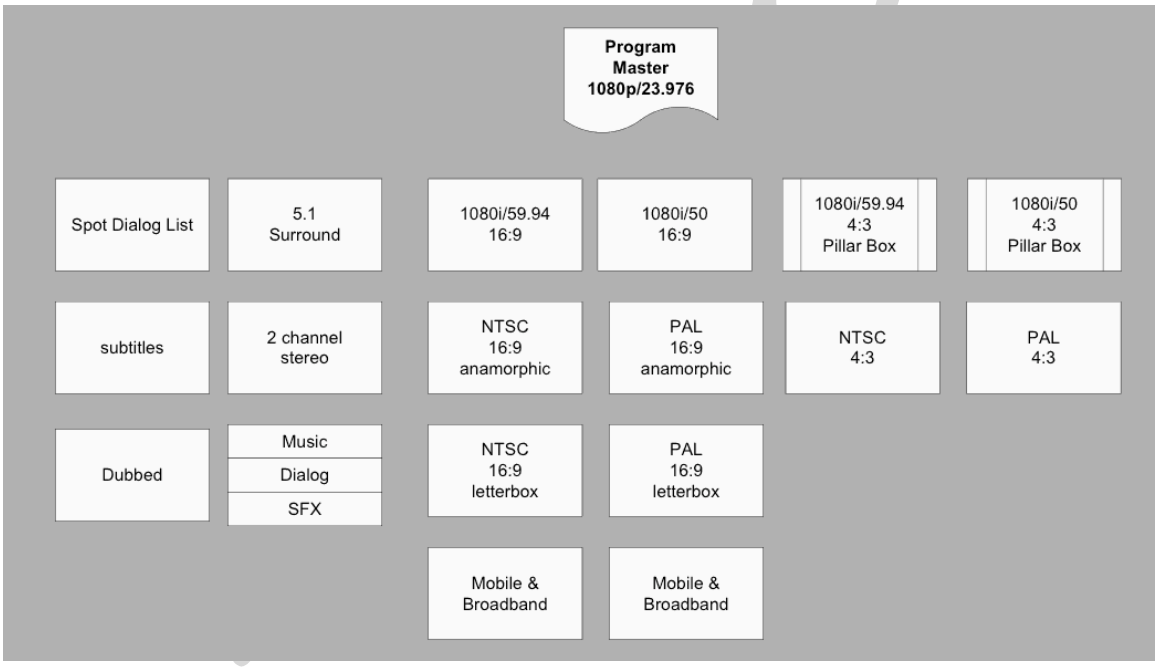
File-based Universal Mastering for Avid Media Composer

History

In 1999, Avid introduced the first non-linear system to offer “Universal Mastering”. Although it was SD only at the time, the features and functionality allowed programs mastered at 23.976p, 24p, and 25p to be output via SDI to tape as 23.976, 24p, 25p, 29.97i and 25i. Because the system slowed up or sped up playback depending on output rate, excellent quality was maintained through the process, as there was no motion adapted pulldown frames being applied. It was either a frame for frame or a simple 2:2:2:2 or 2:3:2:3 being applied. The quality matched any of the standalone standards convertors on the market at the time.

The concept of Universal Mastering is the ability to master a single program at the original native rate of the media, and within the same project output on the fly the different deliverable required for the show.

With the introduction of HD at the end of 1999 and the new century, a true single high quality broadcast master could be created and then deliver from there, as submasters, the domestic and foreign versions of the program. The following graphic shows many of the potential deliverables that might be requested by a broadcaster or distributor for any given program.



HD Universal Mastering did not make its way into Avid Symphony until version 3.5 and while it fulfilled the concept of Universal Mastering, it still missed a lot of the flexibility that was available in the SD only version and the missing functionality was never added back. Features such as “Insert Edit” and maintain pulldown cadence is an important one – when delivering 1080i/59.94 masters with content that has pulldown, it is better to have a continuous 2:3 pulldown from program start to end allowing the MPEG encoding to maintain a higher quality across edit points. High end conversion systems had a process called “Cadence Align” that did just that through motion adaption – but the process bumped a generation and wasn’t as clean as editing at the native rate and deliver a continuous cadence from the start. Also the ability to change the edit/playback rate in a project between 23.976/24 or 24/25, is not available in HD.

The Universal Mastering feature is only available with Symphony while using Avid DX hardware. A good overview of the functionality written by Job ter Burg can be found at his website:
http://www.jobterburg.nl/Publications/UniversalMastering_v1.2.pdf

Later, Avid introduced "Mix and Match", the ability to mix any format and any frame rate into any project type. This is a great feature and meets the needs of many productions having to deal with such a variety of footage. And in some cases can be used as a form of Universal Mastering by opening the sequence in each of the different project types and output from each project as needed. The Media Composer and Symphony products will optimize the cadence and progressive/interlace nature of the conversion on the fly as needed. One thing to note in this conversion process is that "time" will remain constant. Meaning 1 minute at any frame rate will remain 1 minute at the new frame rate. This is done by keeping audio constant (e.g.: 48kHz), and adds or removes frames/fields to the video tracks to compensate for time. In some cases, this is absolutely the right thing to do, such as 1080i/59.94 source in a 23.976 timeline. There are still some unique and innovative enhancements that could be done in an NLE to improve this type of conversion where all the elements in the timeline are still uniquely and relationally addressable.

Where it does not always work well is when working with progressive frame rates of 23.976, 24, and 25. Frame based pulldown insertion tends to result in a stutter look that is visible on any movement or pans. Unfortunately, Avid has yet to offer frame for frame conversion between this progressive frame rates, which would speed up or slow down frames and compensate for the audio on the fly using the real time sample rate conversion already available in the products. It is far easier for the eye to notice pulldown frames, than it is for the ear to notice a one-pass sample rate conversion – the result would be a high quality conversion for these program types.

Universal Mastering is one of the few differentiations between Media Composer and Symphony. Now that Symphony is an option with v7 of Media Composer, this functionality can be added to Media Composer. The requirement for Avid DX hardware still exists, so Universal Mastering, which is still a tape based solution will not work with Avid's Open I/O and third party vendors.

The other limitation with the feature set is that it is still for tape-based output while the world has been quickly moving to file-based formats and deliverables over the past several years. The functionality and feature set of Universal Mastering has not kept up with the changes in the industry and can only look forward to an updated version in the future.

Workaround

While an integrated solution within the Media Composer/Symphony option would be a much better solution, the steps described in the following section will allow a user to create a high quality, frame for frame version of a progressive timeline to a progressive output between 23.976, 24, and 25 frame per second programs. In addition, the audio workflow will not only compensate for the time differences between frame rates, but will also compensate for pitch, which the Media Composer/Symphony version does not. The results of these outputs can still be output over SDI using third party hardware, and more importantly, output as files required for the different deliverables.

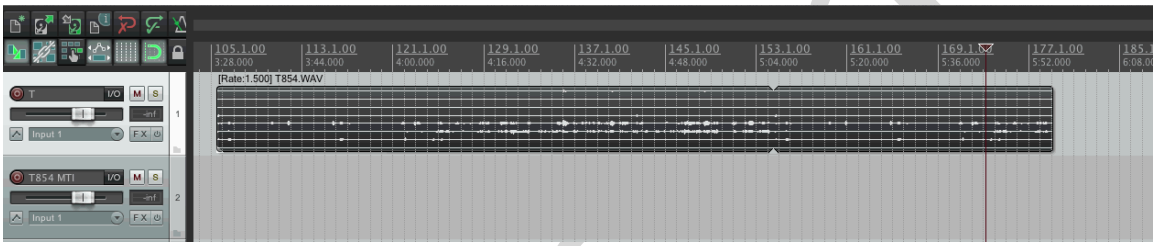
The first requirement is to have the timeline in an Avid DNxHD codec as the step requires an export of the timeline as a QuickTime reference to save time and not have to deal with any additional decompress/recompress steps during the process. The following example will also use 23.976 to 25, but the steps are the same regardless of 23.976p <-> 24p <-> 25p outputs needed.

For 1080p/23.976 Picture to 1080p/25:

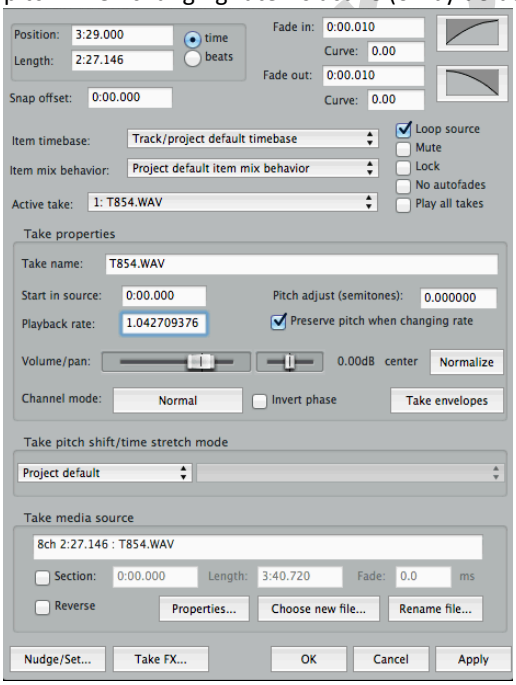
1. From the 1080p/23.976 project, highlight sequence and export as QuickTime reference, with "Mastering" selected as option. Only export the Video tracks, the audio will take a separate path.
2. Create a 1080p/25 project and import the QuickTime reference by first entering "IgnoreQTRate True" in the console. Unfortunately, this will not be a "fast import" but the sequence will come in frame for frame meaning in example, 23.976 will play back 4.1% faster.

For 1080p/23.976 Audio:

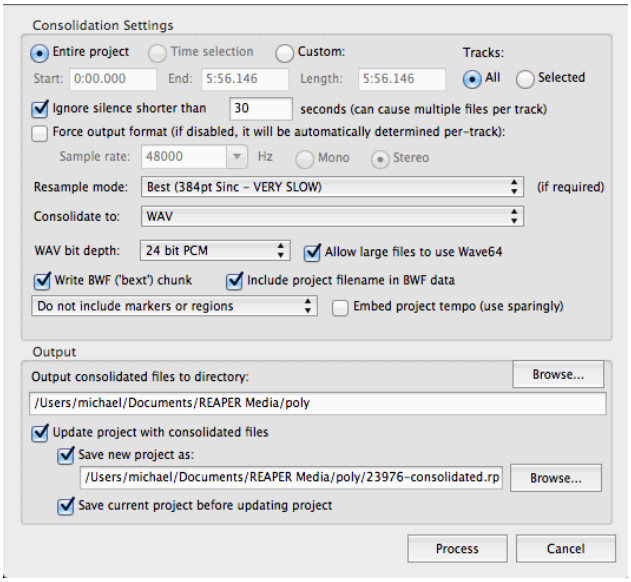
1. Export all audio tracks as "direct out" to maintain the same number of tracks, or if desired a stereo mixdown. That is up to the user and requirements of the program. Export as WAV from Media Composer. This will create a polyphonic WAV file with all tracks available.
2. Using the low cost audio application "Reaper" (http://www.reaper.fm/). Other audio applications may do the same thing, and the steps would be similar if so.
3. Import the WAV file into the project. It will look like a single element in the timeline view:



4. Highlight the element and select "Item Properties" under the Item menu, or do an F2.
5. In the window, enter 1.042709376 into the "Playback rate:" section. This will speed up 23.976 sources to be in sync with 25fps playback. See the chart below for all values to enter when working between 23.976, 24, and 25 frame rates. Also make sure that "Preserve pitch when changing rate" is active (on by default):



6. Click Apply. The next step is to select “Consolidate/Export” from the File Menu and select destination as well as ensuring you have the “resample mode” set to “Best (384pt Sinc – VERY SLOW) in order to create the best quality:



7. Import resulting WAV file into 1080p/25 project. It is suggested that you have a 2-pop or similar sync reference at head and tail of sequence to ensure proper alignment once imported to the sequence. The process has been tested with a 2-hour sequence and sync was only ¼ frame out at the end.
8. As a suggested tip, to compensate for Media Composer’s aligning WAV files to frame boundaries upon import, a user may see that the sync reference at the head of the clip is no longer perfectly aligned to the frame boundary after the export, time shift and import back into a different project. When working in 23.976p, 24p, and 25p project types, you can always set the project to be a 35mm film project will allows the audio to be slipped by ¼ frame increments. This can be used to better align the first sync of reference. See Avid documentation on Slip Sync.

The following table shows the values needed to enter into the “Playback rate” section of the Item Properties in Reaper (or other similar program).

FROM	TO:	23.976	24.000	25.000
23.976		1 (n/a)	1.001001001	1.042709376
24.000		0.999	1 (n/a)	1.041666667
25.000		0.95904	.96	1 (n/a)

An integrated solution would certainly be preferable over the several steps required in this step by step process outlined here, but in the interim, this does provide the required steps to deliver file based programs at different rates while maintaining original pitch and use third party I/O for the tape-based requirements if they are still being requested.