White Paper on Performance Characteristics of MPEG-2 Long GoP vs AVC-I video compression techniques for Broadcast Applications

Introduction

The Broadcast and Program Production industries are experiencing a rapid transition to full use of High Definition in all of their content creation and processing operations.

The core technology of 'Video Compression' – which propelled the introduction of higher levels of picture quality in Standard Definition television, as well as the development of more efficient, file-based, signal workflows – is once again a key technological factor behind the performance levels that can be achieved by the newer High Definition production and storage systems.

During the last few years the industry has seen a wide adoption of HD technologies in all aspects of acquisition, storage, processing, and long term archiving of content for mainstream broadcasting, sports and high-end cinema applications. Moreover, the transition to HD in all ENG and News operations is now fully underway by the adoption of efficient, file-based compressed A/V systems, at levels of picture quality and reduced data rates satisfying the stringent requirements of the News production environment.

After years of detailed analysis of all the technical and workflow requirements facing the broadcast news environment, the Sony Broadcast & Production Systems company selected the video compression scheme of MPEG-2 Long GoP - at up to 50 Mbps with full 4:2:2 high definition signals, - as the most matured and balanced video compression scheme for such applications.

Without any doubts the technologies of audio and video compression have advanced since the early days of standardization by the international MPEG committee, which gave rise to the widely used MPEG-2 A/V data reduction standards.

Newer standards have been established as evolution of older ones – not as radical new schemes. Numerous small improvements in the various data reduction techniques have been added to the compression tools of MPEG-2 which, when fully implemented, can give rise to significant efficiencies in coding rates, especially at low data rates. A recent new comer in this area of video compression is the so called MPEG-4 Part 10, also known as H.264, or Advanced Video Coding (AVC). While matured implementations of this compression scheme are not yet available (in terms of single IC implementation of all the high-end tools, low power consumption levels, high processing speeds, etc), it is certain that the continuing advances in IC manufacturing and computational processing will enable, in the near future, full use of all the complex mathematical techniques embodied in this new video compression standard.

This document will present some of the technical perspectives examined by the Sony Broadcast & Professional company in the area of video compression technologies, as the broadcast industry embraces the use of high quality, matured MPEG-2 schemes for today's state-of-the-art, tapeless broadcast products and systems, and prepares for a rational transition to newer techniques for future HD formats and applications.

Today's High Definition ENG and Broadcast Production Environments

The basic premise of the News Production environment has always been one of speed and workflow efficiencies: from the moment of acquiring the images in the field, to possible field editing, digital microwave transmission to the production centers, to the processing of the received file-based content in the news broadcast environment, and final long-term archiving and asset management.

It has been the trend of the broadcast industry to adopt as many tools as possible from the IT industry in order to use its economies of scale and to enable new signal workflow efficiencies, defined by file-based multi-media applications. This new networked environment of the broadcast news facilities, require the use of manageable file-sizes, for material transported across multiple workstations and for storage efficiencies in editing, production and archiving operations.

Sony B&P group after examining the numerous requirements of the news production environment, and the implementation realities of existing and near-term compression technologies, selected the use of MPEG-2 Long GoP (Group of Pictures), at up to 50 Mbps for the compression of full 1920x1080 HD signals at the 422 chroma structure (see **figure 1** below).

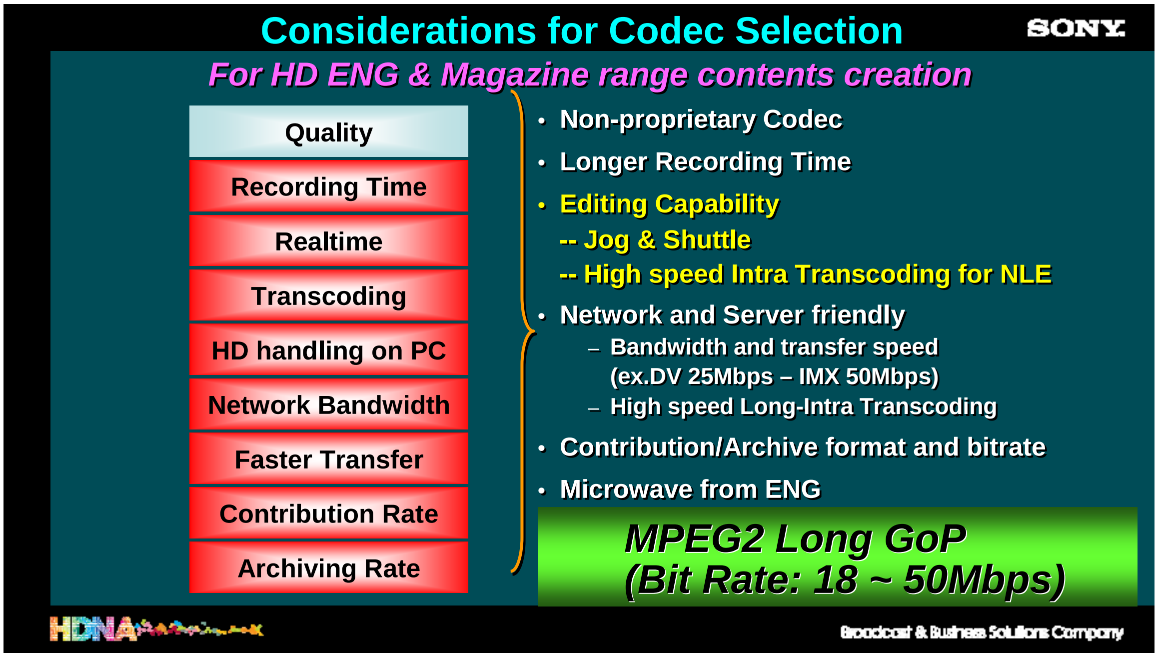

Figure 1: Technical considerations for selection of coding technology for Broadcast News operations

The MPEG-2 Long GoP video compression scheme has been tested by independent organizations under difficult content material and multi-generation operations with excellent results. It most be said that not only is the MPEG-2 algorithm matured in its compression performance and IC implementation (enabling full HD encoder/decoders in single IC devices with minimum power consumption – which is absolutely necessary in a camcorder environment), but also the compression expertise shown by Sony researchers has allowed its use with unique pre- and post coding techniques to guarantee the highest level of performance even in difficult, mainstream broadcast applications.

A relatively new comer in the family of MPEG compression systems (2003-2004) is the MPEG-4 part 10, also known as Advanced Video Coding (or H.264 in the telecommunication industry). This algorithm is a high performance evolution of the original MPEG-2 scheme, with numerous improvements and some new compression 'tricks' to advance compression efficiencies and picture quality for signals and data rates not considered by the original MPEG-2 system.

The MPEG-4/AVC compression scheme achieves most of its bit-rate reduction capabilities by powerfully exploiting temporal (or across frames) redundancies, as well as by the introduction of some effective intra-picture techniques (as compared to MPEG-2). In other words, while there is a good number of innovations in the MPEG-4/AVC algorithm that contribute to its overall higher coding gains, the most effective ones are related to the use Long GoP techniques (or multi-picture processing).

When AVC Long GoP is compared to MPEG-2 Long GoP the commonly found claim is that: 'AVC has double the compression efficiency of MPEG-2'. While this performance advantage is indeed demonstrable at lower bit rates (say below 4-5 Mbps for SD signals) the performance improvements are less pronounced as the available data rates become higher.

Sony's internal evaluation of AVC Long GoP for high-quality full HD signals at 50 Mbps, when compared to the MPEG-2 Long GoP 422 also at 50 Mbps show some interesting results. For most of high-quality HD content - of diverse compression complexity -, the differences in picture quality and levels of compression artifacts are minimal or very difficult to discern between the two compression schemes, (even when these picture quality observations were carried out at very close viewing distance to the evaluation picture monitors).

These surprising results can be explained by the following rationale: while an objective calculation of S/N ratios of the compressed MPEG-2 and AVC Long GoP streams indeed prove the superiority of the AVC Long GoP scheme, in practical terms, it is just about impossible to differentiate between the levels of picture quality of the two compressed schemes, since above approximately 45dB of SNR all compressed material appear pretty much the same.

The consequence of this analysis is that:

'The picture quality level obtained with MPEG-2 Long GoP 422 compression of full 1080 50/60i, 422 signals at 50 Mbps is very high and perfectly suitable for all mainstream broadcast production. There would be not real advantages in terms of achieving higher levels of picture quality if we were to employ AVC Long GoP at 50 Mbps under the same coding conditions'.

On the other hand, it could be argued, that the higher efficiency tools of AVC Long GoP could be use to produce an equivalent quality to MPEG-2 Long GoP, at a lower bit rate. This case has also being evaluated at Sony R&D labs. The result is that an equivalent picture quality to an MPEG-2 Long GoP compression of full 108050i/60i 422 signals at 50 Mbps could be matched by an AVC Long GoP scheme operating at rates between 32-36 Mbps (depending on the complexity of picture content).

When considering the realities of the professional broadcast manufacturing world, does it make sense to adopt a totally immature, albeit, newer compression technology, for a modest reduction in compressed data rate (50 vs 35 Mbps)? Furthermore, the new AVC Long GoP is highly complex in its numerical calculation and has only been executed, at its fullest capability, in software simulations and not yet in full single IC implementation.

Furthermore, in the world of Non-Linear Editors and authoring systems, the use of AVC-Long GoP - in its various forms such as AVCHD or more professional versions - require the use of multi-core computational engines (6 to 8 cores is typical). This is, again, due to the high complexity of the algorithm along with the requirement to achieve close to real-time operations.

The maturity of the MPEG-2 Long GoP scheme, on the other hand, has enabled all NLE systems to be able to handle the compressed streams in their native format and in real-time or even faster than real-time, with modest demands on CPU processing power (details presented in a following section).

Based on the aforementioned facts, Sony B&P group decided to stay with the MPEG-2 Long GoP at its highest quality levels of implementation for HD broadcast production applications employing 1920x1080 50i/60i/24p/25p as well as 720 50p/60p.

What About AVC Intra-Frame Techniques?

There have been announcements and product offerings around the use of AVC-Intra-frame only techniques. This compression scheme is just a very limited subset of the entire portfolio of compression ‘tricks’ offered by the MPEG-4 part 10 full standard

It is a fact that the highest compression gains offered by AVC reside in the use of the Long GoP techniques. The use of Intra-only compression strategies is sufficient only for small values of compression ratios – while maintaining acceptable levels of picture quality and multi-generation robustness. Attempting to compress beyond those limits will simply exposed the AVC-Intra algorithm to conditions which the data reduction techniques cannot cope with, unless exhibiting noticeable compression artifacts.

Testing of equipment using AVC Intra-compression at 100 Mbps shows acceptable levels of picture quality with not difficult to compress video material. With complex material, compression artifacts vary from minor level of artifact visibility to high level of visibility. These artifacts become even more pronounced when the compressed material is subjected to multi-generation cycles of compression-decompression. These results are to be expected since compression of 10-bit, 422, 1920x1080 material down to 100 Mbps forces the AVC-Intra algorithm to operate at compression ratios in the range of 12.4 :1 which is indeed a very high ratio when only considering the use of intra-frame techniques.

The announcement of an AVC-Intra compression scheme at 50 Mbps for 1440x1080 HD signals and with a 4:2:0 chroma-encoding level produces noticeable levels of compression artifacts for conventional program production material even in its first generation. The picture degradations, due to compression artifacts, become highly objectionable during multi-generation operations.

Practical experiences in comparing the picture quality performance of MPEG-2 Long GoP schemes used by Sony in its family of tapeless products against schemes employing AVC-I at 50 or 100 Mbps, support the following conclusions:

- The picture quality level of MPEG-2 Long GoP at 50 Mbps and AVC-I at 100 Mbps with 4:2:2 HD signals are comparable – when evaluated with a large class of program material. Both schemes, however, will exhibit noticeable levels of compression artifacts when exposed to very complex video material - with picture types and conditions being completely different between the codec systems.

- The picture quality performance of AVC-I at 50 Mbps with subsampled, 4:2:0 HD signals, will exhibit various levels of compression artifacts in all but the simplest types of program material (from a picture complexity viewpoint) even on first generations.

- The picture quality level of MPEG-2 Long GoP at 35 Mbps is at least comparable to the quality of older DV-based compression schemes operating at 100 Mbps.

- The use of current AVC schemes - such as AVCHD or AVC-I at its 50 and 100 Mbps implementations – present severe processing limitations in editing environments due to the high codec complexities. Only the use of multi-core CPU workstations with optimized decoding software or external hardware decoder cards can enable reductions in processing times approaching real-time benchmarks.

- The high degree of understanding and integration in the implementation of hardware and software systems based on MPEG-2 Long GoP has enabled very high levels of picture quality and processing speeds when handling HD material in Non-Linear editing and production environments.

Sony MPEG HD vs Panasonic AVC-Intra (AVC-I) Workflow Comparison

While most of the NLE venders have support for XDCAM MPEG-2 Long-GoP, support for P2 AVC-I editing is still at the pre-mature level and the level of support varies with the vendor. In this section a series of benchmark tests are discussed, using the latest version of Apple Final Cut Pro and Avid Media Composer software.

Several identical clips were captured in Sony MPEG HD 50Mbps and Panasonic AVC-I 100Mbps at 1920x1080 59.94i by shooting a subject using the Sony PDW-700 and the Panasonic HJ-HPX2000 camcorders respectively. The codec’s performance was compared by importing, editing, and exporting; using each manufactures comparable transfer devices.

Equipment

Avid Workstation

Computer:	HP xw8600 Workstation
	Intel Xeon X5460
	3.17 GHz, 4 GB of RAM
OS:	Windows XP Professional Service Pack 3
Video Card:	nVidia Quadro FX 3500
Avid:	Avid Media Composer v3.0.5

Final Cut Pro Workstation

Computer:	Apple MacBook Pro
	Intel Core 2 Duo
	2.33 GHz, 2GB of RAM
OS:	Mac OS X 10.4.11
Video Card:	ATI Radeon X1600
Apple:	Final Cut Pro 6.0.5

Camcorders
Sony XDCAM PDW-700 for MPEG HD Long GOP
Panasonic HPX-2000 for AVC-Intra

Ingest Devices
Sony PDW-U1 XDCAM drive (via USB)
Panasonic AJ-PCD P2 drive (via USB)

IMPORT

Apple Final Cut Pro

The import speed test was done using Sony's "XDCAM Transfer" for the MPEG HD codec and Apple's "Log and Transfer" tool for the AVC-I codec. As of today, Final Cut Pro's system does not have native support of AVC-I at 100Mbps, which forces the user to transcode to Apple's ProRes422 145Mbps or HQ 220Mbps codecs. Final Cut Pro, on the other hand, has native support for XDCAM format, so transcoding is not necessary. Table 1 shows the drastic differences in time on importing between the two codecs.

CLIP	DURATION	TOTAL DURATION	XDCAM IMPORT TIME	x TIMES REAL TIME	P2 IMPORT TIME	x TIMES REAL TIME	XDCAM vs. P2
1	0:10						
2	0:20						
3	0:10						
4	0:20	1:00	0:46	1.3	2:16	*0.44	33.82%
5	0:10						
6	0:10						
7	0:10						
8	0:30						
9	0:24						
10	0:16						
11	0:11						
12	0:09	2:00	1:26	1.4	4:27	*0.45	32.21%
13	0:20						
14	0:09						
15	1:21						
16	0:10						
17	0:33						
18	0:27	3:00	1:53	1.59	4:22	*0.69	43.13%
	TOTAL:	**6:00**	**4:05**	**1.47**	**11:05**	**0.54**	**36.4%**

Table 1: File Transfer Speed comparison between MPEG HD 50Mbps & AVCI 100Mbps in Apple Final Cut Pro. *When the number is less than 1.0 that means it's slower than real-time.

Eighteen identical clips were imported. It was considerably slower to import AVC-I clips compared to MPEG HD clips. In most instances, it took AVC-I almost 2 times real-time to complete the import, while MPEG HD was imported approximately 1.5 times faster than real time. ***On average, MPEG HD was 36% faster than AVC-I for file import times***. It was found that the transcode process, along with the large file sizes of the AVC-I format, significantly slows down the import. Simply stated, at half the bit-rate, Sony's XDCAM HD is still able to create high quality clips that prove to be more efficient in Final Cut Pro than Panasonic's AVC-I. ***With everything else being equal, larger file sizes will take longer to import.***

AVID Media Composer

Just like in Final Cut Pro, the ability to create high quality content at half the data rate, efficiently, and with the native support for XDCAM MPEG HD content, explains its superior performance over AVC-I when ingesting clips into Media Composer. From the AV clips tested ***, a 57% difference on average can be seen in performance with MPEG HD over AVC-I with the most processor-intensive sequences.***

CLIP	DURATION	TOTAL DURATION	XDCAM IMPORT TIME	x TIMES REAL TIME	P2 IMPORT TIME	x TIMES REAL TIME	XDCAM vs P2
1	0:09						
2	0:10						
3	0:10						
4	0:10						
5	0:10						
6	0:10	01:00	00:29	2.06	00:46	1.30	63.50%
1	0:15						
2	0:15						
3	0:15						
4	0:16						
5	0:17						
6	0:19						
7	0:20	02:00	00:48	2.46	01:27	1.37	55.80%
1	0:27						
2	0:26						
3	0:33						
4	0:40						
5	0:29						
6	0:29	03:00	01:06	2.73	02:06	1.42	52.26%
	Total:	**06:00**	**02:24**	**7.24**	**04:19**	**4.10**	**57.2%**

Table 2: File Transfer Speed comparison between MPEG HD 50Mbps & AVC-I 100Mbps in Avid Media Composer.

When importing content created in both codecs into Avid Media Composer, it simply becomes a numbers game. MPEG HD files are half the size of AVC-I files and this can be seen since ***the XDCAM content was on average 57% faster to import.***

Another testament to the processing requirements of AVC-I will become apparent during the edit process.

EDIT

AVID Media Composer

To test which codec is more suited for editing applications, a series of Avid sequences were created consisting of AVC-I 100Mbps as well as MPEG HD 50Mbps footage. The rendered footage was then monitored to tabulate the time necessary to export the sequence with a few edits as detailed below.

Table 3 shows the content of sequences that were created to compare the two codecs.

(a) 1 minute sequence	(b) 1 minute sequence
1 layer of video 4 clips 3 dissolves 1 color correction	2 layers of video w/picture in picture 4 clips 3 dissolves 1 color correction
(c) 3 minute sequence	**(d) 3 minute sequence**
1 layer of video w/picture in picture 8 clips 4 dissolves 3 cuts 2 color corrections	2 layers of video w/picture in picture 8 clips 4 dissolves 3 cuts 2 color corrections

Table 3: Sequence Specifications

NOTE: All clips have been ingested and are stored on an internal hard drive on the testing computer. This eliminates any variables with regards to transport interfaces and device drivers.

Figure 2 shows a magnified look at the timeline from the AVC-I 1-minute sequence. During the creation of both the 1-minute and 3-minute 2-layer video sequences, the Avid workstation had extreme difficulties processing the AVC-I content when the second video layer was created using a “picture in picture” effect on the timeline.

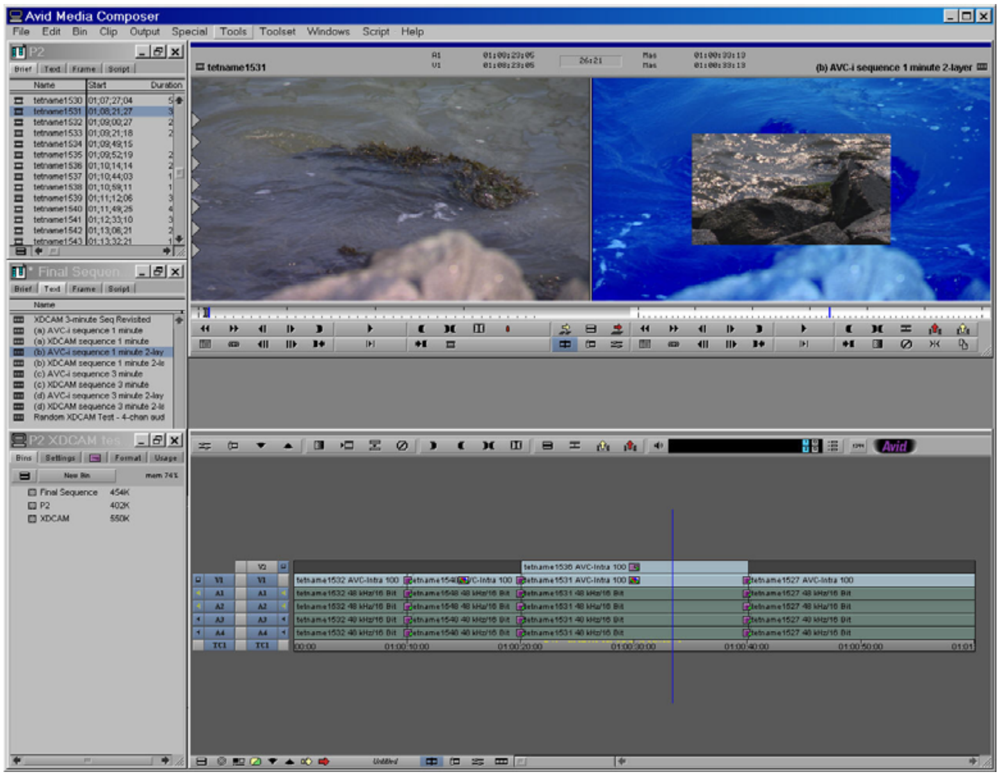

Figure 2: AVC-I 100Mbps 1-minute sequence

As seen in **Figure 2**, when the workstation reached its processing maximum, the frames were dropped, causing the video to freeze up when played back in real-time from the timeline.

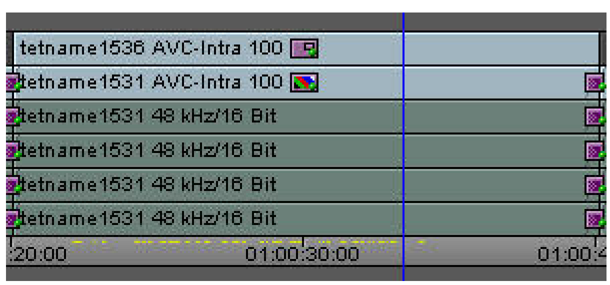

Figure 1: Dropped frames notification on timeline

Because the real-time preview depends on the CPU's ability to perform any variety of timeline operations, Avid offers feedback to help users achieve efficient preview. If the system begins to reach its maximum during preview and is in danger of dropping frames, a yellow line appears beneath the Sequence. If the system actually drops frames, a red or blue line tells the user that the problem is either the CPU or slow disk access. When the frames are dropped, the user will actually see the video freeze up and not play during a real-time playback of the timeline.

This result only occurred when trying to playback the sequences containing AVC-I content. **Figure 3** and **Figure 4** show the same specified sequence created using MPEG HD 50Mbps content and we noticed that at no time were frames dropped to process the content. We were able to play two streams of video with a color correction plus a picture-in-picture effect inserted onto a second video track, and play them in real time using only software. Please note that because of the efficiency of the XDCAM codec, we are also able to process 8 channels of audio as well as the full resolution video stream in Avid. This is compared to only the 4 channels of audio in AVC-I, which still caused Media Composer to drop frames. Even during playback of the AVC-I content, where there were no effects, we noticed that the video was being distorted in the preview window.

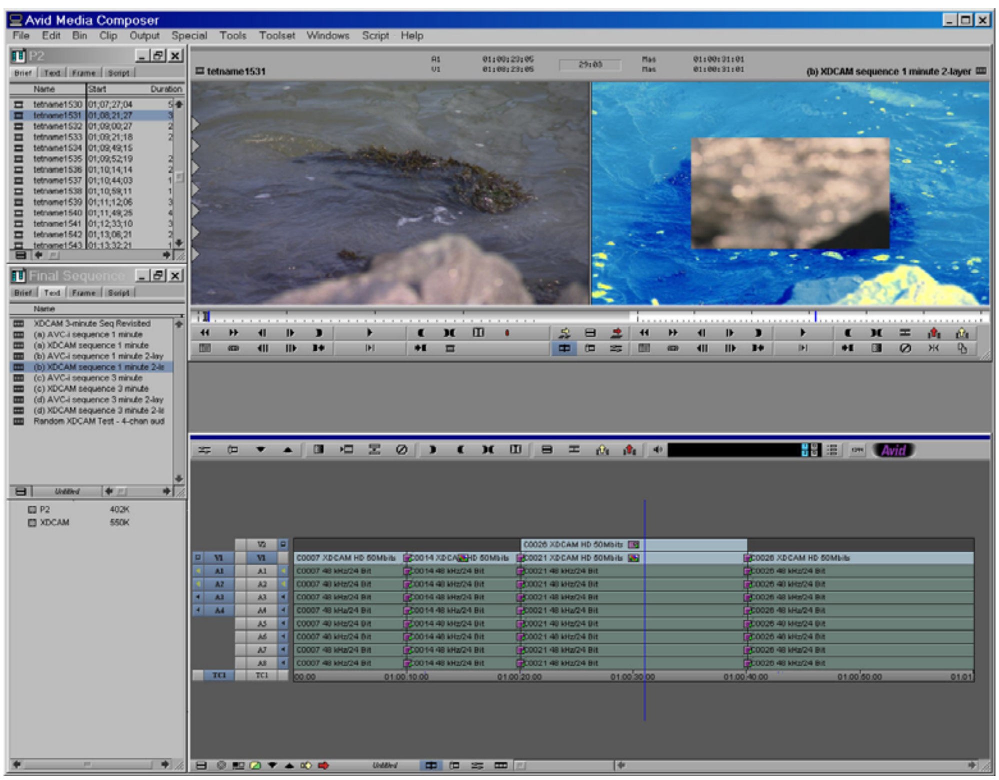

Figure 2: Avid XDCAM MPEG HD 50Mbps 1-minute 2-layer sequence

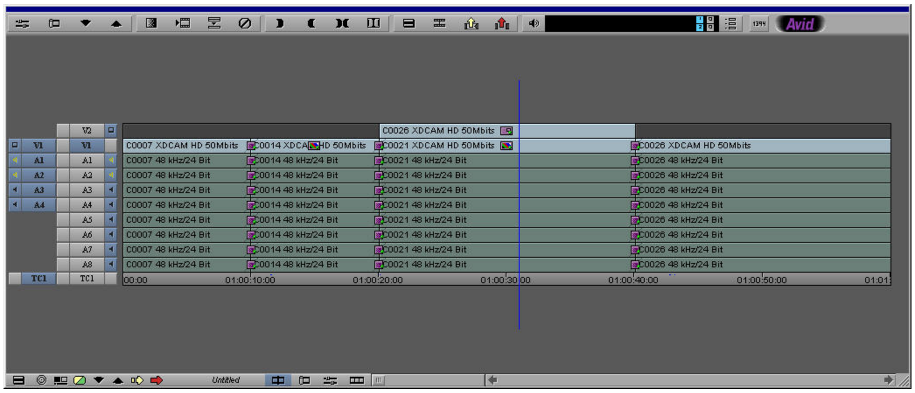

Figure 3: Avid XDCAM MPEG HD 50Mbps 1-minute 2-layer Timeline

Figure 5 and 6 show a magnified view of the AVC-I 3-minute sequence. During testing, Media Composer struggled with clips of extended durations exacerbated by the requirements of the AVC-I content. The following images depict how the machine's processing power is pushed to the limits risking the playback integrity of the video on the timeline.

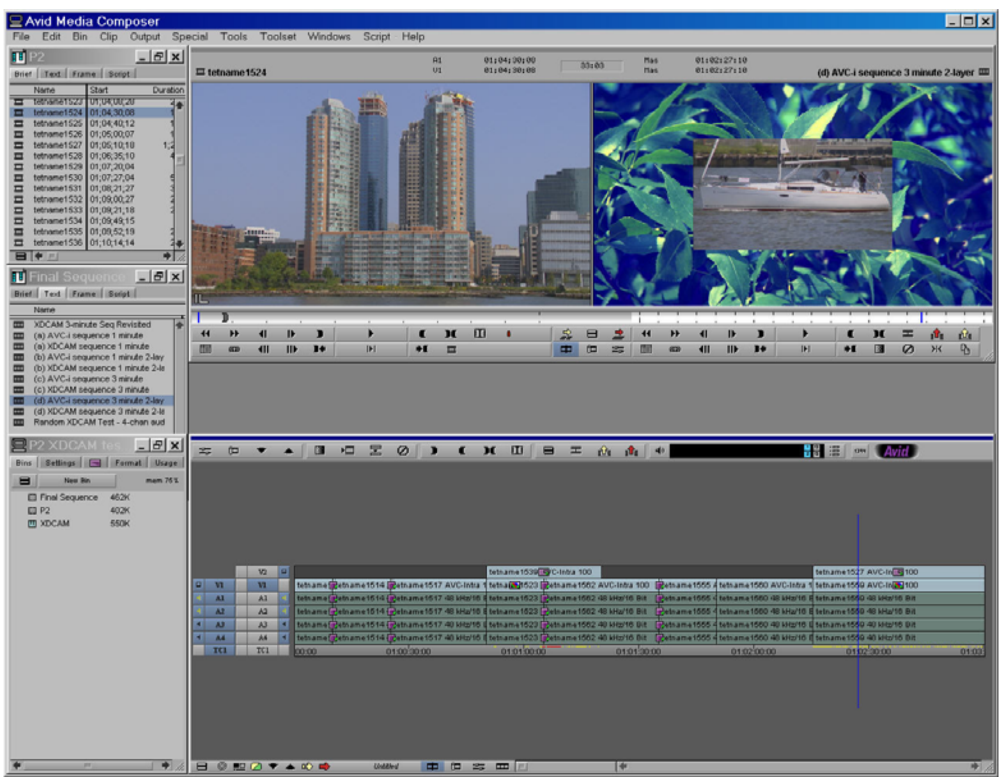

Figure 4: Avid AVC-I 100Mbps 2-layer 3-minute video sequence

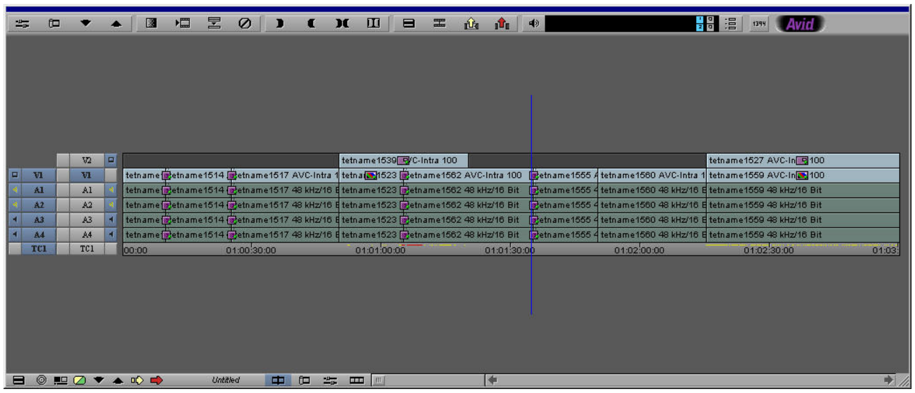

Figure 5: Avid AVC-I 3-min video sequence timeline

Figure 7 is a magnification of the segment containing both a color correction and a picture in picture effect. Here, Media Composer began to warn us that the processor was quickly approaching its limit and performance suffered showing video freezes and minor distortion.

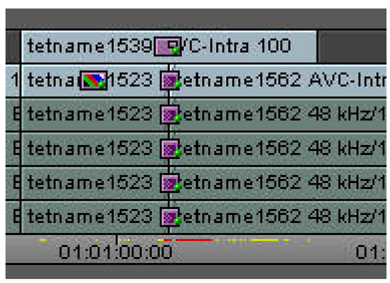

Figure 6: Dropped frames notification on timeline

Figure 8 shows the same 3 minutes sequence consisting of MPEG HD contents. We didn't see any frames dropped as you can see no color indicators in the timeline.

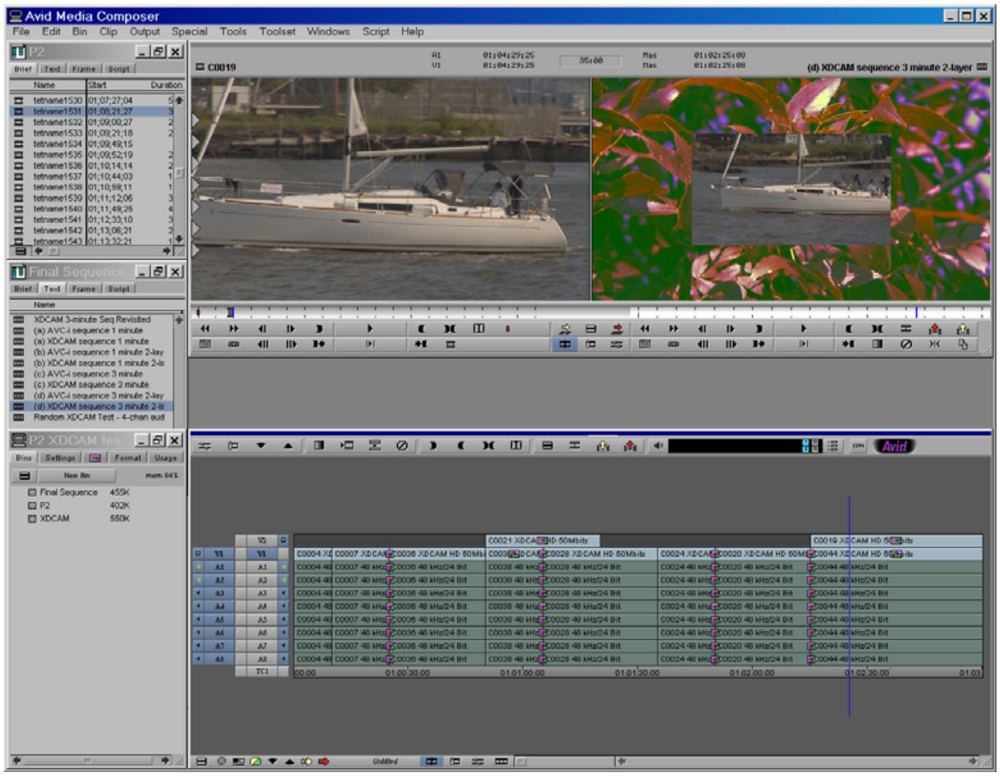

Figure 8: Avid MPEG HD 3-min sequence

EXPORT

Apple Final Cut Pro

As stated earlier, Final Cut Pro does not have native support for the AVC-I 100Mbps format. While the video had to be transcoded from AVC-I 100 to ProRes422 on import, Final Cut Pro does not support exporting the completed sequence back to Panasonic's AVC-I format. Sony's XDCAM HD format is supported natively throughout the editing workflow so the XDCAM sequences can be exported natively or compressed to support several playout/archive methods. AVC-I 100 video transcoded to ProRes 422 would have to maintain the ProRes422 format on export to avoid a second transcode or be compressed as DVCPro HD or another compression natively supported by Final Cut Pro.

To standardize the export test, all clips were exported with the following settings:
QuickTime Movie
Apple ProRes 422 145Mbps 8-bit codec

Table 4 shows the results for the time it took to export.

SEQUENCE DURATION	EFFECTS	XDCAM EXPORT TIME	P2 EXPORT TIME	XD:P2	XDCAM: SEQUENCE	P2:SEQUENCE
01:00	4 Clips 1 Color Correction 3 Dissolves	04:47	02:13	215.79%	478.33%	221.67%
03:00	8 clips 4 Dissolves 3 Cuts	14:30	09:34	151.65%	483.67%	318.94%
01:00	4 Clips 1 Color Correction 3 Dissolves 2 Video Tracks	06:24	05:09	66.92%	640.33%	956.83%
03:00	8 clips 4 Dissolves 3 Cuts 2 Video Tracks	19:09	16:54	113.40%	638.83%	563.33%
	Total:	**44:52**	**38:15**	**547.76%**		

Table 4: Final Cut Pro Export Time Comparison Chart

As expected, the export time for a sequence already transcoded to ProRes 422 was measured to be quicker than a sequence of video kept in the manufacturer's native format based on i-frame codec. Although, we did find it interesting that in some instances, the difference in times between the two formats to export from Final Cut Pro was much smaller than expected.

Avid Media Composer

All clips were exported with the following settings:
QuickTime Movie
DNxHD 145Mbps 8-bit codec

MPEG HD 50Mbps was 88% faster than AVC-I 100Mbps when rendering sequences with one video track, one color correction, and three dissolves. In a real world scenario, it can be easily seen that transcoding the MPEG HD content into Avid DNxHD codec still faired better than AVC-I.

Sequence Time	P2 Output Time	XDCAM Output Time	XD:P2	P2:Sequence	XDCAM:Sequence
1:00	03:27.41	03:03.53	88.49%	345.68%	305.88%
3:00	10:19.41	09:05.15	88.01%	344.12%	302.88%

Table 3: Avid Single Track Export Test Comparison. 1-minute sequences consist of 4 clips, 1 video track, 3 dissolves, and 1 color correction. 3-minute sequences consist of 8 clips, 1 video track, 4 dissolves, 3 cuts, and 2 color corrections.

When it came to sequences consisting of two video tracks, two color corrections, and multiple cuts and dissolves***, MPEG HD still outperformed AVC-I by 90% in some instances.***

Sequence Time	P2 Output Time	XDCAM Output Time	XD:P2	P2:Sequence	XDCAM:Sequence
1:00	03:50.72	03:18.06	85.84%	384.53%	330.1%
3:00	11:25.44	10:19.44	90.4%	380.8%	344.13%

Table 4: Avid Dual Track Export Test Comparison. 1-minute sequences consist of 4 clips, 2 video tracks, 3 dissolves, and 1 color correction. 3-minute sequences consist of 8 clips, 2 video track, 4 dissolves, 3 cuts, and 2 color corrections.

Table 6 summarizes the current 3rd party native support for both formats. As mentioned earlier, while the XDCAM MPEG format is supported natively by all major NLE vendors, the support for AVC-I is still at the pre-mature level, causing the time it takes to import and export much longer and poor performance in editing.

Editing Solutions		ADOBE Premier Pro	APPLE Final Cut Pro	AVID Media Composer	Sony Vegas	Thomson Edius Pro
Native File Import	AVC-I 100	No	No	Yes	No	Yes
	AVC-I 50	No	No	Yes	No	Yes
	MPEG 35	Yes	Yes	Yes	Yes	Yes
	MPEG 50	Yes	Yes	Yes	Yes	Yes

Table 6: Native file import support by 3rd party NLE vendors

Observations from the actual test:

- XDCAM MPEG HD 50Mbps far outperformed AVC-I 100Mbps in both Avid Media Composer and Apple Final Cut Pro. It is due to the XDCAM MPEG HD codec's 3rd party native support and the ability to efficiently create high quality clips at a lower bit rate translating into smaller file sizes.
- AVC-I, Independent frame compression, is only making the file size larger and the file import/export speed slower while penalizing the system with double the data rate - this makes the editing simply more difficult.
- AVC-I codec is not supported natively by most of the NLE vendors, and transcoding is necessary, which slows down the post production process by far.
- The MPEG HD Long GOP compression algorithm that is used in XDCAM is a less complex compression algorithm, producing less latency and requiring less processing than an AVC-Intra codec used in Panasonic cameras.
- With everything else being equal, the use of an immature codec with larger file size and more complex processing makes the import and export functions more time consuming and the editing process inefficient.

In summary, when considering the entire chain of broadcast video processing - from acquisition, through editing, processing and final archiving - under the existing computational infrastructure constraints of the current editing platforms - the MPEG-2 Long GoP video compression scheme has been a picture quality, file-size, and computationally efficient technique. Practically, under the production expectations of today's broadcast environment, the MPEG-2 Long GOP 422 is a technically matured, video compression scheme with sufficient technical performance for mainstream HD broadcast news and program production applications.

Tomorrow's High Definition ENG and Broadcast Production Environments

As expected, exhaustive evaluations have demonstrated that MPEG-2 Long GoP 422 techniques could perform adequately for all types of broadcast production operations, when considering 1080 50i/60i and 720 50p/60p source material.

But can MPEG-2 Long GoP survive the rigorous demands of double the native data rates of 1080 50p/60p for the up-coming family of high-end production HD standards at efficient compressed data rates?

Well, … from and engineering perspective the answer is NO. MPEG-2 Long GoP, say at 50 Mbps, will exhibit, when presented with 1080 50p/60p material, various levels of compression artifacts – perhaps comparable to those encountered when MPEG-2 was to perform at under 2 Mbps for SD signals! In other words, the capabilities of the bit-rate reduction techniques designed for the 'sweet spot' of MPEG-2 have been exceeded and will make its use for compression of 1080 50p/60p, most likely, unacceptable. A solution would be to increase the compressed data rates to 100 Mbps of higher in order to maintain reasonable compression ratios.

An alternative is to use the more efficient coding scheme of AVC Long GoP. As shown in figure 9, instead of using MPEG-2 Long GoP for the compression of 1080 50p/60p at rates approaching 100 Mbps, one could use AVC Long GoP with all of its advanced data reduction techniques to produced robust, compressed video streams at 50-60 Mbps for 1080 50p/60p material, without penalizing the existing broadcast IT-based data transport and storage infrastructure.

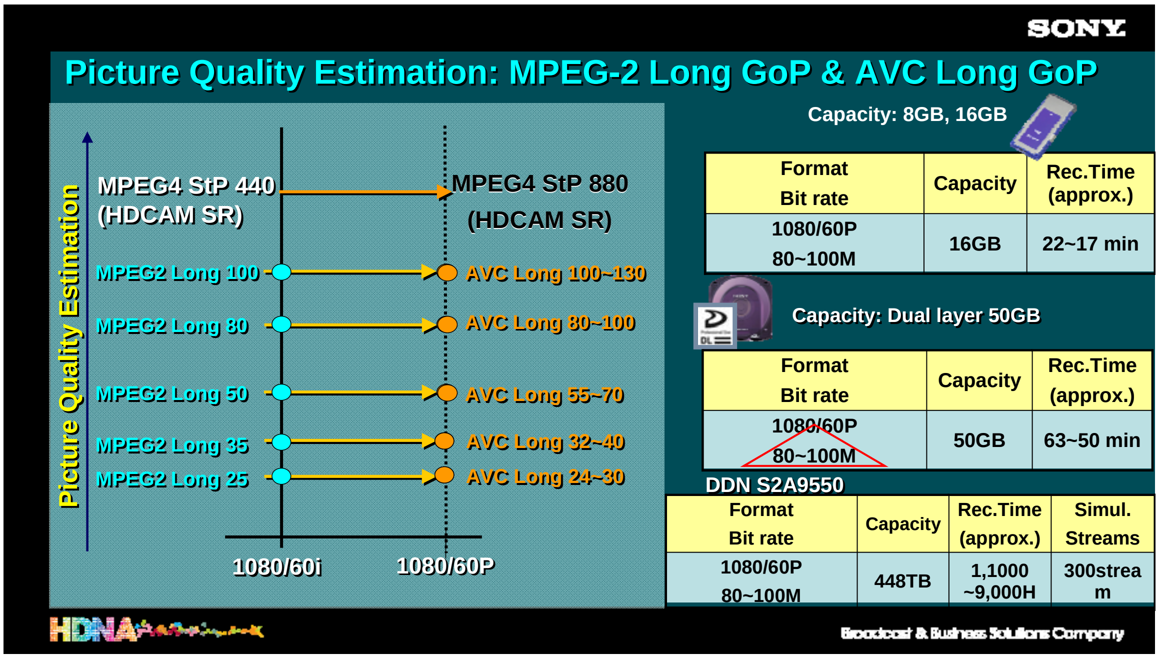

Figure 9: The use of AVC Long GoP for 1080 50p/60p systems

It has been argued, however, that the advantages of lower bit rates for the use of AVC Long GoP have been at the expense of processing complexity. It will indeed take a few years before commonplace multi-core CPU's will be in place, in cost-efficient laptops and desk-top computers, with the computational capabilities for handling the full set of compression tools of the AVC standard.

Hence, it is also possible to employ AVC Intra-only techniques for the handling of 1080 50p/60p signals but only at the higher data rates of 200-300 Mbps for adequate levels of picture quality vs compression ratio performance. The current AVC-intra techniques have been limited by compromises in today's hardware implementations and higher performance schemes can be implemented within the complexities of the standard by better choices of the algorithmic tools.

Sony B&P is developing a highly complex IC which will implement AVC Long & Intra GoP to be deployed in future products, handling 1080 50p/60p signals for a variety of mastering, and …eventually mainstream HD production applications. Sony's new device will be able to flexibly switch between Intra-only or full capabilities of Long GoP depending on the application and compression conditions at hand.

In summary, only then, - at the time of deployment of new professional platforms for 1080 50p/60p -, it will make sense to switch drastically to more efficient, and complex, video compression schemes.

Conclusion

This document has briefly presented an outlined of technical perspectives related to the choice of video compression technologies for the broadcast and high-end movie production industries – this, from the viewpoint of a successful hardware manufacturer, the Sony Broadcast & Production Systems Company.

For decades Sony B&P has selected video processing and compression technologies for the best balance between practical engineering compromises, excellence in picture quality and overall signal performance. As we transition into the use of HD in mainstream broadcast operations, once again, Sony has selected the highest performance techniques for the deployment of high-quality HD production equipment: the XDCAM HD 422 family of products utilizing MPEG-2 Long GoP 422 at up to 50 Mbps.

Continue research and development of newer video compression algorithms and their efficient implementation is at the core of the technological efforts of the Sony B&P company. Sony B&P will deploy new techniques and devices to respond to the challenges of new imaging standards. But the technology selection must have always as a goal, ultimately, the implementation of state-of-the art devices and products that completely fulfill the requirements of the marketplace while sustaining an orderly transition and support from older production technologies.