Native HDV Editing with Final Cut Pro 5

Frequently Asked Questions

What is HDV?

HDV is a compressed MPEG-2-based high-definition video format. Although HDV uses standard MiniDV tapes, HDV content is higher resolution and has more than four times the number of pixels. To fit the high-definition video on a MiniDV tape, the HDV codec uses a complex compression scheme called "long GOP MPEG-2."

What is native editing?

The term "native editing" means that video is transferred directly into Final Cut Pro from the source without any changes. There is no loss of quality and the video is edited in the same camera-original format that was shot and stored on tape. Now including HDV, Final Cut Pro 5 also supports many formats natively: DV, DVCPRO, DVCAM, DVCPRO 50, IMX, and DVCPRO HD.

What is the difference between native and non-native editing?

Non-native editing means that the incoming video signal is converted, or transcoded, into another format during the capture process. Each conversion from and back to the tape can create quality degradation. Editing HDV in its native MPEG-2 format allows for the highest quality possible.

Why edit HDV natively?

Professional customers demand the highest image quality when editing their video. Native editing preserves the quality of the camera-original video by using a no-loss capture workflow.

Non-native applications such as iMovie HD, Final Cut Express HD, and Adobe Premiere Pro all use an intermediate codec. The video is converted, or transcoded, during capture to a different format. This process introduces a generation of image degradation that might be unacceptable to professional customers. On some systems this process can be much slower than real time (meaning you have to wait for the video to be converted before you can start editing).

What are the benefits of native HDV editing?

Native HDV editing offers these benefits:

1. Preservation of the camera-original quality of the source video (no generation loss on capture).
2. Real-time capture (no waiting for transcoding, as on some non-native systems).
3. Smaller files (non-native files are often four times larger).
4. Zero encoding loss when going back to tape for frames not modified in the editing process.
5. Higher-quality output than competitors when going back to tape for frames that have been modified by the editing process.

Are we really editing native HDV?

Adding native HDV editing capabilities to Final Cut Pro was a typical project for Apple: Take something insanely difficult and make it stunningly simple. To Final Cut Pro users, editing HDV is just as easy as editing regular DV.

Editing native HDV (long GOP MPEG-2) poses significant challenges for any software vendor. MPEG-2 was not designed as an "editable" format, and most nonlinear editing applications are not able to work with HDV in the native format. In fact, some of our competitors doubt that we are actually editing native HDV!

It's easy to see that we're editing HDV natively in Final Cut Pro 5. Select any captured HDV clip and view the data rate and codec through the Item Properties command.

Adding support for native HDV editing in Final Cut Pro required work from many different teams at Apple—everybody from our advanced codec engineering group to the QuickTime team, and of course, the Final Cut engineering teams worked on various components to bring this solution to market.

Unlike other native MPEG-2 editing solutions, Final Cut Pro 5 lets you make cuts and edits on any frame—other systems sometimes limit you to cutting on Groups of Pictures (GOPs) boundaries.

How is long GOP MPEG-2 HDV different than regular video codecs?

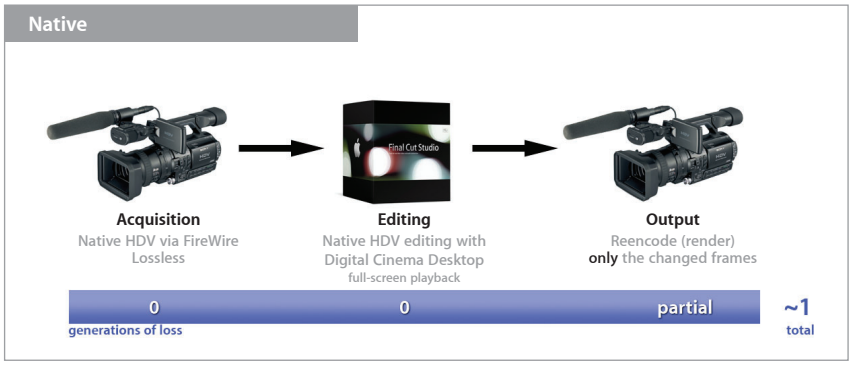
Most codecs, like DV for example, compress the contents of individual frames. Each frame is a single compressed picture called an "I-frame." I-frame codecs work well for editing software like Final Cut Pro because you can park at, cut on, and view any frame.

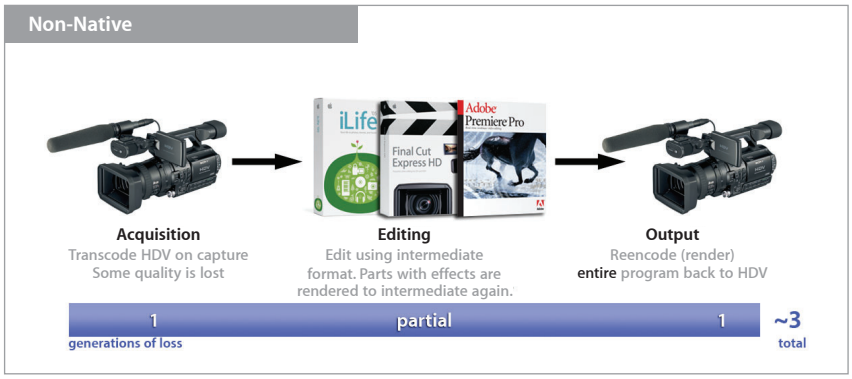
High-definition video encoded using an I-frame codec would be too large to store on the MiniDV tapes that HDV uses.

Long GOP MPEG-2 achieves smaller file sizes by creating GOPs that include different types of frames that rely on each other to complete the image. For example, a Sony HDV 1080i camera uses GOPs that are 15 frames long. The first frame of a GOP contains the only I-frame (complete picture). The rest of the GOP is made up of bidirectional (B) and predictive (P) frames. To see a B or P frame, the system must construct the image by reading multiple frames, starting with the first frame of the GOP.

This process allows for great encoding efficiency and very small files (about 3.5 MBps, the same as regular DV). It also means that working with HDV in its native long GOP MPEG-2 format is difficult; each frame of video the user sees has to be constructed by reading numerous other frames in the GOP.

How are native and non-native workflows different?





Is it true that HDV render times are longer?

The long GOP MPEG-2 encoding used for HDV is computationally intensive and does take longer to process than I-frame-only codecs. Many people are comparing the render times with DV, which is a standard-definition format. This comparison is not fair since HDV contains more than four times the number of pixels than DV. It is more appropriate to compare HDV render times with other compressed high-definition formats, such as DVCPRO HD.

The native workflow used in Final Cut Studio reencodes (renders) only the frames that have been changed by the editing process. The rest of the frames are sent back to tape as is, with zero loss. Non-native solutions must reencode the entire timeline when outputting to tape, meaning they have to render significantly more material than you would if you were using Final Cut Pro 5.

How does the quality of a native HDV workflow compare with the competition?

Apple performed a series of internal tests against the leading Windows-based NLE, Adobe Premiere Pro. A round-trip from camera to hard disk and back is one cycle. We measured PSNR for five cycles; PSNR is a measurement that tells us how much the image has changed. Higher numbers are better.

The numbers below are from tests using the same HDV source content. Different content will yield slightly different numbers. The trends highlighted by the results below will be consistent across the board.

	Final Cut Pro 5 (Native HDV)	**iMovie HD/FCE HD** (Apple intermediate codec)	**Adobe Premiere Pro** (CineForm intermediate codec)
1	∞	44.9dB	37.6dB
2	∞	44.3dB	36.9dB
3	∞	44.0dB	36.4dB
4	∞	43.8dB	36.0dB
5	∞	43.6dB	35.7dB

The first table compares the native HDV workflow of Final Cut Pro 5 with both iMovie HD/Final Cut Express HD and the Adobe Premiere Pro intermediate workflow. iMovie HD and Final Cut Express HD both use Apple's own intermediate codec. Adobe Premiere Pro uses the CineForm intermediate codec. If there are no edits (that is a clip comes in and goes out in its entirety), then no reencoding is necessary. The Final Cut Pro reencoding error is zero pixel levels (or infinite PSNR).

	Final Cut Pro 5 (forced native HDV reencode)	**iMovie HD/FCE HD** (Apple intermediate codec)	**Adobe Premiere Pro** (CineForm intermediate codec)
1	45.4dB	44.9dB	37.6dB
2	44.9dB	44.3dB	36.9dB
3	44.4dB	44.0dB	36.4dB
4	44.1dB	43.8dB	36.0dB
5	43.9dB	43.6dB	35.7dB

The second table shows the native HDV workflow of Final Cut Pro 5 with a forced reencode of HDV compared with the other workflows. Even in this case, when we force Final Cut Pro 5 to reencode the HDV video, the results are clear: After five cycles, Final Cut Pro 5 shows 43.9dB, an average of 1.6 pixel value errors from the original, whereas Adobe Premiere Pro shows 35.7dB, with an average of 4.2 pixel value errors from the original.

How does HDV hold up for visual effects work?

The HDV format is a 4:2:0 codec. This number is a reference to the sampling rate of the luminance (Y) component and two color components (B-Y), (R-Y). In HDV, the vertical and horizontal color resolutions are only half that of the luminance resolution. Professional production studios have standardized on 4:2:2.

HDV holds up considerably well for visual effects work, despite its reduced color space. Final Cut Pro 5 delivers exceptional image quality by compositing and applying effects in uncompressed 4:4:4 color before reencoding the final images back to the sequence's format (HDV, in this case). For output back to HDV tape or HD-DVD, this process preserves the maximum possible quality.

Customers who need higher-quality mastering have the option of transoding HDV into a professional 4:2:2 format, such as DVCPRO HD or even fully uncompressed 10-bit HD. Final Cut Pro 5 configurations that support additional high-definition workflows are available from Apple resellers.