Editing MPEG —
The Myths and the Truths
Tektronix Profile PDR300 and Editware VPE Editing Controller with Super Edit

A Video and Networking Division White Paper

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The Myth

How many times have you read that MPEG is good as a distribution format but you can't edit it, or it's difficult to edit, or you have to encode with only I-frames to edit.
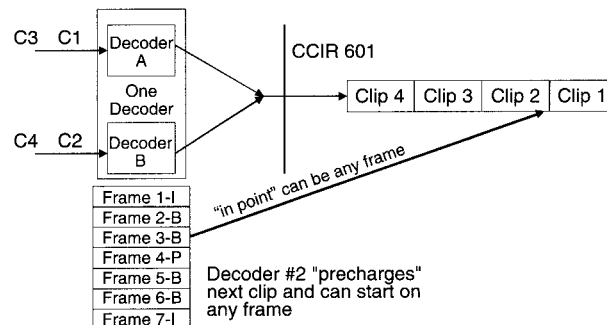
The Truth

With the right products, MPEG is just as editable as M-JPEG or DVCPRO, as can be seen with the Profile PDR300 or PRO series and Editware's VPE or DPE Edit controllers. Editware also edits with M-JPEG on the PDR200 and DVCPRO on the PDR400 so they have the experience to compare the three compression formats from an editing standpoint.

The "Problem" with MPEG

The issue with MPEG that everyone talks about is its use of temporal compression. That is using information from a group of frames/pictures (GOP) to compress each frame. Since there is a tremendous amount of redundancy from video frame to video frame, by only compressing blocks of data once and describing how that block of data moves from frame to frame (motion vectors) MPEG offers a very high level of compression while maintain high video quality. For a detailed description of how MPEG compression works, see Tektronix White Paper #2AW-at **http://www.tek.com/VND/PDFs/whitepapers/videostorage-generic/MPEG2.PDF**.

MPEG encodes frames three different ways.

- I frames - all information is included to reconstruct that frame

- P frames - frames which use motion estimation from a previous frame and contains about _ the information of an I frame.

- B frames - frames which use motion estimation from surrounding I frames and P frames and contain about _ the information of an I frame

If you encode material as I frame only, then you have a frame based compression format similar to JPEG and DVCPRO but you do not get the advantages of temporal compression. But as the myth says, this format of MPEG is easy to edit because each frame has all the information it needs. But users choose MPEG for its compression efficiency — normally double that of JPEG or DVCPRO.

The Solution — Profile and Editware

The PDR300 MPEG compression system is designed to allow for seamless playback of clips encoded at different bit rates and GOP structures. The basic idea is each play channel uses two MPEG decoders, each with its own buffer. The Profile toggles between the two decoders as it plays out clips. In the example below, as clip 1 is playing out of decoder A, clip 2 is being decoded by decoder B. The switch between clips is done downstream of the decoder in the video domain. At that point, there is no such thing as a B or P frame, it's all video. For a detailed description of this technique, see Tektronix PDR300 data sheet #2AW-1064-03 at **http://www.tek.com/VND/prods/pdr300/pdr300.pdf.**

The diagram shows how Profile's dual decoder technology enables playing back MPEG clips seamlessly regardless of bit rate or GOP structure.

In

I B B P I B B P // I B B P I B B P   Clip#1 – Decoder A

Out

I B B P I B B P I B B // P I B B P   Clip#2 – Decoder B

In

Clip#3 – Decoder A

Out

I B B P I B B // B P I B B P

In

Out
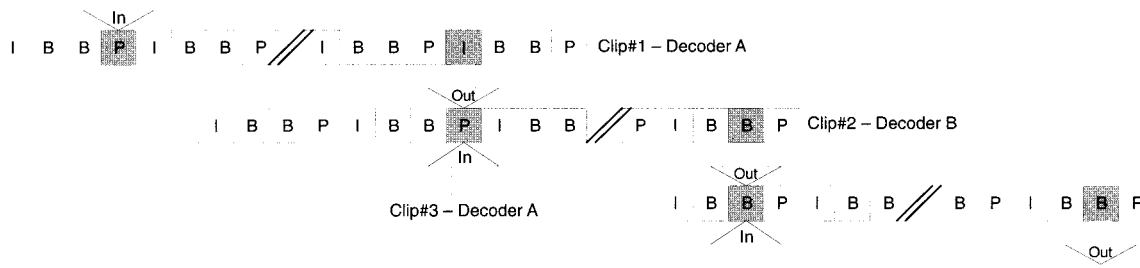
In the example above, the VPE editor is describing a series of edits
by identifying the in and out points of three different clips.

Editing with Editware

Editware's VPE and DPE editors take full advantage of the non-linear aspects of the Profile. When the editor is in "Super Edit NLE" mode, the "R-VTR" is really a Profile Timeline. NLE allows the user to list and select individual Profile clips and add material to the Timeline by moving pointers on the Profile in a non-linear way. When modifying the timeline by rearranging or resizing edits, or when inserting material from Profile clips, editing is non-linear. When recording material from tape, or through a video switcher, audio mixer or other effects device, material is encoded to MPEG-2 (digitized) and added directly to the Timeline in real time. Once material has been added to the Timeline, it can be manipulated in a non-linear way. Editing with Profile and NLE works equally well when using MPEG-2 or other formats, though there is a limit on the number of consecutive very short edits when using MPEG. The speed in which the alternate decoders can be loaded determines the length of the edits.

NLE editing creates a Profile Timeline or play list. When working with a JPEG or DVCPRO Timeline, the Timeline can be saved either as a simple movie (a new 'flat' clip) or as a complex movie (a list of clips). An MPEG Timeline is always saved as a complex movie. A complex movie can be moved over a fibre channel network and used by other applications similar to a simple clip, with one exception: When it is used as a source clip in an NLE edit, it is always played out and re-recorded as a new clip on the current timeline.

Example

In the above example, Clip #1 is loaded on the Profile timeline, fed into Decoder A and starts playout on the frame as specified by the in-point. While Clip #1 is playing, clip #2 is loaded into Decoder B and starts decoding up to the in-point #2. When Clip #1 hits the out-point frame, the Profile toggles decoders and starts playing at the in-point #2 on the very next frame — the switch is seamless. While Clip #2 is playing, clip #3 is loaded into decoder A and the sequence starts over.

The minimum clip length of a single edit is determined by how much time is to needed to access material from disk and play out through a decoder. The time needed is affected by a number of factors, including the GOP length, the length of the previous edit and overall load on the file system. Clip lengths can routinely be as short as 2 seconds or is some cases just a few frames.

MPEG-2 Editing

The following table shows the main elements of the Editware NLE application as they relate to MPEG-2 editing, and the Profile resources required for different editing capabilities. The flexibility of the application allows a single Profile Video Server to be used by more than one editor for NLE editing. Clips can be used for editing while they are still being recorded under control of another editor or application.

MPEG Resources vs. Features

These features are described fully in the section following this table.

Encoders	Decoders	Logger Mode	R-VTR = Timeline	Modify Timeline	Non linear insert from Profile Source	No. of Profile sources assigned (A-VTR, B-VTR)	Edit to Timeline from external sources or effects	Full view record, ("E-E")	Pre-Read capability	Swap
	1D	No	Yes	Yes	No	0	No	No	No	Yes
	2D	No	Yes	Yes	Yes	1	No	No	No	Yes
	3D	No	Yes	Yes	Yes	2	No	No	No	Yes
1E		Yes	No	No	No	0	Yes	No	No	No
1E	1D	Yes	Yes	Yes	No	0	Yes	Yes, ext sources only	Yes, ext sources only	Yes
1E,	2D	Yes	Yes	Yes	Yes	1	Yes	Yes	Yes	Yes
1E,	3D	Yes	Yes	Yes	Yes	2	Yes	Yes	Yes	Yes
2E		Yes	No	No	No	0	Yes	No	No	No
2E	1D	Yes	Yes	Yes	No	0	Yes	Yes, ext sources only	Yes, ext sources only	Yes
2E	2D	Yes	Yes	Yes	Yes	1	Yes	Yes	Yes	Yes
2E	3D	Yes	Yes	Yes	Yes	2	Yes	Yes	Yes	Yes

Description of Editware NLE Features

These items correspond to columns in the table above.

Logger Mode. The Super Edit Logger mode is used when a separate, batch digitizing step is appropriate. When in Logger Mode, digitizing is the only function being performed. Tape material is played and selected, then "auto-assembled". The Logger Mode auto-assemble function digitizes individual clips for each edit. Material can be logged from the editor itself, or an externally generated "logger" list can be used.

Timeline Represented by R-VTR. In NLE, the R-VTR key selects the Profile Timeline. The Edit Decision List (EDL) represents the Timeline — so playing the Timeline is, in effect playing back the EDL.

Modify Timeline: Once the material is on the Timeline, it can be manipulated in a non-linear way. Edits can be moved, copied, lengthened, shortened, deleted, etc, by commands which just move pointers on the Profile. Additional material can be inserted, deleted and moved anywhere on the timeline regardless of original edit boundaries.

Non linear insert from Profile Source. A cut to a Profile source is done instantly, as the Profile material is not copied, the Timeline is updated by moving pointers. A non-linear cut is performed just like a linear cut — only much faster!

Number of Profile sources assigned (as A-VTR, B-VTR). The NLE application allows flexible allocation of resources. Some applications may only require the Profile Timeline, others may work best with and additional 1 or 2 non-linear sources. Aspects of NLE are supported.

Edit to Timeline from external sources or effects. Source material from VTRs or from a switcher or other effects device is recorded in real time and placed on the Timeline. JPEG material can be recorded directly to an MPEG Timeline and vice versa. The same commands are used to do a linear edit as are used to do a non-linear edit. The integration of linear and non-linear mode is seamless.

Full view record, ("E-E"). This feature assigns a second playback resource (JPEG codec or MPEG decoder) to the "R-VTR" so that linear-type edits can be monitored in context. That means that as an edit is done, during the preroll the previously recorded material is seen, and a seamless switch to the new material being recorded is done at the IN point, then back to the previous material during the postroll.

Pre-Read Capability — The NLE pre-read function works like VTR pre-read, allowing use of the R-VTR as if it were a source. A transition to or from the R-VTR performs a perfect match to previously recorded material. There are some advantages of NLE pre-read over normal VTR pre-read: With NLE, the previously recorded material is never lost; pressing the UNDO key instantly reverts to the state of the timeline before the pre-read. Another advantage is that the "R-VTR" can be played back at programmed motion speeds!

Swap — A single keystroke switches the R-VTR (Timeline) with a selected VTR source, making the edited Timeline immediately available to use as a source, with an actual recorder as the R-VTR.