Final Cut Studio

Native Long-GOP Editing

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Introduction

- NLE traditionally based on “I-frame” formats
- 2004: Long-GOP HDV burst on the scene
- 2005: Native HDV editing in FCP v5
  - Intermediate-codec HDV editing in FCE & iMovie
- Let’s examine:
  - Can Native HDV = truly pro performance & results?
  - Pros/cons of Native vs Intermediate-codec HDV editing

First, some preliminaries...

Two Approaches to HDV Editing

- Edit with an "Intermediate" codec
  - Transcode to a (typically) I-frame format during capture
  - Use traditional I-frame-based editing techniques
  - Transcode back to long-GOP for output back to device
- Edit Natively*
  - Solve the hard problems of dealing directly with Long-GOP at every phase of the NLE process

*Some vendors use Native merely to mean "built-in" to their NLE, i.e., not supplied by a 3rd party

Native Editing

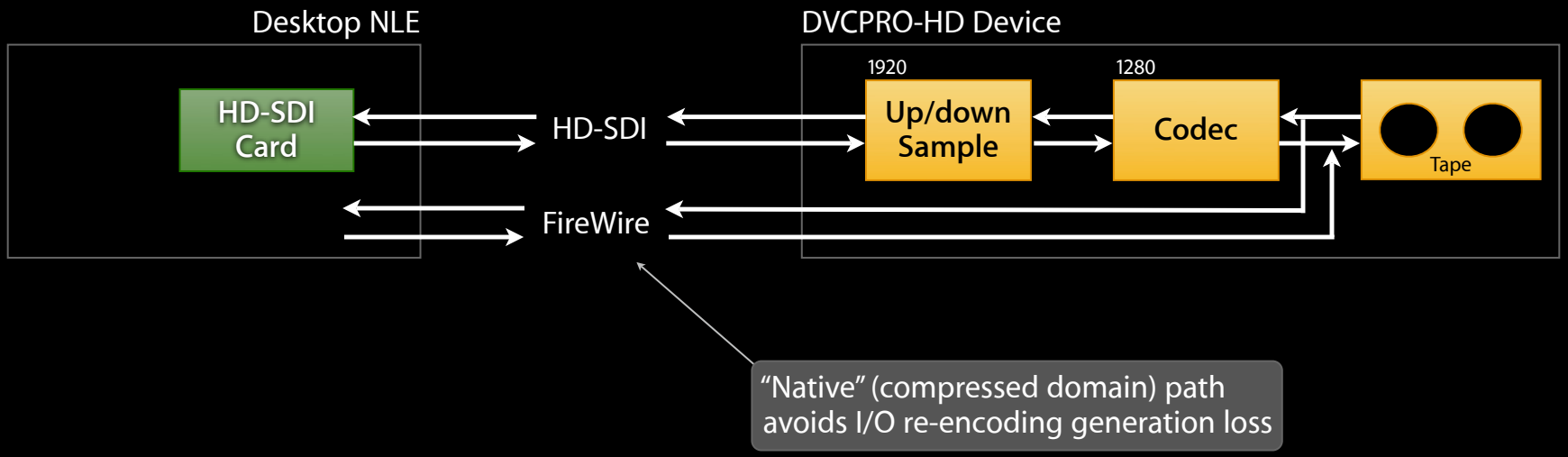
Shoot, edit, and output in the same format

Key Principles of Native Editing

- Preview op'ns (RT Playback, Scrub, etc) are decode-only
- Re-compress only frames modified by edits
- Re-compress matters only at final rendering time
- Optimize encoder to minimize re-compression degradation

Example of Native Device I/O

Baseband vs Device-native compressed



I-frame vs Long-GOP Data Rates

Table shown for 1080i60 format

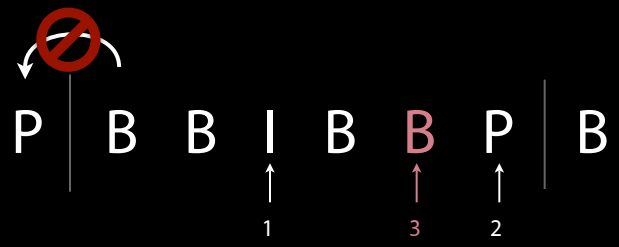
Codec	Bit rate (Mbit/s)	HDD Xfer (MByte/s)	Storage (GByte/hr)
DVCPRO-HD (for reference)	100	12	45
HDV Long-GOP	25	3	11
AIC (transcode of HDV Long-GOP)	~110*	~13*	~50*

*Apple Intermediate Codec (AIC) uses VBR encoding

HDV rates attractive for laptops & low-cost hard drives

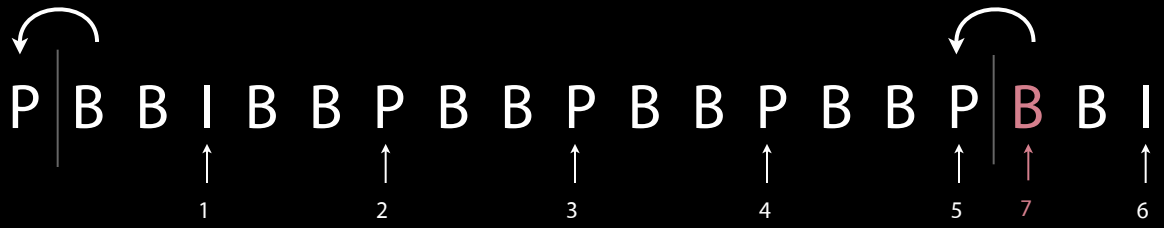
HDV MPEG-2 GOPs

GOP = Group of Pictures



JVC 720p30
6-frame Closed GOP

Worst-case random access: 3 frames to decode



Sony 1080i60
15-frame Open GOP

Worst-case random access: 7 frames to decode

Next, consider basic NLE operations, comparing I-frame to Long-GOP...

Basic NLE Operations

1. Video input (capture, import)
2. Video editing
   - RT playback with FX
   - Scrubbing
   - Jog/shuttle (JKL)
3. Video output (PTV, export)

All operations complicated by long-GOP formats

Video Input

I-frame: capture at any in/out frames

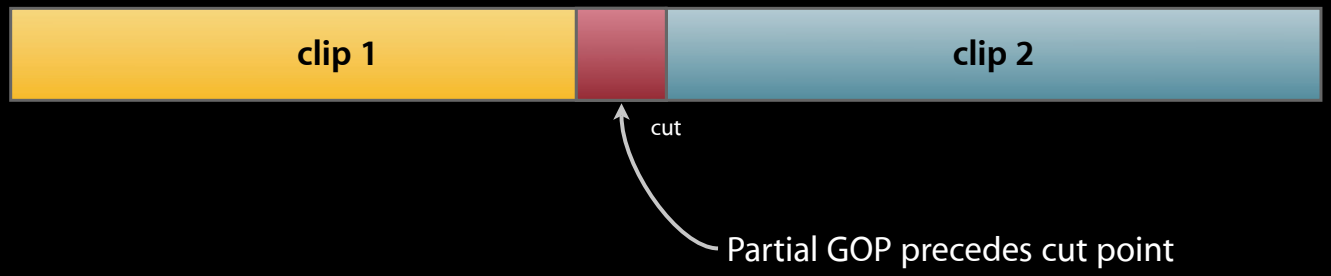
Long-GOP: extend capture to GOP boundaries

User perceives only in/out points — QuickTime does the bookkeeping

Editing: RT Playback

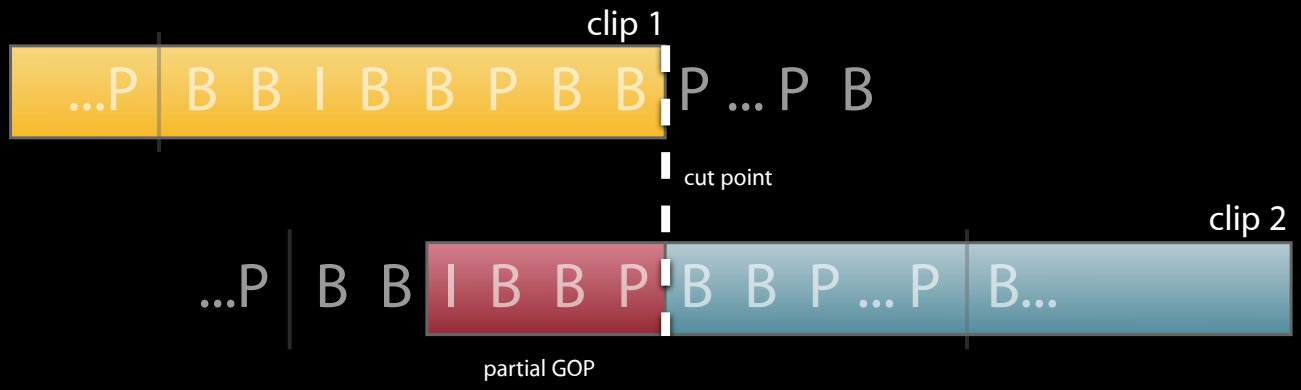
I-frame— simple seamless playback

Long-GOP— cuts will not always be on GOP boundaries



Long-GOP RT Playback

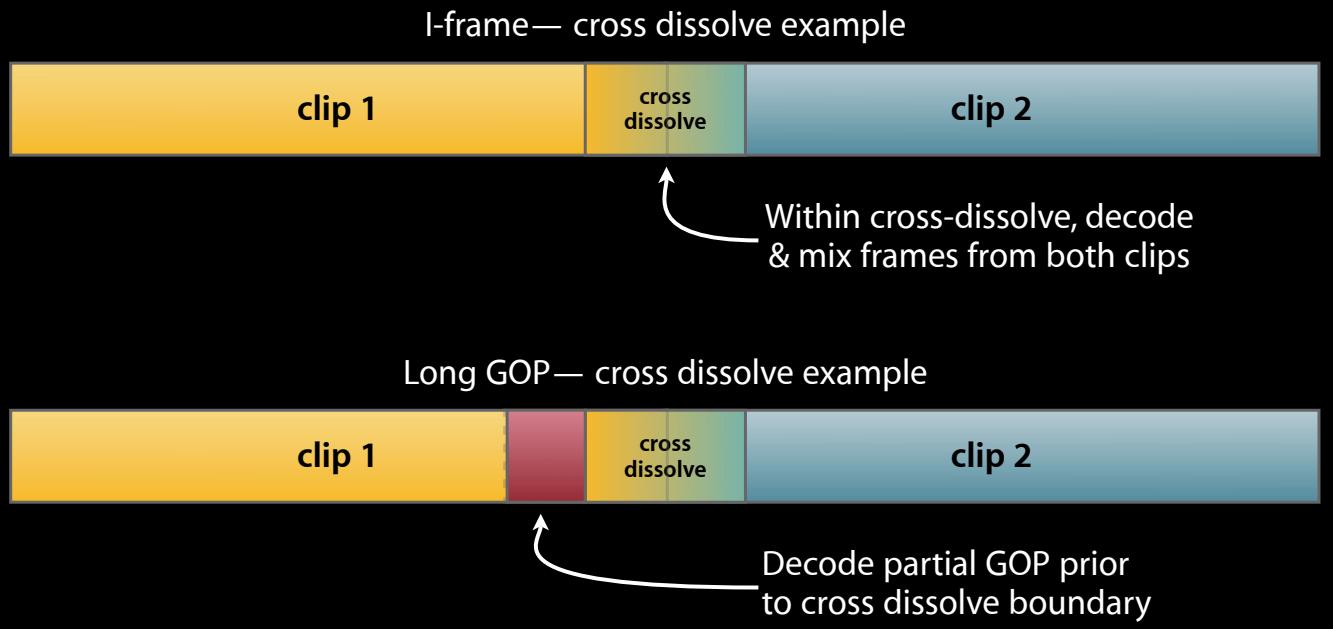
Detailed look at previous slide



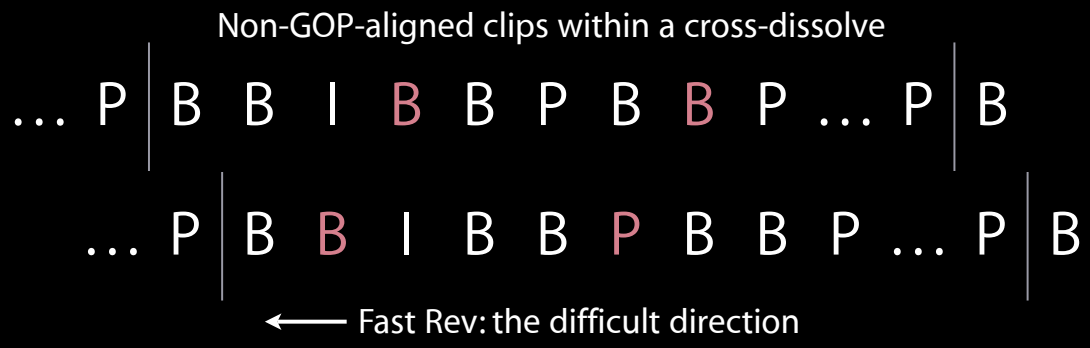
Seamless RT playback achieved as follows:

- Extra frames to be decoded prior to Clip 2 cut point
- Trick: schedule decoding in advance, as with transitions

Editing: RT Playback with FX

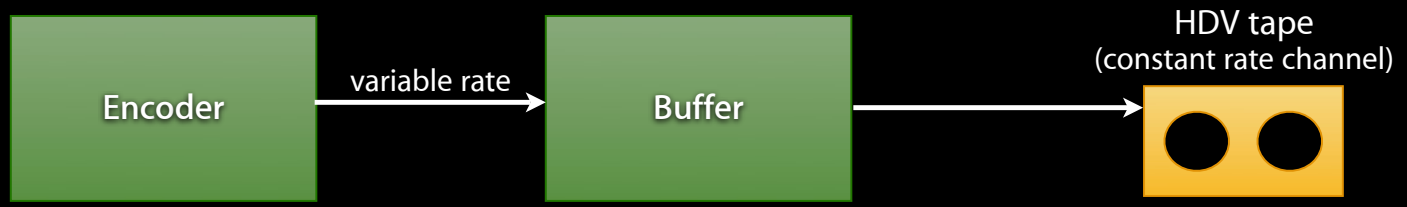


Long-GOP Scrubbing & Jog/Shuttle



- Speed playback through an effect, fwd or rev
- Decode, mix, & display every Nth (red) frame
- Secret: buffer recent frames in both directions
- FCP responsiveness is remarkably fluid

Video Output to HDV Tape

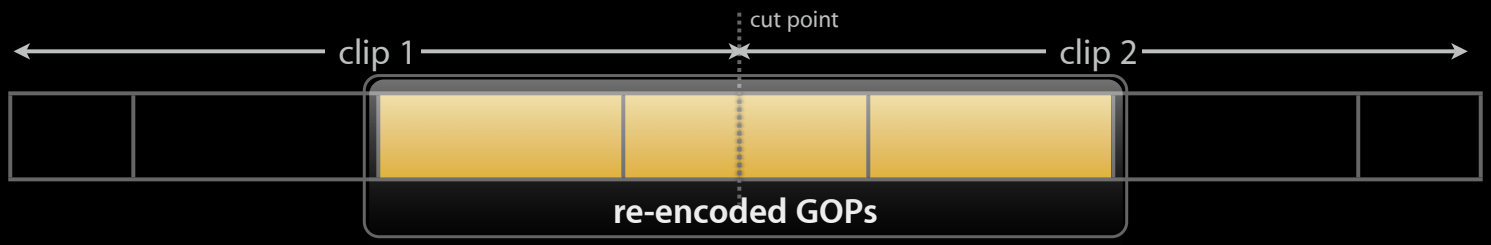


- HDV tape imposes strict CBR requirement
- If using intermediate codec, entire timeline must be re-encoded to long-GOP CBR, in order to output to HDV tape

Video Output to HDV Tape

Long-GOP Case: Conformant Re-encoding

- As with Native I-frame editing, (most) unmodified frames do not get re-encoded
- But neighborhood around cuts must be re-encoded to properly formed GOPs
- CBR buffer fullness must be continuous at boundaries

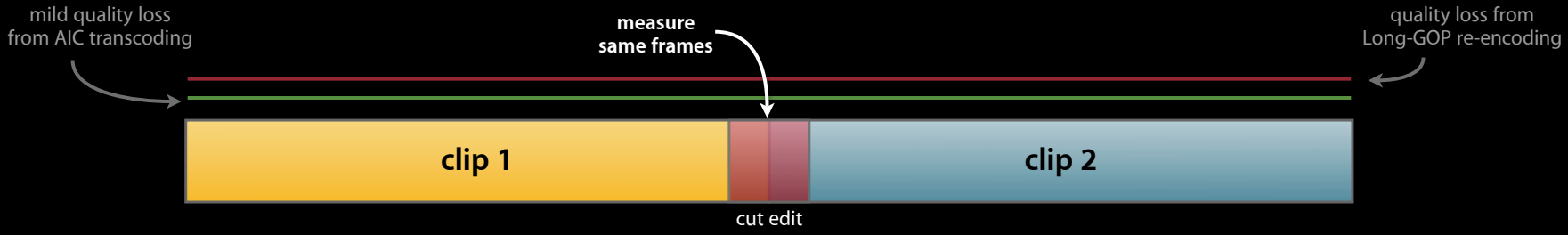


AIC vs. Native HDV Quality

Measurement of video-out to HDV tape

For long-GOP Native timeline, measure average PSNR of
re-encoded frames around cut

For AIC timeline, measure average PSNR compounded from
(a) AIC transcode at capture time, and
(b) Long-GOP re-encode of entire timeline at video-out time



AIC vs. Native HDV Quality

Measurement of video-out to HDV tape

Timeline Codec	Capture PSNR	+ Long-GOP re-encode for output	Frames with zero quality loss
AIC	43.10 dB (1.8 levels avg)	35.6 dB (4.2 levels avg)	None
Native Long-GOP	No transcode Infinite dB (0 levels)	36.1 dB (4.0 levels avg)	Unedited frames: Infinite dB (0 levels)

Measurements taken from unusually challenging material

Native HDV beats AIC on quality

- Slightly around edit boundaries
- Substantially, for unmodified footage

Performance Comparison

1080i60 — PowerMac G5 Quad 2.5GHz

Codec	High-Quality Decode (simultaneous streams)	Medium-Quality Decode (simultaneous streams)	High-Quality Encode (frames per second)
DVCPRO HD*	4.8	6.6	~130
AIC*	4.3	9.0	~170
Native HDV	4.9	6.5	~20

** DVCPRO HD & AIC require RAID for multistream playback*

Native HDV performance ≈ DVCPRO HD

- AIC at Medium quality is slightly better
- DVCPRO HD & AIC require RAID for multi-stream playback
- HDV encoding slow, but Native only re-encodes the changes

Conclusions

- Native HDV Long-GOP NLE highly effective
  - RT performance competitive with I-frame
  - Scrubbing/JKL performance is highly responsive
  - Output-to-tape quality better than intermediate
- Principles and methods should be extended to future formats, like H.264