernan Communications, developing real-time MPEG-2 video encoders for digital satellite newsgathering and high-definition television network distribution. He switched to consumer products as a principal engineer in Plantronics' Advanced Technology Group, where he developed several advanced technology prototype headsets incorporating digital signal processor, Bluetooth, and Wi-Fi. Since then, he has consulted for several clients, including GoPro, Intel, Clair Global, and TiVo. Reuss is active in the SMPTE Standards Community, where he serves as a cochair of the Technical Committee for Coding of Essence (TC-10E). He is also a Senior Member of the IEEE and a past voting member of the IEEE 802.11 Wireless Local Area Networks Working Group.

Film Applications (20F)

Chair: John C. Miller

Overview

This 20F technology committee supports all aspects of film and its applications, including general audio and projection cinema presentation.

Organization

The work of the 20F committee has been organized into broad-based working groups, each maintaining their specific application with recommendations to 20F for action. Most standards are mature; many have been made stable.

TC-20F.10 Film Production Technology (Chair: John C. Miller)

This working group maintains dimensional specifications for cutting, perforating, and identification of motion picture films and components. These include camera use, original image areas, sound application areas, and interchangeability.

TC-20F.20 Laboratory Services (Chair: Michel Golitzinsky)

This working group maintains all phases of laboratory services to include preparation, processing, and duplication of motion pictures.

TC-20F.30 Audio Technology (Chair: Ioan Allen)

This working group deals with the production, processing, recording, reproduction, distribution, and presentation of sound records for motion picture systems, including the mechanisms and practices relating to acoustic issues for audio presentation of all media in screening rooms and commercial theaters.

TC-20F.40 Theatrical Projection (Chair: Jess Daily)

This working group deals with nontelevision presentation of motion pictures, including specifications for image areas intended for projection, and image measurement practices for theatrical presentation. Also included are dimensions for projection reels and containers and print identification and leaders.

Work in Progress

The drafting group (DG) has been formed for the on-screen light measurement and is now chaired by Dave Schnuelle, with Matt Cowan as the document editor.

This DG will recommend a unified approach to screen luminance measurement. There are three different applications of the screen luminance measurement procedure: review rooms and premium cinemas, general cinemas, and 3-D. The measurement procedure will apply to digital projection primarily—and recommendations for test patterns will be focused on digital platforms—but will also be applicable to film presentations. The absolute screen brightness values are not the subject of this Recommended Practice (RP) but of other standards that will refer to this measurement method RP.

This RP will be written based on a review of the 20F Technology Committee On-Screen Light Measurement Study Group Report on light measurement methodology. This document will define requirements for light measurement methods (not light levels) for cinema screens. A single method will be recommended for on-screen light measurement for 2-D exhibition and for on-screen light measurement for stereoscopic exhibition.

This DG will also look at ISO relevant documents. There will be a liaison with TC-21DC, where the projector makers are members; the DG e-mail reflector includes both 20F and 21DC.

Working Group Status

There is no additional activity other than five-year reviews and ongoing verification checks within the digital library.

About the Author

John C. Miller is a technical support specialist in the Consumer Film, Industrial Film and Chemicals division of Eastman Kodak Co. He has 38 years of experience with motion picture films, beginning in film manufacturing, where he quickly moved into process and product quality. Miller's work contributed to the introduction of the "Keykode" bar code print, as seen on the edge of Kodak motion picture films, which dramatically simplified film editing for the industry. Miller also participated on many film product development teams, including the Kodak "Vision" family of films. He has been active in SMPTE standards work since 2003, and has chaired the 20F.10 Film Production Technology working group since 2005. Miller has been an SMPTE Fellow since 2008. He had previously chaired the TC-20F Film Applications committee from 2009 to 2011. He is also active in ISO/TC 36 Cinematography standards work.

Digital Cinema (21DC)

Co-Chairs: Dean Bullock and Mike Radford

Overview

The scope of the 21DC technology committee applies to the application of mastered essence to theatrical digital distribution, including compression, encryption, wrapping, marking, packaging, media, logging, playout, projection, reproduction, and related topics.

Organization

The 21DC technology committee is working on 11 active projects in three subgroups.

Work in Progress

21DC Amendment to ST 429-6 MXF Encryption for TC-35PM (Chair: Chris Witham)

A liaison request from TC-35PM resulted in the creation of this project. The goal of the project is to make minor edits to ST 429-6 to change the document to support the Interoperable Master Format (IMF) as well as digital cinema.

Since the scope of this project is small, the work reports directly to TC-21DC.

Impact: Allows IMF work in TC-35PM to reference existing documents to avoid duplicate work.

Projects:

21DC Amendment to ST 429-6 MXF Encryption for TC-35PM

Stereoscopic Subtitling (Chair: Jean-Philippe Viollet)

This adhoc group is focused on the revision of the existing standards to support stereoscopic rendering and to improve descriptions as needed for comparable results among the various implementations. ST 428-7 has been published, and two other related documents (Timed Text Track File and Operational Constraints) are still under development.

Additionally, to aid in interoperability, the group is investigating the addition of various Extensible Markup Language (XML) constraints.

Impact: This work will result in improved fidelity of subtitle rendering between systems. Most importantly, it will add run-time rendering of subtitles for stereoscopic programs. This is expected to significantly reduce post-production and distribution costs. The addition of new XML constraints could potentially invalidate some existing Digital Cinema Package (DCP) inventory. Additionally, some DCP mastering systems may require updating.

Projects:

- 21DC ST 428-7 Revision (Subtitles)
- 21DC ST 429-2 Revision (DCP Operational Constraints)
- 21DC ST 429-5 Revision: Timed Text Track File
- 21DC XML Constraints

FLM Exchange Protocol and 430-7 Revision (Chair: Chris Witham)

This drafting group (DG) was formed in November 2014 and is focused on revising ST 430-7 so that it more closely aligns with the current industry practice (which has, up until now, been based on an unpublished ad hoc format). Additionally, the group is developing a network-based protocol to efficiently publish, retrieve, and synchronize aggregate Facility List Message (FLM) instances over the internet.

Impact: Allows digital cinema entities, which are involved at any level in the collation of lists of digital cinema equipment (Trusted Device List [TDL]), to distribute digital cinema content (DCP and Composition Playlist [CPL]) and to distribute key (Key Delivery Message [KDM]) digital cinema content to efficiently manage, share, and consume TDL data over the internet using interoperable methods.

Projects:

- 21DC FLM Exchange Protocol
- 21DC ST 430-7 Revision (FLM)

FIPS Revisions (Chair: Anthony Wechselberger)

This DG has been tasked with drafting changes to ST 430-1 and ST 430-2.

Changes to ST 430-1 are due to a deprecation of the current Random Number Generator (RNG) algorithm by the U.S. government's Federal Information Processing Standard (FIPS). The current formulation of the Message Integrity Code (MIC) in track files makes use of a deprecated RNG algorithm, and an alternative ("MIC payloads in KDMs") has been proposed. The proposed resolution to this issue will require a standardized means of including hash message authentication code keys in the KDM.

In addition, this group is working on specifying a new KDM key type for use with Aux Data specified in ST 429-14.

Changes to ST 430-2 are to provide a new role for the digital cinema certificate to identify secure digital cinema implementations that support the new MIC KDM payload.

Impact: This work will allow future digital cinema secure implementations to continue to maintain FIPS compatibility. The KDM type will allow KDM distribution entities to create SMPTE-compatible KDMs that contain keys for Aux Data tracks.

Projects:

- 21DC ST 430-1 Revision (KDM) for FIPS
- 21DC ST 430-2 Revision (DCert) for FIPS/35PM

Integration of D-Cinema Additional Frame Rate documents (Chair: Kommer Kleijn)

This working group (WG) has been tasked with defining the work required to integrate the existing cinema frame rate documents and then creating drafting groups, as needed, to complete the work of integration.

As directed by TC-21DC, this WG will review the 21DC Integrate Additional Frame Rate documents project and make changes to the project scope and description, as determined by the members of the WG. Following that, the WG will form ad hoc groups, study groups, and/or DGs as needed to complete the work described in the possibly modified project. The project scope shall not exceed the general outline of the existing project without consensus from TC-21DC. Specifically, the scope must not be expanded to include work outside what is needed to integrate the current frame rate documents.

Impact: This work will allow users of the SMPTE standard set for digital cinema to reference two

documents instead of four when creating and packaging digital cinema content.

Projects:

21DC Integrate Additional Frame Rate documents

About the Authors

Dean Bullock has been working in the cinema industry since joining Dolby Laboratories in 1996 as an embedded systems engineer working on the Dolby D-Cinema processor product line. As an engineering director, Bullock led Dolby's Digital Cinema engineering team and then the cinema engineering quality assurance group. Currently, he is the director of technology strategy for Dolby's Cinema group. He has worked to implement SMPTE and other standards since starting at Dolby, and since 2009, he has been actively participating in SMPTE committees. Bullock holds a BS in computer and electrical engineering from Purdue University.

Mike Radford is the vice president of engineering for 20th Century Fox. His responsibilities include both standards work within SMPTE as well as the design and development of critical production software systems in the area of D-Cinema key management, mastering, and workflow. He is also the chair of the Digital Cinema Initiatives Technical Committee. Before that, Radford worked for Fox Television in its Advanced Engineering Group, where he specialized in radio frequency propagation modeling and developed software systems to predict digital television (DTV) coverage and interference. Using the tools he authored, he participated in the design of more than 50 new Fox DTV broadcast facilities across the country.

Television and Broadband Media (24TB)

Chair: Michael A. Dolan

Overview

The 24TB technology committee covers the application of mastered essence for television and broadband distribution (both separately and for hybrid television/broadband environments), including compression, encryption, wrapping, marking, packaging, media, tracking/control, presentation, reproduction, and related topics.

Organization

The current work is organized as individual, project-oriented drafting groups (DGs) and study groups (SGs).

Work in Progress

Lip Sync Standards and Practices DG (Chair: Paul Briscoe)

This project is developing standards to enable distribution systems to keep video and audio tracks time-synchronized. This technically difficult but important industry project continues to advance its core standards: Fingerprint Generation (Part 1) and Fingerprint Stream Transport (Part 2), which includes VANC in SDI/HD-SDI, IP, and MPEG Transport published in late 2015. Work on a companion Engineering Guideline is progressing.

Open ID Binding (Chair: Chris Lennon)

This project is a follow-on standardization effort from the report that was published last Fall, by a study group of a similar name. These standards will define an open binding technology standard (e.g., watermarks, fingerprints, and metadata sidecars) for embedding persistent content identifiers into audio/video essence in a way that survives compression and distribution through the supply chain. An initial Request for Proposal (RFP) was issued last year with a number of responses, and a second RFP was issued as the work expanded into the carriage of time labels and channel identifiers, as well as both electrical and acoustic detections. Evaluation of responses is under way at the time of this writing. Drafting of several SMPTE publications will commence shortly.

Maintenance Projects

To focus on other committee work, several maintenance projects have been suspended as follows:

- Revision to Standard 96, "35- and 16mm Motion-Picture Film—Scanned Image Area"
- Revision of ST 333:2008, "DTV Closed-Caption Server to Encoder Interface"
- Revision of RP 2007:2007, "Closed-Caption CDP and "Grand Alliance" Serial Interfaces for DTV"
- Revision of ST 2010, "VANC Data Mapping of ANSI/SCTE 104 Messages"

A new revision project has started on ST 2016-1:2009, "Format for Active Format Description and Bar Data" (Bill Miller). There have been requests from the Advanced Television Systems Committee (ATSC) and Digital Video Broadcasting to add bar data for UHDTV (1 and 2). Additionally, there has been interest from the Consumer Technology Association (CTA) (formerly Consumer Electronics Association) related to their CEB-16, which references 2016-1. This project was just approved and is getting under way.

About the Author

Michael A. Dolan is the founder and president of Television Broadcast Technology, providing specialized professional encoders, test tools, and technical consulting in the field of digital television and internet media. He holds a BSEE from Virginia Tech (1979) and has worked for and founded various leading-edge computer graphics and real-time systems companies since then, including early foundational work in the World Wide Web Consortium (W3C) technology and analog data broadcasting. Dolan has been involved in digital television engineering for many years, including data broadcast system architecture, digital receiver design, and compliance. He also currently chairs the ATSC Technology Group 1 (TG1), its Data Broadcasting Specialist Group (TG1/S13), and TG3 group on Dynamic Adaptive Streaming over HTTP (DASH). In addition to chairing the SMPTE Committee on Television and Broadband (24TB) and the Digital Entertainment Content Ecosystem/Ultraviolet Technical Working Group, he is an active representative in ISO/MPEG, IEC/TC 100, W3C, and DASH Industry Forum. Dolan is an SMPTE Fellow and a former SMPTE Governor for the Hollywood Region. He received the ATSC Bernard J. Lechner award and the CTA Technology Leadership Award, and he has been recently recognized for his contribution to a 2016 Emmy Award to SMPTE, related to closed captioning. He has authored the Almanac column in the *SMPTE Motion Imaging Journal* for over 15 years, is a coauthor of a foundational textbook, *Data Broadcasting*, and holds several patents in computer web technology.

Cinema Sound Systems (25CSS)

Co-Chairs: Brian Vessa and Kurt Graffy

Overview

The TC-25CSS technology committee is addressing new standards for cinema sound and the interoperability of immersive sound systems in D-Cinema. Topics include measurement techniques, calibration specifications, sound system architecture and performance, theater acoustics, immersive audio, and immersive sound systems. The overall goal is to improve the quality and consistency of sound in cinemas and indoor spaces while improving the efficiency and interoperability of audio delivered to theaters.

Project Plan

The Technology Committee project plan is as follows: (1) optimize and codify current best cinema sound practices, (2) lay the groundwork for new standards, (3) ensure interoperability among sound systems, (4) set a higher bar by creating new standards, recommended practices, and engineering guidelines, and (5) set the stage for the future.

Recent Projects

Last year, the Digital Pink Noise Test Signal drafting group (Chair: Pete Soper, Meyer Sound Laboratories, Inc.) published the ST 2095-1 "Calibration Reference Wideband Digital Pink Noise Signal" standard. This is the first digital pink noise standard since the industry moved to digital. The standard from the SMPTE store is bundled with pink noise .wav files at 48 and 96 kHz, an algorithm to create the signals, and a reference script in Python code that can generate the signals. SMPTE is in the process of making DCPs available with the ST 2095-1 test signals in the SMPTE store later this year.

Work in Progress

Two subgroups within the Technology Committee are working on various aspects of cinema sound systems standards.

B-chain Modern Calibration Procedure (Chair: Brian Long)

Measurement and sound system technology has advanced greatly since the current ST 202 and RP 200 standards documents were written. New cinema sound system and calibration standards are needed. As a first step to this ultimate goal, this group is drafting two recommended practices and an engineering guideline that codifies and expands on the existing standards with a "best practice" sound system measurement methodology. Using the information gained through the B-chain Study and Theater Testing Report, and utilizing the ST 2095-1 digital pink noise signal, the two Recommended Practices respectively detail step-by-step procedures for a baseline calibration and a maintenance calibration of the frequency response and sound pressure levels in a theatre using today's technology and analyzers. An engineering guideline detailing the theory and methodology behind the measurements and calibration, including the use and pitfalls of target curves, equalization, data interpretation, and other issues, is also being created and will be invaluable to technicians in the field.

This is the first time that this type of detailed information has been available to the industry in a standards document, and it promises to foster much greater consistency in the performance and calibration of mixing theaters and cinema spaces. It will also feed into the new cinema sound standards work that is planned for later this year.

Interoperability of Immersive Sound Systems in Digital Cinema (Chair: Pete Ludé)

As per the recommendations detailed in the Immersive Audio Study Group report, coupled with requests from DCI and NATO, a working group (WG) was formed to address the interoperability of immersive sound systems in digital cinema.

Currently, each brand of immersive audio mixing tools creates its own proprietary audio format, which can be used with only that same brand of immersive sound system. This requires content providers to mix and deliver a specific audio format for each immersive sound system. Additionally, each immersive sound system has its own proprietary method of packaging and moving immersive audio data within the D-Cinema architecture, as well as its own sound calibration schema. Each of these points is being addressed to ensure true interoperability of immersive audio and immersive sound systems.

The anticipated result is a suite of documents that will specify all aspects necessary to achieve immersive sound system interoperability.

Recent Projects

An update to the D-Cinema architecture was needed to ensure the interoperability of immersive audio that is delivered as aux data in a DCP. ST 430-14, Digital Sync Signal and Aux Data Transfer Protocol, was published this year to specify the protocol for transferring aux data. This standard also specified a server-generated synchronization signal to sync the data transfer, which can also be used as a stand-alone sync signal.

Ongoing Projects

Immersive Sound Model and Bitstream Drafting Group (Chair: Pete Ludé)

This drafting group (DG) has created an audio object model that specifies a common metadata schema to be associated with audio objects and is now working on standardizing a single delivery bitstream to carry this metadata that can be utilized by any immersive audio renderer and immersive sound system. This standardized bitstream will allow the interoperable creation and delivery of immersive audio soundtracks as well as foster a healthy market of D-Cinema equipment that can create and utilize it.

Immersive Audio Renderer DG (Chair: Ton Kalker)

This DG is working on defining the expected behavior of an immersive audio renderer. The renderer is the key audio processor that determines how audio objects and channels are reproduced in the sound system and speakers that are in a given playback theater and thus is key to translating the audio from the mixing theater to the exhibition theater.

Looking Forward

The Technology Committee is busy with projects that are designed to bring the cinema sound industry up to date and foster interoperability. Plans are now being discussed for the next projects on the roadmap, which include the following: (1) cinema sound system performance parameters, (2) new electroacoustic and calibration methodology standards, (3) cinema acoustics standards, (4) immersive sound system measurement and calibration methodology, and (5) cinema soundtrack loudness measurement parameters and methodology.

It is an exciting time for cinema sound, which is enjoying higher visibility than in many years, and may finally be getting its due as 50% of the cinema experience. The standards that TC-25CSS is creating will play an important part in fostering the delivery of quality sound to the ears of appreciative moviegoers.

About the Authors

Brian Vessa is a dedicated audio professional with more than 35 years of experience in the industry. After attending the University of California, Los Angeles (UCLA) Engineering School, he became a recording engineer, producing albums and recording orchestras. His passion was hot-rodding studio gear and discovering novel recording techniques. Vessa transitioned into film post-production as a music editor and a sound editor, became a re-recording mixer at Cannon Films and MGM and then handled audio restoration at NT Audio. He was hired by Sony Pictures in 1998, and today he is their executive director of digital audio mastering and representative to Digital Cinema Initiatives (DCI). Vessa is a member of the Academy Sound Branch, SMPTE, and the Audio Engineering Society. He chairs the SMPTE Technical Committee on Cinema Sound Systems, TC-25CSS, as well as D-Cinema and Interoperable Master Format subcommittees, and is the current chair of the DCI Technical Committee. He has written many audio specifications, including a white paper on near-field mixing for home theater, which has been widely adopted.

Kurt Graffy spent more than 15 years in concert/theater sound and lighting design/production in California and the San Francisco Bay area, both as a lead designer of the San Francisco Arts Commission Technical Resources Group and as a freelance mixer/designer, after receiving a BA in technical theater from the University of San Francisco. Leaving the arts scene, he worked at Data General Corporation as a computer systems field engineer, prior to joining Paoletti-Lewitz Associates as a staff acoustical consultant in 1985. He joined Arup Acoustics,

an international acoustical consulting firm based in the U.K., in 1998, when he established their San Francisco office for acoustics. At Arup, he is a principal consultant in acoustics, responsible for room acoustics and audio system design, measurement, and specification, including computer model testing and analysis. Graffy has presented and taught at numerous Audio Engineering Society (AES) and Acoustical Society of America (ASA) engineering conferences as well as SynAudCon special workshops, including the Horns: Function, Measurement, Arraying and Alignment Workshop and the Loudspeaker Arrays Workshop in Nashville in 2002. He is a member of the ASA and the AES (where he is a cochairman for the Technical Committee on Acoustics and Sound Reinforcement) and a cochairman on the TC-25CSS committee and a chief writer for the SMPTE B-Chain Cinema Testing Report.

Metadata and Registers (30MR)

Chair: John Hurst

Overview

The committee deals with the application of the general scope as it applies to definition and implementation of the SMPTE Registration Authority, which is used to identify digital assets and associated metadata. Additionally, the committee deals with defining a common semantic meaning for metadata across multiple committees.

Documents Published in the Last Quarter

The first edition of the new XML-based registers is available online at https://smpte-ra.org/smpte-metadata-registry.

3D Glossary

DG Project: EG 2061: Glossary of Stereoscopic 3D Terms

This project takes as its starting point the glossary developed by the 3D Home Master project in TC-35PM.

Status: Published.

Business Impact: Understanding and common use of terms.

UMID Projects

SG Project: Application of the UMID

The Unique Material Identifier (UMID) is standardized in ST 330, and RP 205 covers the application of UMIDs in Production and Broadcast Environments. This study group (SG) is studying ways to make the UMID more useful, particularly in material location across various systems. The SG has prepared two reports: "Study Report on UMID Applications Part 1 (UMID Application Principles, Best Practices)" and "Study Report on UMID Applications Part 2 (Additional Technology that needs Standardization)."

Status: Published.

DG Project: ST 330 Revision

This project will produce an updated version of ST 330 titled "Unique Material Identifier (UMID)," based on the recommendation of "Study Report on UMID Applications Part 2-2" created by the TC-30MR SG UMID Applications. Specifically, it additionally defines new methods for the generation of UMID Material and Instance Numbers. It also specifies an extension of the Source Pack to accommodate a shooting direction of a camera, in addition to its position information.

Status: The group is working toward a working draft (WD).

SMPTE Core

DG Project: New Standard ST 2102: SMPTE Core Metadata Set

This group's scope is to define an interoperable minimum core set of descriptive metadata for professional motion imaging applications and users. Existing SMPTE metadata is application specific and is not supported right through media workflows.

Status: The group received many constructive comments during the pre-FCD review and is preparing a new WD.

Business Impact: Potential foundation for metadata.

Metadata Strategy

SG Project: Metadata Strategy

This review of the role of the technology committee (TC) started in the 2012-03 meeting round, examining how the focus of the TC should expand beyond the registration of metadata and toward standardizing metadata schemes and XML projects.

Status: This work has been halted due to substantial overlap with the XML Registers project.

Register Structure Document Projects

There are several SMPTE standards defining the structure of various metadata registers defined by ST 336: Data Encoding Protocol Using Key-Length-Value. They are all being updated to include new requirements, such as including XML symbols.

DG Project: Draft ST 2088: SMPTE Essence Element Key Register Structure

This project creates a controlling standard for SMPTE Universal Labels used as essence keys in MXF standards.

Status: The group has produced a WD document, currently being balloted.

DG Project: Revision ST 336: Data Encoding Protocol Using Key-Length-Value

Revise ST 336 to update references and review whether its provisions reflect the current register operation.

Status: The group has produced a WD document, currently being balloted.

DG Project: Revision ST 335: Metadata Element Dictionary Structure

An error was introduced that was not present in previously published versions and is in conflict with other standards.

Status: A Committee Draft document has been submitted.

WG Project: Metadata Definition

This Working Group (30MR10) coordinates a number of DG projects for adding or maintaining metadata items in registers. Because the registers are updated frequently, a version number identifies each revision.

Status: Version 1 of the XML registers was published in Q1 of this year. The WG is working now to bring version 2 to the FCD ballot.

About the Author

John Hurst is a cofounder and the chief technology officer at CineCert, LLC, an internationally recognized developer of digital cinema technology. Hurst has more than 30 years of experience in entertainment technology, at first in the practical application of recording and post-production and later by following his interests in product development. He has been involved in developing technologies for D-Cinema since 2000. Under his direction, CineCert has produced several benchmark D-Cinema projects, among them the Waimea KDM authoring system, the DCI Compliance Test Plan, and the open source AS-DCP file access library. Hurst has developed many SMPTE standards for D-Cinema. He is an SMPTE Fellow.

File Formats and Systems (31FS)

Co-Chairs: Bruce Devlin and Paul Gardiner

Overview

The 31FS technology committee (TC) concerns itself with File Formats and Structures. This applies to the definition of common wrapper and file structures for storage, transmission, and use in the carriage of all forms of digital content components. Well-known formats, such as Digital Picture Exchange (DPX), Material Exchange Format (MXF), General eXchange Format (GXF), Academy Color Encoding System (ACES), and recently ProRes, have been studied within this TC.

Organization

TC-31FS has a number of subgroups, notably drafting groups for MXF mappings of Advanced Audio Coding (AAC) audio, VC-2 codec, VC-3 codec, VC-5 codec, ACES Codestreams, Ad-iD Digital Slate metadata, KLV extensions; a drafting group for encoding Dynamic Metadata for Color Volume Transformation; a study group for the mappings of time code into MXF; and a group concerned with defining and drafting the Archive Exchange Format (AXF).

Recent Publications

Over the past 12 months, TC-31FS has published the following documents:

- SMPTE EG 42:2015, Material Exchange Format (MXF)—MXF Descriptive Metadata
- SMPTE ST 2001-1:2015 (Revision of SMPTE ST 2001-1:2013), XML Representation of SMPTE Registered Data (Reg-XML)—Mapping Rules
- ST 2019-4:2014, Mapping VC-3 Coding Units into the MXF Generic Container
- RDD 39:2016, MXF OP-1a Interoperability Specification for AVC-ULTRA

Work in Progress

Much of the work in recent times has involved the mappings of various codecs and metadata into the MXF wrapper format. This is a general sign that SMPTE's MXF standard continues to go from strength to strength. Close liaison with other committees, particularly the 30MR Metadata Registries committee, ensures that the specifications form a coherent SMPTE ecosystem for media professionals.

Recent work in the TC includes the VC-5 (commonly known as GoPro CineForm) mapping into MXF maps RGB(A) and $YC_BC_R(A)$ color-difference images into MXF as well as defining the corresponding subdescriptors. The ACES mapping into MXF defines the descriptors and wrapping of the bitstream as well as labels for the descriptors. The AAC mapping defines the wrapping modes and descriptors for a constrained set of AAC audio formats in MXF. Ad-iD is a metadata scheme for identifying adverts, and a mapping for this in MXF is being defined. Technical Committee 10E has defined dynamic metadata for color volume transforms, and the 31FS committee is mapping this into MXF.

Projects at or near completion include the KLV encoding syntax project that defines a mechanism for defining new MXF KLV labels within an MXF file. RDD 39 defines the mapping of AVC-Ultra into MXF. A study group that has been investigating the use of time code in MXF is almost ready to publish its report. There are a number of revisions of documents that include the ST 380 MXF Descriptive Metadata Scheme 1; the VC-2

(commonly known as Dirac) mapping into MXF, which includes constraints for maintaining frame boundaries in cutting, editing, and switching applications; the VC-3 (commonly known as DNxHD and DNxHR) mapping into MXF maps RGB(A) and $YC_BC_R(A)$ color-difference images into MXF as well as defining the corresponding subdescriptors and revised application constraints.

The AXF is a major project defining a standardized structure, semantics, and format for long-term archival of media. The standard ST 2034-1 has been successfully interchanged between different vendors, and work continues in the committee to extend and evolve the format.

The committee is starting work on two projects. One is an RDD that will map the Apple ProRes codec into MXF, and the other will create a constrained DPX application standard to support HDR imagery. Toward the end of 2016, the five-year review of the underlying MXF standard ST 377-1 will commence. Future work is also expected to include mapping HEVC streams into the MXF Generic Container.

About the Authors

Bruce Devlin has been working in the media industry for 30 years and is the chief media scientist at Dalet Digital Media Systems as well as the founder of MR MXF Ltd. and the cofounder of Media Bay LLC. He is well known in the industry for his technology presentations, particularly his educational YouTube series—Bruce's Shorts. Devlin has designed everything from application-specific integrated circuits to algorithms. He tweets as @MrMXF, chaired the SMPTE working groups, and literally wrote the book on the MXF format. Devlin is an alumni of Queens' College, Cambridge, U.K. He is a member of the International Association of Broadcast Manufacturers and Digital Production Partnership, a Fellow and U.K. Governor of SMPTE, a recipient of SMPTE's David Sarnoff Medal and the British Kinematograph, Sound and Television Society's Achievement award, and a rider of bicycles (occasionally quickly). He is keen on educating the world about media.

Paul Gardiner is currently the standards manager at Sony Broadcast and Professional Research Labs within Sony Europe Ltd., based in Basingstoke, U.K. His career in broadcasting spans 40 years. Gardiner studied electronic engineering at the University of Southampton before joining the Independent Broadcasting Authority in 1974. His career has included television technical regulation and R&D project management, with responsibility for various international collaborative research projects. He has also regularly been involved in the work of the International Telecommunication Union Radiocommunication Sector (ITU-R). Since joining Sony in 2007, he has been an active participant in the SMPTE standards community. He is an SMPTE Fellow.

Network/Facilities Architecture (32NF)

Co-Chairs: Friedrich Gierlinger and John F. Snow

Overview

The 32NF technology committee covers matters supporting the infrastructures of content production and distribution facilities, including file management, transfer protocols, switching mechanisms, synchronization systems, and physical networks that are both internal and external to the facility, including final distribution methods.

Organization

The committee is divided into four standing working groups, each focused on one of these four areas:

- 6G-SDI and 12G-SDI interfaces
- All other SDI interfaces and SDI related standards
- Internet Protocol (IP) interfaces
- Time labeling and synchronization

In addition, the committee has a drafting group focused on the ST 337 family of audio interface standards and a study group investigating flow management for professional media networks.

Work Completed

The following new documents were completed during the previous year:

- SMPTE 12-3:2016, Time Code for High Frame Rate Signals and Formatting in the Ancillary Data Space
- SMPTE EG 2059-10, Introduction to the New Synchronization System
- SMPTE RP 2076-1, Production Timing and Synchronization—for S3D or Multi-View Camera Systems
- SMPTE ST 2081-11, 2160-line Source Image and Ancillary Data Mapping for Dual-link 6G-SDI
- SMPTE ST 2081-12, 4320-line and 2160-line Source Image and Ancillary Data Mapping for Quad-link 6G-SDI
- SMPTE ST 2082-11, 4320-line and 2160-line Source Image and Ancillary Data Mapping for Dual-link 12G-SDI
- SMPTE ST 2082-12, 4320-line and 2160-line Source Image and Ancillary Data Mapping for Quad-link 12G-SDI

- SMPTE RDD 37:2016, Uncompressed Video Transport Over MPEG-2 Transport Stream
- SMPTE ST 2101:2015, Format for Non-PCM Audio and Data in AES3—AC-4 Data Type
- SMPTE ST 2106:2016, Format for Non-PCM Audio in AES3—Type 17 Compressed Audio.

The following revisions were completed during the previous year:

- SMPTE RP 184:2015, Specification of Jitter in Bit-Serial Digital Systems
- SMPTE RP 192:2015, Jitter Measurement Procedures in Bit-Serial Digital Interfaces
- SMPTE ST 2036-3:2015, Ultra High Definition Television—Mapping into Single-link or Multi-link 10 Gb/s Serial Signal/Data Interface

Work in Progress

32NF-40 SDI Interfaces WG (Chair: John Hudson)

Work is under way to create an engineering guide on SDI electrical interfaces, a standard for ruggedized optical connectors, a standard for coarse wavelength division multiplexing optical transport of multilink SDI, and a standard for high dynamic range and wide color gamut signaling on streaming interfaces.

32NF-60 Video Over IP WG (Chair: Thomas Edwards)

This working group is developing a new multipart standard (ST 2110) for live production uncompressed elementary essence flows over IP.

32NF-70 UHD-SDI Interfaces (Chair: Nigel Seth-Smith)

This working group is drafting a set of standards for aggregating multiple HD-SDI or 3G-SDI streams onto 6G-SDI interfaces and multiple HD-SDI, 3G-SDI, and 6G-SDI streams onto 12G-SDI interfaces, thus enabling the carriage of UHDTV1 and UHDTV2 essence over coaxial interfaces.

32NF-80 Time Labeling and Synchronization (Chair: Pat Waddell)

This working group continues its efforts on the new IP-based studio synchronization system (ST 2059) by performing the following tasks:

- Holding a series of interoperability tests for ST 2059–based equipment
- Publishing the EG 2059-10, Introduction to the New Synchronization System
- Continuing to draft several other engineering guides to help the industry adopt this new synchronization system

In addition, the working group is looking at future time labeling methods.

About the Authors

Friedrich Gierlinger has worked at IRT, the Research and Development Institute of public broadcasting corporations of Germany (ARD, ZDF, DRadio), Austria (ORF) and Switzerland (SRG/SSR), since 1979. As an employee of the IRT, he was involved in the development of different measurement techniques for analog and digital standard television for the public broadcasters and their standardization. He chairs the German system and measurement expert group and is a member of a working group of measurement and service department leaders of the Public Broadcasters in Germany. In the European Broadcasting Union, Gierlinger is a co-chair of the Quality-Control working group as well as a member of the Beyond-HD working group. In addition to TC-32NF, he is a member of several other SMPTE groups.

John F. Snow represents Cobalt Digital, where he is a senior field-programmable gate array (FPGA) architect. He began his career at Evans & Sutherland Computer Corporation, where he held various positions, including director of engineering, over a 19-year period. In 2001, he joined Xilinx, Inc. as a video architect and was responsible for the development of SDI and other audio and video interfaces for Xilinx FPGA devices. Snow holds a BS degree in electrical engineering from Brigham Young University and is a Senior Member of the IEEE. He holds two patents in the area of high-speed serial interfaces. He has been an active member of the SMPTE Standards Community for almost ten years and a cochair of the 32NF committee for four years.

Media Systems, Control and Services (34CS)

Co-Chairs: Chris Lennon and Karl Paulsen

Overview

The 34CS Technology Committee is responsible for matters in the areas of media services, methods of managing and controlling hardware devices and software systems, and the management of media workflow processes, including associated signaling and control mechanisms.

Organization

34CS currently has two drafting groups (DGs) reporting to it: 34CS-10 BXF and Media Device Control over IP.

Work in Progress

The following documents are currently in progress within this committee:

- EG 2021-4—BXF Schema Docs
- ST 2071-1—Media Device Control Framework
- ST 2071-2—Media Device Control Protocol
- ST 2071-3—Media Device Control Capability Interfaces
- ST 2071-4—Media Device Control Capability Interface Registration

BXF DG (Chair: Chris Lennon)

Broadcast Exchange Format (BXF) 5.0 is well under way in this DG. About half of the items have been completed. Topics include BXF SDK, Quality Control, NABA DPP schema, program synopsis, point of interest, graphics slate template support, and other small improvements. The goal is to have BXF 5.0 headed to publication by the end of 2016.

It is likely that the BXF SDK will reside in a new document.

Media Device Control Over IP DG (Chair: Steve Posick)

This group, working on standardizing the control of media devices in professional production and distribution systems, has advanced a couple of document revisions to publication, and two more are in progress. Revisions to 2071-1 and 2071-2 are about to be published, whereas 2071-3 and 2071-4 are headed to the Draft Publication ballot.

The group is determining the action to take on the topic of RESTful or REST-like protocol for ST 2071.

New Registered Disclosure Document: RDD 38 Sony Lightweight Networked Device Control Protocol

RDD 38 (Networked Device Control Protocol—Message data structure and method of communication) is in ST Audit, closing on 30 June 2016.

About the Authors

Chris Lennon serves as president and the chief executive officer of MediAnswers, a leading firm in the area of media software systems. MediAnswers assists suppliers, system integrators, media organizations, standards bodies, and nonprofit groups in creating, integrating, and optimizing complex software and workflow solutions. Lennon is an SMPTE Fellow and a recipient of its 2009 Society Citation.

Karl Paulsen is the chief technology officer at Diversified, a full service systems and media technology integration firm addressing the broadcast, audiovisual, IT, and radio frequency market segments. Paulsen is an SMPTE Fellow, the Secretary/Treasurer of the SMPTE Pittsburgh Section, a life member of the Society of Broadcast Engineers, a certified professional broadcast engineer, and a feature columnist for TV Technology's section on "Media and Storage Technologies."

Media Packaging and Interchange (35PM)

Chair: Pierre-Anthony Lemieux

Overview

The 35PM Technology Committee on Media Packaging and Interchange oversees standards for the interchange of complete audiovisual work in professional fields related to media creation, production, and post-production archiving.

TC-35PM focuses on maintaining and extending the Interoperable Master Format (IMF), a suite of standards designed to enable the efficient exchange of high-quality and component-based masters for use in distribution channels worldwide. In particular, IMF supports masters that combine high dynamic range and wide color gamut image, baseband audio, and XML-based subtitles (both text-based and image-based).

TC-35PM has more than 350 members.

Organization

In addition to undertaking work directly, TC-35PM has three subgroups focused on specific areas.

The 35PM50 Working Group (WG) on Document Maintenance and Sample Material Interchange collects feedback on published specifications and coordinates their revision as needed. As a primary tool to gather implementation experience, the WG organizes regular plugfests, which provide an opportunity for implementers to exchange test content.

The IMF Output Profile List (OPL) Drafting Group and the IMF Audio Drafting Group are tasked with extending the IMF specifications to allow the predictable transformation of masters into deliverables for distribution

channels and to meet emerging audio requirements, respectively.

Work in Progress

IMF 1.1: IMF 1.1 consists of the first revision of the IMF suite of standards, based on initial implementation experience. Publication of the following revised specifications is imminent:

- SMPTE ST 2067-2:2016, IMF Core Constraints
- SMTPE ST 2067-3:2016, IMF Composition Playlist
- SMPTE ST 2067-5:2016, IMF Essence Component
- SMPTE ST 2067-20:2016, IMF Application #2
- SMPTE ST 2067-21:2016, IMF Application #2E

Sample Material Interchange: Three plugfests were held last year, one in Europe and two in North America, with each one attracting around 60 industry participants. The next plugfest is scheduled for September 14 at the European Broadcasting Union in Geneva, Switzerland.

Audio Content Kind and Element Kind: The accurate labeling of audio material is critical to allow the automated processing of masters into deliverables. This effort intends to create a controlled vocabulary describing the contents of audio material (e.g., Music and Effect).

SMPTE ST 2067-40, IMF Application #4 (Cinema Mezzanine): This application of IMF is intended for the exchange of cinematographic work after digital post-production. The specification is currently undergoing the Draft Publication ballot, with a publication expected toward the year's end.

About the Author

Pierre-Anthony Lemieux is a partner at Sandflow Consulting, where he works with both Hollywood and Silicon Valley clients on worldwide standards, proof-of-concept development, and product architecture. His expertise covers the entertainment technology ecosystem, from content authoring to playback, including audio and video and timed text, file formats, and content protection. His recent engagements include representing clients at industry forums (including SMPTE and W3C), developing standards for file-based post-production workflows, and implementing audio processing algorithms. Lemieux is an SMPTE Fellow and currently serves as a document editor in multiple SMPTE projects, in addition to chairing TC-35PM. He has a PhD in physics from the University of California, Los Angeles (UCLA) and a BSc from McGill University.