

# WHAT IS HAPPENING WITH IMF?

THE FILE FORMAT, NOT THE INTERNATIONAL MONETARY FUND

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# Agenda

- Brief History on IMF
- Latest Updates with IMF (including broadcast-centric IMF)
- Deeper Dive into IMF for Broadcast and Cable Industries

# Brief History on IMF

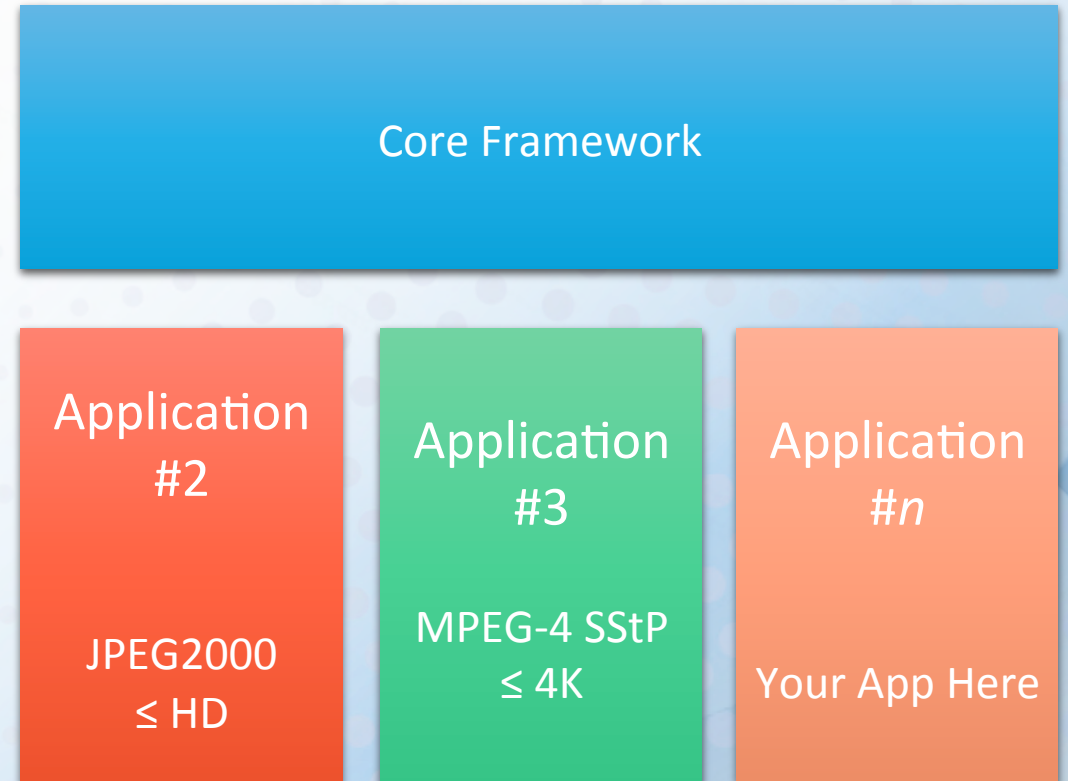
- 2006 – Disney/Pixar discussions about the need of a master file format with versioning
- 2007 – Studios talked about the need for a distribution file format
- 2008 – USC ETC was a “safe home room” for 5 (and later 6) Hollywood Studios
  - Originally called, “Digital Video Package” or DVP



- February 2011 – USC ETC published IMF Specification v1.0
- March 2011 – SMPTE started work on IMF

# Brief History on IMF

- Core Framework
  - Composition Play Lists
  - MXF Wrapping
  - Major Constraints
  - General Image, Audio and Subtitling Parameters
- Modular Applications
  - “Plug-in” to framework
  - Allow for specific functionality
    - Higher compressed CODECs
    - Specific resolutions or frame rates
    - Allows for different problems to be solved
  - Interchange **within** an Application



# Published IMF Applications (as of July 2018)

Core Framework

Application #1  
"Reserved"

Application #2E  
JPEG2000 ≤ 4K

RDD 45  
App #2E but using ProRes

Application #3  
MPEG-4 SStP ≤ 4K

TSP 2121 (draft)  
DPP ProRes

Application #4  
Cinema Mezzanine

Application #5  
ACES

Application #n  
Your App Here

IMF was started for the movie industry, but now can be used for any content that has a lot of versioning!

# RDD 45:2017 – IMF – Application ProRes

- ProRes is not a Standard
- Apple and others wanted IMF Application #2E but with ProRes instead of J2K



- SMPTE RDD 36                      Syntax and Decoding ProRes
- SMPTE RDD 44                      MXF wrapping of ProRes
- SMPTE ST 2067-2                    IMF Core Constraints
- SMPTE ST 2067-21                   IMF Application #2e

- Removed items that ProRes couldn't do (16-bit RGB)
- Recent plugfest in Munich – good turnout of manufacturers

# TSP 2121: DPP ProRes (Draft)



- EBU and Digital Production Partnership (UK)
- SMPTE Technical SPecification – Engineering Document
- Further constrains RDD 45
  - HD, UHD
  - 4:2:0, 4:2:2, 4:4:4
  - 25 Fps, 50 Fps
  - 10 and 12 bit
  - ITU-R BT.2020
  - ITU-BT.2100 HLG & PQ HDR
  - Surround Audio, 128 Audio Tracks w/up to 128 Channels per Track
  - SMPTE ST2067-9 Sidecar Metadata (contains metadata for QC, AS-11, EBU-TT, etc.)



# DEEPER DIVE INTO IMF

# What IMF is (and is not)

- Business-to-Business (not meant for Consumer)
- High quality file-based FINAL master that has a lot of versions!
  - Image
  - Audio
  - Subtitling/Captioning
  - Technical Metadata
  - Playlists for the content
  - Language versions, different edits and S&P
- Minimizes storage
  - Uses mezzanine level compression
  - Store differences between versions, not flattened long-play versions
- Meant for pre-created masters - Not meant for live-to-air



# Doctor Who Use Case

## Television Distribution

- 2D HD Versions
  - 1080P/25 (50i-psf)
  - 1080P/24 (24/1.001i-psf)
  - 1080P/29.97 (59.94i-psf)
- 3D HD Versions
  - Left/Right Eye 1080P/25
  - Left/Right Eye 1080P/24
- 5 Language TV Versions



## Cinema Distribution

- 2D and 3D DCP 24fps Versions
- 24 Countries

# Doctor Who Use Case

## Storage Overview

- Each version 77 minutes duration
- TV Versions 31 ProRes 27MB/s files
  - 30GB each = **4TB total**
- Cinema Versions 75 DCP 2K @192MB/s files
  - 890GB each = **67TB total**
- Total storage requirement = **70TB!**
- But over **90%** of the material is duplicated **MANY** times



# Doctor Who Use Case

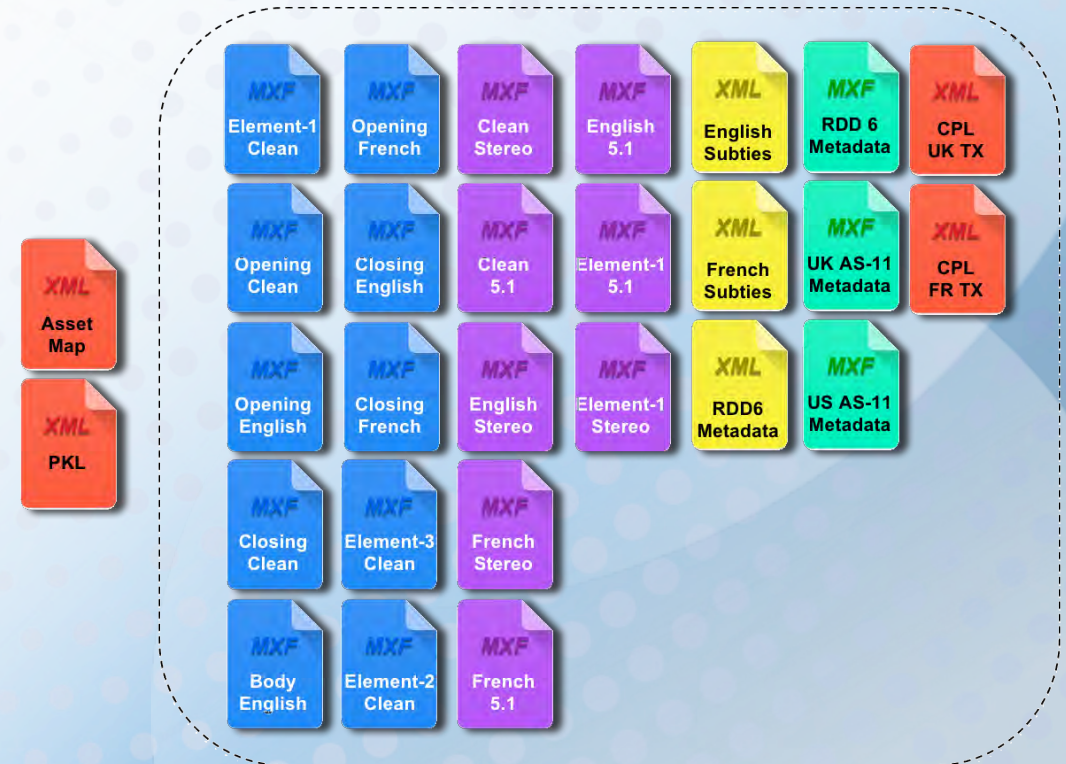
## Storage Overview – if IMF

- Each version 77 minutes duration
- TV Versions 31 ProRes 27MB/s files
  - 30GB each = ~~4TB total~~ (IMF = 90GB)
- Cinema Versions 75 DCP 2K @192MB/s files
  - 890GB each = ~~67TB total~~ (IMF = 2.6TB)
- Total storage requirement = ~~70TB!~~ >3TB!
- But over 90% of the material is duplicated *MANY* times



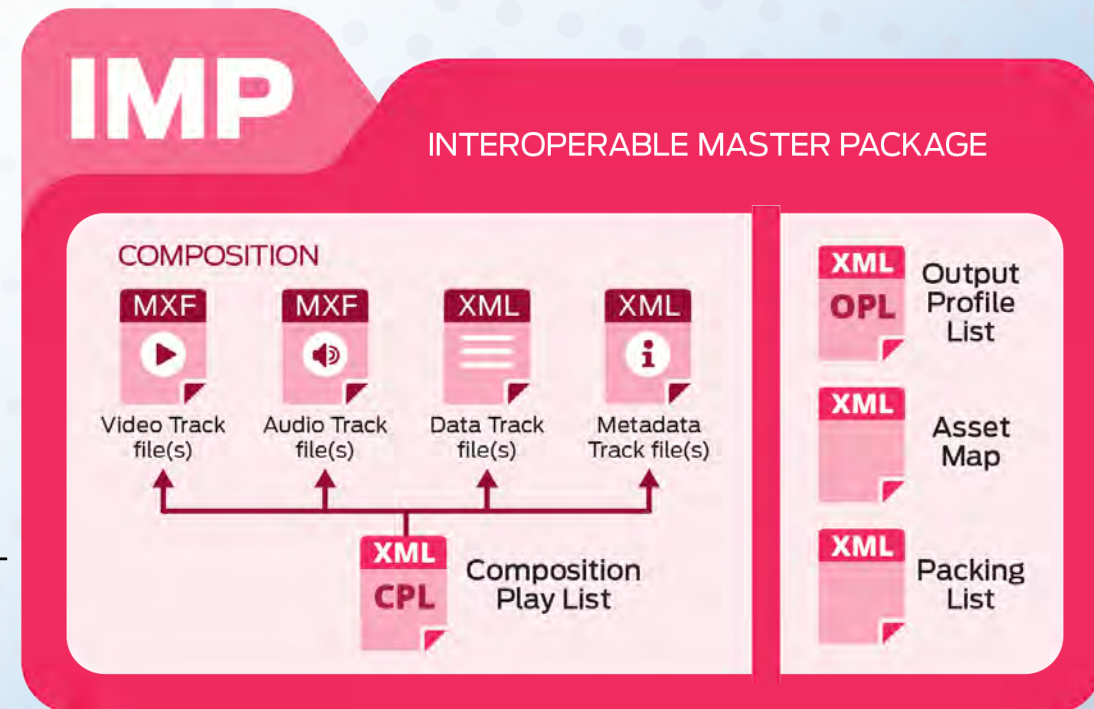
# IMF Structure

- Componentized Content
  - Get used to not having a **single file** for each program version!
  - Each master consists of;
    - Single **core** asset
    - **Delta** clips for alternate versions
    - Up to 128 Audio Track Files
    - Up to 128 Channels per Track
    - MXF wrapped media
    - XML described content

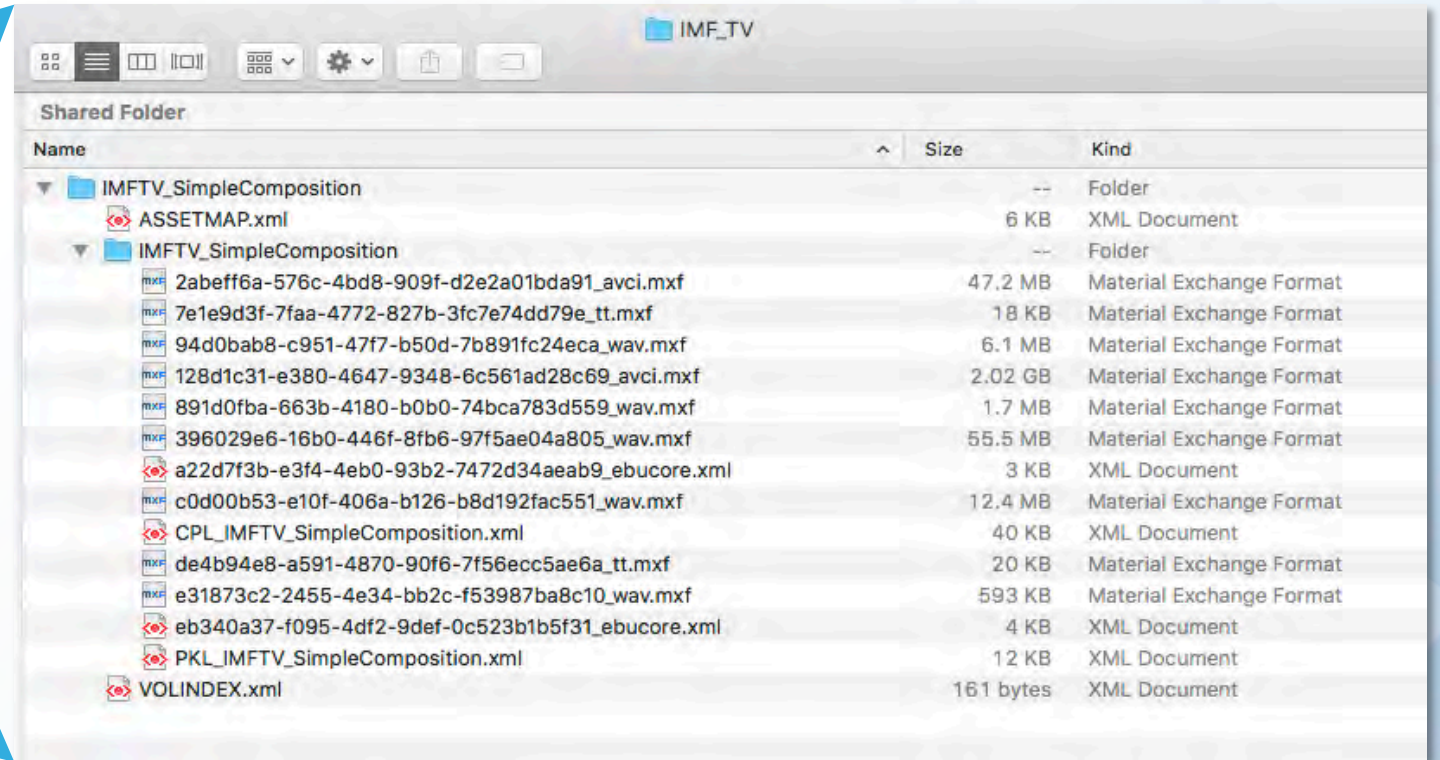


# The IMP

- The Interoperable Master Package
  - The IMF “bundle” for shipping
    - Packing List
    - Video MXF
    - Audio MXF
    - Captions MXF
    - Metadata MXF or XML
    - Composition Play List (CPL) XML
    - Asset Map
    - Output Profile List (OPL) XML



# What's in the bundle?



Name	Size	Kind
IMFTV_SimpleComposition	--	Folder
ASSETMAP.xml	6 KB	XML Document
IMFTV_SimpleComposition	--	Folder
2abeff6a-576c-4bd8-909f-d2e2a01bda91_avci.mxf	47.2 MB	Material Exchange Format
7e1e9d3f-7faa-4772-827b-3fc7e74dd79e_tt.mxf	18 KB	Material Exchange Format
94d0bab8-c951-47f7-b50d-7b891fc24eca_wav.mxf	6.1 MB	Material Exchange Format
128d1c31-e380-4647-9348-6c561ad28c69_avci.mxf	2.02 GB	Material Exchange Format
891d0fba-663b-4180-b0b0-74bca783d559_wav.mxf	1.7 MB	Material Exchange Format
396029e6-16b0-446f-8fb6-97f5ae04a805_wav.mxf	55.5 MB	Material Exchange Format
a22d7f3b-e3f4-4eb0-93b2-7472d34aeab9_ebucore.xml	3 KB	XML Document
c0d00b53-e10f-406a-b126-b8d192fac551_wav.mxf	12.4 MB	Material Exchange Format
CPL_IMFTV_SimpleComposition.xml	40 KB	XML Document
de4b94e8-a591-4870-90f6-7f56ecc5ae6a_tt.mxf	20 KB	Material Exchange Format
e31873c2-2455-4e34-bb2c-f53987ba8c10_wav.mxf	593 KB	Material Exchange Format
eb340a37-f095-4df2-9def-0c523b1b5f31_ebucore.xml	4 KB	XML Document
PKL_IMFTV_SimpleComposition.xml	12 KB	XML Document
VOLINDEX.xml	161 bytes	XML Document

- Each of the components is arranged in a simple folder structure
  - The Asset Map and Packing List are used to identify the Components
  - The Composition Play List pulls the Components in a Version together

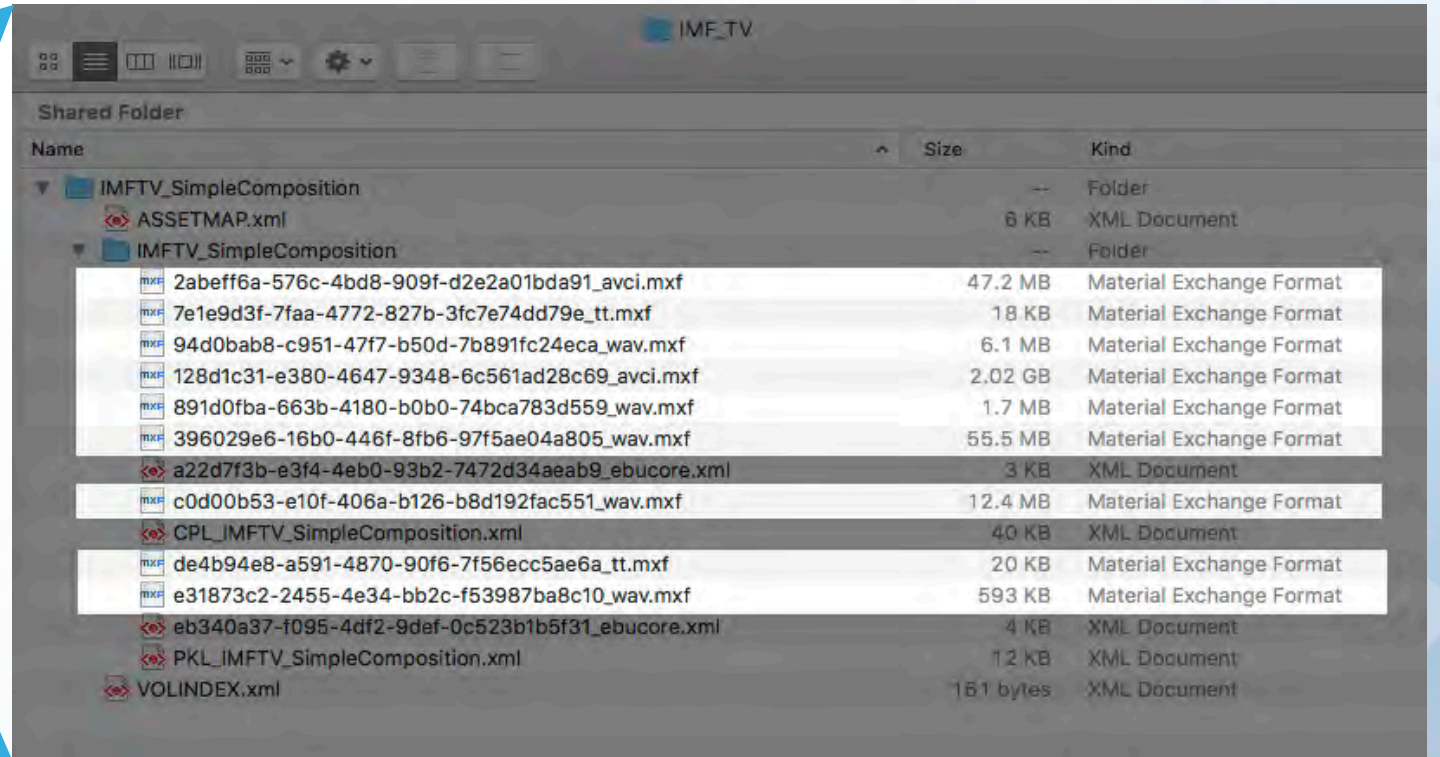
# Broadcaster Shocker #1

- IMF breaks with current ways of working
  - The format does not use...
    - File Names or File Paths

afb1ccac-1a91-4d3d-9ca7-c7cf5b03e61e\_j2c.mxf



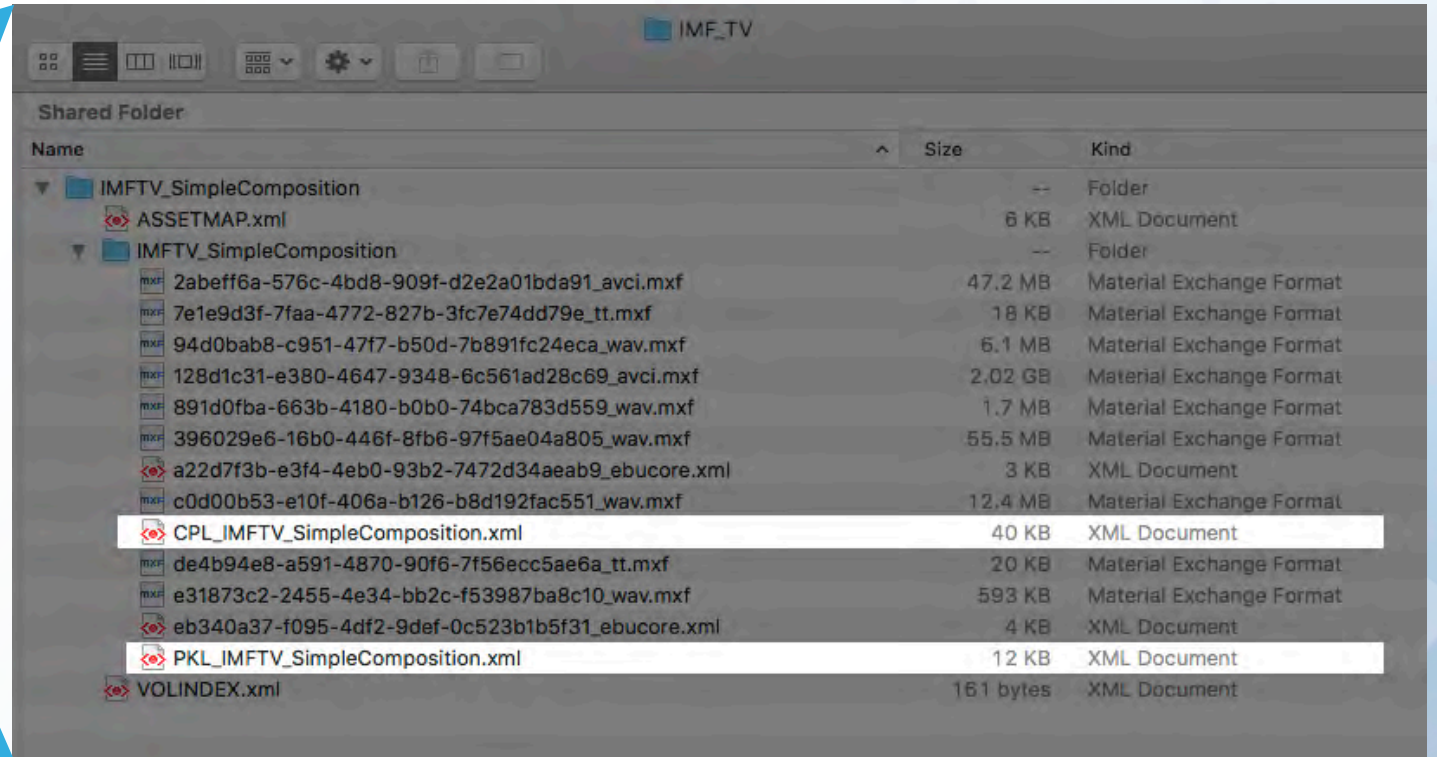
# Files with no names!



Name	Size	Kind
IMFTV_SimpleComposition	--	Folder
ASSETMAP.xml	6 KB	XML Document
IMFTV_SimpleComposition	--	Folder
2abeff6a-576c-4bd8-909f-d2e2a01bda91_avci.mxf	47.2 MB	Material Exchange Format
7e1e9d3f-7faa-4772-827b-3fc7e74dd79e_tt.mxf	18 KB	Material Exchange Format
94d0bab8-c951-47f7-b50d-7b891fc24eca_wav.mxf	6.1 MB	Material Exchange Format
128d1c31-e380-4647-9348-6c561ad28c69_avci.mxf	2.02 GB	Material Exchange Format
891d0fba-663b-4180-b0b0-74bca783d559_wav.mxf	1.7 MB	Material Exchange Format
396029e6-16b0-446f-8fb6-97f5ae04a805_wav.mxf	55.5 MB	Material Exchange Format
a22d7f3b-e3f4-4eb0-93b2-7472d34aeb9_ebucore.xml	3 KB	XML Document
c0d00b53-e10f-406a-b126-b8d192fac551_wav.mxf	12.4 MB	Material Exchange Format
CPL_IMFTV_SimpleComposition.xml	40 KB	XML Document
de4b94e8-a591-4870-90f6-7f56ecc5ae6a_tt.mxf	20 KB	Material Exchange Format
e31873c2-2455-4e34-bb2c-f53987ba8c10_wav.mxf	593 KB	Material Exchange Format
eb340a37-f095-4df2-9def-0c523b1b5f31_ebucore.xml	4 KB	XML Document
PKL_IMFTV_SimpleComposition.xml	12 KB	XML Document
VOLINDEX.xml	161 bytes	XML Document

- An MXF asset is identified by UUID
  - Video and Audio essence, Captions and Data files...

# How do you find them?



- A CPL for each Version
  - Brings together the Package Content and the Version Content

# CPL - PKL

```
<?xml version="1.0" encoding="UTF-8"?>
<CompositionPlaylist xmlns="http://www.smpte-ra.org/schemas/2067-3/2013" xmlns:xsi="http://www.w3.org/2001
instance">
  <Id>urn:uuid:2f631054-1862-45de-a0d4-dceb3fb4dccb</Id>
  <Annotation>IMF_SHR_F_EN_US-G_51_4K_20141024</Annotation>
  <IssueDate>2014-10-24T12:46:27+00:00</IssueDate>
  <Issuer>Company</Issuer> <Creator>Company Product</Creator> <ContentOriginator>Company</ContentOriginator>
  <ContentTitle>IMF_SHR_F_EN_US-G_51_4K_20141024</ContentTitle>
  <ContentKind>short</ContentKind>
  <ContentVersionList>..... snipped .... </ContentVersion>
</ContentVersionList>
  <CompositionTimecode>
    <TimecodeDropFrame>0</TimecodeDropFrame>
    <TimecodeRate>24</TimecodeRate>
    <TimecodeStartAddress>00:00:00:00</TimecodeStartAddress>
  </CompositionTimecode>
  <EditRate>24000 1001</EditRate>
  <SegmentList>
    <Segment>
      <Id>urn:uuid:534a18e6-925c-4125-8b04-d0081bf3431d</Id>
      <SequenceList>
        <cc:MainImageSequence xmlns:cc="http://www.smpte-r.org/schemas/2067-2/2013">
          <Id>urn:uuid:508f3990-36b9-413e-ac78-13a40e2951ba</Id>
          <TrackId>urn:uuid:9ce9c1bc-a5dc-4ce7-b217-6828dbdc010c</TrackId>
          <ResourceList>
            <Resource xsi:type="TrackFileResourceType">
              <Id>urn:uuid:b68809f4-92e6-4c76-bae6-d09ebdcd6783</Id>
              <Annotation>001_1.mxf</Annotation>
              <EditRate>24000 1001</EditRate>
              <IntrinsicDuration>719</IntrinsicDuration>
              <EntryPoint>0</EntryPoint>
              <SourceDuration>719</SourceDuration>
              <SourceEncoding>urn:uuid:b68809f4-92e6-4c76-bae6-d09ebdcd6783</SourceEncoding>
              <TrackFileId>urn:uuid:b68809f4-92e6-4c76-bae6-d09ebdcd6783</TrackFileId>
              <Hash>Ql+JtpHEFk4erLVIC4K5o7xdgAw=</Hash>
            </Resource>
          </ResourceList>
        </cc:MainImageSequence>
      </SequenceList>
    </Segment>
  </SegmentList>
</CompositionPlaylist>
```

CPL

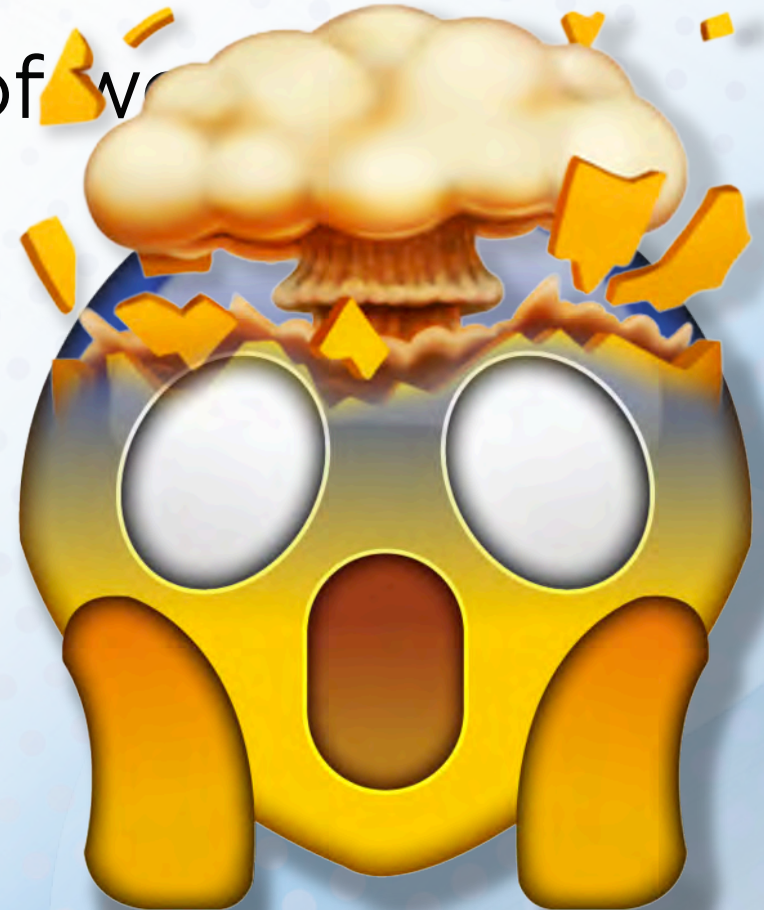
```
<?xml version="1.0" encoding="UTF-8"?>
<PackingList xmlns="http://www.smpte-ra.org/schemas/429-8/2007/PKL">
  <Id>urn:uuid:adc19cd0-7cd0-f87d-a688-33842ac8d546</Id>
  <AnnotationText>IMF_SHR_F_EN_US-G_51_4K_20141024</AnnotationText>
  <IssueDate>2014-10-24T12:46:27+00:00</IssueDate>
  <Issuer>Company</Issuer>
  <Creator>Company Product</Creator>
  <AssetList>
    <Asset>
      <Id>urn:uuid:b68809f4-92e6-4c76-bae6-d09ebdcd6783</Id>
      <AnnotationText>001_1.mxf</AnnotationText>
      <Hash>Ql+JtpHEFk4erLVIC4K5o7xdgAw=</Hash>
      <Size>1682112440</Size>
      <Type>application/mxf</Type>
      <OriginalFileName>001_1.mxf</OriginalFileName>
    </Asset>
    <Asset>
      <Id>urn:uuid:9456a52e-f4d4-401f-cba2-83033a7a98fb</Id>
      <AnnotationText>001_1_audio.mxf</AnnotationText>
      <Hash>J+1ZfBAFeM8+HE80iTu+7n4oyo4=</Hash>
      <Size>25935421</Size>
      <Type>application/mxf</Type>
      <OriginalFileName>001_1_audio.mxf</OriginalFileName>
    </Asset>
    <Asset>
      <Id>urn:uuid:2f631054-1862-45de-a0d4-dceb3fb4dccb</Id>
      <AnnotationText>CPL_2f631054-1862-45de-a0d4-dceb3fb4dccb.xml</AnnotationText>
      <Hash>Kkx5d5I0rbk4CLwYEr/493lwpim=</Hash>
      <Size>3108</Size>
      <Type>text/xml</Type>
      <OriginalFileName>CPL_2f631054-1862-45de-a0d4-dceb3fb4dccb.xml</OriginalFileName>
    </Asset>
  </AssetList>
</PackingList>
```

PKL

# Broadcaster Shocker #2

- IMF breaks with current ways of working
  - The format does not use...
    - Timecode

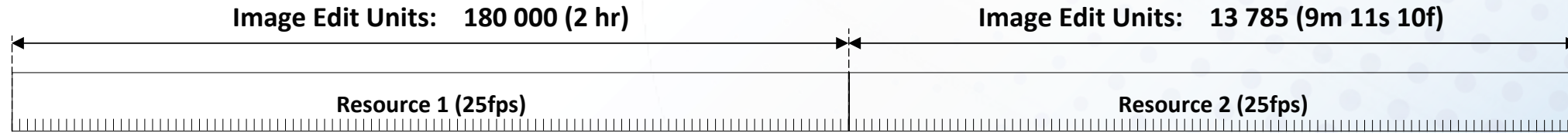
~~23:59:59.29~~



# Where does it go?

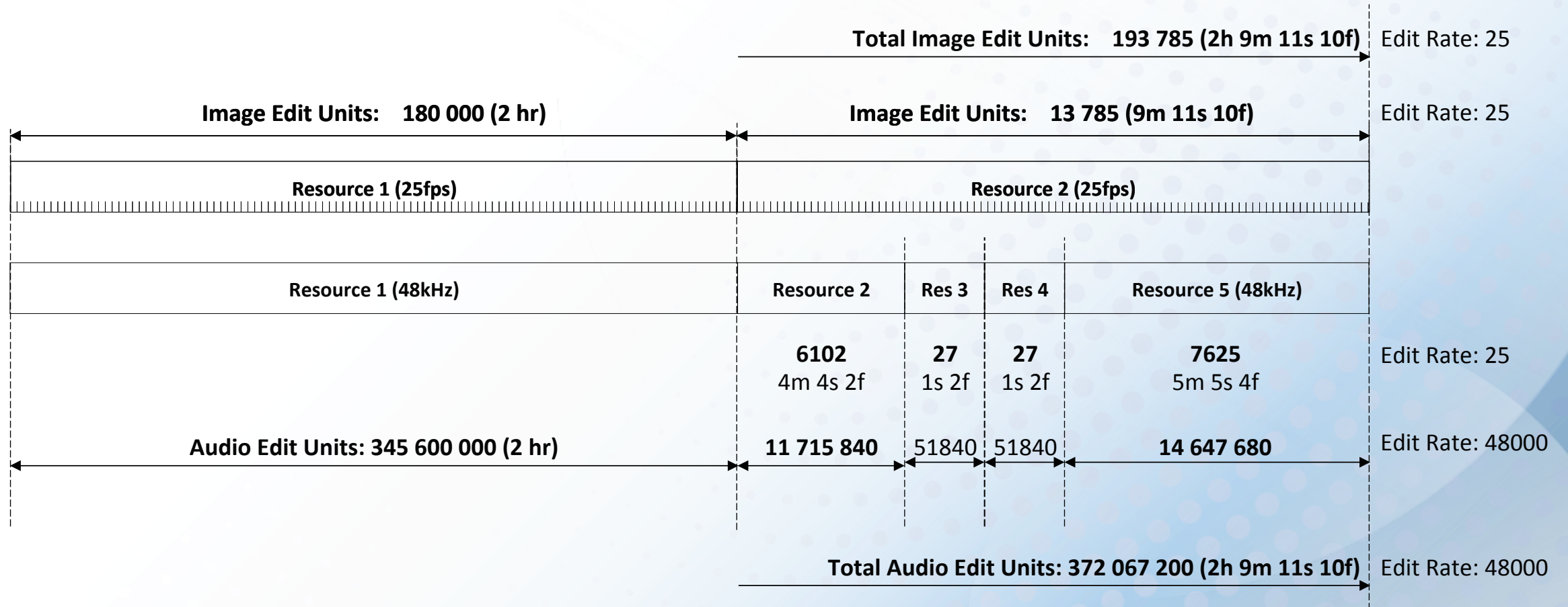
- If there is no Timecode, how can it work?
  - All assets have a ZERO start time
  - In a Version, the CPL gives
    - an assets location - as a count from the **start of the version**
    - an assets in-point - as a count from the **start of the asset**
    - an assets duration as a count from the **in-point of the asset**
    - for any tape editor, this is a simple **three point** edit!
    - The CPL counts in “*Edit Units*”

# The Edit Unit



- Edit Units (EU) define asset duration and position
  - An EU is the **smallest** time unit for the asset
  - The Edit Rate is the “**frequency**” of the Edit Unit
    - The Edit Rate for Video is usually the **frame** rate
    - The Edit Rate for Audio is usually the **sample** frequency
    - Versions cannot mix different frame rates or sampling frequencies

# The Composition Timeline



- Track durations must be identical
  - Sum of Video Frames = Sum of Audio Samples

# IMF Summary

- IMF started as a need for a standardized file format for movie distribution masters, but now has functionality for Cable and Broadcasters
- IMF allows for flexible versioning and different CODECs using Applications
- IMF breaks away from traditional workflows - bundle of files and no timecode! But necessary to keep pace
- IMF requires an IMF-aware system for ingest and AM
- You can make your own application that fits your needs!

# Questions?

- [annie.chang@nbcuni.com](mailto:annie.chang@nbcuni.com)
- Join the SMPTE effort!
  - 35PM Media Packaging and Interchange Technology Committee
  - Several drafting groups active
    - Audio Essence
    - Document Maintenance
    - DPP Application
    - Output Profile Lists
    - Plugfests