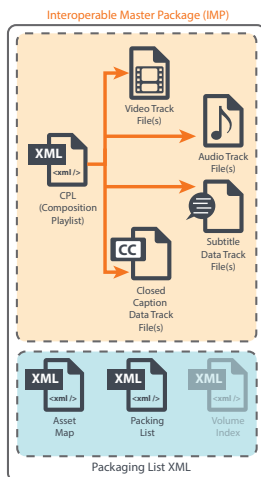


A Guide To The Interoperable Master Format (IMF)

Interoperable Master Format (IMF) is a SMPTE standard for providing a single, interchangeable master file format and structure for the distribution of content between businesses around the world. IMF provides a framework for creating a true file-based final master.

The process of creating and distributing content has always been a complex one, but that complexity has increased exponentially in the last several years as the number of distribution outlets and delivery mechanisms that a content distributor must address has grown. Previously, media companies would distribute their programming to a small number of geographies in a small number of languages for display on a limited number of devices (typically just 2 -theatrical release and TV versions). In contrast, the modern distribution chain consists of multiple global geographies – each with their own set of regulatory requirements – and a much wider set of playout devices. Certain types of content – nudity and/or profanity, for example – may need to be removed for deliverables to be acceptable to certain cultures. In addition, material must be tailored for multiple individual playout platforms within (and across) those geographies. Multiple alternative distribution versions such as “airline cuts” – again with their own unique requirements – are also often required. Indeed, one major long-form program creator and distributor has gone on record saying that they are forced to create 3500 separate versions of every major asset in order to satisfy all of their distribution points! The processing required to fulfill all of these disparate requirements presents a number of problems, not the least of which is the need for dubbed audio and subtitle addition – and each of these functions need to be performed for each of the languages and playout platforms required. This is clearly an inefficient scenario. It is this precise challenge that IMF (the Interoperable Master Format) was designed to address.



IMF is a framework of SMPTE specifications designed to streamline the management and processing of multiple versions of material destined for distribution channels worldwide. It should be noted here that the framework is not intended to function as the mechanism for final delivery to the consumer – rather it is intended to streamline the process of inter-company (“B2B”) delivery in order to then facilitate delivery in the final format to the consumer.

Key deliverables identified for IMF were:

1. Support for multiple audio and video formats, with associated/language specific graphics, subtitles, captions, etc.;
2. Support for dynamic metadata that is expected to be synchronized to an essence;
3. The use of well known, standardized technology for wrapping media into individual tracks and identifying the tracks needed to create an individual deliverable

This last point was satisfied through the use of a combination of 2 existing technologies. Essence files are wrapped using SMPTE standard MXF (Media eXchange Format) wrapping – specifically OP1a – and the files making up a deliverable are identified using technology derived from the DCP standards which were also developed by SMPTE and released in 2009.

The structure of an IMF Package

An IMF package is not a single file (although it may sometimes be delivered via a zip archive) – it is actually a collection of files which together make up the content, be it a full-length movie, a documentary or an episode of a series. Along with the essence files, which are detailed later in this paper, the package contains some “housekeeping” files, which are largely used to check that the package has been completely transferred. The housekeeping files are:

The “Packing List” – this file is a list of all of the files which are contained in the package. It is used by the receiving device to determine that the package has been received in its entirety. If files are listed in the Package List but are not yet in the received folder – perhaps because they are still being transferred – the receiving system knows that it should wait before applying any processing.

The “Asset Map” – this file is somewhat similar to the Packing List, except that it lists the mapping of UUID to file name and location. Within an IMF package, files are not referenced by file name (which is highly prone to error) – rather, each file contains a UUID (“Universally

Unique Identifier”). All references to files are then made via these UUIDs. The Asset Map provides a look up table, which is a quick way to locate any particular UUID within a package by linking the UUID to the file.

The “Volume Index” – This file is intended to provide information about which physical storage volumes are used to store the files within the package (this allows for different media assets to be stored on different storage systems if so desired). In reality, most modern storage systems have volumes that are so large that the IMF packages are stored on a single volume, hence it is not unusual for this file to not be included in the package itself.

Each version of a piece of content is called a Composition, which is the set of all essence and metadata that makes up a particular deliverable. An example of a composition might be the US TV version of the theatrical cut of a movie, or the German version of an episode within a series.

When parsing an IMF Composition, a device first looks for a file called a Composition Playlist (CPL). The CPL is like an edit decision list – it defines the playback timeline for the Composition and includes metadata applicable to the Composition as a whole. One very important point here is that the CPL is not designed to contain essence but rather references external (MXF) Track Files that contain the actual essence (see fig. 1).



Fig. 1: A CPL points to individual essence files

Using this mechanism massively simplifies the versioning issue mentioned earlier: to create a different language version of a piece of content, all that’s needed is another CPL, which points to different audio files and different graphics files. All other pointers can remain the same (see fig 2.). This CPL and its associated additional media tracks can be contained in the original package or sent later in what is referred to as a “Supplemental Package”.

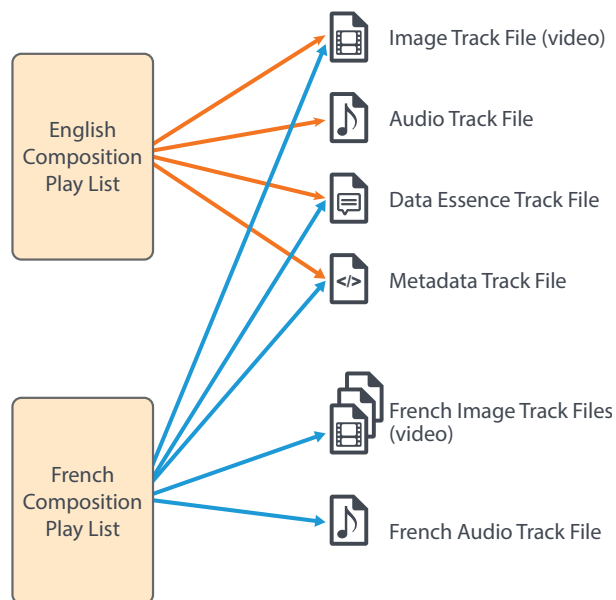


Fig. 2: Multiple versions share essence files

IMF essence files

IMF essence files can take a number of forms:

Video essence – up until recently, video encoding was restricted to JPEG 2000 for all resolutions, up to and including UHD. In August of 2018, SMPTE – in collaboration with the DPP and the NABA – announced the release of the TSP 2121-1 specification, which details the use of Apple ProRes encoding for HD and UHD content. In all cases, the video essence is encapsulated in an MXF OP1a wrapper

Audio essence - 24bit uncompressed PCM, any number of channels, also encapsulated in an MXF OP1a wrapper

Data essence (subtitles & captioning using IMSC Timed Text)

Dynamic metadata - metadata which changes over time as defined in SMPTE ST 2094. Examples of this are HDR10+/Dolby Vision scene-based metadata, or tone mapping metadata

IMF essences are defined by application specifications that allow for different codec types, frame rates and resolution. Two application specifications, Application #2, Application #2 Extended and TSP 2121-1 are applicable to the broadcast media market. Application #2 supports SD/HD with JPEG-2000 Broadcast Profile; #2 Extended supports UHD (up to 4K) with JPEG-2000 Broadcast Profile media up to 10bit. As noted above, TSP 2121-1 also covers HD and UHD resolutions, but uses ProRes as the codec for the video. More information on IMF can be found [here](#).

A concrete example of the value of this object-based approach is detailed in a recent posting in Netflix's technical blog, which details the use of IMF in mastering its "House of Cards" program. In 2015, shortly before the release date for series 3, Netflix modified its opening logo to add sound. Unfortunately, all the variants (languages, etc.) for series 3 had already been mastered and distributed to the playout hubs. Without IMF, it would have been impractical to update series 3 with the new opening logo, but with IMF, changing to the new version involved a trivial adjustment to the CPLs to point to different opening and closing "snipes" – each of which was approximately 100 frames long - and the change had no effect on audio/video/subtitle synchronization at all. No "re-QA" was required – the series released on its original schedule.

As a follow on point, it should be noted that - as of this writing - Netflix now requires that HD/UHD/4K material must be delivered to them as an IMF package.

Recognizing that almost all media enterprises have different deliverable requirements (format, etc.) IMF also allows for the creation of many different distribution formats from the same composition if required. This is accomplished through another file, called the Output Profile List (OPL), which specifies the processing/transcoding instructions required for each distribution format.

Vantage support for IMF

Vantage supports many of the processing operations in an IMF workflow: It can ingest an IMF CPL as a master source input to create all appropriate outputs, it can create single segment IMF Master Packages as an output, and via the "IMF Producer" option, it can interact with Adobe Premiere to simplify the creation of Primary and Supplemental Packages directly from the Premiere timeline.

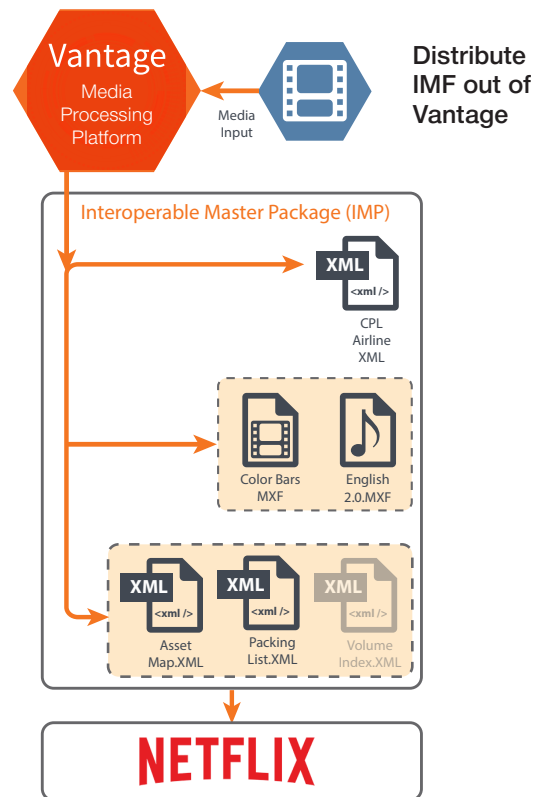
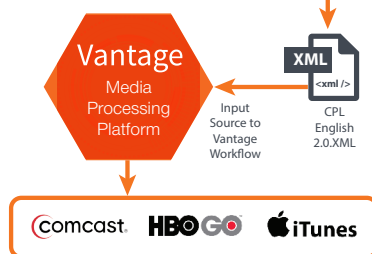
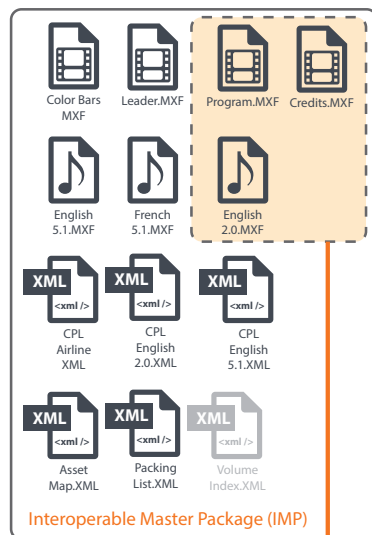
Ingesting an IMF package into Vantage

Vantage supports multi-segment Application #2, Application #2 Extended and TSP 2121-1 IMF packages as inputs. Vantage takes an IMF CPL file as an input source for a Vantage workflow and processes it to create any output that may be required. IMSC 1.0 subtitle/closed caption files are passed through without additional processing. Decoding/translating of the IMSC 1.0 content can be achieved through the use of Vantage's Timed Text Flip option, if required.

Creating an IMF package with Vantage

Vantage supports the creation of single segment (one video and audio file) Application #2, Application #2 Extended and TSP 2121-1 IMF packages. Vantage writes the files needed to create an IMF package into the directory specified within the workflow. The output packages consist of a video and audio essence files (MXF), a CPL XML, an Asset Map XML and a (user supplied) IMSC 1.0 file. If an existing IMSC 1.0 file is not available, it can be created from all of the major broadcast file formats using Vantage's Timed Text Flip option.

Ingest IMF into Vantage



Vantage and Switch support for IMF (continued)

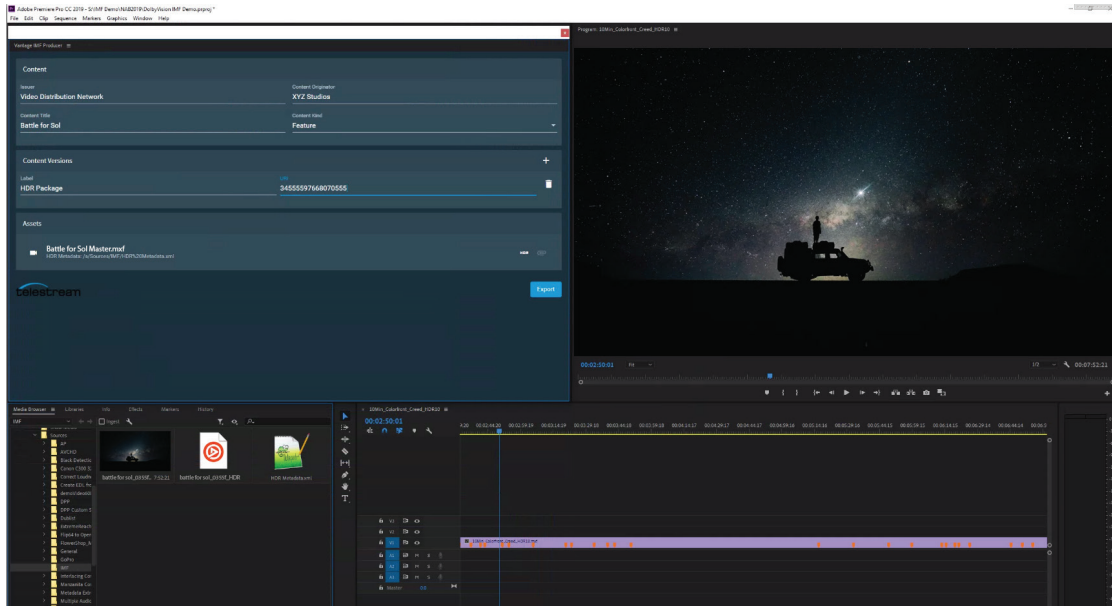


Fig. 3: IMF Producer simplifies IMF package creation in Adobe Premiere

Creating an IMF package with IMF Producer

Offering a simple to use plug-in panel to Adobe Premiere, Vantage IMF producer automates the creation of all the files required in an IMF package from a single output render of the Premiere timeline (see fig3). In addition to generating the Primary package, editors can put markers on the timeline to indicate which sections are “localizable” into different language versions and then instruct Vantage which replacement media is required to complete the versioning. Vantage will then automatically create well-formed Supplemental IMF Packages which can then be distributed to the relevant playout systems. Through the use of this automated processing, editing staff can focus on the creative functions of storytelling and pacing without worrying about the complexities of the delivery formats.

Confidence checking an IMF package with Switch

To complete the IMF toolkit, the latest version of Telestream’s universal media player, Switch, has the capability to parse, inspect and play any industry-standard IMF package. This advanced feature gives any user the ability to validate and troubleshoot any IMF package: either on receipt (before costly additional processing is applied – giving facilities the ability to reject malformed packages from their suppliers at the point of ingest), or at the end of the processing chain as a media validation tool before packages are delivered down the supply chain.

No matter what your needs, Telestream has technology to help you maximize the efficiency and efficacy of your IMF workflows. For more information – or if you have questions – contact Telestream or your regional sales manager.

