USING IMF FOR INTERNATIONAL DISTRIBUTION: WHAT DOES THAT MEAN?

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ABSTRACT

IMF has nothing to do with the International Monetary Fund. It is an Application Specification of MXF being developed within the SMPTE. The goal is to create a delivery format that meets the business needs of shipping versioned content around a country and around the world. This presentation will be in three parts: (1) a review of IMF technology and how it works; (2) a review of IMF workflows that could exist when an IMF ecosystem exists; and (3) some of the savings that might be realised by using IMF. The presentation will consider not only the file formats and processes, but also the preservation of multi-platform captions, metadata and media life cycles within MAM systems as well as the benefits that can be achieved by considering versioning from the initial concept of a programme

INTRODUCTION

Speed reading can often lead to misinterpretation. The title of this paper, "USING IMF FOR INTERNATIONAL DISTRIBUTION", is intentionally ambiguous, hence the subtitle WHAT DOES THAT MEAN? Assuming that you interpret IMF as SMPTE's *Interoperable Mastering Format (1)*, the ambiguity comes from the word *using*. One reader may think instantly of sending IMF bundles to a destination, another reader may think of IMF as a service mezzanine in a facility, and another reader, as a MAM representation of the versioning requirements.

All of these interpretations are equally valid, and in this paper I won't try to differentiate between them. What I will attempt to do is review the technology and some of the working practises, then consider how IMF is a standardised technology that can assist in providing workable solutions to a management and distribution problem that has both national and international implications.

The underlying approach to IMF is that of a componentised workflow. All the different elements in an IMF bundle are stored in separable files so that they can be re-used. Much of the inspiration for the structure comes from current software working practises where different versions of an application can be made using identical code that is localised using specific libraries for different operating systems. There exists today a huge number of tools for retargeting and reversioning code to get maximum re-use. In the media world, it would be nice if we could get close to that level of efficiency without losing the essential entertainment value of the underlying content.

The basic problem we're trying to solve is the creation and management of many versions of the same title (for example a movie, sports programme, episodic or documentary) with efficient use of storage, compute, transfer and human resources. As an example, a movie distributed for television may have hundreds of different versions created due to differences in language, subtitling, compliance editing (removing video and audio content), localisation (e.g. adding dubbing credits or updating signposts to a local language) and even the addition of telephone numbers and hyper-local inserts for regional content.

Today, there is a broad range of workflows that can achieve this. At one extreme we have tape-based workflows where one tape is created per version (and then a spot reel to fill in the errors found when ingesting the first tape). At the other extreme we have the emerging importance of IMF.

THE BASICS OF IMF

The full IMF standards can be obtained from the SMPTE standards library(1). Useful background reading is the "Digital Cinema Packaging" set of specifications (2) and the AMWA AS-02 specification (3), both of which laid the groundwork for the creation of IMF.

Making a great version of media is like baking a great cake, so I will use a food analogy to help explain the role of the various elements of IMF.

All Essence is in Track Files

When one visits the supermarket, speed and convenience is achieved by having a consistent packing and labelling strategy. The same is true in IMF. All essence is in an MXF track file.

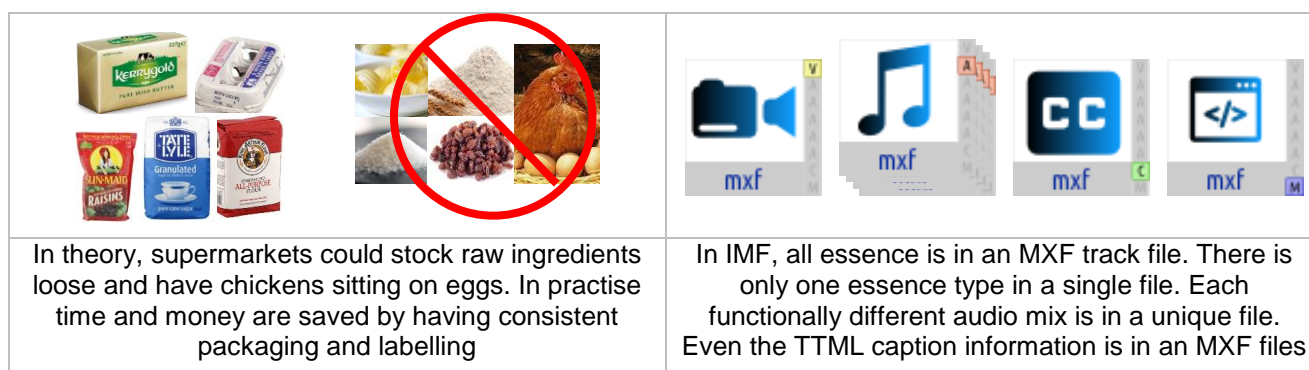| In theory, supermarkets could stock raw ingredients loose and have chickens sitting on eggs. In practise time and money are saved by having consistent packaging and labelling	In IMF, all essence is in an MXF track file. There is only one essence type in a single file. Each functionally different audio mix is in a unique file. Even the TTML caption information is in an MXF files

Figure 1 - Track files

The track files (SMPTE ST 2067-5) all have common MXF constraints and common ways of constructing index tables. This improves both consistency and interoperability. For each track file, the UMID of the File Package is used as an identifier to ensure that the IMF XML documents can strongly reference the correct file.

The design of IMF uses IDs for linking and identification. File names are considered fragile and transitory therefore the design allows filenames to be changed without any of the structure being broken.

The important point here is *don't rely on filenames for linking in IMF*.

The Timeline Recipe is in a Composition Play List File

IMF has tools for managing the complexity of a versioning workflow. For each timeline variant, there will be a Composition Play List or CPL. The CPL can be thought of as the recipe for a given version of the title.
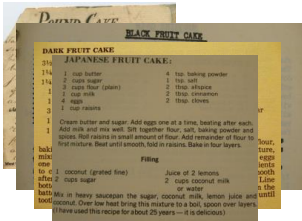
If you're baking a fruitcake, there are many variations of the recipe that can tailor the cake for a particular audience to meet local customs and traditions.	When localising a title, work can be done from simply adding captions through to replacing sections of the title, adding in extra credits, replacing sound tracks and other tweaks to optimise for a local audience. This is the job of the CPL

Figure 2 – CPL – Composition Play List

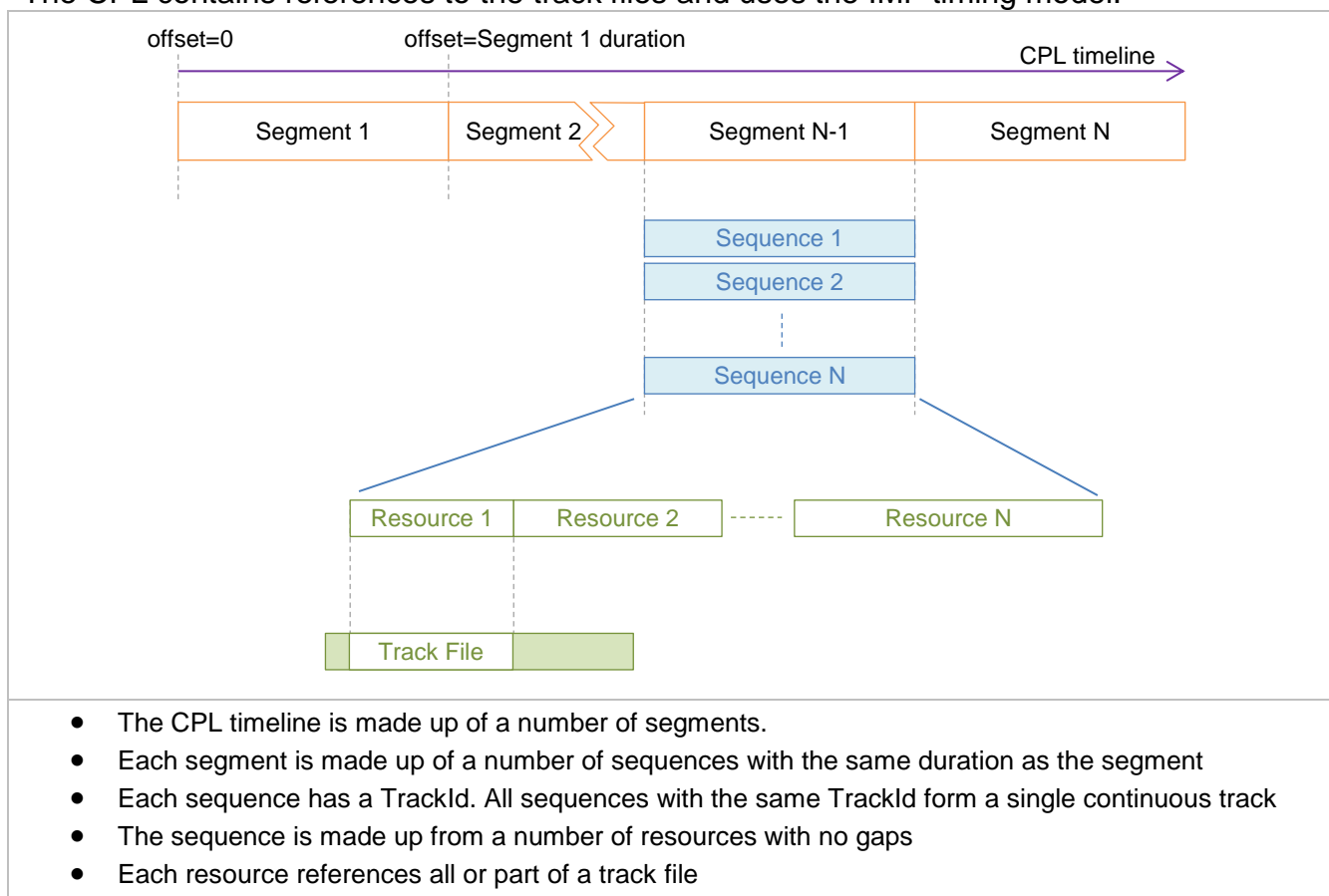The CPL contains references to the track files and uses the IMF timing model:

- The CPL timeline is made up of a number of segments.
- Each segment is made up of a number of sequences with the same duration as the segment
- Each sequence has a TrackId. All sequences with the same TrackId form a single continuous track
- The sequence is made up from a number of resources with no gaps
- Each resource references all or part of a track file

Figure 3 – IMF Timing model

The Size and Shape of the Output is in an Output Profile List File

Converting a title from a given master to a different size and shape output with a different audio mix often requires instructions in addition to the *automatic* modes of a given transcode engine. The OPL is intended to give these instructions.

For any given recipe, you can change the shape of the tin and change the way in which the cake is baked (including my personal speciality of setting fire to the fruit)	Changing colour sampling and colour space as well as scaling and cropping instructions along with audio mixing instructions are typical examples of how a title might be modified for certain distribution channels

Figure 4 – OPL – Output Profile List

Packaging for interchange

When an IMF bundle is interchanged, it is important to be able to quickly associate IDs with filenames at the point of interchange as well as provide checksums to ensure that the correct file has been included in the package. The Packing List or PKL (SMPTE ST 429-8) is an xml file that provides this functionality at the point of interchange. It's important to note that systems should not rely on the PKL being stored permanently.

Applications

The requirements for IMF are grouped together into applications intended to solve a particular problem. The applications provide constraints on codecs, resolutions, audio, colour and other variable parameters that need to be managed in order to achieve interoperability.

All applications build upon the core constraints of IMF (SMPTE ST 2067-2) which define the constraints common to all of the applications. These constraints include audio sampling rates, representation of subtitles and captions, wrapping of essence, audio labelling and the like.

At the time of writing, Application #2 (SMPTE ST 2067-20) is receiving the majority of interest and it constrains (amongst other things):

- Picture resolution (up to HD)
- Colour components (R'G'B' or Y'C_B'C_R')
- Pixel Bit Depth (8 or 10 bits)
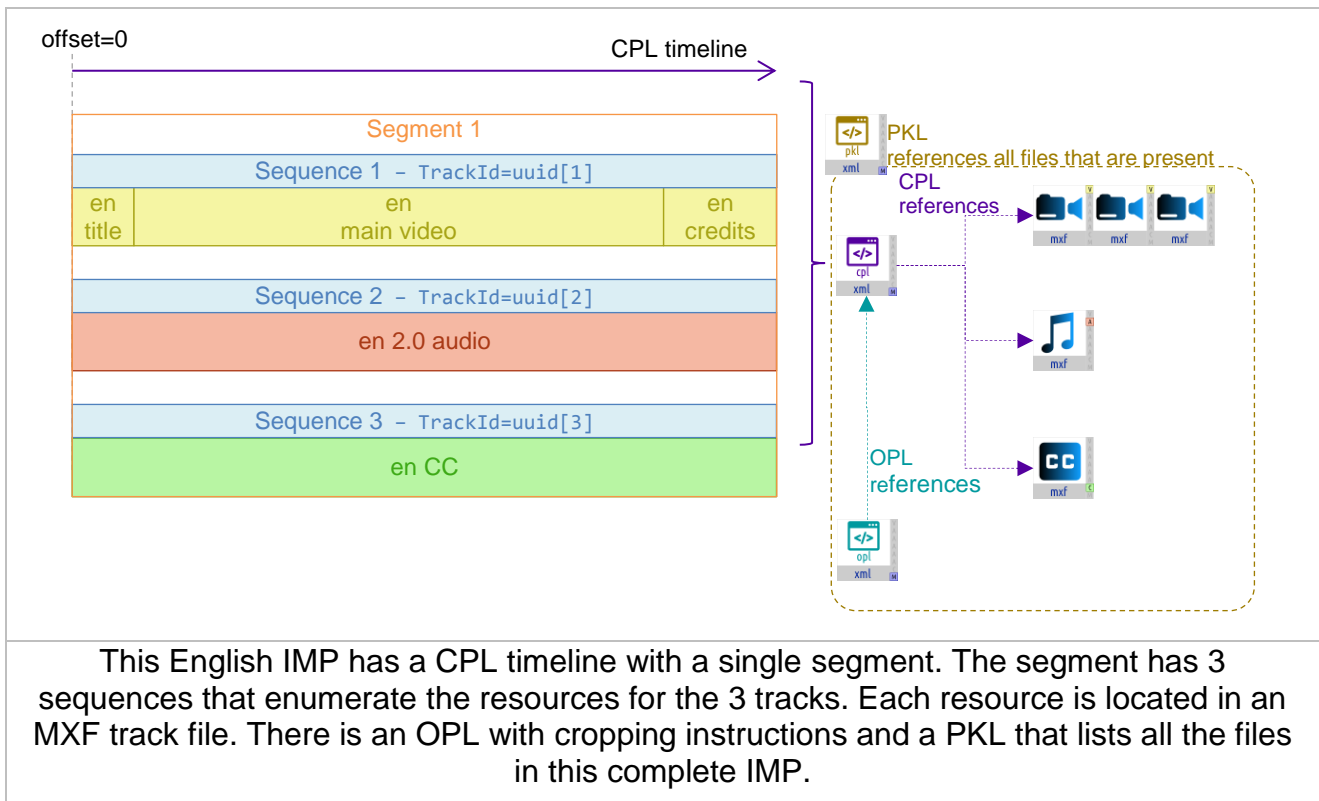- Compression (JPEG 2000 Broadcast Contribution)

IMF WORKFLOWS

The basic technology of IMF builds upon existing MXF and SMPTE's Digital Cinema technologies and is constrained by the application to encourage interoperability. If IMF workflows are to succeed in the market place, they must offer some benefit over existing workflows.

The most obvious workflow to look at is International versioning. Here, a title modified so that it can be exported – often to a country with a different dominant language. Whilst this is done today in many post houses around the world, only IMF provides a standardised way of recording and publishing the *delta* from the original file. Until now, the delta has been recorded with proprietary editor project files or internal formats. The advantage of a standard in this area is that this record of change can be moved between facilities, between MAMs and archived for future use without fear of the underlying format changing.

International Versioning Workflow

The workflow starts with the creation of an IMF Master Package (IMP). In the words of the specification (SMPTE ST 2067-2) the IMP can take two forms – Complete or Partial. In the colloquial language used operationally, a *Master Package* is often used when speaking of a complete package and a *Supplemental Package* is often used to mean a partial package. I will use the phrases *Complete IMP* and *Supplemental IMP* in the text below. The phrase *IMF Bundle* is used to describe a collection of IMF files without knowing its completeness or integrity.
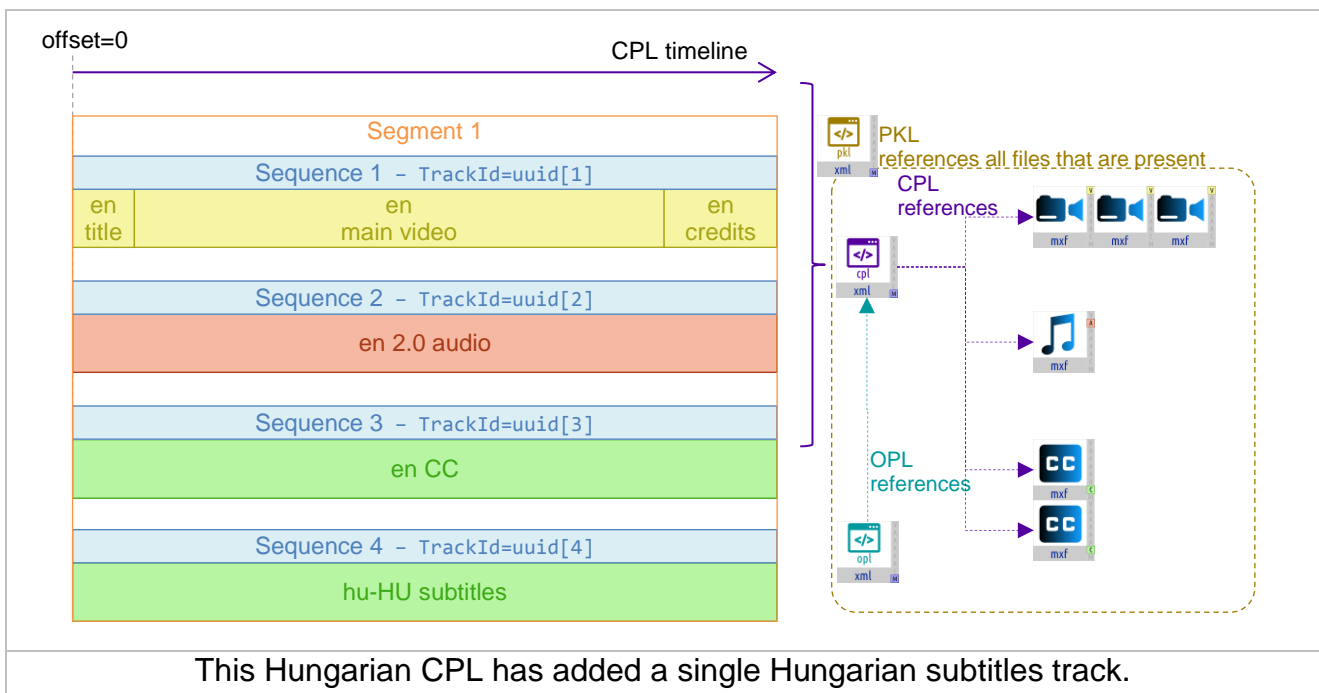
IMF does not rely on filenames, it relies on IDs and a tracking system such as a MAM to locate all the components of an IMF bundle, which easily determines whether the bundle is complete or if there are missing track files. In Figure 5 below you can see a package for a title comprising five MXF track files, a CPL, an OPL file and a PKL file.

offset=0
CPL timeline

Segment 1
Sequence 1 – TrackId=uuid[1]
en title | en main video | en credits
Sequence 2 – TrackId=uuid[2]
en 2.0 audio
Sequence 3 – TrackId=uuid[3]
en CC

PKL references all files that are present
CPL references
OPL references

This English IMP has a CPL timeline with a single segment. The segment has 3 sequences that enumerate the resources for the 3 tracks. Each resource is located in an MXF track file. There is an OPL with cropping instructions and a PKL that lists all the files in this complete IMP.

Figure 5 – A Complete English IMP – IMF Master Package (complete)

We can imagine the complete IMP being sent to a facility where the various SD, HD, OTT and other deliverables are rendered from this master package. Now we need to send the content to a new territory by simply adding a set of foreign language subtitles.

offset=0
CPL timeline

Segment 1
Sequence 1 – TrackId=uuid[1]
en title | en main video | en credits
Sequence 2 – TrackId=uuid[2]
en 2.0 audio
Sequence 3 – TrackId=uuid[3]
en CC
Sequence 4 – TrackId=uuid[4]
hu-HU subtitles

PKL references all files that are present
CPL references
OPL references

This Hungarian CPL has added a single Hungarian subtitles track.

Figure 6 – OPL – A Complete Hungarian Subtitle IMP

It is obvious from Figure 6 that there are a lot of repeated track files in the new complete package. The IMF XML files are only a few kBytes and a subtitle file is usually less than 1MByte. Video and audio track files can be tens or hundreds of GBytes in size. By sending and storing only the deltas we can save a lot of bandwidth and storage. The Supplemental Hungarian subtitles package is shown in below.

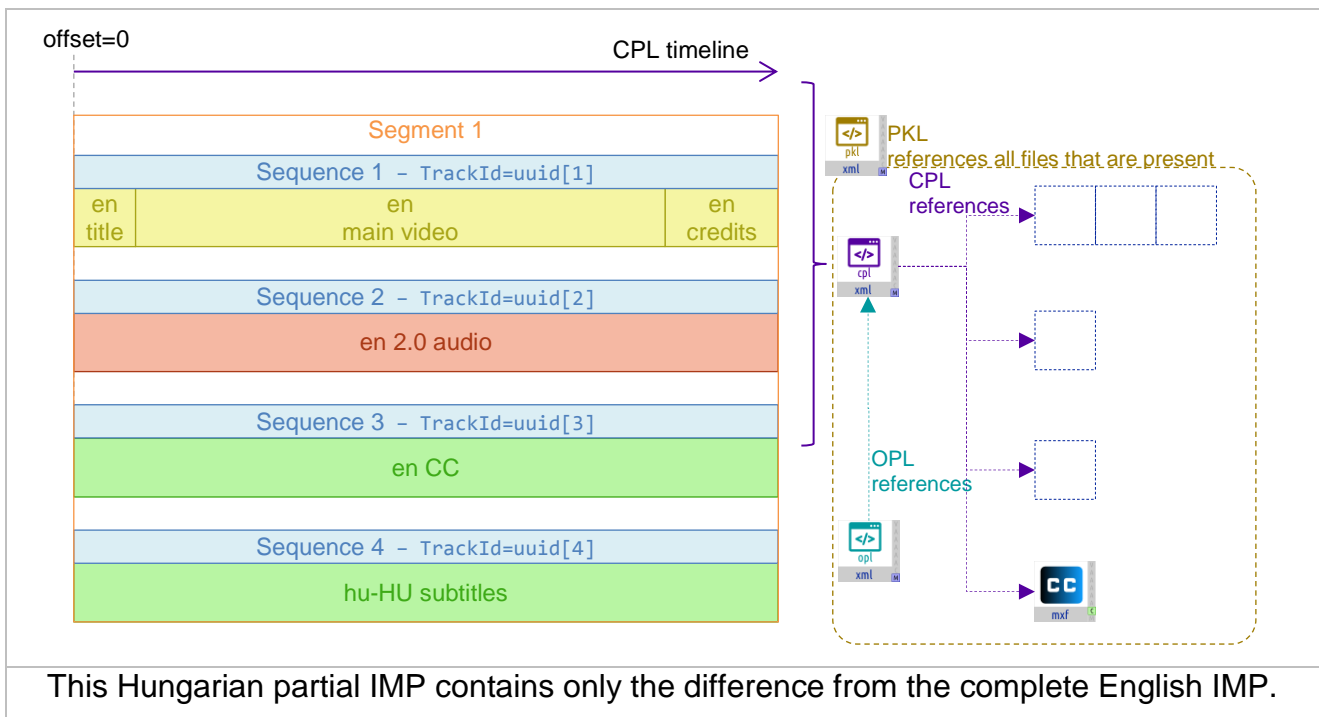This Hungarian partial IMP contains only the difference from the complete English IMP.

Figure 7 – OPL – A Supplemental Hungarian Subtitle IMP

You can see in Figure 7 above that a Supplemental IMP contains all the references to the media but only the new media is sent as track files. The packing list only contains information about the media files that are actually sent in the IMF bundle. The location of the missing references needs to be resolved by the local asset tracking system such as a MAM.

Assuming the subtitled version of the content is a success, it might be worth investing a little more in creating a dubbed version of the content.

offset=0 | CPL timeline | hu dub credits

Segment 1
Sequence 1
hu title | en main video | hu credits
Sequence 2
hu 2.0 audio
Sequence 5 – TrackId=uuid[5]
en 2.0 audio
Sequence 3
en CC
Sequence 4 – TrackId=uuid[4]
hu-HU subtitles

PKL references track files that are present
CPL references
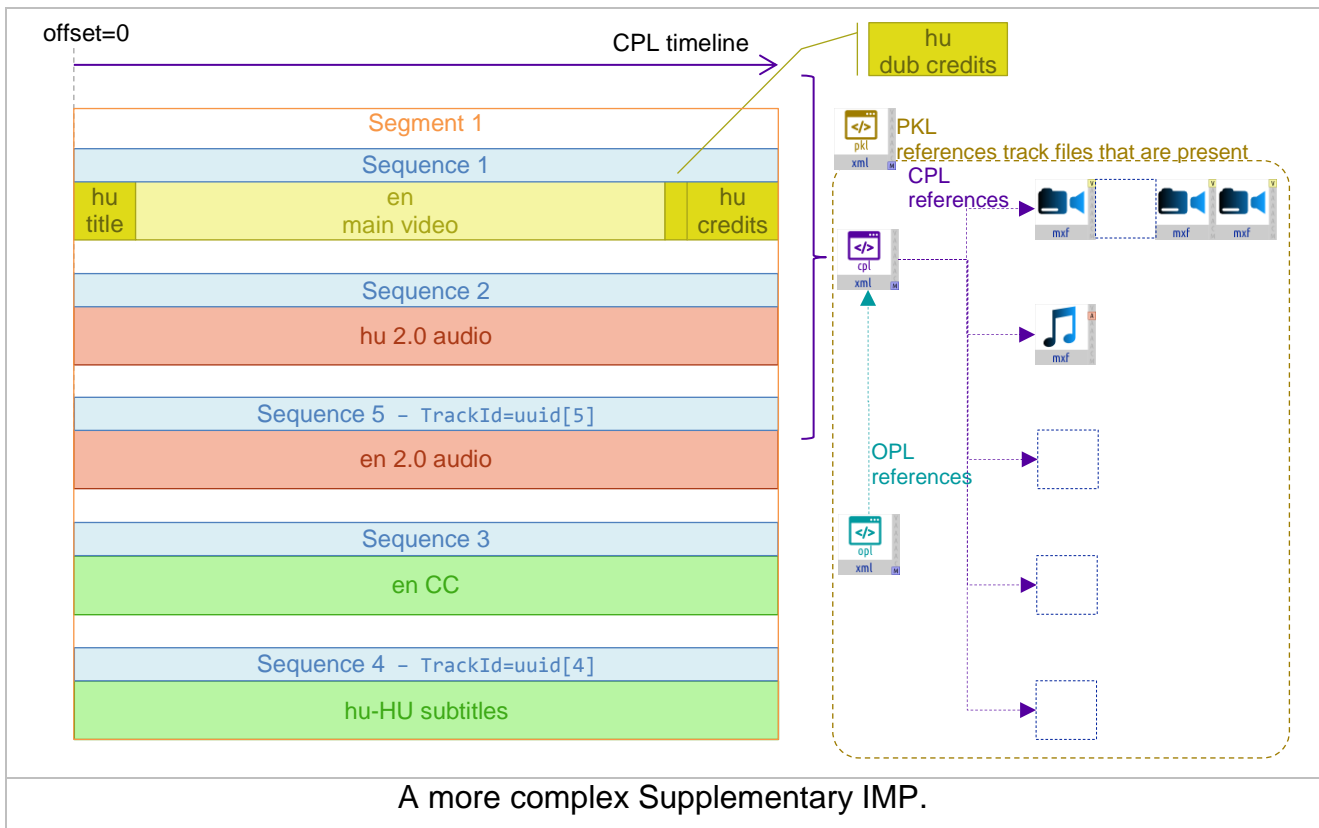OPL references

A more complex Supplementary IMP.

Figure 8 – OPL – A Supplemental Hungarian Dubbed IMP

In Figure 8 above we have created a new IMP that packages together the new track files and all the metadata required to render the new dubbed content. The figure assumes that the Hungarian subtitle supplemental has been sent. Note that the recipient of the IMF bundle is able to uniquely identify any missing content because of the IDs and metadata descriptors used in the format. If a recipient did not get the subtitle supplemental, they would know that the content was in its own track, they would know that it was a subtitle file and they would know the ID of the file. This rich metadata allows for automated fulfilment of missing content and thus increases the levels of automation possible by using IMF in this application.

IMF SAVINGS

The rich metadata and strong bindings of IMF allow for a standardised description of versioned content in three important orthogonal areas:

- The timeline of a version of a title
- The master parameters for rendering that content in a size / shape / colour space
- The inventory of media files required to create that version

Given the richness of the metadata and the appropriateness of that metadata for automated content assembly and transcoding, systems and products based on IMF should be highly interoperable for the media processes that can be automated.

Many of the processes involved in international versioning will always rely on humans. Creating great subtitles and great dubs is (and in my opinion always will be) a creative task

that requires human skill. The tedious parts of assembly, asset tracking and transcode configuration are destined to be increasingly automated as IMF usage permeates around the industry.

CONCLUSIONS

IMF is now a standard and its richness and versatility will almost certainly lead it to be a valuable tool in the creation of multi-version, multi-platform content. Products are appearing on the market and interoperability testing shows that good constraints by the format designers has led to a format that promises to be highly interoperable and stable.

REFERENCES

1. SMPTE ST 2067 – Interoperable Mastering Format. standards.smpte.org
2. SMPTE ST 429 – Digital Cinema Packing. standards.smpte.org
3. AMWA AS-02 – amwa.tv/projects/AS-02.shtml