

Technical Analysis:
Apple/Avid Production Platforms



**Studio & Broadcast
Operations**

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Revision History

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1	Picture Quality Tests	2/1/09	RZ
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Table 1 : Document Revision History

Introduction

This paper presents an analysis of two different production platforms used at HBO. The Apple and Avid production platforms are included in this analysis. Results are presented in summary form as well as in-depth form. Features and functions of the production platforms are listed, and results of several specific tests are presented. This is a technical analysis that highlights features and functions of importance to Engineering. It is not an attempt to declare a “winner” and a “loser”.

Engineering has explored the technical features of both platforms during Q1 2009. Research was conducted regarding features and functions of the platforms. Product road-maps were explored where available. Analyses were performed using several techniques including full-reference Picture Quality Analysis and Quality Function Deployment House of Quality, and systems were timed while performing typical operations. The design of a production platform requires making certain compromises. The same is true of the deployment of a production platform. No platform is perfect. However, either Apple or Avid platforms (or both) can meet HBO’s needs for production.

Explanation of Document Layout

This document is presented in six sections. Items deemed to be of most importance to the Engineering organization are covered.

- Section I. Analysis Overview:** Presents the goals and benefits of the analysis as well as the strategic initiatives supported.
- Section II. Executive Summary:** Review of the items covered in the sections to follow as well as the high-level results. Section II can be read by those wishing to see only the results of the analysis.
- Section III. Feature Discussion:** Explains similarities and differences between the platforms. Features of importance to Engineering are discussed.
- Section IV. Qualitative Analysis of Requirements:** Uses the Quality Function Deployment House of Quality analysis methodology. The House of Quality shows those features that can be delivered together without compromising each other. Items analyzed include an overview of technical features including the performance of the compute platform, and quality of training and tech support resources.
- Section V. Picture Quality Analysis:** Reports on the picture quality of the Apple and Avid Video Encoding and Decoding methods (CODECs) and Video Input / Output (I/O) subsystems.
- Section VI. Test and Measurement:** Shows measurements taken from Apple Final Cut Pro and Avid Nitris DX systems at HBO Studios.
- Section VII. Vendor Partnerships:** Highlights vendor partnerships in the Apple and Avid production platforms and includes a list of complementary software, plug-ins and helper applications.
- Section VIII. Configuration Comparison:** Shows a comparison of configurations for 100 Terabytes of shared storage to support 10 editors, including media management. Highlights similarities and differences between configurations.

Section I – Analysis Overview

Section I - Analysis Overview

Section I – Analysis Overview

Analysis Overview

Studio Engineering has analyzed the Apple and Avid production platforms. These are the two primary production platforms currently in use at HBO. The analysis focuses on technical requirements as they relate to each production platform.

Audience

This document is written for all technical engineering management.

Assumptions

- Working knowledge of computerized edit systems.
- Technical support of production and post-production environments.
- Exposure to terms commonly used in computer disk sharing including SAN, LAN, NFS, CIFS, SMB, AFP.
- Basic working understanding of Fibre Channel, iSCSI, Ethernet.
- Audio and video data rates, frame rates, sample rates, word sizes.
- Serial Digital Video, AES Audio and Embedded Audio.
- Knowledge of Picture Quality Analysis including full-reference picture quality analyzers.
- Signal, Noise, Signal to Noise Ratio, Macroblock, Edge-Compensation, Luma, Chroma, and Average Picture Level.
- Familiar with CODECs used in edit environments.
- Knowledge of color sub-sampling and notations such as 4:4:4, 4:2:2, 4:2:0.

Company Alignment

What strategic initiative is supported by this analysis?

Digital End to End (DETE) including Ingest, Metadata, Desktop Edit, Digital Asset Management (DAM) Initiative, High Definition (HD) Migration Initiative.

How does this analysis line up with the strategic initiative?

A well-documented analysis will provide studio management with an objective body of knowledge regarding performance and image quality of production platforms currently in use, as well as those considered for future deployment. This analysis can also help the studio to move to a single production platform or to move to both production platforms, if so desired.

This analysis will provide specific objective data regarding each production platform. The features of each platform will directly impact the platform's ability to support the initiatives above.

Why is this analysis important to the initiative?

HBO supports two production platforms making it more difficult to deliver a high-quality experience throughout the edit life-cycle on both platforms. Compromises are continually being made to accommodate two different workflows.

This analysis helps to determine the viability of supporting one production platform or both production platforms.

Which departments or groups benefit?

HBO Studio and Broadcast Operations and Engineering benefit from this analysis.

Who, When, Where did the analysis?

Larry Klein, Charles Lonigro, Reynold Rossi and Robert Zimmelman conducted this analysis in Q1 2009 at HBO Studios.

What is being analyzed?

Technical features of production platforms are analyzed in this document. An attempt is made to produce quantifiable results in the analysis. "Look and feel", Operational Features, and vendor or manufacturer issues are out of scope for this analysis.

It is important to note that the analysis is of the platform rather than of one edit product. A platform may consist of several levels of hardware I/O and acceleration. A platform may include more than one computer model or operating system. Additionally, the platform may include one or more components useful to broadcasters such as integration with ingest devices and broadcast video servers. Finally, the platform may include certification of partner hardware and software that supports workflows important to broadcasters or rich media management components useful to broadcasters and large post-production facilities.

Section I – Analysis Overview

Performance

Performance has several facets including the number of layers of real-time video supported; speed of effects rendering or existence of real-time effects; time to export a commonly used work product (eg. a Screening Room file); time to back up and restore a project to a SAN partition if available or a LAN share are all aspects of performance.

Media Management

Media Management has many facets. One must consider the workflow that is being managed. Ingest, Storage, Edit, Project and Media Sharing, Metadata Management, Transcode, Media Delivery, Archive and Retrieval are all facets of Media Management.

Training & Support

Training may be offered via the web or in person. In person training may be offered in a classroom at the facility where the production platform is housed, or in a classroom at the manufacturer's headquarters. Support may be offered by telephone, via the web, or may be offered on-site. Support may be geared to broadcasters, to media professionals in general, or to consumers. Support and training may be offered by the company that creates the production platform or may be offered by third parties.

Quality of CODECs and I/O Subsystem

Apple's Video Encoding and decoding methods (CODECs) and Input/Output (I/O) Sub-System are compared to Avid's at comparable data rates using the Digital Cinema Initiative (DCI) Standard Test Material (STeM) footage. Signal to Noise Ratio of the two CODECs are tested.

Partner "Landscape"

The "Partner Landscape" refers to the availability of plug-ins, complementary software and hardware, and tools to aid in the entire broadcast workflow. A production platform can not offer all components from a single manufacturer, so a strong "partner landscape" is important.

Both Apple and Avid have strong "partner landscapes" as illustrated by the wide availability of plug-ins, libraries, and helper applications (See Section VI: Test and Measurement).

Section II – Executive Summary

Section II - Executive Summary

Section II – Executive Summary

Executive Summary

HBO Studios uses production platforms from Apple and Avid. The systems have grown organically over the years. There are benefits from a deeper understanding of the platforms from a technical perspective. In Q1 2009, Engineering analyzed these production platforms. Engineering found the platforms to be similar in many ways. However, the platforms do have some differences worthy of note. Both platforms can meet HBO's current requirements for offline-online edit workflow.

This document does not cover HBO Engineering's expectations for today, but rather explores the features that are possible to deploy on the Apple and Avid platforms given the available systems and architecture from the two companies.

Some of the most important features were:

1. **Image quality:** Both platforms have a high-quality and lower-quality HD CODECs. In most of our tests, the Apple and Avid CODECs performed similarly at comparable data rates. Each platform's highest-quality HD CODEC showed strengths in our tests of the Digital Cinema Initiative Standard Test Material. An ideal edit system would preserve 100% of the image quality obtained by comparing a video image to itself (eg. from two outputs of a VTR). Neither system comes close to this quality, which is attainable only in theory as all edit VTR and edit systems apply some compression to the video signal. On average, the Avid system under test showed better signal quality than the Apple system under test. The Apple system's image quality was 89% of the Avid system's image quality for lower data rate HD edit material, and 95% of the Avid system's image quality for highest quality HD edit material.
2. **Media Management (and Project Sharing):** Media Management is broad-ranging, covering many topics from Ingest to Air Play. Apple's media is tightly coupled to the workstation, user, and the disk storage location, while Avid's is not. This is a deficiency in the Apple platform because if media is moved, a time-consuming manual reconnect-to-media operation is required. The Avid platform uses a Media Object and Media Database structure that does not suffer from this limitation. Both platforms offer Media Management software. Apple's Media Management is done by the Final Cut Server application. Avid's Media Management is done by the Interplay suite of products. Both Apple's XSAN and Avid's Unity shared storage systems allow media to be shared by multiple editors. Avid's Unity product supports project sharing by the creation of Shared Project workspaces. The Avid Unity project sharing feature is not currently in use at HBO to its full potential at this time, because HBO does not utilize shared project workspaces. Apple's XSAN product does not support project sharing, so editors can not share the same output project at the same time. Apple's edit platform software is supported on the Avid Unity shared storage solution in limited configurations. Avid's software does not allow it to be used in Apple's XSAN shared storage solution.

Section II – Executive Summary

3. **Storage Protection, Rebuild Time, Bandwidth Guarantees:** The system should be able to maintain adequate performance during times of drive failure and RAID rebuild. The Apple platform is storage-independent, so the level of data protection and down-time during drive failure depends upon the RAID system employed. It is possible to meet or exceed Avid's Unity system performance by employing extremely high-quality Enterprise-grade storage for the Apple system. Avid's Unity system is capable of providing protected storage and fast rebuild times by utilizing simple data protection (RAID1 and in Q3 2009, RAID5). The Configuration Comparison section highlights several performance features that are present in the Avid platform that are not present in the Apple platform. Bandwidth guarantees are provided in Avid's platform but are not present in Apple's platform. Section VIII – Configuration Comparison Section illustrates Avid's concept of providing shared storage by the "stream". Avid configures its storage to support a guaranteed number of real-time "streams" of video and uses "Media Engines" to ensure that the disk sub-system is not over-subscribed. Apple's XSAN shared storage does not have this provision.
4. **Technical Support:** Apple offers a broad range of support geared to the consumer or small workgroup user. Apple's professional services organization is able to provide support, however comprehensive 24x7 Enterprise support similar to Avid's offering must be negotiated with a third party vendor. Avid is capable of providing 24x7 comprehensive Enterprise level technical support via certified technicians, supporting a well-known platform, with escalation procedures appropriate to broadcasters. For the reasons stated, Avid's Technical Support offering is stronger than Apple's.
5. **Certification and Training:** Apple provides advanced certification for the components of their production platform including Final Cut Pro, XSAN, and workgroup storage. It is possible for HBO's technicians to become certified by Avid to support all of the products making up the production platform.
6. **Software Platform Independence:** It is important to use software that runs on more than one computing platform. This helps to future-proof HBO from changes as new computing platforms emerge. Apple's production platform runs only on the Macintosh Operating System while Avid's production platform runs on both Macintosh and Windows Operating Systems.
7. **Turn-Key System:** Availability of a turn-key system from a single vendor who supplies the component parts of the system is valuable to any Enterprise production platform customer. Both platforms are available as turn-key systems. Apple turn-key solutions are delivered by third-party consultants and professional services organizations, as illustrated in Section VIII – Configuration Comparison Section. Avid can supply all of the component parts of a turn-key system as a single-vendor solution or via third party integrators.

Section II – Executive Summary

8. **Industry Standard Media Format Support:** It is important to a broadcast enterprise to use media file formats that are certified by one or another standards body. Apple's edit media is stored in a QuickTime wrapper, which is an industry-standard, but not one created by a standards body such as the Society of Motion Picture and Television Engineers (SMPTE). Licensing for Apple's ProRes422 CODECs is currently not available. Avid's media is stored in an MXF wrapper (SMPTE 377M). Avid's DNX220 CODEC has been certified as the SMPTE VC-3 standard file format. DNX220 adheres to several SMPTE specs under SMPTE 2019. Avid's CODEC and wrapper code is available on their web site as part of the open source AAF Toolkit.
9. **Performance (Real-Time Effects, Effects Render Time and File Export Time):** The Test and Measurement Section (Section VI) reveals that the Avid Nitris DX outperforms the Apple Final Cut system in all empirical tests conducted by HBO Engineering. By comparison, in all but two cases, the Apple Final Cut Pro system was the slowest system tested. Overall (if all of the tests are conducted in sequence), the **Avid Nitris DX is 8x as fast as the Apple Final Cut Pro system to complete all tests. The Avid Nitris DX is 30x as fast as the Apple Final Cut Pro system for Screening Room exports. Many effects run just as fast on the Nitris DX regardless of complexity of the effect.** Avid's platform is unique in its ability to provide a variety of useful real-time effects, hardware effects acceleration, and render-farm configurations to offload graphics intensive processing to compute servers on the LAN. The **Avid Nitris DX performs many effects in real-time, providing output instantly that takes minutes to render on the Apple Final Cut Pro system.**
10. **Vendor Partnerships:** Because user requirements constantly evolve and no single vendor can create all of the production tools required by all customers, it is important for a production platform to maintain strong vendor partnerships. Strong vendor partnerships allow the platform to be extended by other manufacturers, making the entire platform more useful to customers. Both Apple and Avid production platforms have extensive and versatile partner relationships. These partners extend both platforms with plug-ins, helper applications, and ancillary hardware.

Section III - Feature Discussion

Media Management

This section discusses the Apple and Avid platforms' media management capabilities.

Media Management is specific to workflow. A platform that handles all of the primary steps in HBO's workflow is more desirable. Both Apple's Final Cut Server product and Avid's Interplay product support HBO's workflows at a high-level.

At HBO, Media Management touches on the following items:

1. Application Programming Interfaces (APIs)
2. Acquisition
3. Ingest
4. Cataloging
5. Metadata
6. Search
7. Bin Creation
8. Rough Cut Editing (offline editing)
9. Sharing of Projects and Media (during offline editing and conform)
10. Conform (online editing)
11. Archive (also after broadcast media creation, mezzanine creation)
12. Sound Sweetening (music and F/X)
13. Alternate Language audio
14. Metadata Requirements for Broadcast (including VITC, Closed Captions, Ratings, CGMS, VANC, HANC, AFD)
15. Delivery (to broadcast center and to affiliates)
16. Broadcast (linear)
17. Mezzanine File Creation
18. Traditional VOD distribution
19. File-based Enhancements (including subtitling, Chaptering)
20. DVD and BluRay Authoring
21. File-Based Delivery (including iTunes)

Media Management Comparison

Apple's media management offering is Final Cut Server. This product was acquired from the ArtBox™ Company and modified to include functionality needed by production workgroups.

Avid's media management offering is Interplay. This product was acquired from the Alien Brain™ Company and modified to include functionality needed by production workgroups.

Media and Project Sharing

Media Sharing is supported in both Apple and Avid platforms at a high level. Engineering has found that both products may require work-arounds as we examine specific items in HBO's workflow in detail.

Project Sharing is not implemented in the Apple platform. Apple's documentation recommends that editors create separate projects for different areas of the timeline, and then combine the projects later, as a means of Project Sharing. **Project Sharing** is supported in the Avid platform via Unity shared storage. This allows several editors to work on the same project timeline at the same time.

Archive

Archive is supported in Apple's platform. Archive to removable hard drive is mentioned in Apple's Final Cut Server documentation. Though there is no specific mention of more elaborate archive methods such as robotic tape, it is possible to implement such a solution in Apple's platform by assembling third party components such as StorNext Storage Manager.

Archive is supported in Avid's platform including robotic tape backup with the Avid Archive product. Avid Archive is a third-party product that is very tightly integrated with the platform and has had extensive field-testing. Archive for the Avid product is provided by SGL Flashnet, Masstech Group, and Front Porch Digital.

Application Programming Interfaces

Enterprise Media Management like that required in an organization of HBO's size is done by other applications, some of which may exist already. An Application Programming Interface (API) is important because it facilitates access to the platform's media management functions by applications which may be necessary in an Enterprise, but are not provided by the platform vendor.

Apple Media Management Application Programming Interfaces (APIs)

AppleScript Interfaces and Extensible Markup Language (XML) Interfaces

Apple offers integration with its products using the AppleScript interfaces. Apple also supports Extensible Markup Language (XML) integration with Final Cut Server. More specifically, there is a 'Run an external script or command' response in Final Cut Server allowing any executable on the machine running Final Cut Server server to be run. The response has a field for 'Command Parameters'. The responses can be triggered by a number of different mechanisms - eg: a metadata field changing; a user logging in; at a specific time; from a 'watch' folder.

Integration with other Platform Applications is supported in the Apple platform via a "send to" feature. Final Cut Pro editors can "send to Motion" or "send to Soundtrack Pro" for example. According to Apple's documentation, when using Final Cut Server, as the "Motion" or "Soundtrack Pro" piece of the work is complete, the updates are visible on the Final Cut Pro editor's timeline.

Final Cut Server has a Read XML response and a Write XML response. The Write XML response can be called to write all metadata fields for a production or asset to an XML file. The Read XML response can be used to modify metadata for a given entity, based on its unique Asset ID or Production ID.

Avid Media Management Application Programming Interfaces (APIs)

Avid Web Services API

Avid offers a Web Services API implemented using the Simple Object Access Protocol (SOAP) version 1.1 protocol and offering support via Windows .net 2.0 as well as Sun's Java X APIs. Avid offers access to assets, the edit timeline, users and groups via the SOAP API. Access to sub-clip creation, head frame creation, locator access and creation are supported via the API.

Avid Interplay Transfer Manager Software Developers Kit (SDK)

The Avid Interplay media management system supports the proprietary Transfer Manager and Media Manager Interfaces.

The Avid Transfer Manager APIs and SDK support four primary transfer types as follows:

- Workgroup Transfers – moves media files and metadata from one Transfer Manager to another. Workgroup transfers can also be initiated by dragging media objects from the Media Manager Graphical User Interface (GUI) to another workgroup's Media Manager GUI, or to a bin in the editor GUI.
- Playback Transfers – moves edited sequences of media to video servers for on-air playback. Playback transfers can be initiated from the editor by selecting a destination playback device from a menu.
- Ingest Transfers – pulls media from a video server, and creates media files. In the case of the Avid AirSPACE, Omneon, or Thomson Grass Valley Profile video server, ingest transfers can be initiated by dragging a clip from the vendor's media management application to a bin in the editor.
- Dynamically Extensible Transfers – Moves media files and metadata to and from third-party applications.

Avid Media Manager Access SDK

The Avid Media Manager Access SDK allows third-party applications to query the Media Manager database, check-out media files, and delete media from Avid Unity systems. The Media Manager Access SDK also provides context-based search capabilities, including both simple and complex multiple-attribute searches across Projects, Bins, and Catalogs. For example, third parties can use the SDK to identify objects that match certain criteria before using other supported SDKs to transfer, delete or archive media.

Functionality of the Avid Media Manager Access SDK includes the following:

- Login, Logout
- Search
- Checkout (Avid and non-Avid format files)
- Delete

The SDK does not provide a full interface to the Media Manager server, but is intended to provide to the third-party application a subset of functionality for limited retrieving and querying of MOBs (media objects) and MOB metadata from the Media Manager server.

Capabilities include the following:

- Checkout OMF or AAF file
- Add/modify/delete custom metadata
- Change name of a checked-in MOB
- Delete (arbitrarily) a checked-in MOB's metadata and/or media file
- Batch import custom metadata

The Media Manager API can query for:

- MOBs based on specified MOB ID
- MOBs based on specified Catalog or Project; can match on name, type (sequence, clip, effect) and date
- Catalogs, Projects, Bins based on name

Media Organization

Apple Media Organization Notes

Apple's media is tied to three items:

1. the workstation running the application
2. the user running the application
3. the disk storage location

If any of these items above are changed, then all media is lost to the system, and must go through a process of "manual re-connect" in order to re-use the media on the platform. **This is a deficiency in the Apple platform for the Enterprise user.**

The majority of Apple platform users are unaffected by this limitation. However, breaking the connection of workstation-user-disk storage location causes loss of media that must be re-linked manually, one file at a time.

This affects only a small percentage of Apple platform users, as most deployments consist of a single user on a single workstation. In HBO's case, the user logs in to the system with a userid that is assigned to the room (for example, the user logs in to the Apple system as "NL-1"). So, despite the room being shared, the software sees only one user and one disk location.

The problem presents itself when media is archived or backed up on one system and restored to another system, as would occur in an Enterprise deployment of the platform. In that case, it is very easy to break the critical workstation-user-location connection and to have issues with media that require manual intervention to correct.

Avid Media Organization Notes

Avid's media is identified by unique Media Object Identifiers (MOB IDs) and a reconstructable Media Database. Avid's use of MOB IDs and the ability to reconstruct the Media Database serves as an anchor to the avid media files. This feature makes the Avid platform's media relatively simple to make available for use even if it is moved or edited by a different user than the creator of the media.

Compute Platform

Apple Compute Platform

Apple offers Dual Quad Core Xeon CPUs in the Mac Pro computer. The machine multitasks well, and can be equipped with 32GB of RAM running with the 64-bit Mac OS/X Operating System.

Avid Compute Platform

Avid offers similar CPUs and configurations to Apple in its Macintosh-based edit clients. Avid's production platform also includes PC edit clients. Avid has certified the Windows Vista Operating System for use in its production clients, and so also supports similar configurations on their PC clients (eg. 32GB RAM, Intel Xeon CPUs) as on their Macintosh clients.

Avid is unique in the ability to provide **hardware acceleration and render farm capabilities on their production platform**. Avid DS RP render farm option allows for high-performance background rendering that has only been possible on an advanced system like the Flame™ from Autodesk. The DS system ships with one license of RP rendering, and additional licenses are available for purchase. It is possible to create a very high performance render-assisted edit system with this configuration. Apple offers render farm capabilities as well.

Single Vendor Turn-Key Solution

Apple is able to deliver a turn-key solution. With the Apple platform, deployment and commissioning is done by third-party vendors. Avid is able to deliver a single-vendor turn-key solution. With the Avid platform, deployment and commissioning are done by either its own Avid Commissioning Services organization or by third party vendors.

Professional Services and Consulting

Apple offers consulting from the Apple Consultant's Network as well as referrals to Certified Professionals. Apple also has a Professional Services organization that offers a full range of design, installation, and consulting services including "Apple Rapid Deployment" teams who can provide outside consulting or do hands-on work.

Avid's Professional Services organization has experience in planning, design, workflow analysis, network consulting, and commissioning of large and small deployments. Avid has experience with facility integration, change management, on-air concerns, and operation of production systems for broadcasters.

Industry Standard File Formats

Apple's media is based on the QuickTime wrapper, which is a de-facto industry standard with wide support and widely available documentation and the ProRes422 CODECs, which are proprietary to Apple.

Avid's media is based on DNxHD CODECs and MXF wrappers.

DNxHD CODEC is compliant with SMPTE VC-3. The relevant SMPTE documents covering Avid's DNxHD CODECs and MXF wrapper are:

- SMPTE 377M-2004 Material Exchange Format (MXF) – File Format Specification
- SMPTE 390M-2004 MXF – Specialized Operational Pattern "Atom"
- SMPTE 2019-1 VC-3 Picture Compression And Data Stream Format
- SMPTE RP 2019-2 VC-3 Decoder and Bitstream Conformance
- SMPTE 2019-3 VC-3 Type Data Stream Mapping over SDTI
- SMPTE 2019-4 Mapping VC-3 Coding Units into the MXF Generic Container

Platform Application Integration Overview

Both platforms have accessible media because they use file “wrapper” structures and CODECs that are readable and writeable via developer libraries. Both applications also support a “plug-in” architecture that allows application developers to extend the functionality of the software. Developers have written a rich set of applications for platforms to support advanced graphics, subtitling, audio sweetening, transcoding, color grading, storyboarding, and more. A list of this plug-ins follows in the Vendor Partnerships Section of this document.

Apple Platform Integration

The Apple production platform’s uses Apple’s own QuickTime™ file format to allow applications to achieve integration with the platform’s media.

QuickTime is an enabling technology that simplifies using multiple applications to work on media files. The QuickTime file format is a “container” that “wraps” various audio and video CODECs as individual “tracks” in the file. QuickTime supports a timecode track for strong integration with traditional video applications.

A graphics application using the QuickTime developer libraries can read and decode individual frames of video, modify them, and write those frames of video back into the same QuickTime file or into another QuickTime file. The QuickTime file format definition and documentation are available for download from Apple’s Developer Web Site.

Advanced Integration with other Apple Platform Applications: Audio mixing is done in the Apple production platform with Soundtrack Pro™. The Apple production platform **supports a “Round Trip” feature** from the Final Cut Pro application that allows applications to do a “Send To” operation to SoundTrack Pro as well as to other ancillary applications (eg. DVD Studio Pro). This “Send To” operation allows the ancillary application to work on a part of a production and, when finished, to have the results of the ancillary application’s work to show up on the Final Cut Pro timeline.

Avid Platform Integration

Avid’s production platform uses the MXF file format to allow application developers to integrate with their platform’s media.

The MXF file format is also a container (like QuickTime) that wraps audio and video CODECs and support timecode as well. Because MXF was designed for broad use, it is defined in several specifications from the Society of Motion Picture and Television Engineers (SMPTE). The MXF container specifications are available as SMPTE 377M. The wrapping of VC-3 (DNXHD) essence in MXF containers is specified as SMPTE Recommended Practice 2019-4 (RP-2019-4). Because MXF is based on readily-available published standards, it is possible for developers to read audio and video that is wrapped in MXF.

Applications using the Avid platform can use the Avid libraries to decode individual frames of video or audio samples, modify them, and write them back out to the same or different MXF files. Avid’s media can be read and decoded via Open Source libraries.

Section III – Feature Discussion

Advanced Integration with other Avid Platform Applications: Audio mixing is done in the Avid platform with the Pro Tools application. While Pro Tools is an application agnostic audio workstation and works very well as a component of the Apple production platform, Pro Tools' integration with the Avid production platform is impressive. The Pro Tools application can be configured (**via the Satellite feature**) to "drive" and Avid edit system in order to display broadcast-quality video in an audio mixing session. The Avid edit system "chases" the Pro Tools application much in the same way that a traditional VTR does.

Technical Support Overview

Apple's support is prosumer oriented. Apple's support includes a telephone hotline. Apple has a local office in New York, but does not routinely offer on-site support from New York. Apple does not offer 24x7 Enterprise Support. Apple Enterprise Support is available from third-party professional services organizations. Limited Enterprise Support for the Apple platform is available in New York from TekServe or Virtual Media, for example.

Avid has 24x7 Enterprise Support Services geared to the broadcaster. Avid provides local support in New York utilizing Avid-trained and certified employees who are accustomed to working onsite with broadcasters. There are several Avid resellers in New York who provide limited Enterprise support for the platform including Video Corporation of America, Virtual Media, and Dale Pro Audio.

Apple Technical Support Offerings Web Site

A brief look at the Apple web-site shows a link to "Support". Software downloads are offered, and a reference to "Apple Care" support is shown. There is a link to "Support Providers" as well. After navigating to the "U.S." link, the user is presented with the following sections:

Finding a Service Provider

If your Mac or iPod needs service, please visit the Genius Bar at your local Apple Store. For Mac-related service, you may also contact an Apple Authorized Service Provider. The Mac Geniuses or Service Provider can help identify the nature of your problem and, if a hardware repair is required, explain to you all of your available service options.

Services Provided.

Some Service Providers may offer "Carry-in" or "On-site" service. For "Carry-in," customers bring their Macs to the Service Provider. For "On-site," the Service Provider will go to the customer location to make repairs.

Visit an Apple Store.

The Apple Store is the best place to learn everything there is to know about the Mac or iPod. Let the Mac Specialists answer all your questions. Visit the Genius Bar for one-on-one support and advice. Attend free workshops — for beginners and pros — and learn how to bring your ideas to life.

Find a Reseller.

Thousands of Apple resellers can help you discover the Mac that's right for you.

Avid Technical Support Offerings Web Site

A brief look at the Avid web-site shows several levels of support including:

Avid Standard Support

Avid Standard Support provides an economical option for casual and project-based customers working in environments where there is little complexity, and system availability is not mission-critical. With this

Section III – Feature Discussion

package, customers will receive assisted phone support during standard business hours, 24x7 access to Avid's on-line self-help center and community forums (including the knowledge base), and regular software updates designed to help customers protect and extend their investments.

Avid Priority Support

Avid Priority Support is ideal for customers who require software investment protection and access to exchange hardware replacement materials, but do not work in mission critical, round-the-clock environments. In addition to receiving all the benefits of the Standard Support package, customers will also have access to expedited replacement materials and accelerated support response during standard business hours.

Avid Uptime Support

Avid Uptime Support is designed for small to mid-sized broadcasters and post production and audio facilities that require system availability beyond standard business hours. This package provides customers with all the benefits of the Priority Support package as well as priority queuing, around-the-clock access to assisted support and rapid response to critical issues.

Avid Enterprise Support

Avid Enterprise Support provides the highest level of coverage and is designed for the most complex media production environments such as large networked broadcast organizations and post production facilities, where even a few minutes of downtime can impact operations and revenue. In addition to receiving all the benefits of the Uptime Support package, these customers will have an Avid support team dedicated to their organization and be able to take advantage of benefits such as a periodic review of the support program, custom support alerts, virtual annual health checks, and workflow and third-party integration support.

Training Overview

This section compares Apple's and Avid's training offerings. Both Apple and Avid offer comprehensive training.

Apple Training

Apple offers on-line courses as well as classroom training.

Several HBO Engineering staff have completed third-party classroom training for Apple's products. For example, "XSAN for Pro Video" training was comprehensive and ended with a certification test. Attendees have the ability to become certified in "XSAN for Pro Video" and should be capable of setting up the XSAN software on Apple's hardware.

Apple has limited online training for management of its products, while Avid's online training is comprehensive, full-featured, and directed at a limited set of products provided by Avid.

Section III – Feature Discussion

Avid Training

Avid's training and support offerings include online training using the A.L.E.X. system, classroom training at their offices or via third parties.

HBO Production Engineering personnel have attended Avid classroom training provided at Avid's headquarters. This training was found to be comprehensive and well done. HBO Engineering personnel have also attended other Avid platform training. This training was delivered by a professional, was tailored to the group of Engineers taking the course, and was well presented.

Feature Discussion Conclusion

Both platforms offer media management components that run on Macintosh and Windows. Both platforms support HBO's production workflow. Apple's simple media management paradigm causes the need to perform a "manual reconnect to media" when media is moved. Avid's use of Media Object IDs and a reconstructable Media Database makes moving media from system to system easier. This difference between the platforms' basic media management paradigms only show itself in large Enterprise deployments. Both platforms' media management features can be supported at HBO.

Apple's platform uses the Industry Standard QuickTime file format and proprietary CODECs. Avid's platform uses SMPTE Standard MXF file format and the SMPTE Standard VDC-3 CODEC. Both file formats and CODECs can be supported at HBO.

The two platforms are built on similar compute platforms. Apple's production platform runs on Apple Macintosh computers with the exception of Final Cut Server Windows client, while Avid's production platform consists of Apple Macintosh as well as Microsoft Windows clients.

Both platforms offer training that includes on-line and classroom offerings. Both platforms offer support via the manufacturer as well as via third parties.

24x7 Enterprise Support for the Apple platform must be negotiated with a third party service provider. Avid offers 24x7 Enterprise Support through its own employees and via third party service providers. In conclusion, both platforms features are very similar. Either or both platforms can be supported at HBO.

Section IV – Qualitative Analysis of Requirements

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House of Quality Overview

The Quality Function Deployment (QFD) House of Quality (HOQ) method was used for this analysis. The House of Quality methodology is a Six Sigma tool that has been used in manufacturing and product design, in order to create successful products for customers around the world, for more than 40 years.

In the “House of Quality” analysis, a matrix is created to correlate customer requirements to product features. Following the entry of the relationship between requirements and features, another matrix is created correlating the various features to each other, illustrating those features support each other, and those features whose attributes conflict with each other. Finally, products are rated against each other on their ability to deliver the customer requirements.

1. Requirements of the “customer” (HBO Engineering) are listed in a column on the left side of the matrix.
2. Importance values were applied to each requirement (**what the customer wants**) in the list.
3. Technical features or attributes (**how the want is met technically**) of a production platform were listed across the top of the matrix.
4. Technical targets (**the empirical measurement that is to be met technically**) are listed across the bottom of the matrix.
5. Difficulty factors are entered at the bottom of the matrix, below their respective technical attributes and targets to be hit.
6. Correlations were entered between the various features and the technical targets (or between the **customer wants** and the **how the technical feature is accomplished**) for each platform.
7. Correlations were entered between the various technical targets and each other. This is the “roof” of the “House of Quality”. A **stronger roof** (with more positive correlation between the technical means of meeting the customer’s needs) will indicate a **stronger overall technical platform** (one that meets the customer needs without compromising the individual components of the platform).

What is the objective of the QFD House of Quality analysis?

There are several objectives of this analysis.

1. Where possible, to measure both platforms on various attributes and to record the results of measurements taken on the production platforms in order to objectively rate the platforms on attributes deemed to be of importance to Engineering.
2. To objectively rate systems on features that are not specifically measurable as quantities.
3. To add to Engineering's body of knowledge.
4. To record information that provides the ability to objectively compare ratings of production platforms in use now to those considered in the future.

Where possible, Engineering will measure performance numbers (eg. in Mbytes per second or in the number of seconds required to perform the operation). Where this is not possible, features or functions will be listed for a side-by-side comparison. In this case, the absence or presence of a particular feature may be noted.

Section IV –Qualitative Analysis of Requirements

What are the parameters of the analysis?

In this analysis, the parameters were the customer requirements of HBO's Studio Engineering department.

Abbreviated requirements list

A shortened requirements list is presented, containing the items deemed most important by the analysis team:

- Strong image quality
- Strong data protection
- Strong Support
- Certification and training for HBO's technicians
- Software that runs on more than one computer platform.
- Ability to purchase a turn-key system from a single vendor
- Support for industry standard media formats.

What was the method of analysis?

These parameters were analyzed using the House of Quality method. Separate House of Quality diagrams were created for Media Formats and Quality, Support and Certification, Storage, and overall System Performance.

What processes are improved by learning the results of this analysis?

Objective edit system and platform selection is improved as a result of this analysis. Decision makers will be armed with the specific, measurable attributes of the systems, and decisions can be supported by facts.

House of Quality Results

House of Quality analysis shows the following:

1. **House of Quality: Summary** shows that the two compute platforms are similar. Avid Tech Support is more advanced, and Avid is capable of delivering a single-vendor turn-key solution.
2. **House of Quality: Tech Support and Training** shows that both platforms offer similar basic tech support and training. Avid offers 24x7 Enterprise support for broadcasters, provided by Avid. Apple has no such support offering.
3. **House of Quality: Compute Platform** shows that both platforms are delivered on computers with similar power. Avid delivers some production workstations with hardware acceleration, which offers dramatic performance improvement.
4. **House of Quality: Effects Rendering / Import Export** shows that the Avid system offers faster Effects rendering and Import / Export times.

Title: Apple / Avid Platform High - Level View

Author: Robert Zimmelman

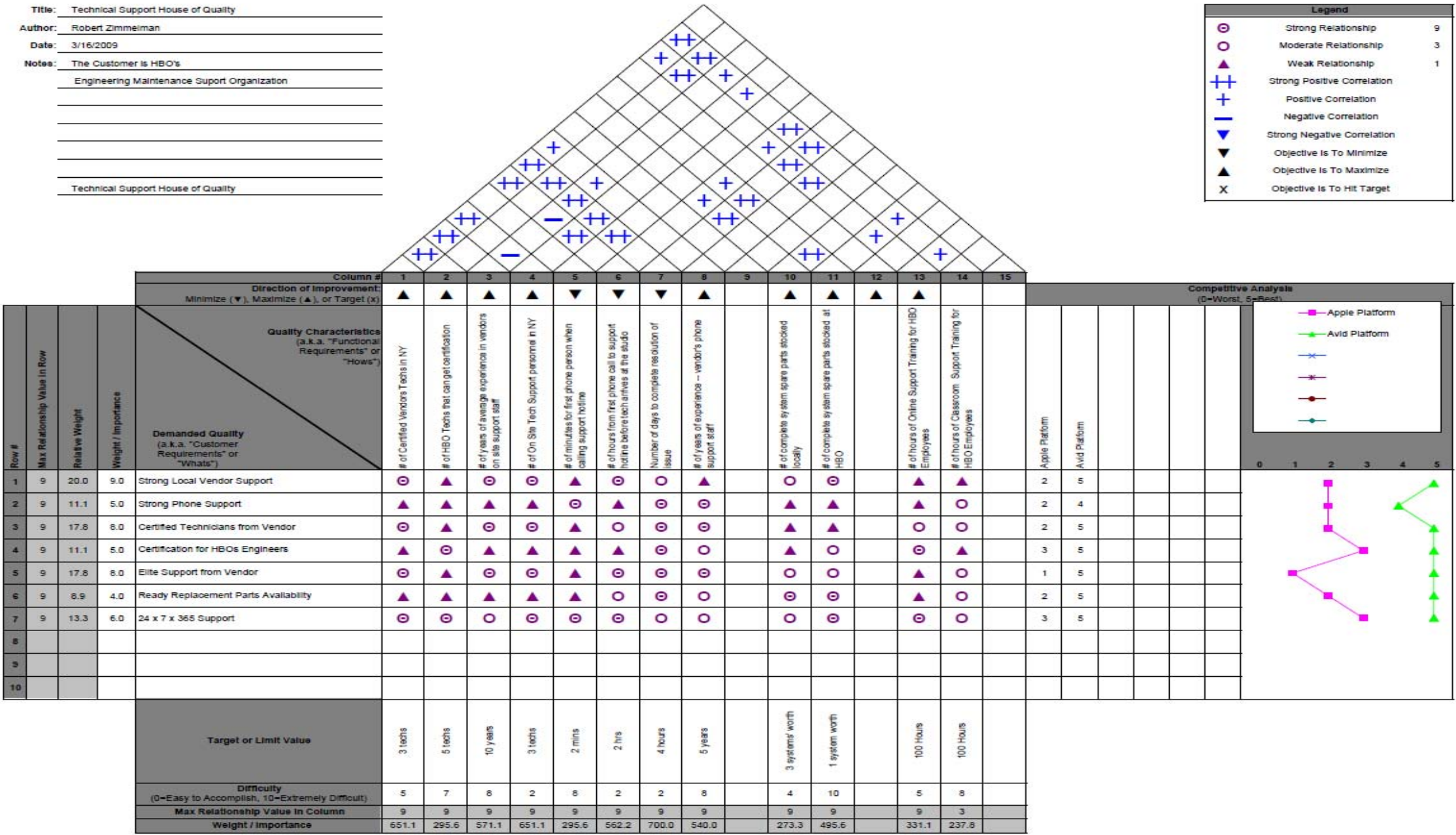
Date: 3/16/2009

Notes:



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House of Quality: Tech Support



1. Local, Enterprise-Level 24x7 Tech Support Available from Avid

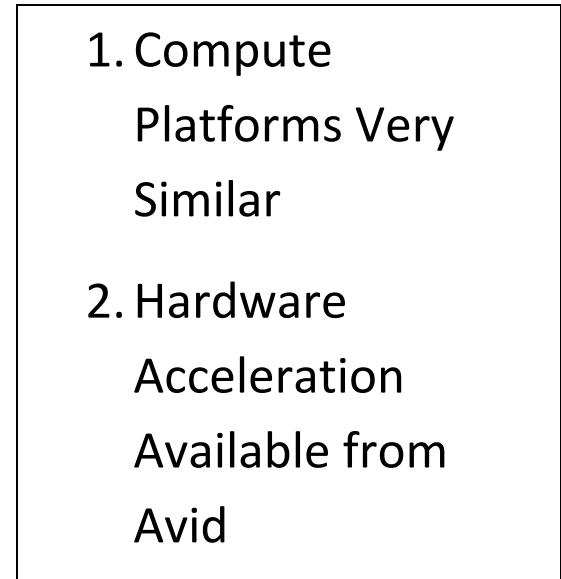
Figure 2 : House of Quality: Tech Support

Title: Compute Platform HQQ

Author: Robert Zimmelman

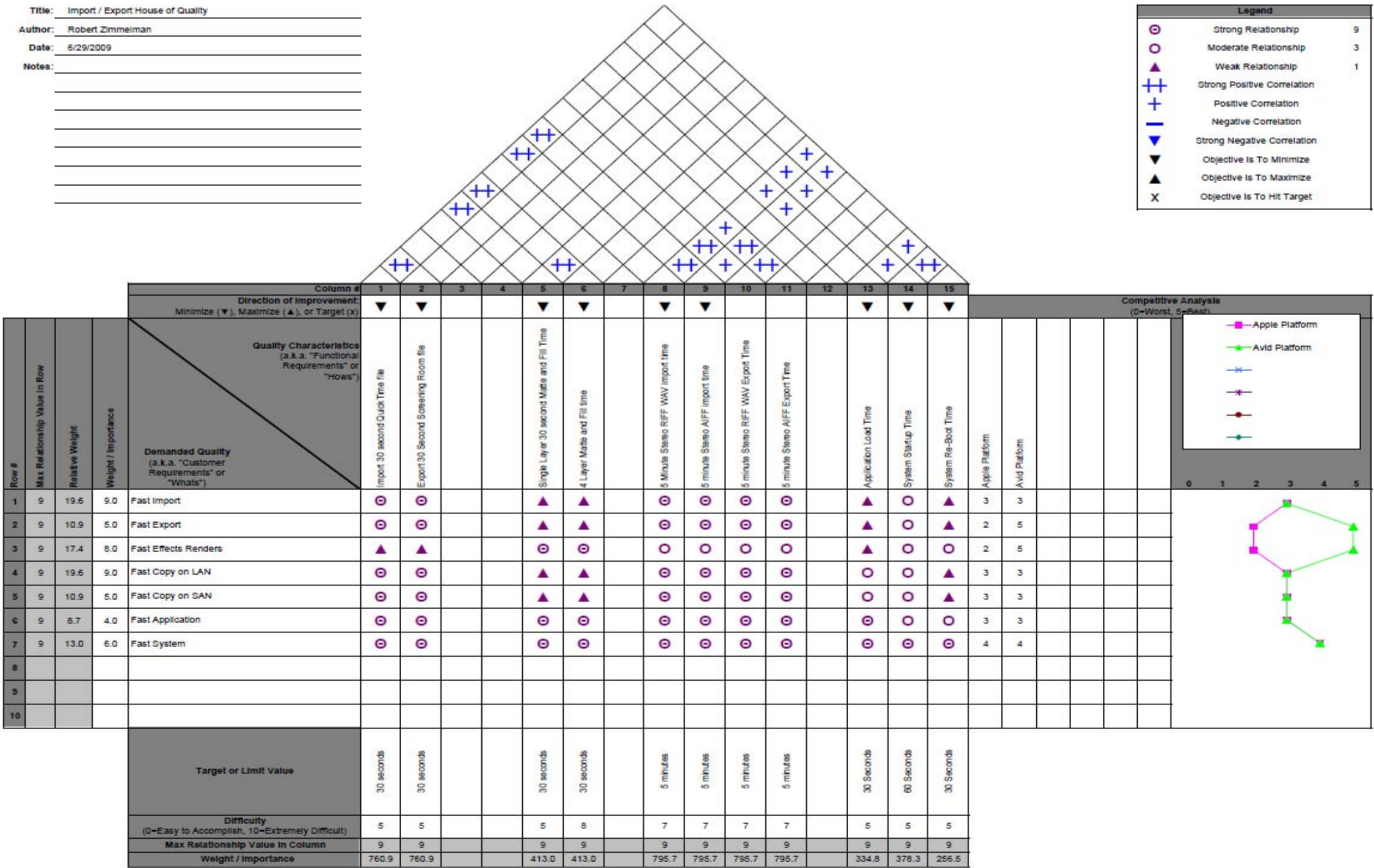
Date: 3/16/2009

Notes: Engineering is the customer



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House of Quality: Effects Rendering and Import/Export



1. Avid outperforms Apple in Effects Rendering and Import / Export times.

2. Number of Real-Time Streams is Storage-Dependent on Both Platforms

Figure 4 : House of Quality: Effects Rendering and Import / Export

For Further Information regarding QFD House of Quality Analysis

“Quality Function Deployment”, Cohen, Addison Wesley Publishers, c 1995, Addison-Wesley Publishing Company, Reading, MA, ISBN: 0-201-63330-2

“House of Quality in a Minute”, 2nd Edition, c 2006, Chi Publishers, Fairfield, CT, and ISBN: 0-9676023-6-X, Library of Congress Catalog Number: 2005911278

Section V – Picture Quality Tests

Section V - Picture Quality Tests

Section V – Picture Quality Tests

Overview of Apple / Avid CODEC Picture Quality Tests

SBO Engineering has tested the Picture Quality of the CODECs used in both platforms. Both platforms have CODECs that run at approximately the same data rate. Both platforms have a highest-quality and lower-quality CODEC. The highest-quality CODECs run at 220 megabits per second and the lower-quality CODECs run at 145 megabits per second.

Apple and Avid captures and output were recorded and then subsequently analyzed with an Omnitek™ full-reference Picture Quality Analyzer – Model PQA. The Picture Quality Analysis results are shown in this document.

Apple HD CODECs

Apple's production platform consists of several software products that share Encode/Decode (CODEC) technology and the QuickTime file format. Apple's Final Cut Pro software uses several certified Input/Output (I/O) cards and common CODECs. For compressed HD editing, Apple's production platform uses the ProRes422 CODECs.

Apple's ProRes 422 CODECs are analyzed in this section. Apple's HD ProRes CODECs are both 10 bit CODECs. Apple ProRes422 is a 145 megabit per second 10 bit CODEC, and Apple ProRes422HQ is a 220 megabit per second 10 bit CODEC.

Apples HD CODECs are variable-rate CODECs, so that each frame of video may have a different amount of data applied to it, and the data rate will equal the stated average rate only when looking at a number of frames. For example, for the Apple CODECs each second of video will equal 220 megabits of data, but each frame will not have the same amount of data applied to it (each frame will not be 7.3 megabits. Eg. $7.3 = 220/30$). More complex frames can use more data when encoded and less complex frames can use less data when encoded, thereby making potentially higher quality video at the expense of more mathematically complex encoding and decoding processes.

Avid HD CODECs

Avid's HD CODECs are fixed-rate CODECs, so that each frame is encoded with the same number of bytes. Each frame will be the same size with a fixed-rate CODEC.

Avid's production platform consists of several software products that share Encode/Decode (CODEC) technology. HBO has standardized on Avid's Symphony and Media Composer products that share Avid's HD CODECs for online edit use. Avid's DNXHD CODECs are analyzed in this section.

Avid refers to its CODECs with the letters "DNX" followed by the data rate in megabits per second for its 8-bit CODECs. Therefore, DNX145 is a 145 megabit per second 8 bit CODEC and DNX220 is a 220 megabit per second 8 bit CODEC. Avid's 10 bit CODECs are indicated with a trailing "X" at the end of the CODEC name. For example, DNX220X is a 10-bit version of the 220 megabit per second DNX CODEC.

Section V – Picture Quality Tests

Why are these Picture Quality Tests important?

The tests will shed light on the quality issues inherent in the Apple and Avid CODECs.

These tests will provide objective data that can be used in support of future decisions regarding edit systems in use at HBO, and may be helpful in choosing a “mezzanine” file format (also referred to as a “tape replacement” format for HBO). The tests focus on specific Signal/Noise Ratio information for each of the CODECs used in HD editing on Avid and Final Cut Pro.

These tests are important to the company because the two edit systems create visually similar output. Some objective knowledge of the inherent picture quality of the CODECs helps qualify edit systems used within HBO’s productions. This data is also helpful in supporting future edit system choices, as a record is provided of the picture quality of the edit systems under evaluation as regards well known test material.

Who did the Picture Quality Tests and Ingest/Output?

Stephen Rinaldis did the initial loading and output to HDCAM SR tape of YUV Digital Cinema Initiative (DCI) Standard Test Material (STeM) footage. Ultan Byrne performed the Ingest and Output (I/O) on an Avid Symphony Nitris DX System. Robert Zimmerman performed the I/O on a Final Cut Pro system and performed the Analysis using the Omnitek Model PQA Picture Quality Analyzer.

What is being tested?

Engineering is testing the Picture Quality of Avid’s and Apple’s CODECs using the Digital Cinema Initiative (DCI) Standard Test Material (STeM). Several CODECs are tested.

Engineering is testing the Apple CODECs (ProRes422 and ProRes422HQ) vs. Original Source Material on HDCAM SR video tape at 29.97 Hz for the Digital Cinema Initiative (DCI) Standard Test Material (STeM) sequence. This well-known test sequence is composed of frame-based material originally captured on film and supplied as uncompressed HD YUV files. These uncompressed YUV files were ingested on an Avid Symphony Nitris DX and output to video tape to be used as master material for the analysis. The identical tape was used as source material for both Apple and Avid CODEC tests.

Engineering is also testing the Avid CODECs (DNX145 and DNX220X) vs. Original Source Material on HDCAM SR video tape at 29.97Hz for the DCI STeM sequence.

The graphs below show a Picture Quality comparison of the “highest quality” Apple CODEC (ProRes422HQ) compared to the “highest quality” Avid CODEC (DNX220X) as well as a Picture Quality comparison of the “lower quality” Apple CODEC (ProRes422) compared to the “lower quality” Avid CODEC (DNX145).

Section V – Picture Quality Tests

What software was used in the Picture Quality Tests?

Omnitek PQA software Version 2.2.0.8 was used for this analysis. Omnitek PQA is a “full reference” picture quality analyzer. According to the manual, the description of the PQA as “full reference” means that picture quality is determined by comparing the test signal against a known reference version of the same image sequence. The Omnitek PQA software runs under the Windows XP Operating system.

Additional PQA Testing to be conducted in Q2 and Q3 2009 depending upon staff and vendor demo equipment availability.¹

Apple Final Cut Pro version 6.0.1 on an Apple computer running the Mac OS/X 10.5.5 operating system.

Avid Symphony Nitris DX version 1.8.1 was used on HP computers running the Windows XP 2002 Service Pack 2 operating system.

What hardware was used in the Picture Quality Tests?

The Final Cut Pro System was an Apple Power Mac Dual Quad Core Intel Xeon 3GHz CPU with 8 GBytes of 667 MHz DDR2 FB-DIMM memory and AJA Kona3 Input/Output (I/O) card).

The Avid System was a Symphony Nitris DX System built on an HP XW8600 Workstation with Dual 3GHz Intel Xeon CPUs, 4 GBytes of RAM and Nitris Input/Output (I/O).

What processes are improved by learning the results of the Picture Quality Tests?

HBO’s picture quality can be improved as a result of these tests. As a result of these tests, HBO can objectively determine the high picture quality obtainable from an edit system. When economics dictate the use of compressed video on HBO’s production platforms, the platform supporting the highest quality CODEC can be objectively deployed.

¹ HBO Engineering desires to conduct identical tests with other vendors Test and Measurement equipment to verify accuracy of the Picture Quality Analysis results.

Section V – Picture Quality Tests

Picture Quality Test Results

Picture Quality Tests were performed using Digital Cinema Initiative (DCI) Standard Test Material (STeM) images. Results of these tests are shown as Signal / Noise ratios across 30 seconds of footage. Both CODECs are capable of producing high quality video. The differences of the CODECs under test may or may not be significant. The results are discussed below.

Lower Quality Compressed HD CODECs

For lower quality compressed work (~145 Mbits/second) Apple's 10-bit ProRes422 CODEC is outperformed by Avid's 8-bit DNX145 CODEC on the DCI STeM sequences.

Highest Quality Compressed HD CODECs

The Apple 10-bit, 220 megabit per second ProRes422HQ CODEC is outperformed by the Avid 10-bit, 220 megabit per second DNX220X CODEC on the "Warm Night" DCI STeM Sequence.

The Apple 10 bit, 220 megabit per second ProRes422HQ CODEC outperforms the Avid 10 bit, 220 megabit per second DNX220X CODEC on the "Rain" DCI STeM Sequence.

The Apple 10 bit, 220 megabit per second ProRes422HQ CODEC outperforms the Avid 10 bit, 220 megabit per second DNX220X CODEC on the "Cool Night" DCI STeM Sequence in the Chroma component (PSNR C, CSNR C).

The Apple 10 bit, 220 megabit per second ProRes422HQ CODEC outperforms the Avid 10 bit, 220 megabit per second DNX220X CODEC on the "Cool Night" DCI STeM Sequence in the Luma component (PSNR Y, CSNR Y).

Section V – Picture Quality Tests

Apple / Avid CODEC Comparison – Tables

Cool Night	Baseline	ProRes 422	Avid DNX 145	Apple / Avid %	ProRes 422HQ	Avid DNX 220X	Apple / Avid %
PSNR Y	100	41.44	48.92	84.71%	49.17	51.88	94.78%
PSNR C	100	45.21	47.92	94.34%	51.12	50.36	101.51%
CSNR Y	100	45.11	53.95	83.61%	54.62	58.04	94.11%
CSNR C	100	50.04	52.89	94.61%	56.93	56.76	100.30%

Warm Night	Baseline	ProRes 422	DNX 145	Apple / Avid %	ProRes 422 HQ	DNX 220X	Apple / Avid %
PSNR Y	100	36.18	44.32	81.63%	38.20	47.66	80.15%
PSNR C	100	41.28	43.77	94.31%	43.18	46.85	92.17%
CSNR Y	100	37.76	46.50	81.20%	40.15	50.89	78.90%
CSNR C	100	43.06	45.16	95.35%	45.45	49.33	92.13%

Rain	Baseline	ProRes 422	DNX 145	Apple / Avid %	ProRes 422 HQ	DNX 220X	Apple / Avid %
PSNR Y	100	37.04	43.84	84.49%	47.15	47.12	100.06%
PSNR C	100	40.94	43.30	94.55%	47.70	46.30	103.02%
CSNR Y	100	39.27	46.85	83.82%	51.82	51.79	100.06%
CSNR C	100	44	45.96	95.74%	52.53	50.30	104.43%

145 Mbit Average	89.03%		220 Mbit Average	95.13%
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Table 2: Apple / Avid CODEC Comparison Tables

Section V – Picture Quality Tests

Cool Night DCI STeM Sequence

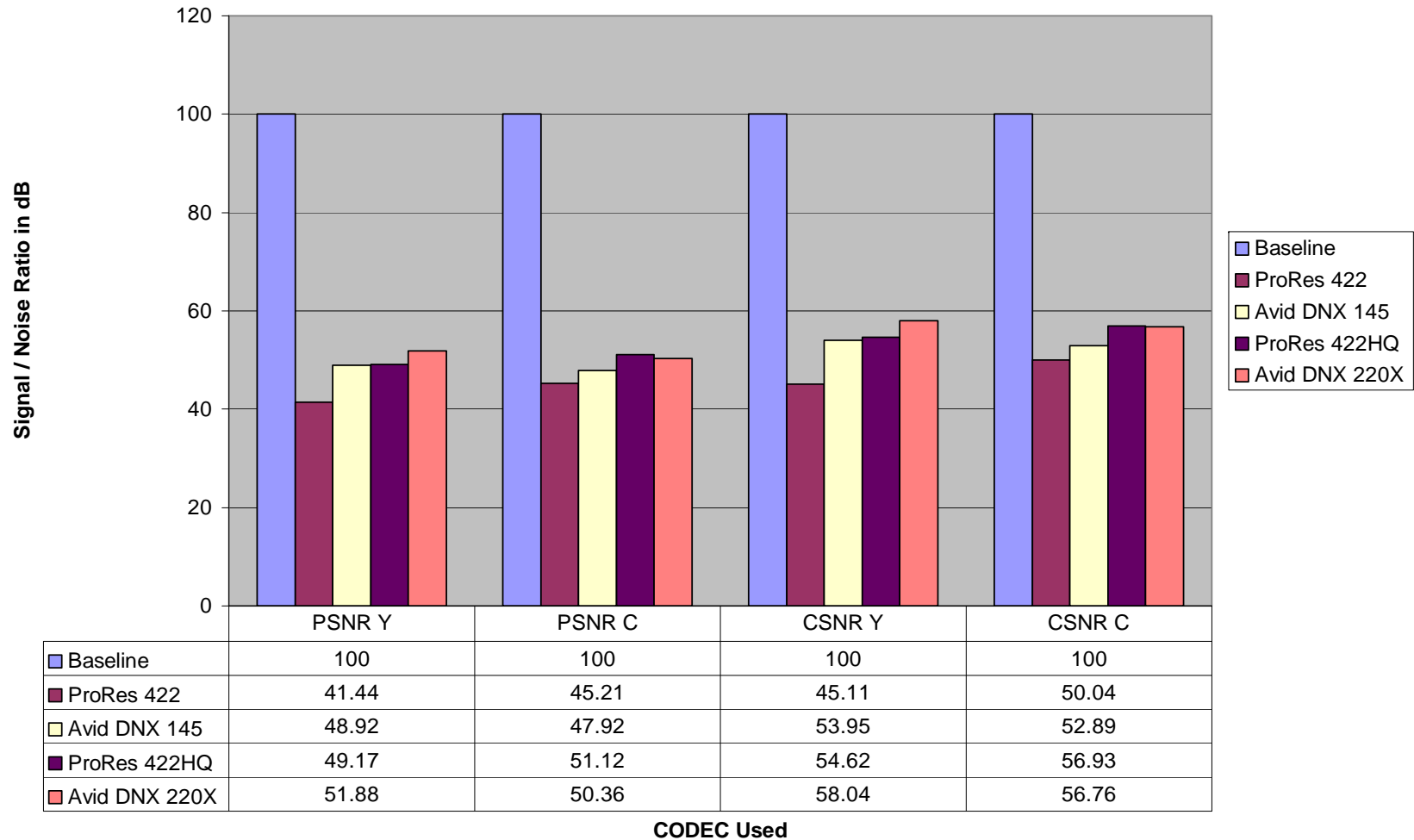


Figure 5 : Cool Night DCI STeM Sequence

Section V – Picture Quality Tests

Warm Night DCI STeM Sequence

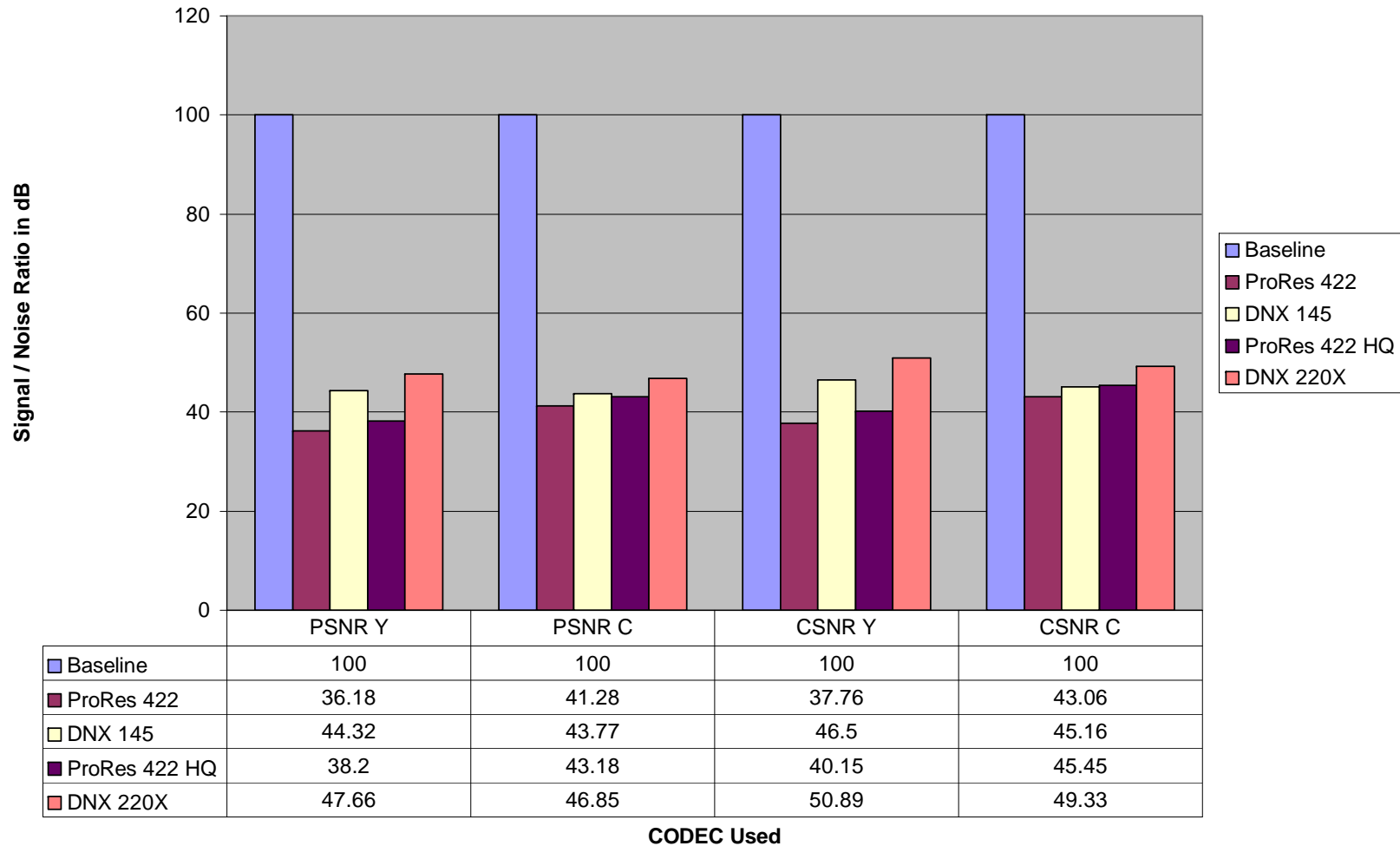


Figure 6 : Warm Night DCI STeM Sequence

Section V – Picture Quality Tests

Rain DCI STem Sequence

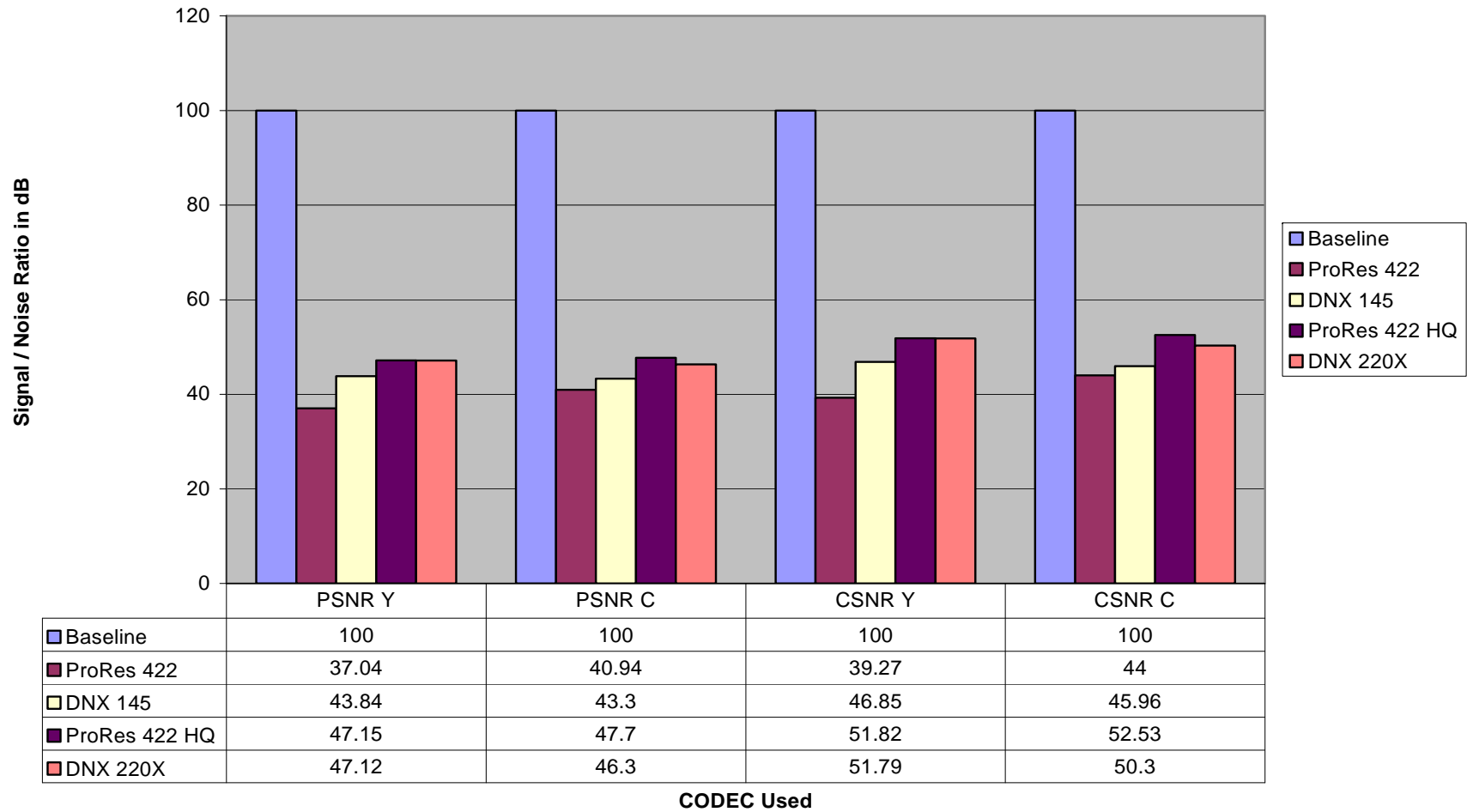


Figure 7 : Rain DCI STem Sequence

Section V – Picture Quality Tests

What are the parameters and method of the Picture Quality Tests?

The tests report on Signal / Noise Ratio for Luma and Chroma (PSNR Y and PSNR C) and Edge Compensated Signal / Noise Ratio for Luma and Chroma (CSNR Y and CSNR C)².

The method of testing was:

- An HDCAM SR tape containing Digital Cinema Initiative Test Sequences was created for use in these and other tests.
 - i. Digital Cinema Tests Images were procured as uncompressed YUV files.
 - ii. These files were ingested to an Avid Symphony Nitris DX and output as uncompressed video to HDCAM SR tape.
- The DCI Test Sequence was ingested from HDCAM SR tape into an Apple system at the Broadcast Center (**Final Cut Pro**) using the ProRes422 and ProRes422HQ CODECs.
- Material was output to HDCAM SR tape from the Apple Final Cut Pro system.
- The DCI Test Sequence was ingested from HDCAM SR tape into the Avid system in Digital Online C (**Avid Symphony Nitris DX**) using the DNX145 and DNX220X CODECs. It should be noted that all Avid Professional Products support the DNX CODECs.
- Material was output to HDCAM SR tape from the Avid Symphony Nitris DX system.
- The Omnitek model PQA software was configured to capture 30 seconds (900 frames) of video for analysis.
- Capture of video from the HDCAM SR tapes above was triggered by timecode allowing the capture to happen at the same time on each tape, making comparisons of identical material in subsequent captures possible.
- Source tapes were compared to record tapes using the Omnitek Picture Quality Analyzer model PQA.
- Graphs and reports were saved from the analysis runs.
- Comparison graphs were produced by the Omnitek PQA software. These graphs are shown in the report.

² CSNR is claimed by Omnitek Engineering to provide a more accurate representation of perceived image quality for a human observer.

Technical Analysis: Apple/Avid Production Platforms

Section V – Picture Quality Tests

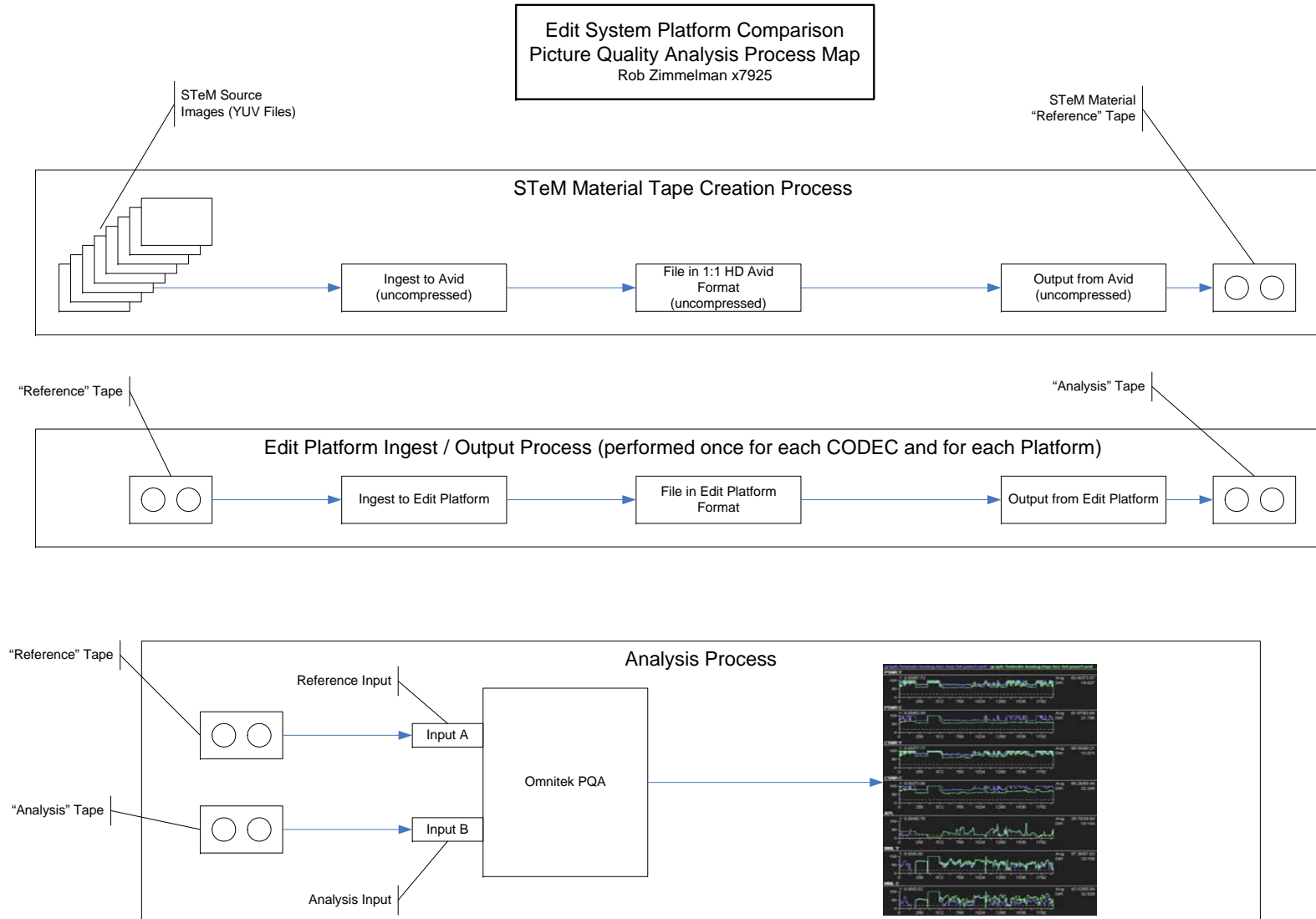


Figure 8 : Picture Quality Analysis Process Map

Section V – Picture Quality Tests

Sample Images

In order to better illustrate the material used in the tests, images from the test sequences are shown.

Warm Night

The DCI “Warm Night” scene is list with “warm” lighting (low color temperature).



Figure 9 : DCI Warm Night Image

Section V – Picture Quality Tests

Cool Night

The DCI “Cool Night” scene is lit with “cool” lighting (high color temperature). There is strong fog throughout the scene.



Figure 10 : DCI Cool Night Image

Section V – Picture Quality Tests

Rain

The DCI “Rain” sequence is a dark scene with a lot of high-frequency information, caused by the “noisy” rain that includes droplets of water on a dark cobblestone street.



Figure 11 : DCI Rain Image

Section V – Picture Quality Tests

[Interpreting the Graphs](#)

The following is an Excerpt from the Omnitek Model PQA Reference Manual, describing the way to interpret the Graphs produced by the PQA product:

PSNR Graphs

“The PSNR graphs show peak signal-to-noise ratio measurements, calculated in real-time for the luma component (PSNR-Y) and the chroma component (PSNR-C). The algorithm used to calculate the results is the industry-standard algorithm for PSNR, details of which are given in Appendix A of the Omnitek PQA manual. Measurements are made on every field of the input video signal (or frame in progressive-scan formats). The vertical axis is calibrated in dB. In practical terms, a PSNR value of 100dB means that the test and reference signals are identical, to an accuracy of one pixel per field. Opinions on the interpretation of other PSNR values vary, but it is generally accepted that measurements of 30dB or below are of “unacceptable quality”.

CSNR Graphs

The CSNR graphs also show signal-to-noise ratio measurements but here edge enhancement and luma compensation techniques have been used to provide a measurement of that reflects more closely subjective visual determinations of picture quality. The CSNR algorithm is proprietary to OmniTek and is dependent on an Edge threshold parameter which is set through the Picture Quality Configuration dialogue. Again the vertical axis of the quality graph is calibrated in dB, with a value of 100 indicating that the test and reference images are identical. What CSNR level represents the boundary between unacceptable quality and acceptable quality for any specific environment is really for the user to decide, but it is suggested that a value of 40dB is a useful starting point for discussion.

Section V – Picture Quality Tests

APL Graph

The APL graph shows the average luma level of either the test image or the reference image (selected through the control panel). This level is calculated simply by summing the total value of the pixel luma values over the whole video field or frame, then dividing by the size of the field or frame. On this graph, the vertical axis is calibrated in “percent full-scale digital”, such that a flatfield image at SMPTE digital white level (940) will have a value of $940 / 1023 = 91.9\%$ on the graph.

MNL Graphs

The MNL-Y and MNL-C graphs show the Macroblock Noise Level detected in the test image in luma and chroma, respectively. These are single-ended measurements that do not require the reference video to be present. Macroblocks are artefacts typical of certain types of compression techniques, in particular those used in JPEG and MPEG-2 files which are based on 8x8 or 16x16 blocks. The MNL values are therefore calculated by summing the number of 8x8 or 16x16 block edges detected in the image on a field-by-field (or, in progressive formats, frame-by-frame) basis. The values obtained are scaled such that a value of 100 means no edges detected while 0 means that many edges have been detected (i.e. poor overall quality). The nature of the detection algorithm means that the basic MNL-Y and MNL-C measurements are dependent on picture content and are anyway somewhat subjective.

The PQA’s macroblock algorithm therefore provides alternative edge and luma compensation modes that enhance the accuracy of the basic calculation. These modes are enabled through the Picture Quality Configuration dialogue, which is displayed by taking the Configuration option from the Options menu at the top of the Picture Quality window.”³

³ Source: Omnitek PQA Reference Manual

Section V – Picture Quality Tests

BASELINE – SINGLE SOURCE COMPARED TO ITSELF

Below you will see the graph of one VTR connected to both inputs of the PQA while viewing the “Cool Night” sequence. You will note that all Signal to Noise Ratios are 100, meaning that there is no difference between the two signals. This is to be expected, and is included as a part of the tests to provide confidence to the reader that the equipment is working as specified.

While the Signal to Noise ratio is constant and perfect, the Average Picture Level changes according to the content of the video. Please note that the graph below represents **one test run** while the remaining graphs in the analysis represent **comparisons of one run to another**.

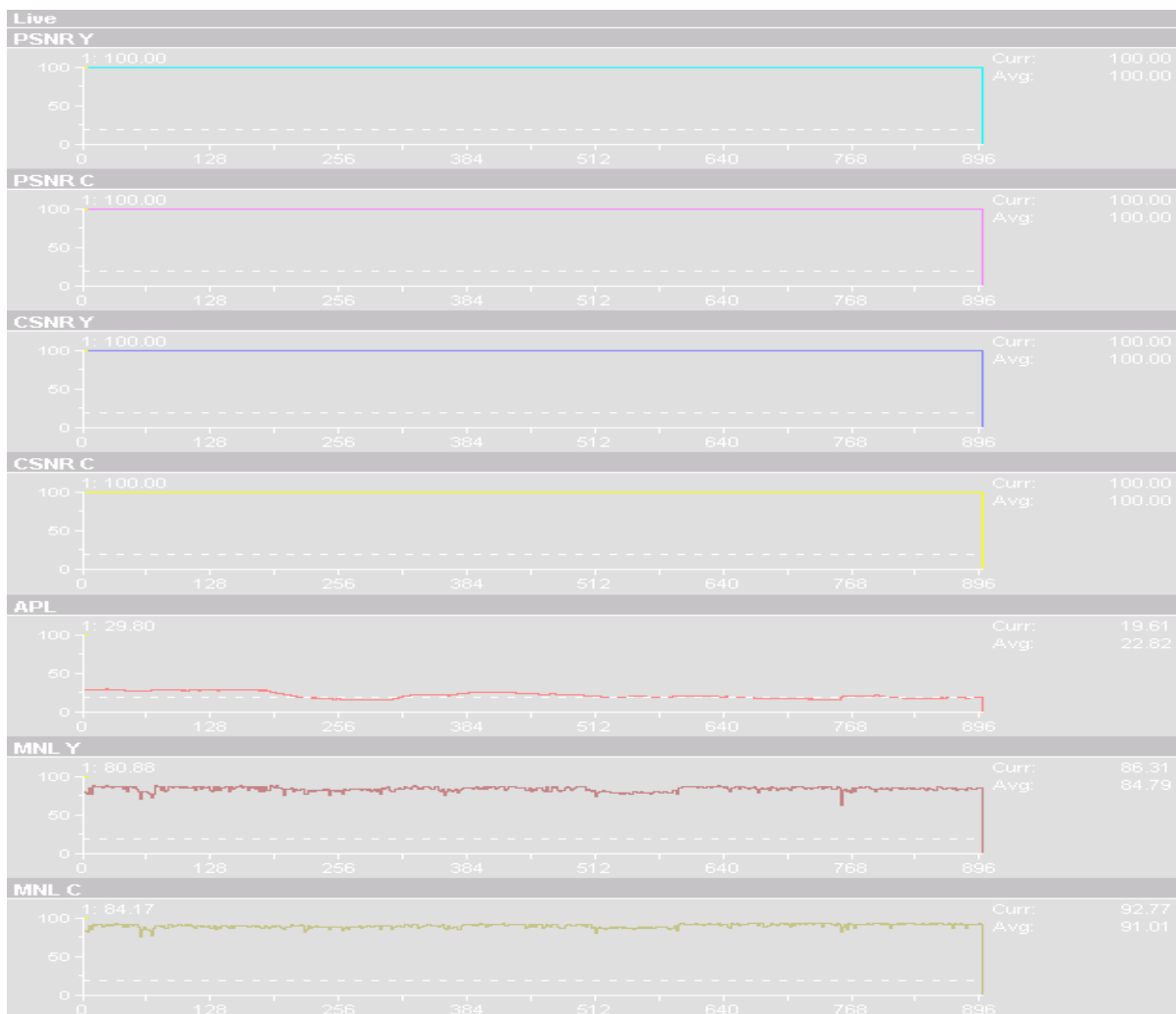


Figure 12 : PQA Baseline Graph

Section V – Picture Quality Tests

Picture Quality Test Graphs

COOL NIGHT DNX145 (blue) and DNX220X (green)

Below you will see a comparison of the two HD Avid CODECs to uncompressed source material.

In the graph below you will see that DNX145 (blue) delivers almost 49dB of PSNR, while DNX220X (green) delivers almost 52dB of PSNR. The DNX220X material more closely resembles the source material as indicated in the better Signal/Noise Ratio. This is a dark scene, as illustrated in the Average Picture Level (APL) graph. The DNX220X outperforms the DNX145 CODEC by 4dB in CSNR Y, which is stated by Omnitek Engineering to be a better indicator of perceived image quality by a human observer.

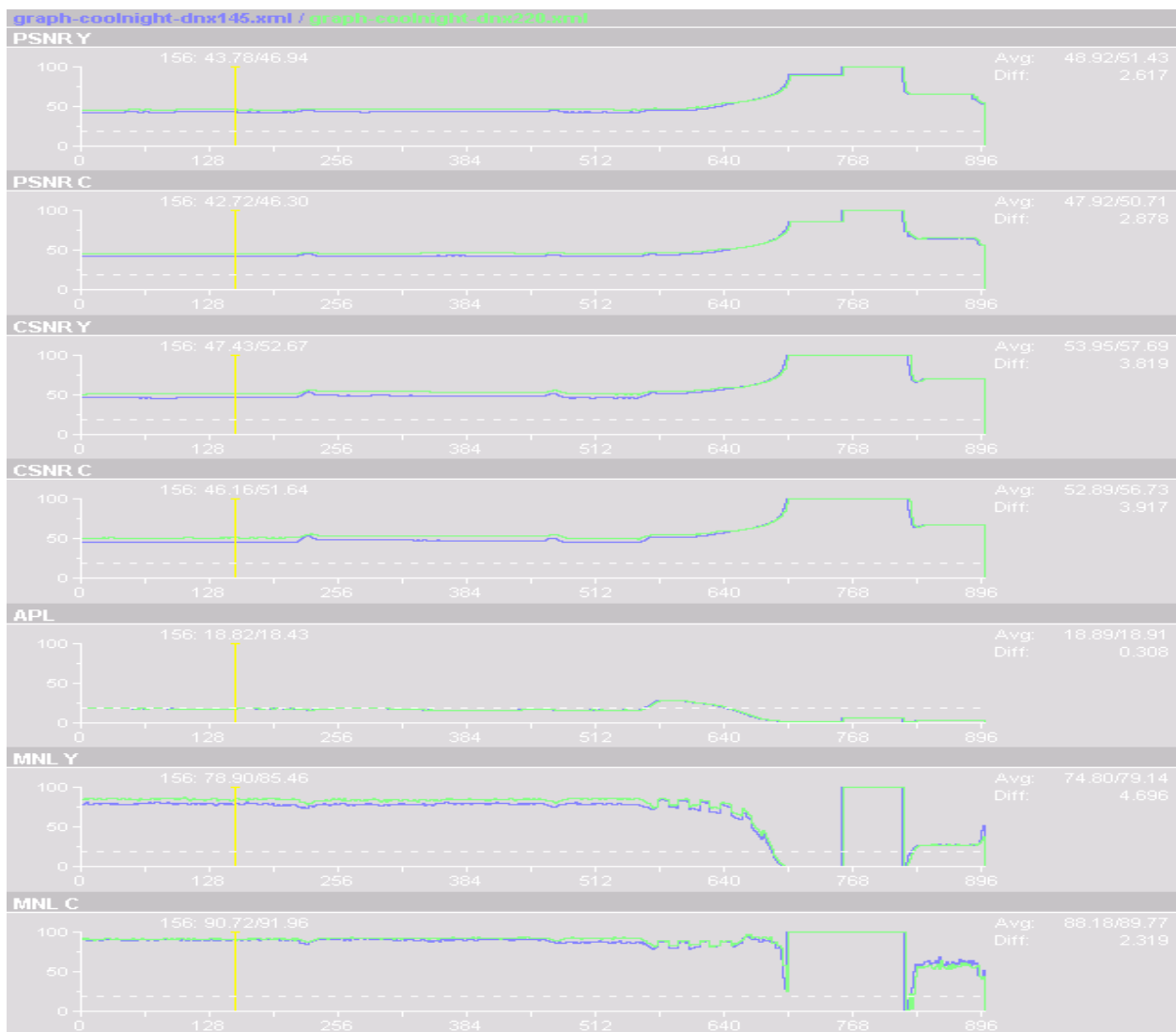


Figure 13 : DCI Cool Night Sequence: DNX145 and DNX220X

Section V – Picture Quality Tests

COOL NIGHT DNX145 (blue) and PRORES422 (green)

Below you will see a comparison between the “lower quality” HD CODECs from Apple and Avid. You will see DNX145 (~49dB PSNR) in blue and ProRes422 (~41.5dB PSNR) in green. In the difficult fog scene at the beginning of this test sequence, the Avid CODEC outperforms the Apple CODEC at an average of 7.6 dB PSNR and by 8.843 dB CSNR, stated by Omnitek Engineering to be a better indicator of perceived image quality by a human observer.

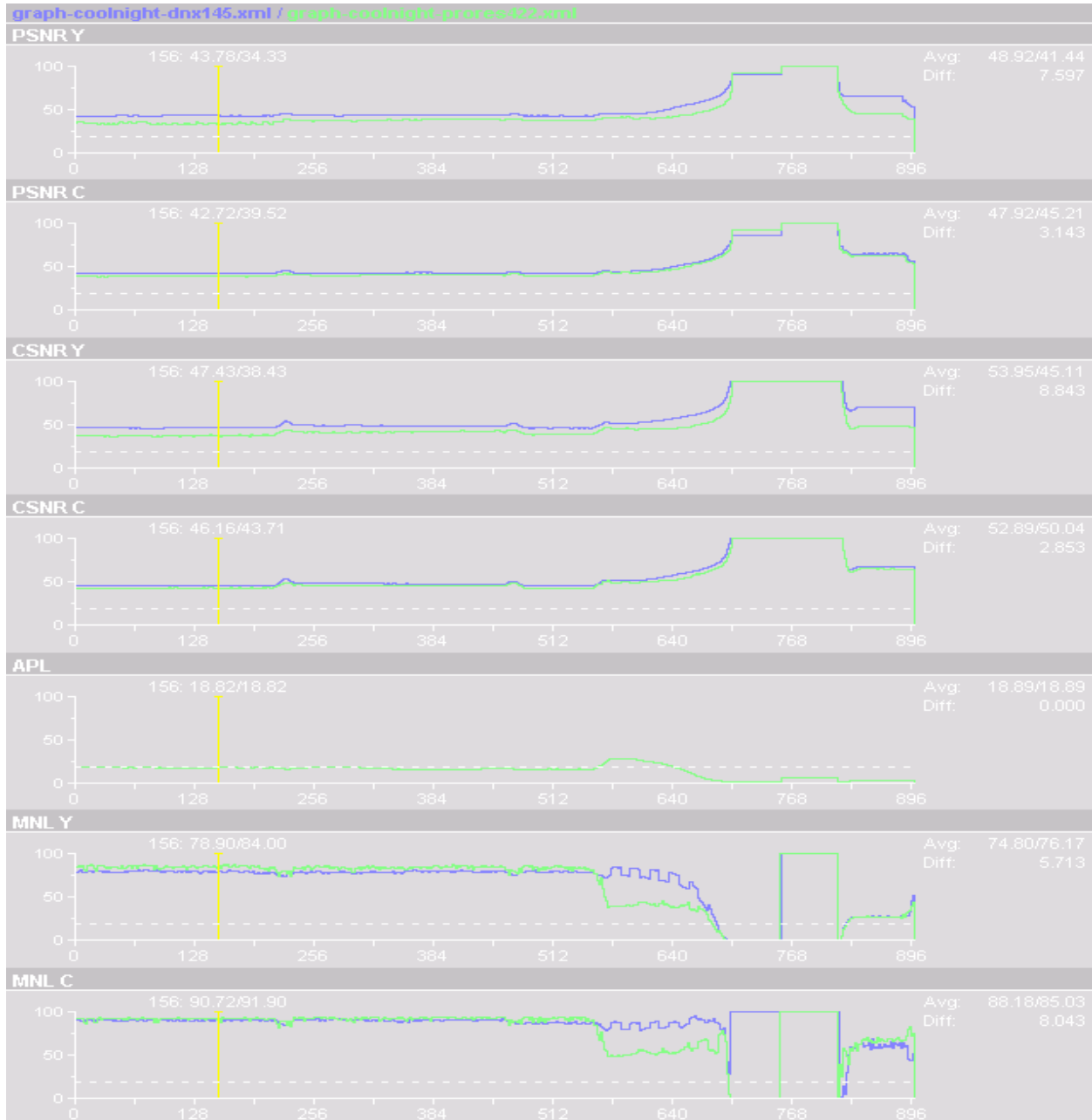


Figure 14 : DCI Cool Night Sequence: DNX145 and ProRes422

Section V – Picture Quality Tests

COOL NIGHT DNX220X (blue) and PRORES422HQ (green)

Below you will see a comparison between the “highest quality” HD CODECs from Apple and Avid. You will see DNX220X (~52dB PSNR) in blue and ProRes422HQ (~50dB PSNR) in green. The Avid CODEC outperforms the Apple CODEC at an average of 4.6 dB PSNR and 5.2 dB CSNR, stated by Omnitek Engineering to be a better indicator of perceived image quality by a human observer.

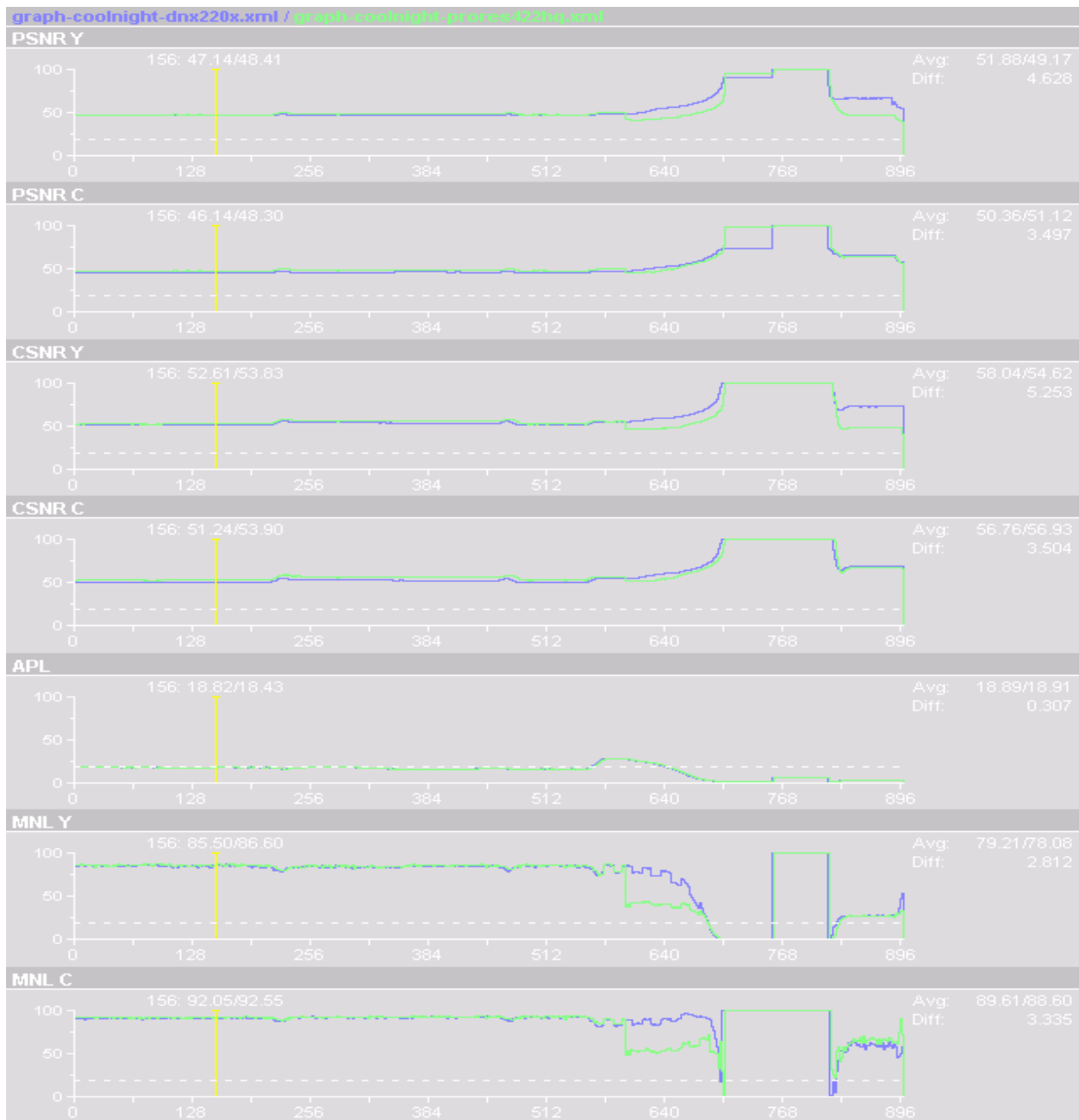


Figure 15 : DCI Cool Night Sequence: DNX220X and ProRes422HQ

Section V – Picture Quality Tests

COOL NIGHT PRORES422 (blue) and PRORES422HQ (green)

Below you will see a comparison between the two Apple HD CODECs. You will see ProRes422 (~41.5dB PSNR) in blue and ProRes422HQ (~50dB PSNR) in green. As expected, the higher quality Apple CODEC outperforms the lower quality Apple CODEC at an average of 7.8 dB PSNR and 9.6 dB CSNR, stated by Omnitek Engineering to be a better indicator of perceived image quality by a human observer.

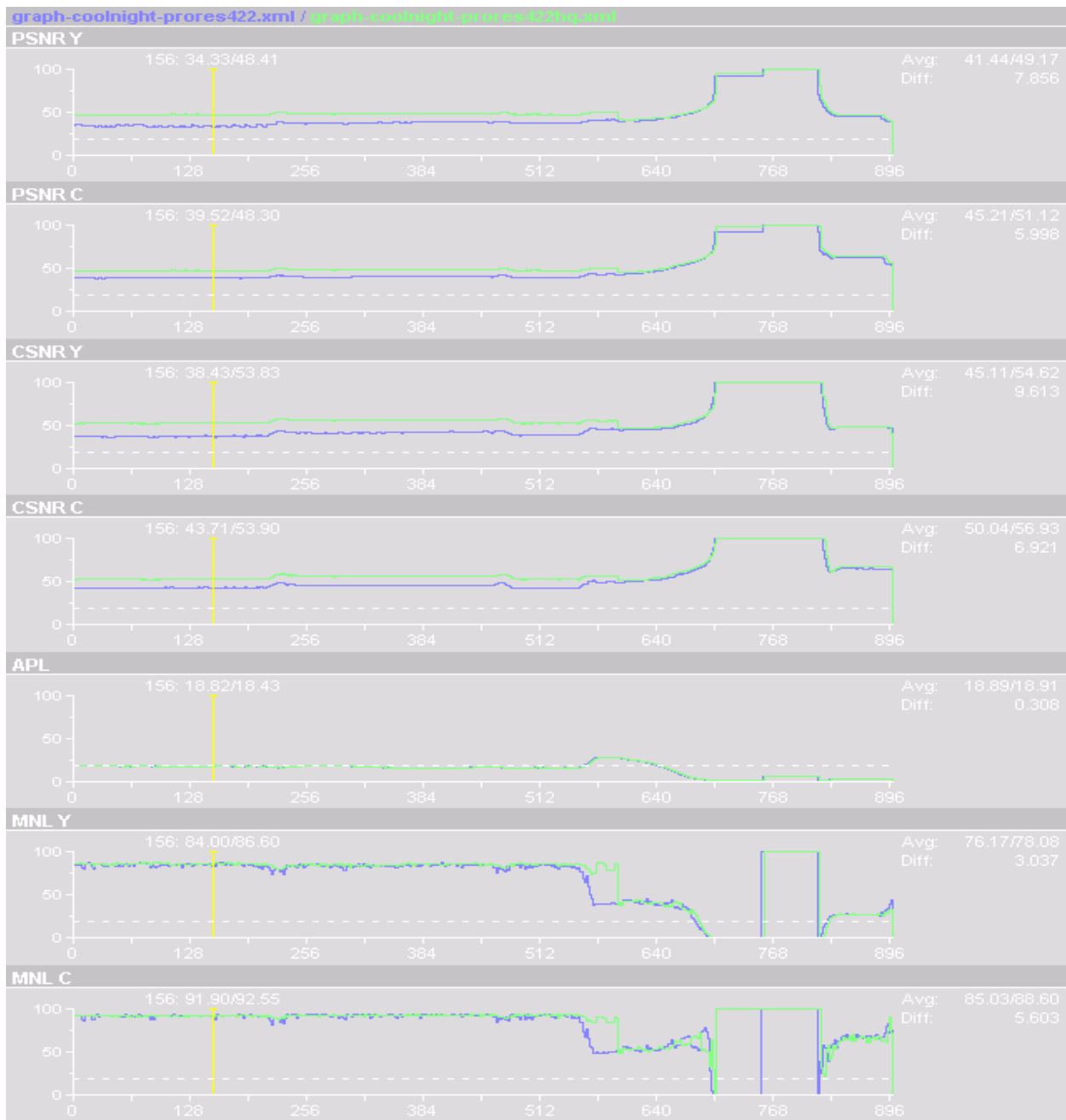


Figure 16 : DCI Cool Night Sequence: ProRes422 and ProRes422HQ

Section V – Picture Quality Tests

RAIN DNX145 (blue) and PRORES422 (green)

Below you will see a comparison between the two “lower quality” HD CODECs from Apple and Avid in the difficult “Rain Sequence” of the STeM material. You will see DNX145 (~44dB PSNR) in blue and ProRes422 (~37dB PSNR) in green. The Avid CODEC outperforms the Apple CODEC at an average of 6.8dB PSNR and 7.62 CSNR, stated by Omnitek Engineering to be a better indicator of perceived image quality by a human observer.

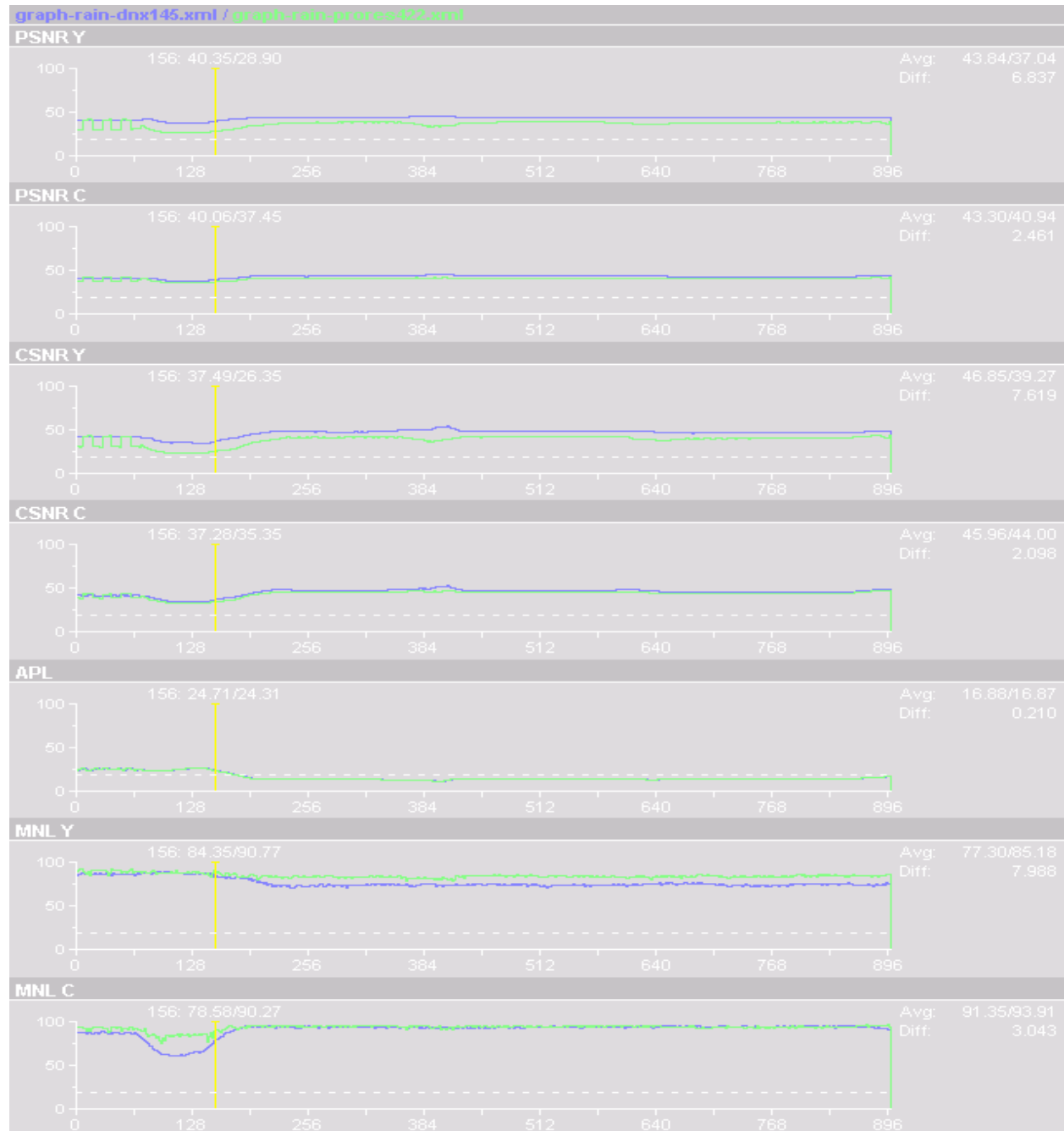


Figure 17 : DCI Rain Sequence: DNX145 and ProRes422

Section V – Picture Quality Tests

RAIN DNX220X (blue) and PRORES422HQ (green)

Below you will see a comparison of the DCI STeM Rain Sequence between the “highest quality” HD CODECs from Apple and Avid. You will see ProRes422HQ (~47dB PSNR) in green and DNX220X (~47dB PSNR) in blue. In this sequence, the Apple and Avid CODECs performed similarly, with the exception of the end of the sequence, where the Avid CODEC outperforms the Apple CODEC.

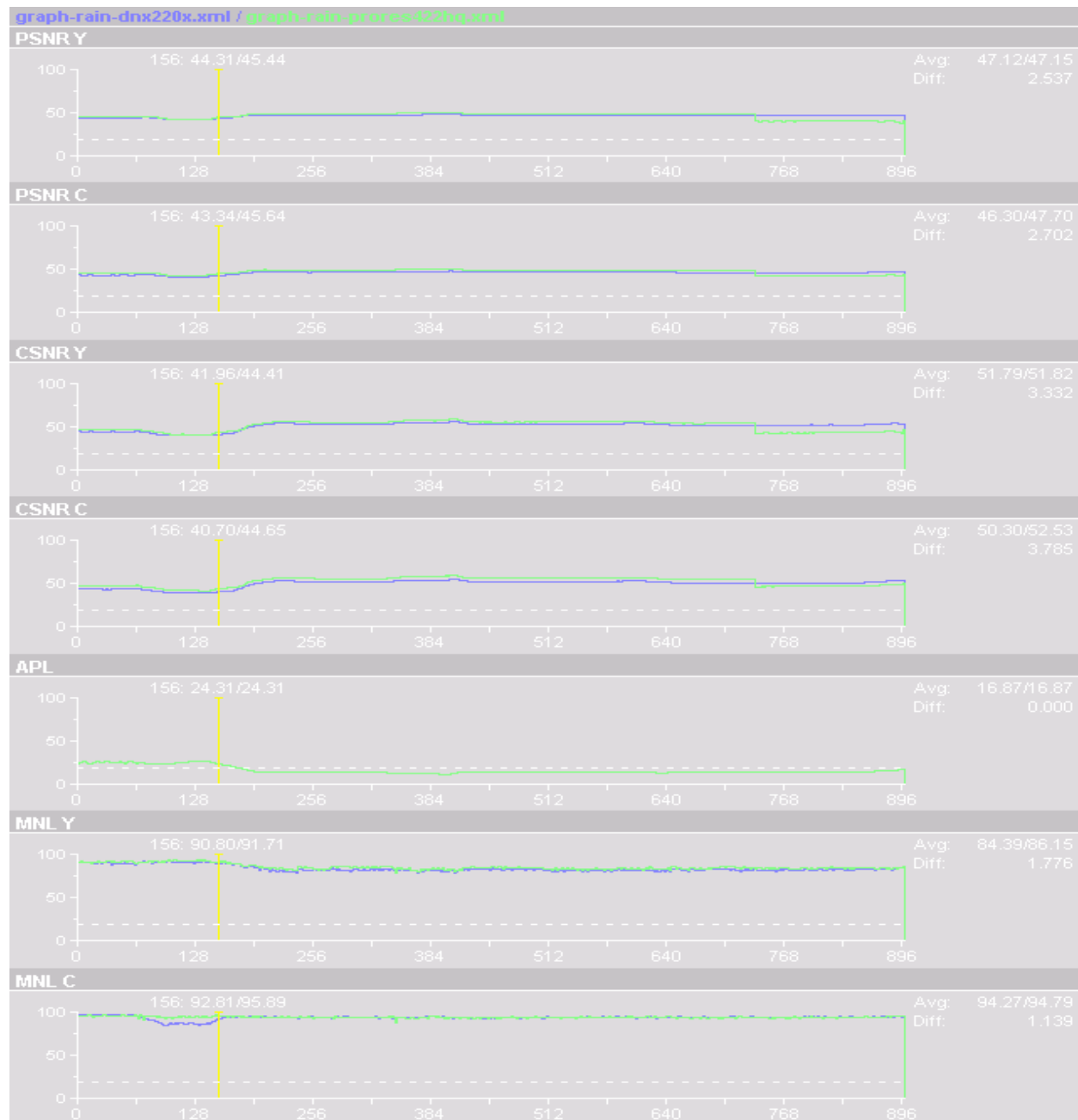


Figure 18 : DCI Rain Sequence: DNX220X and ProRes422HQ

Section V – Picture Quality Tests

WARM NIGHT 2 DNX145 (blue) and PRORES422 (green)

Below you will see a comparison of the DCI STeM “Warm Night” images between the two “lower quality” HD CODECs from Apple and Avid. You will see DNX145 (~44dB PSNRY) in blue and ProRes422 (~36dB PSNRY) in green. The Avid CODEC outperforms the Apple CODEC in this scene at an average of 8.3dB PSNRY and 9.145 dB CSNRY, stated by Omnitek Engineering to be a better indicator of perceived image quality by a human observer.

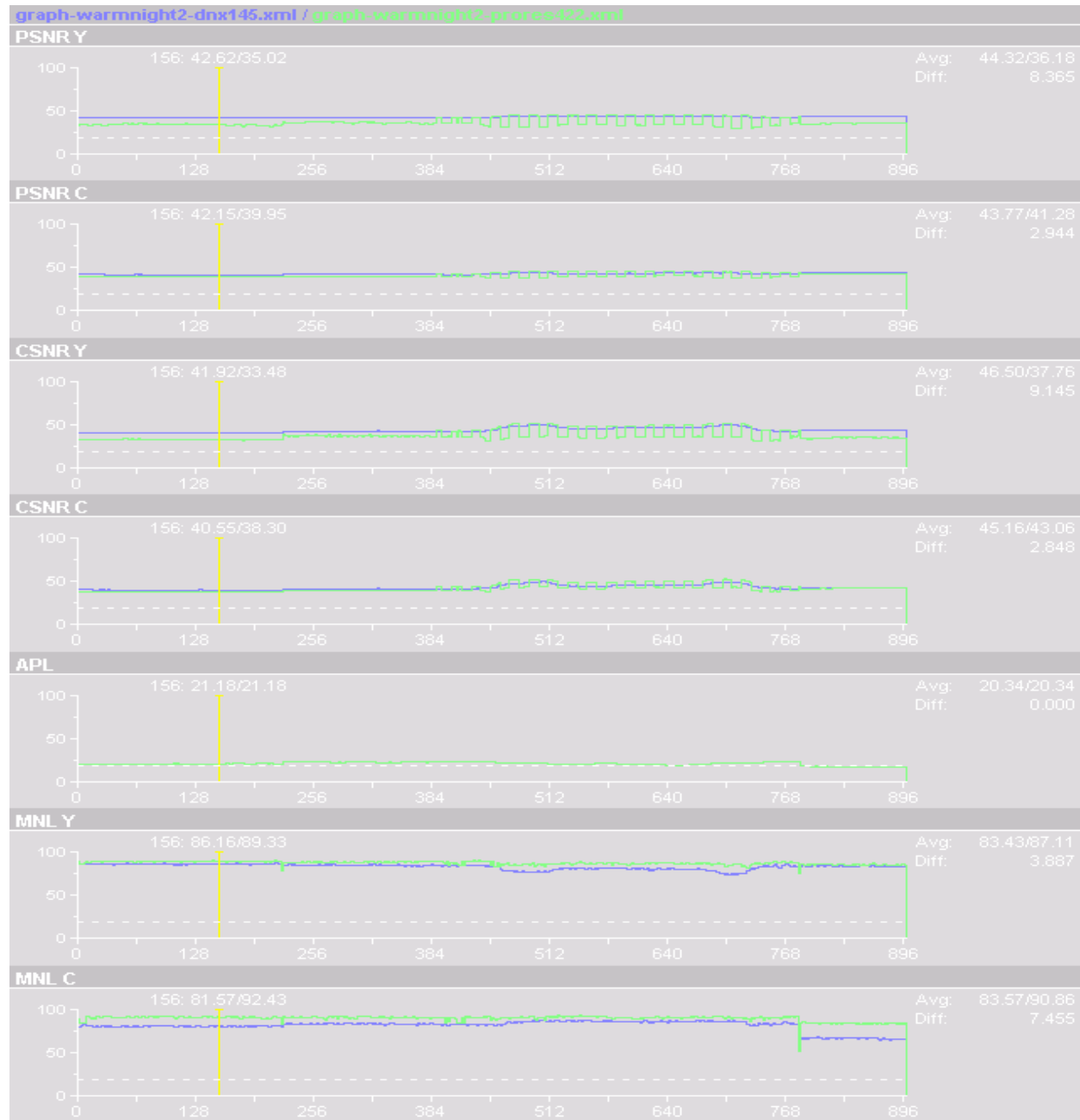


Figure 19 : DCI Warm Night Sequence: DNX145 and ProRes422

Section V – Picture Quality Tests

WARM NIGHT 2 DNX220X (blue) and PRORES422HQ (green)

Below you will see a comparison of the DCI STeM “Warm Night” images between the two “best quality” HD CODECs from Apple and Avid. You will see DNX220X (~47.6dB PSNR) in blue and ProRes422 (~38.2dB PSNR) in green. Once again, the Avid CODEC outperforms the Apple CODEC at an average of 9.7dB PSNRY and 11.06 dB in CSNRY, stated by Omnitek Engineering to be a better indicator of perceived image quality by a human observer.

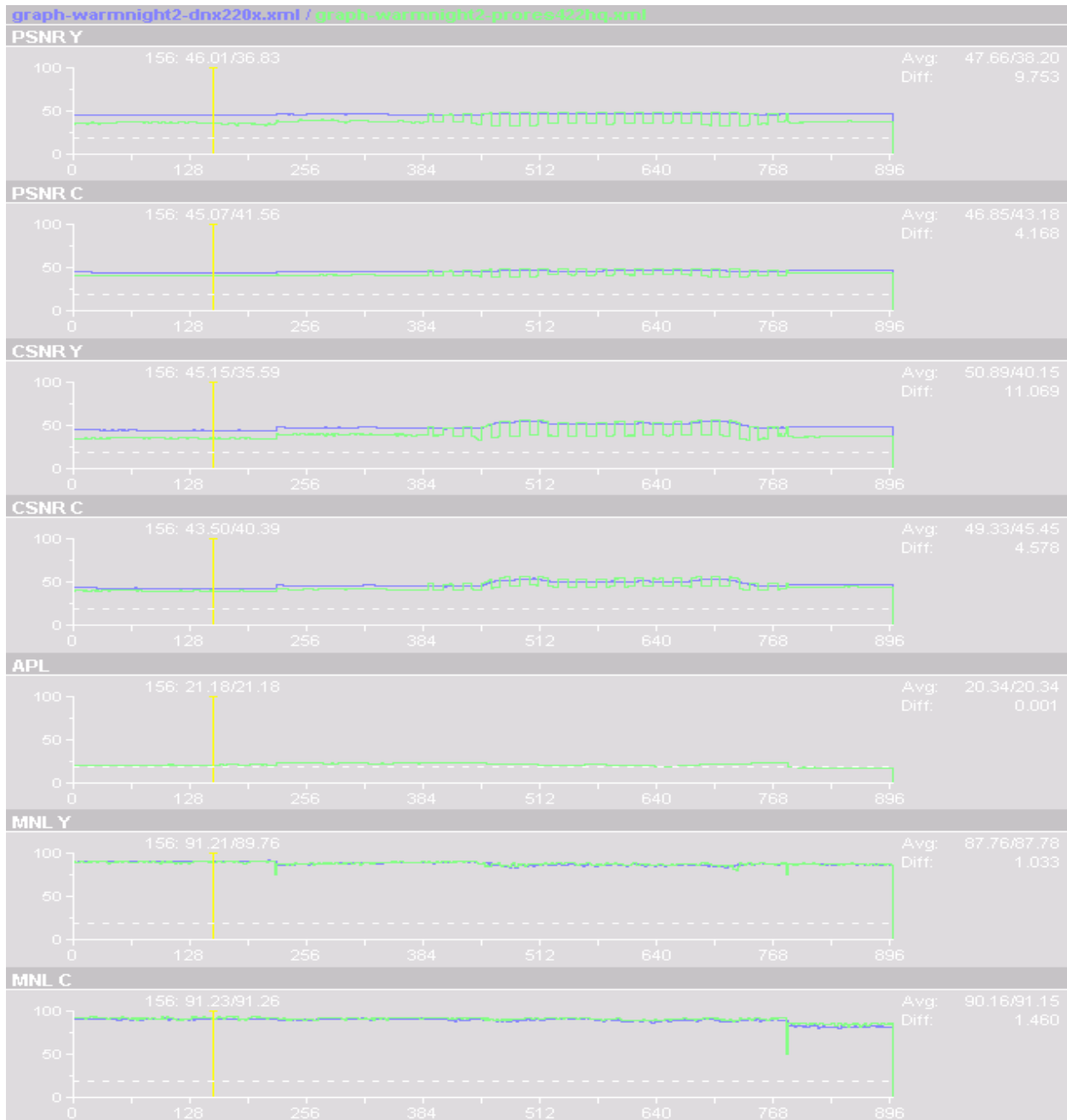


Figure 20 : DCI Warm Night Sequence: DNX220X and ProRes422HQ

Section V – Picture Quality Tests

WARM NIGHT DNX145 (blue) and PRORES422 (green)

Below you will see a comparison of the DCI STeM “Warm Night” (start of sequence) images between the two “lower quality” HD CODECs from Apple and Avid. You will see DNX145 (~45.4dB PSNR) in blue and ProRes422 (~36.2dB PSNR) in green. The Avid CODEC outperforms the Apple CODEC in this scene at an average of 9.2dB PSNRY and 10.286 dB CSNRY. Results are similar to the “Warm Night 2” sequence above, because the tests are from different areas of the same scene.

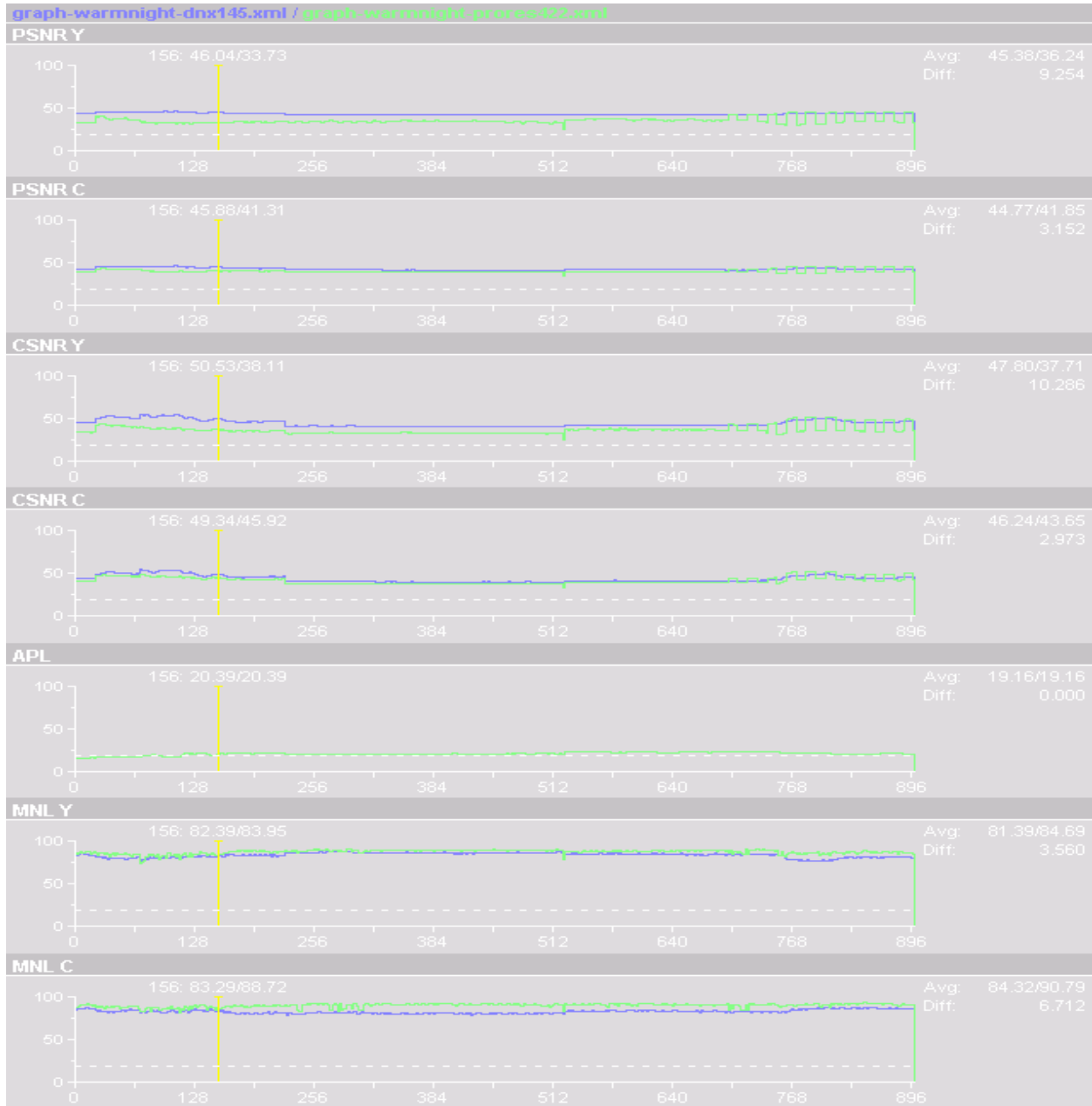


Figure 21 : DCI Warm Night Sequence: DNX145 and ProRes422

Concepts / Terms in the Picture Quality Tests Section

Some terms used in this section follow:

Luma	The black/gray/white information in a video signal, represented as the letter "Y"
Chroma	The color information in a video signal, represented as the letter "C"
Signal	The information transmitted over a in a particular channel
Noise	1. Any difference between the information transmitted over a particular channel and the information received over the channel. 2. Inaccuracy in the analysis image compared to a reference image.
SNR	Signal / Noise Ratio. 1. The ratio of pure Signal to Noise in the image being analyzed. 2. Accuracy of an image sequence being analyzed compared to a reference image sequence
PSNR Y	Peak signal to noise ratio for Luma
PSNR C	Peak signal to noise ratio for Chroma
CSNR L	Edge compensated signal to noise ratio for Luma. According to the Omnitek manual, edge enhancement and Luma compensation techniques have been used to provide a measurement of that reflects more closely subjective visual determinations of picture quality.
CSNR C	Edge compensated signal to noise ratio for Chroma.
APL	Average Picture Level for either the Reference channel or the Test channel, depending on the APL Channel Select setting. This is the level that the Engineer would see on the video scope. This level is calculated simply by summing the total value of the pixel Luma values over the whole video field or frame, then dividing by the size of the field or frame.
MNL Y	Macroblock level on the Test channel for Luma
MNL C	Macroblock level on the Test channel for Chroma
Pixel	Picture Element. One "dot" on the display grid. HD video contains 1920 x 1080 pixels
Mezzanine	Video Tape replacement file format. This file format will be used throughout the organization in support of several strategic initiatives
I/O	Input / Output. Ingest / Output.

For Further Information regarding Avid and Apple

www.avid.com

www.apple.com

For Further Information on Test System used to Analyze Avid and Apple CODECs

Omnitek Web Site: www.omnitek.tv

For Further Information on Interpreting the Graphs

See the section titled, “Interpreting the PQA Graphs” for assistance and a brief explanation of the various terms reported in the graphs.

For Further Information on Digital Cinema Initiative Test Sequences

Digital Cinema Initiatives. Digital Cinema Initiatives, LLC (DCI) was created in March, 2002, and is a joint venture of Disney, Fox, Paramount, Sony Pictures Entertainment, Universal and Warner Bros. Studios. DCI's primary purpose is to establish and document voluntary specifications for an open architecture for digital cinema that ensures a uniform and high level of technical performance, reliability and quality control.

Digital Cinema Initiative Web Site: <http://www.dcinovies.com/>

Section VI – Test and Measurement

Section VI – Test and Measurement

Test and Measurement Introduction

The Test and Measurement section contains results of tests that were conducted and measurements that were taken on production systems from Apple and Avid. The tests consisted of performance benchmarks on existing HD edit systems at the Studio. Results of these performance benchmark tests are presented in table and bar-graph form. The tests were performed by a staff editor and timed by Engineering personnel. The purpose of performing these empirical benchmark tests was to obtain quantifiable performance metrics from Apple and Avid production systems when creating commonly used effects at the studio.

The Test and Measurement Section also contains a List of Production Platform Attributes. This List of Production Platform Attributes contains all of the items discovered in interviews with Production Engineering personnel and management regarding important features of a production platform, whether tested or not.

Test and Measurement Audience

This test and measurement section was written for HBO Studio Operations and Engineering Management.

Test and Measurement Assumptions

It is assumed that the reader is familiar with commonly-used effects and workflows in post production. It is also assumed that the reader is familiar with the terms real-time, rendering, text titles, matte, fill, fade, wipe, dissolve, picture-in-picture, video layers, and file exports.

What strategic initiatives are supported by this section's analysis?

The Test and Measurement section supports the Desktop and DETE Initiatives by providing detailed measurements of platform performance. Results of tests in this section help HBO Studios to deploy an optimally configured system in support of these initiatives.

Why is this analysis important to the initiatives?

The data gathered in this analysis helps the Production Engineering department to deploy the appropriate system for each post production project. The results of the tests help determine the power of each production system performing typical effects work. Depending upon the type of effects work done, systems of different power can be deployed. If simple cuts-only effects represent the majority of work done in the edit suites, then a larger percentage of lower-powered systems should be deployed. If complex multi-layer graphics represent the majority of the work done in the edit suites, then a larger percentage of higher-powered systems with hardware acceleration should be deployed.

Which departments or groups benefit from the analysis?

All groups that use the Studio's edit systems benefit from this analysis.

Who performed the tests and measurement?

Phil Chalmers performed the edit tests on the Apple and Avid systems. Reynold Rossi and Rob Zimmelman performed the measurements.

What is being analyzed?

The speed of Apple's and Avid's edit systems when running commonly-performed edit session operations is analyzed. The speed of the systems was discovered in empirical tests. The empirical tests consisted of blurs, picture-in-pictures, time slow-downs, titles, fades, wipes, dissolves, matte and fills, and file exports.

When and where did this analysis take place?

The analysis took place in June, 2009 in HBO Studio's Edit Suites DOD, DOC, DOA.

How was the analysis done?

The analysis was done by timing effects, entering data in Excel™ charts, creating graphs, and scrutinizing the charts and graphs for similarities and differences in the speed of the systems to complete the effects.

The tests were conducted using the following method:

1. Editor digitizes material.
2. Editor creates timeline.
3. Editor creates the effect on the timeline.
4. "Timer" holds the stopwatch and waits for the word "start" to begin the test.
5. Editor counts down the render and starts the render while saying "start".
6. "Timer" starts stopwatch.
7. Editor indicates the end of the effect by saying, "stop".
8. "Timer" stops stopwatch.
9. Analyst enters data in spreadsheets.
10. Tables and graphs are created.
11. Tables and graphs are examined for similarities and differences in test times.

Section VI – Test and Measurement

What are the parameters of the analysis?

The parameters of the analysis were machine type, edit software, effect or operation type, effect or operation duration, and render time (when required by the system).

What were the additional details of the analysis process?

Tests were manually timed using two different stopwatches, both capable of reading out times to the hundredth of a second. One stopwatch used was an LG Dare™ Verizon cell phone. The other stopwatch used was an Apple Stopwatch Widget installed in the edit suite's I.T. Macintosh. While the tests were manually timed, they were repeatable. In several fade tests that resulted in test times to the hundredth of a second, when repeated, the second test results were identical to the first test results.

What is improved by learning the results of this analysis?

Several improvements are achieved by learning the results of this analysis. The edit and effects processes are improved by helping HBO to deploy an appropriate system for the complexity of the edit session. Prices of edit systems vary widely depending upon hardware acceleration. HBO can deploy expensive edit systems with hardware-acceleration where the highest performance is required, and deploy less expensive software-only edit systems where the highest performance is not required, but where low cost is more important. Client relations are improved because less time is spent in effects-intensive edit sessions when a hardware-accelerated system is deployed. The company's bottom line is improved by deploying less expensive edit systems for less complex jobs, where more expensive hardware acceleration is not required.

Section VI – Test and Measurement

Test and Measurement – Performance Comparison of Representative Systems

Systems under test included a representative Apple Final Cut Pro system and two Avid systems, both Media Composer Adrenaline and Media Composer Nitris DX. All systems contained dual Quad-Core Intel Xeon CPUs running at 3GHz. The Apple Final Cut Pro system and the Avid Media Composer Adrenaline system were Mac Pro computers with 8GB of RAM running OS 10.4. The Avid Nitris DX was an HP xw6200 Workstation with 3.25 GB of RAM running Windows XP2002 SP2.

Test and Measurement – Computer Hardware and Software Under Test

	Apple Final Cut Pro	Avid Media Composer Adrenaline	Avid Media Composer Nitris DX
Hardware Vendor	Apple	Apple	HP
Hardware Model	Mac Pro	Mac Pro	xw8600
CPU Type	Intel Xeon	Intel Xeon	Intel Xeon
CPU Speed	3.00 GHz	3.00 GHz	3.00 GHz
CPU Number of Cores	8 (Dual Quad Core)	8 (Dual Quad Core)	8 (Dual Quad Core)
RAM	8 GB	8 GB	3.25 GB
Hardware Acceleration	No	No	Yes
Operating System	OS 10.4.10	OS 10.4.11	Windows XP2002 SP2
Application Software	Final Cut Pro 6.0.2	Media Composer 2.8	Media Composer 3.1

Table 3: Hardware and Software Under Test

Section VI – Test and Measurement

Test and Measurement –Test Descriptions

Engineering began by interviewing the Edit Group to identify tests that were representative of actual production work. Personnel were asked to identify commonly-used effects in typical edit sessions. Several effects were identified for testing. Tests included export times for “Screening Room” files and render times for often-used effects like Blurs, Picture in Picture, Time Effects, Fades, Wipes, Dissolves, Titles, Matte & Fills. Identical effects were created on Apple and Avid systems by the same editor. Effects renders were timed when rendering was required by the system. Real-time effects were noted when present.

Blurs and Picture-In-Picture Effects Timing

Blurs and Picture-In-Picture effects are commonly used at the Studio. These simple effects are used often, and the ability to deliver them quickly is important. A simple 30 second blur can take as much as 5 minutes to render on a typical system.

Time Slow-Down Effects Timing

Time Slow-Down effects are used at the Studio. In these effects, frames of video are blended in order to make motion go slower. These effects are simple but used often, so a system capable of delivering Time Slow-Down effects quickly is important.

Fades, Dissolves and Wipes Render Timing

Fades, dissolves and wipes are commonly used in most editing projects. The time spent creating these simple transitions is minimal, however the ability to quickly create fades, dissolves and wipes is important. A system that is able to create these simple transitions quickly is more likely to perform well creating more complex effects.

Titles over Video Render Timing

The Studio creates a large amount of titles that are keyed over video. The large volume of titles coupled with the desire to ‘tweak’ the titles makes a system capable of delivering titles quickly important.

Matte and Fill Effects Render Timing

Matte and Fill Effects are commonly used at the Studio. Single-layer Matte and Fills (with moving video keyed over moving video using a reveal matte) are used often, as are Four-Layer Matte and Fills (with two layers of moving video keyed over moving video using two separate reveal mattes).

File Export Timing

“Screening Room” files are created at the end of almost every edit session. Sometimes several files are created. A system’s ability to deliver these files quickly is important, as “Screening Room” files are created during billable time, while the Producer is still in the edit session. In the File Export Timing test, “Screening Room” files were created from 30 seconds of video. The time required to export the file was recorded on each system.

Section VI – Test and Measurement

Test and Measurement Results – Blur, Time Effect, Fades and Dissolves, Titles over Video Tests

	Apple FCP	Avid Adrenaline	Avid Nitris DX	Adrenaline compared to Apple	Nitris DX compared to Apple
Blur					
30 Second 50% Blur	285	163	55	57%	19%
PIP 50% Blur Centered in 50% Blur	510	542	129	106%	25%
Time Effect					
50% Time Slow Down	85	42	55	49%	65%
Fades and Dissolves					
Fade to Black	2.86	1.95	2.00	68%	70%
Dissolve to Black	3.00	1.71	2.20	57%	73%
Wipe to Black (left to right)	2.48	1.81	1.50	73%	60%
Cross Dissolve	3.28	1.53	2.00	47%	61%
Wipe Dissolve	2.93	2.01	2.10	69%	72%
Titles over Video					
2 Titles over 1 Layer of Video	165	108	1	65%	1%
1 Title over 1 Layer of Video	65	54	1	83%	2%

Table 4 : Blur, Time Effect, Fades and Dissolves, Titles over Video Test Results in Seconds

Section VI – Test and Measurement

Blur, Time Effect, Fades and Dissolves, Titles over Video Tests Results

Results are shown for Blur effects, Time Slow-Down effects, Fades, Dissolves and Titles over Video in Table 4. The Avid Nitris DX system performs more quickly than the Avid Adrenaline system or the Apple Final Cut Pro system for most effects.

Blur Effects Test Results

30 Second 50% Blur Effect

First Place	Avid Nitris DX	55 seconds
Second Place	Avid Adrenaline	163 seconds
Third Place	Final Cut Pro	285 seconds

The Avid Nitris DX completes the **30 Second 50% Blur Effect** fastest, followed by the Avid Adrenaline. The Apple Final Cut Pro system is slowest in this blur test. The Apple Final Cut Pro system takes nearly twice as long (285 seconds) as the Avid Adrenaline system (163 seconds) and more than five times as long as the Avid Nitris DX (55 seconds) to complete the 30 second 50% Blur.

30 Second 50% Blur in Picture in Picture over 50% Blur Background Effect

First Place	Avid Nitris DX	129 seconds
Second Place	Final Cut Pro	510 seconds
Third Place	Avid Adrenaline	542 seconds

The Avid Nitris DX completes the **30 Second 50% Blur in Picture in Picture over 50% Blur Background Effect** fastest, followed by the Final Cut Pro system. The Avid Adrenaline is slowest in this blur/picture-in-picture test. When a Picture in Picture is combined with the 50% Blur effect, the Apple Final Cut Pro system takes slightly less (510 seconds) than the Avid Adrenaline system (542 seconds). For this same Picture in Picture with a Blur effect, the Avid Nitris DX takes only 129 seconds. This is one quarter of the time that the Apple Final Cut Pro system takes (510 seconds) or the Avid Adrenaline system takes (542 seconds).

Time Slow-Down Effect Test Results

30 Second 50% Time Slow Down Effect (:30 in - :30 out)

First Place	Avid Adrenaline	42 seconds
Second Place	Avid Nitris DX	55 seconds
Third Place	Final Cut Pro	85 seconds

The Avid Adrenaline completes the **30 Second 50% Time Slow Down Effect** fastest, followed by the Avid Nitris DX system. The Apple Final Cut Pro system is slowest for this time slow-down effect. The Apple system completes a 30 second 50% Time Slow-Down effect (30 seconds in ; 30 seconds out) in 85 seconds , which is twice the time of the Avid Adrenaline (42 seconds). The Apple system takes roughly 155% of the time (85 seconds) that the Avid Nitris DX system does (55 seconds) to complete the Time Slow-Down effect.

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Fades and Dissolves Test Results

The Avid Nitris DX system and the Avid Adrenaline systems complete the Fades and Dissolves renders in 1.5 to 2.1 seconds. The Apple Final Cut Pro system completes the Fades and Dissolves renders in between 2.48 and 3.28 seconds, which is as much as twice the amount of time required by the Avid systems. Though fades and dissolves do not take a large amount of time to render, systems that are faster when performing these simple effects are more likely to be faster when performing complex effects.

30 Frame Fade to Black

First Place	Avid Adrenaline	1.95 seconds
Second Place	Avid Nitris DX	2.00 seconds
Third Place	Final Cut Pro	2.86 seconds

The Avid Adrenaline completes the **30 Frame Fade to Black** fastest, followed by the Avid Nitris DX system. The Apple Final Cut Pro system is slowest for this fade effect. The Avid Adrenaline system completes the 30 Frame Fade to Black in 1.95 seconds as compared to 2.00 seconds on the Avid Nitris DX system and 2.86 seconds on the Final Cut Pro system.

30 Frame Dissolve to Black

First Place	Avid Adrenaline	1.71 seconds
Second Place	Avid Nitris DX	2.20 seconds
Third Place	Final Cut Pro	3.00 seconds

The Avid Adrenaline completes the **30 Frame Dissolve to Black** fastest, followed by the Avid Nitris DX system. The Apple Final Cut Pro system is slowest for this dissolve effect. The Avid Adrenaline system completes the 30 Frame Dissolve to Black in 1.71 seconds as compared to 2.20 seconds on the Avid Nitris DX system and 3.00 seconds on the Final Cut Pro system.

30 Frame Wipe to Black (left to right)

First Place	Avid Nitris DX	1.50 seconds
Second Place	Avid Adrenaline	1.81 seconds
Third Place	Final Cut Pro	2.48 seconds

The Avid Nitris DX completes the **30 Frame Wipe to Black** fastest, followed by the Avid Adrenaline system. The Apple Final Cut Pro system is slowest for this wipe effect. The Avid Nitris DX system completes the 30 Frame Wipe to Black in 1.50 seconds as compared to 1.81 seconds on the Avid Adrenaline system and 2.48 seconds on the Final Cut Pro system.

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30 Frame Cross Dissolve

First Place	Avid Adrenaline	1.53 seconds
Second Place	Avid Nitris DX	2.00 seconds
Third Place	Final Cut Pro	3.28 seconds

The Avid Adrenaline completes the **30 Frame Cross Dissolve** fastest, followed by the Avid Nitris DX system. The Apple Final Cut Pro system is slowest for this cross dissolve effect. The Avid Adrenaline system completes the 30 Frame Cross Dissolve in 1.53 seconds as compared to 2.00 seconds on the Avid Nitris DX system and 3.28 seconds on the Final Cut Pro system.

30 Frame Wipe Dissolve

First Place	Avid Adrenaline	2.01 seconds
Second Place	Avid Nitris DX	2.10 seconds
Third Place	Final Cut Pro	2.93 seconds

The Avid Adrenaline completes the **30 Frame Wipe Dissolve** fastest, followed by the Avid Nitris DX system. The Apple Final Cut Pro system is slowest for this wipe dissolve effect. The Avid Adrenaline system completes the 30 Frame Wipe Dissolve in 2.01 seconds as compared to 2.10 seconds on the Avid Nitris DX system and 2.93 seconds on the Final Cut Pro system.

Text Titles over Moving Video – Test Results**Text Titles over Moving Video – One Title over One Layer of Video**

First Place	Avid Nitris DX	Real-Time
Second Place	Avid Adrenaline	54 seconds
Third Place	Final Cut Pro	65 seconds

The Avid Nitris DX completes the **Text Titles over Moving Video – One Title over One Layer of Video** fastest, followed by the Avid Adrenaline system. The Apple Final Cut Pro system is slowest for this Text Titles effect. The Apple system takes 65 seconds to render a 30 second sequence with a Text Title over 1 Layer of Video as compared to 54 seconds on the Avid Adrenaline. The Avid Nitris DX does Text Titles in real-time, so no rendering is required. On the Avid Nitris DX, the Text Titles effect is available immediately, at the time of creation. Text Titles are a real-time effect in the Avid Nitris DX.

Text Titles over Moving Video – Two Titles over One Layer of Video**Text Titles over Moving Video – Two Titles over One Layer of Video**

First Place	Avid Nitris DX	Real-Time
Second Place	Avid Adrenaline	108 seconds
Third Place	Final Cut Pro	165 seconds

The Avid Nitris DX completes the **Text Titles over Moving Video – Two Titles over One Layer of Video** fastest, followed by the Avid Adrenaline system. The Apple Final Cut Pro system is slowest for this Text Titles effect. In the test with Two Text Titles over 1 Layer of Video, the Apple Final Cut Pro system renders in 165 seconds. The Avid Adrenaline system renders in 108 seconds. The Avid Nitris DX does not require rendering for the 2 Titles over 1 Layer of Video tests, because Text Titles are a real-time effect on the Nitris DX.

Test and Measurement – Blur and Picture-in-Picture Graphs

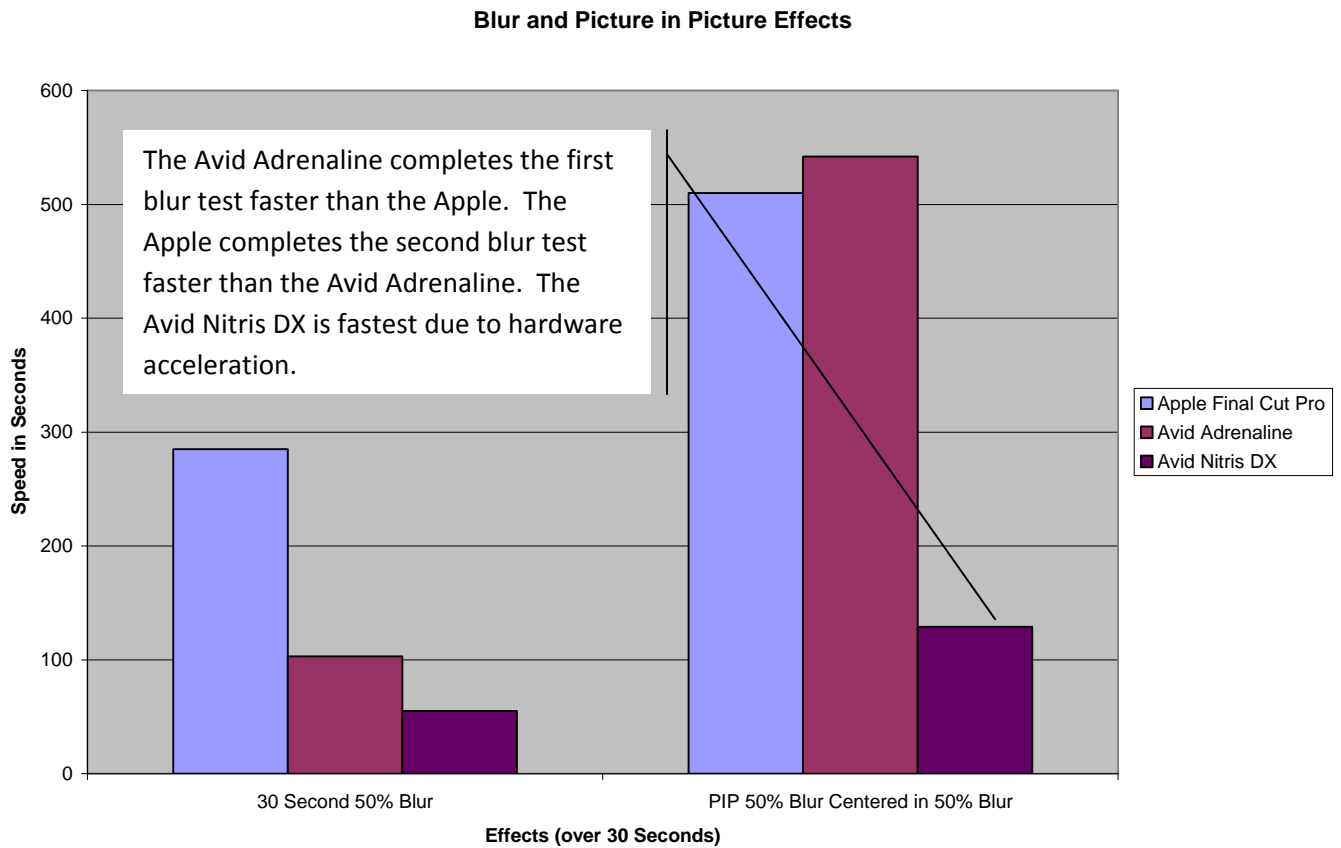


Figure 22: Blur and Picture-in-Picture Graphs

Test and Measurement – Time Slow - Down Graph

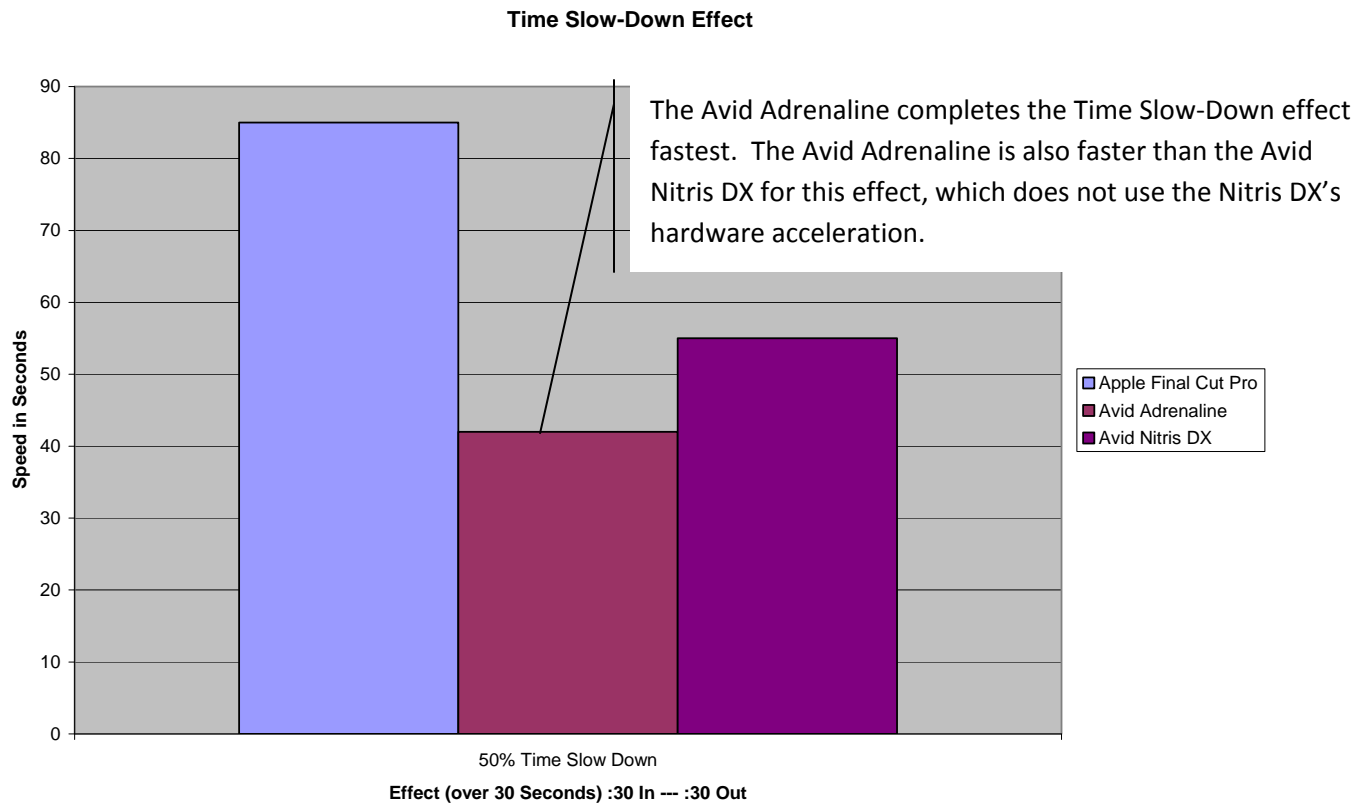


Figure 23: Time Slow-Down Graph

Test and Measurement – Fades, Wipes and Dissolves Graphs

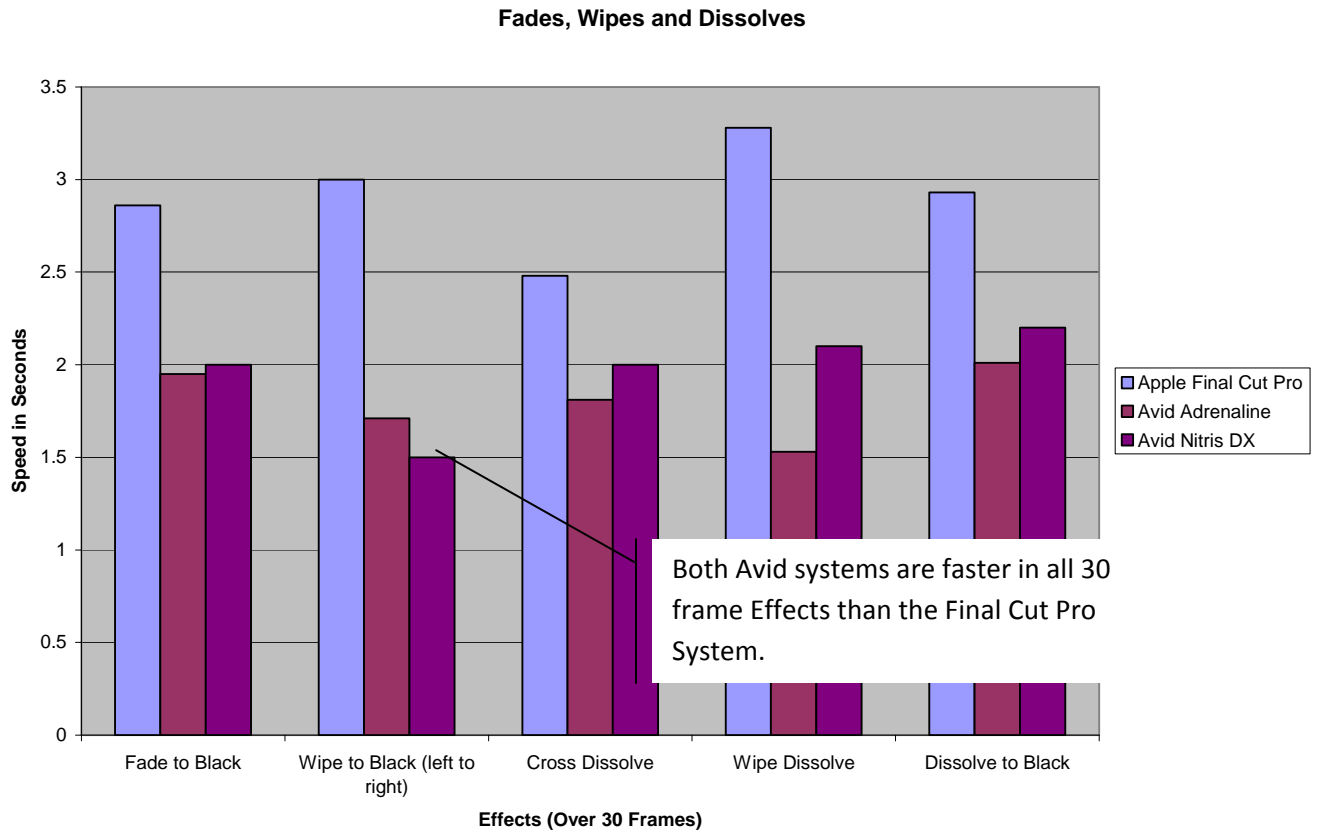


Figure 24: Fades, Wipes and Dissolves Graphs

Test and Measurement – Titles over Video Graphs

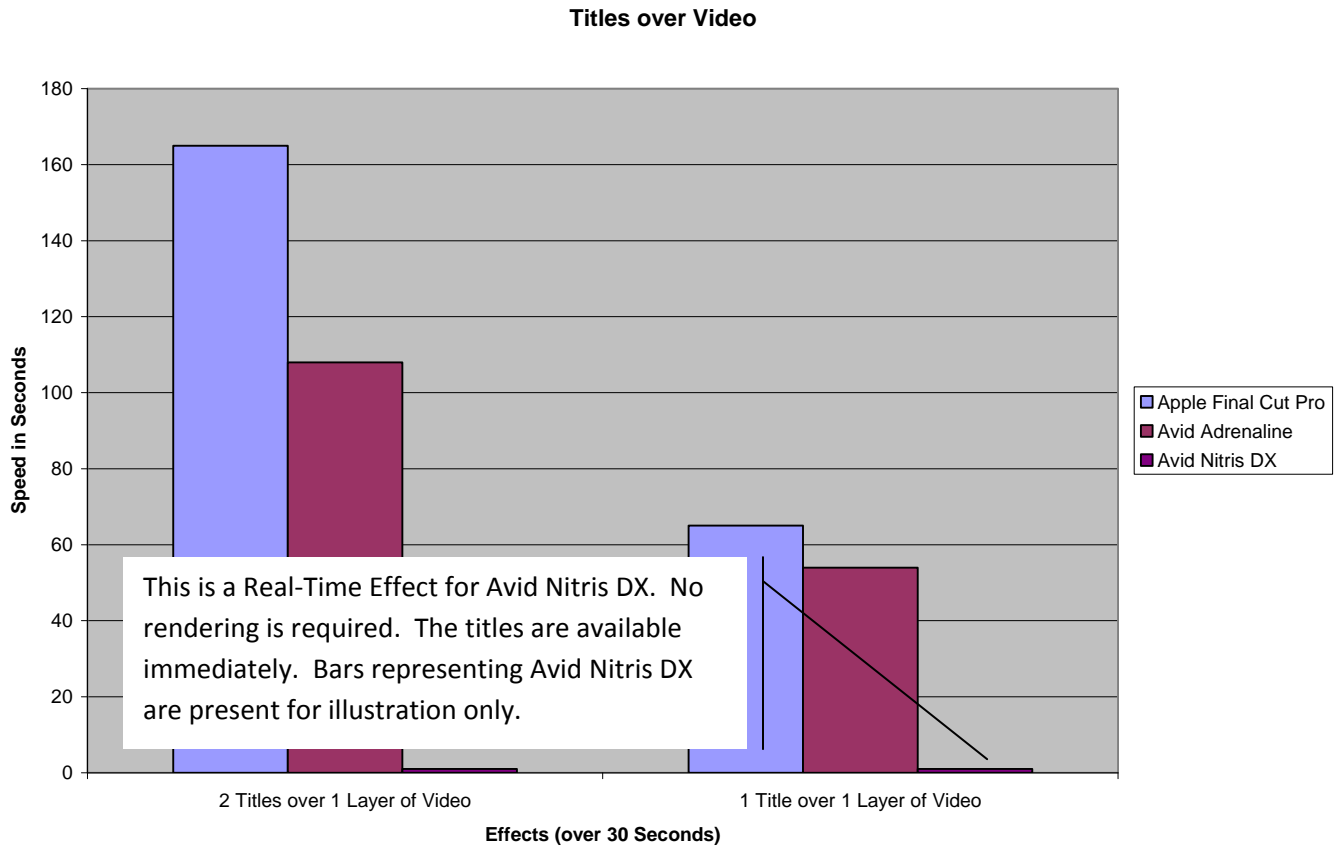


Figure 25: Titles over Video Graphs

Section VI – Test and Measurement

Test and Measurement Results – Matte and Fill, File Export Test Results

	Apple FCP	Avid Adrenaline	Avid Nitris DX	Adrenaline compared to Apple	Nitris DX compared to Apple
Matte and Fill HD (60 Seconds)					
Test One - Moving Video - Moving Fill - Moving Matte	736	85	52	12%	7%
Test Two - Moving Video - Moving Fill - Still Matte	545	173	59	32%	11%
Test Three - Moving Video - Still Fill - Still Matte	232	103	53	44%	23%
4 layer Matte and Fill HD (60 Seconds)					
Test One - Moving Video - Moving Fill - Moving Matte - Moving Matte 2 - Moving Fill 2	1263	371	107	29%	8%
Test Two - Moving Video - Moving Fill - Still Matte - Still Matte 2 - Moving Fill 2	755	259	106	34%	14%
Test Three - Moving Video - Still Fill - Still Matte - Still Matte 2 - Still Fill 2	249	256	104	103%	42%
File Export (30 Seconds)					
Screening Room Export	929	75	30	8%	3%
TOTAL TEST TIME	6244.56	2704.81	776.73157	43%	12%

Table 5 : Matte and Fill, File Export Test Results in Seconds

Section VI – Test and Measurement

Test and Measurement Results –Matte and Fill, File Export Tests

Results are shown for Matte and Fill Effects and File Export tests in Table 5. The Avid Nitris DX system performed best in these tests, followed by the Avid Adrenaline system. The Apple Final Cut Pro system was the slowest in these tests. The Avid Nitris DX is able to complete Matte and Fill Effects of varying complexity in the same amount of time. This was true whether the fills were still graphics or moving video. The Avid Adrenaline system performed better than the Apple Final Cut Pro system for Matte and Fill Effects. The Avid Nitris DX performed fastest in the File Export (Screening Room) Tests, followed by the Avid Adrenaline. The Apple Final Cut Pro system performed slowest on the File Export Tests.

Single Layer Matte and Fill Effects

Single Layer Test One: Moving Video – Moving Fill – Moving Matte

First Place	Avid Nitris DX	52 seconds
Second Place	Avid Adrenaline	85 seconds
Third Place	Final Cut Pro	736 seconds

The Avid Nitris DX completes the **Matte and Fill Single Layer Test One: Moving Video – Moving Fill – Moving Matte** fastest, followed by the Avid Adrenaline system. The Apple Final Cut Pro system is slowest for this Matte and Fill effect. The Matte and Fill tests show Apple Final Cut Pro system completing renders of moving video in the background with a moving matte revealing moving video (Matte and Fill Test One) in 736 seconds. The Avid Adrenaline completes the render in 85 seconds. The Avid Nitris DX is able to complete this same render in 52 seconds.

Single Layer Test Two: Moving Video – Moving Fill – Still Matte

First Place	Avid Nitris DX	59 seconds
Second Place	Avid Adrenaline	173 seconds
Third Place	Final Cut Pro	545 seconds

The Avid Nitris DX completes the **Matte and Fill Single Layer Test Two: Moving Video – Moving Fill – Still Matte** fastest, followed by the Avid Adrenaline system. The Apple Final Cut Pro system is slowest for this Matte and Fill effect. Matte and Fill tests with moving video in the background with a still matte revealing moving video (Matte and Fill Test Two) render on the Apple Final Cut Pro system in 545 seconds compared to 173 seconds on the Avid Adrenaline and 59 seconds on the Avid Nitris DX.

Single Layer Test Three: Moving Video – Still Fill – Still Matte

First Place	Avid Nitris DX	53 seconds
Second Place	Avid Adrenaline	103 seconds
Third Place	Final Cut Pro	232 seconds

The Avid Nitris DX completes the **Matte and Fill Single Layer Test Three: Moving Video – Still Fill – Still Matte** fastest, followed by the Avid Adrenaline system. The Apple Final Cut Pro system is slowest for this Matte and Fill effect. Matte and Fill tests with moving video in the background with a still matte revealing a still image (Matte and Fill Test Three) render on the Apple Final Cut Pro system in 232 seconds compared to 103 seconds on the Avid Adrenaline and 53 seconds on the Avid Nitris DX.

Section VI – Test and Measurement

Four Layer Matte and Fill Effects

For complex Four-Layer Matte and Fill tests, the Avid Nitris DX is able to complete the 60 second effects in 10% of the time required by the Final Cut Pro system. The Nitris DX renders a 4 layer Matte and Fill with all layers moving in under 2 minutes compared to 7 minutes on the Avid Adrenaline and 20 minutes on the Apple Final Cut Pro system. In simpler Matte and Fill tests, the Avid Nitris DX performance compared to the Avid Adrenaline system or the Final Cut Pro system is closer, ranging from 2.5 to 7.5 times faster than either system.

The reader may notice that both single layer and four layer Matte and Fill tests complete in the same amount of time on the Avid Nitris DX regardless of their complexity, while more complex Matte and Fill operations require more time than simple Matte and Fill operations on either the Avid Adrenaline or the Apple Final Cut Pro system.

Four Layer Test One: Moving Video – Moving Fill – Moving Matte – Moving Matte 2 – Moving Fill 2

First Place	Avid Nitris DX	107 seconds
Second Place	Avid Adrenaline	371 seconds
Third Place	Final Cut Pro	1263 seconds

The Avid Nitris DX completes the **Four Layer Matte and Fill Test One: Moving Video – Moving Fill – Moving Matte – Moving Matte 2 – Moving Fill 2** fastest, followed by the Avid Adrenaline system. The Apple Final Cut Pro system is slowest for this Matte and Fill effect. Four Layer Matte and Fill Test One contains moving video in the background with two layers of moving video revealed by two moving mattes. This test renders on the Apple Final Cut Pro system in 1263 seconds compared to 371 seconds on the Avid Adrenaline and 107 seconds on the Avid Nitris DX.

Four Layer Test Two: Moving Video - Moving Fill - Still Matte - Still Matte 2 - Moving Fill 2

First Place	Avid Nitris DX	106 seconds
Second Place	Avid Adrenaline	259 seconds
Third Place	Final Cut Pro	755 seconds

The Avid Nitris DX completes the **Four Layer Matte and Fill Test Two: Moving Video – Moving Fill – Still Matte – Still Matte 2 – Moving Fill 2** fastest, followed by the Avid Adrenaline system. The Apple Final Cut Pro system is slowest for this Matte and Fill effect. Four Layer Matte and Fill Test Two containing moving video in the background and both additional layers revealed by still mattes renders on the Apple Final Cut Pro system in 755 seconds compared to 259 seconds on the Avid Adrenaline and 106 seconds on the Avid Nitris DX.

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Four Layer Test Three: Moving Video - Still Fill - Still Matte - Still Matte 2 - Still Fill 2

First Place	Avid Nitris DX	104 seconds
Second Place	Final Cut Pro	249 seconds
Third Place	Avid Adrenaline	256 seconds

The Avid Nitris DX completes the **Four Layer Matte and Fill Test Three: Moving Video – Still Fill – Still Matte – Still Matte 2 – Still Fill 2** fastest, followed by the Avid Adrenaline system. The Apple Final Cut Pro system is slowest for this Matte and Fill effect. Four Layer Matte and Fill Test Three containing moving background video and two additional still layers revealed by still mattes take 249 seconds to render on the Apple Final Cut Pro system compared to 256 seconds on the Avid Adrenaline and 104 seconds on the Avid Nitris DX.

File Export Test - “Screening Room” File

The File Export test shows that the Avid systems are able to create the Screening Room file faster than the Apple systems. The Nitris DX is significantly faster than the Avid Adrenaline for the File Export test (Nitris completes the test in 1/2 the time of Adrenaline). The Nitris DX is much faster than the Final Cut Pro system in the File Export test (Nitris completes the test in 1/20 the time of Final Cut Pro).

File Export Test (30 Second Screening Room File)

First Place	Avid Nitris DX	30 seconds
Second Place	Avid Adrenaline	75 seconds
Third Place	Final Cut Pro	929 seconds

The Avid Nitris DX completes the **File Export Test** fastest, followed by the Avid Adrenaline system. The Apple Final Cut Pro system is slowest in the File Export Test. While the Apple system takes 929 seconds for the Screening Room export, the Avid Adrenaline does the export in 75 seconds, and the Avid Nitris DX does the export in 30 seconds. This potentially saves a client 15 minutes of billable time for each Screening Room file that is created when using the Avid Nitris DX or the Avid Adrenaline instead of Final Cut Pro.

Test and Measurement – Single Layer Matte and Fill

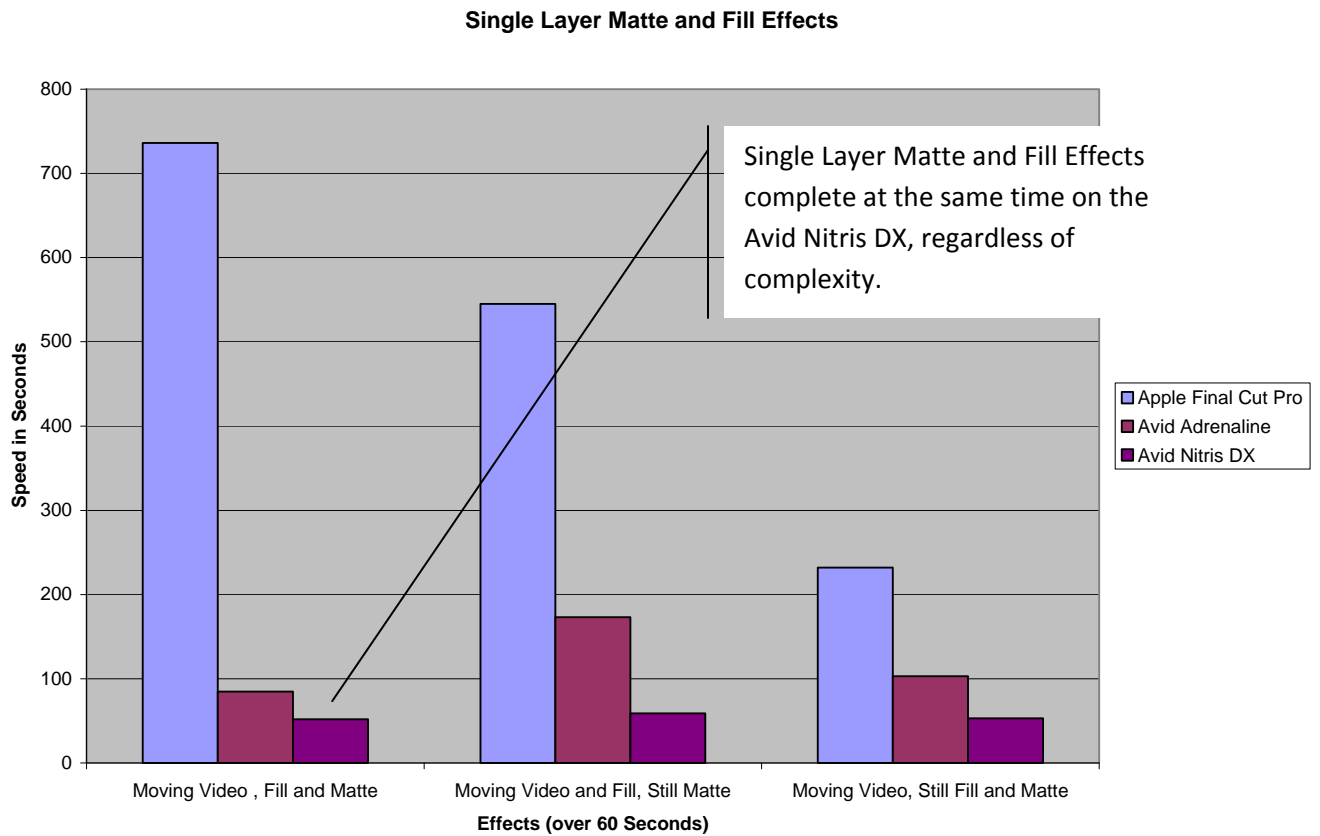


Figure 26: Single Layer Matte and Fill Effects

Test and Measurement – Four Layer Matte and Fill

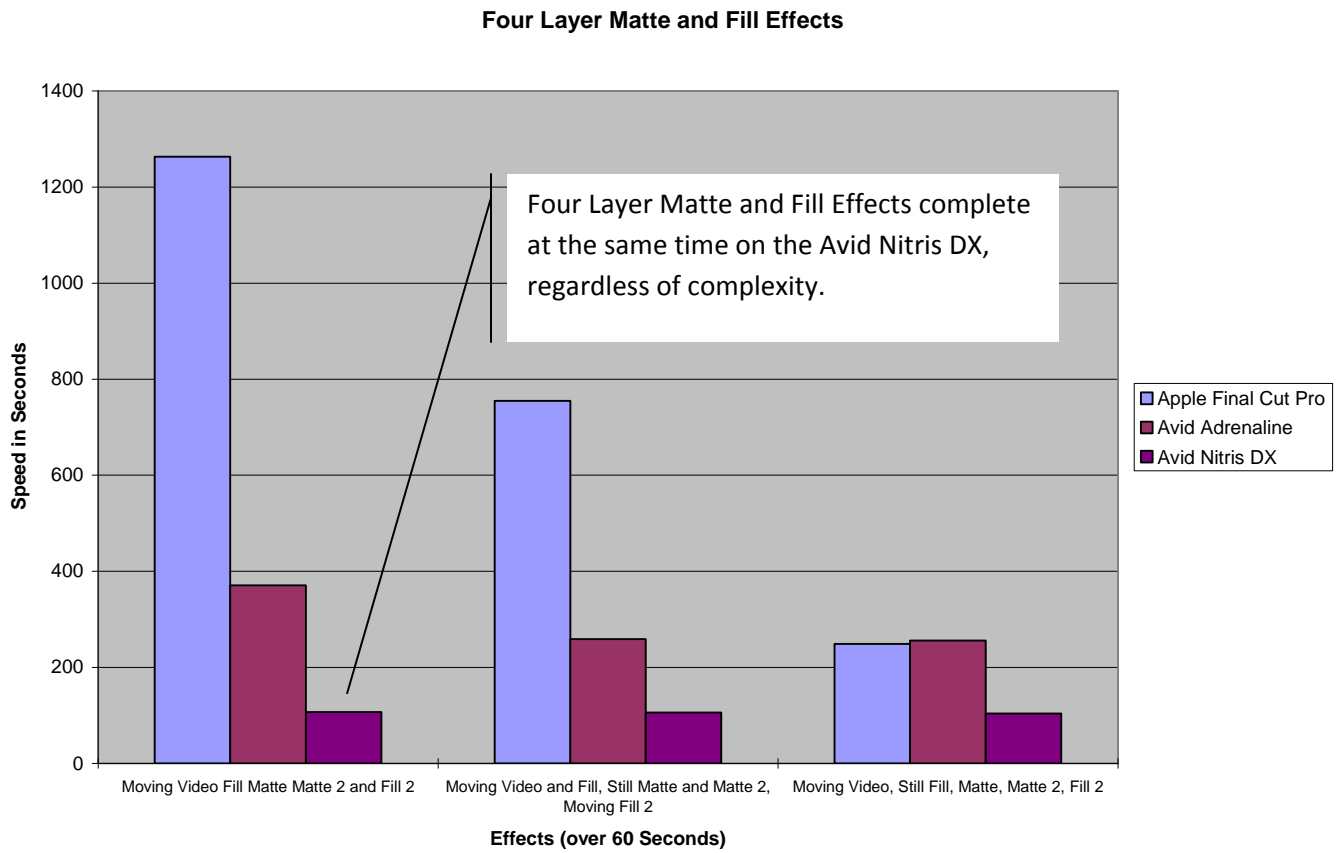


Figure 27: Four Layer Matte and Fill Graph

Test and Measurement – Screening Room Export Graph

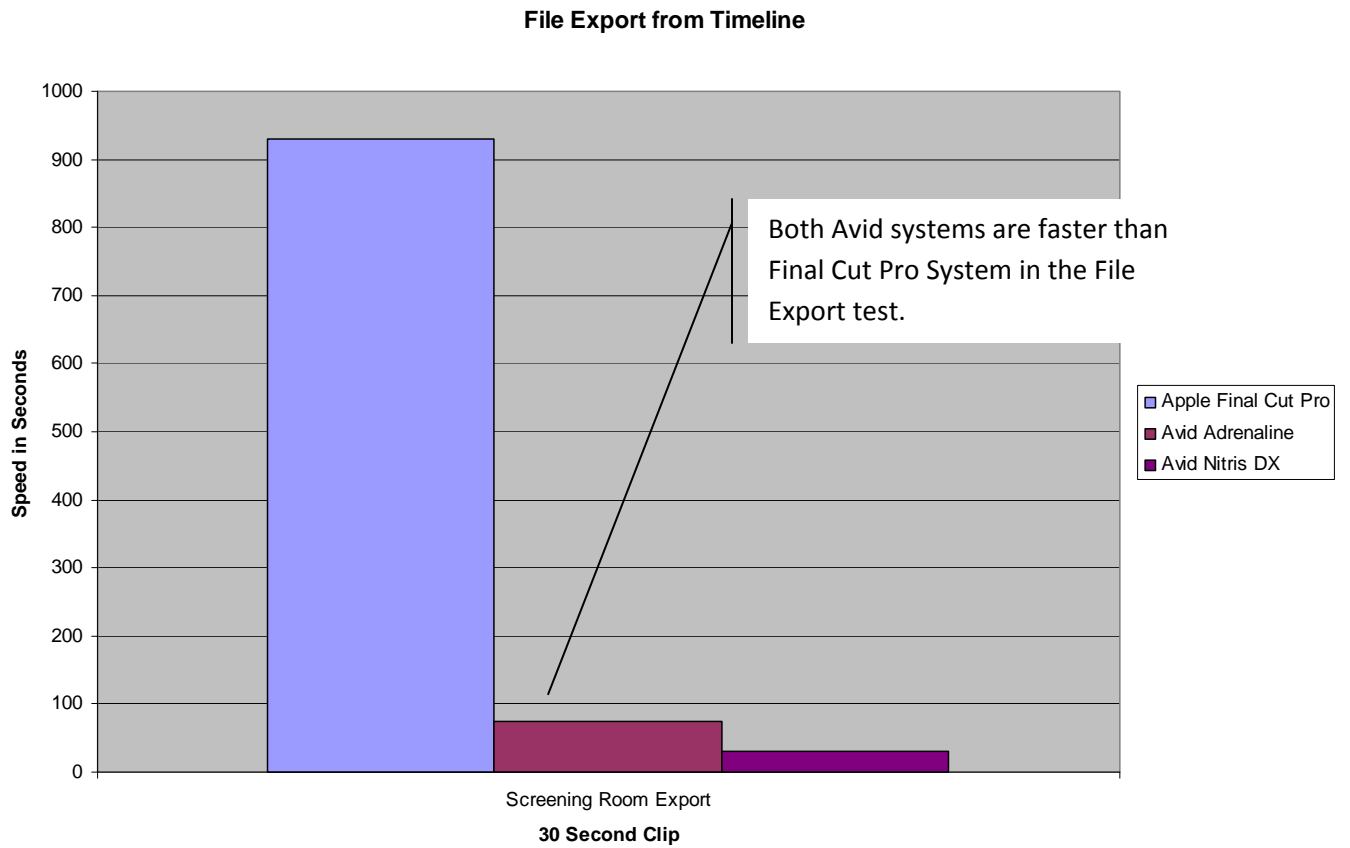


Figure 28 : Screening Room Export Chart

Test and Measurement – All Tests Run Sequentially

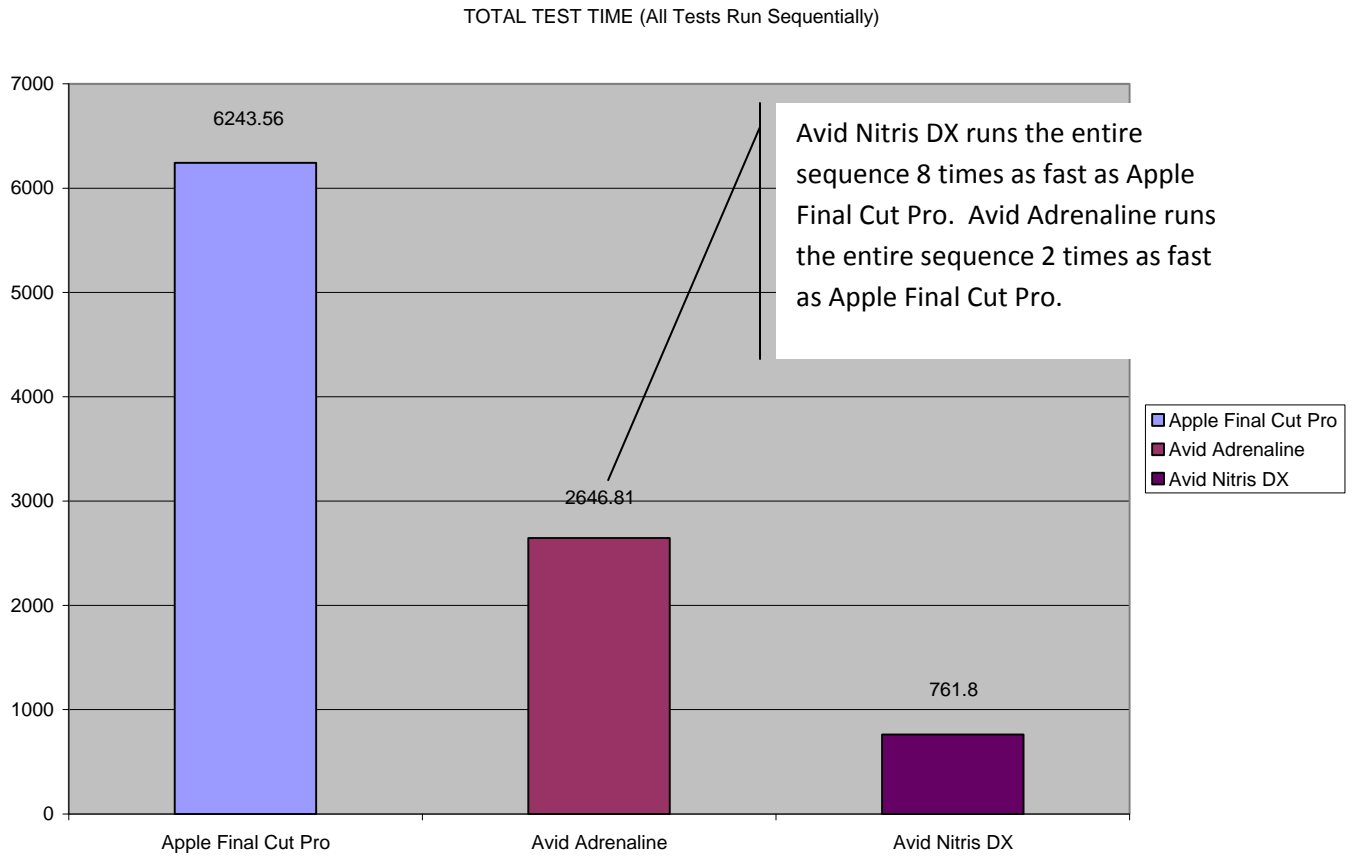


Figure 29 : All Tests Run Sequentially

Test and Measurement - Conclusion

Results of the Test and Measurement section show that the Avid Nitris DX is the fastest system in almost all cases (see Table 4: Blur, Time Effect, Fades and Dissolves, Titles over Video Test Results in Seconds and Table 5: Matte and Fill, File Export Test Results in Seconds). There are a few cases when the Avid Adrenaline is the fastest system, such as in the Time Slow-Down Effects (see Figure 23: Time Slow-Down Graph) or a few Fade tests (Figure 24: Fades, Wipes and Dissolves Graphs). However, The Avid Nitris DX outperforms both systems in almost all other tests. Hardware acceleration helps the Avid Nitris DX to outperform the other systems in render tests, but also to deliver many effects in real-time, with no rendering required (see Figure 29: Titles over Video Graphs and Figure 28: Screening Room Export Chart). The Apple Final Cut Pro system never the fastest system. The Apple Final Cut Pro system is the slowest system for almost all tests.

Titles and File Exports complete much more quickly on the Avid Nitris DX system than on the Avid Adrenaline system or the Apple Final Cut Pro system, due to the hardware effects acceleration in the Avid Nitris DX. Time Slow-Down Effects do not seem to go much faster on the Avid Nitris DX than the other systems, believed to be due to hardware acceleration not being used.

If all tests are run sequentially, as shown in Figure 29, the Avid Nitris DX (762 seconds) completes the effects 8 times faster than the Apple Final Cut Pro system (6244 seconds). The Avid Adrenaline (2647 seconds) completes the effects 2 times faster than the Apple Final Cut Pro system. Both Avid systems significantly outperform the Apple system.

Significance of High-Performance Compute Platform

Where real-time effects are not available and rendering is required, the computer that performs the renders fastest is most desirable. Renders are performed during billable time, while clients are waiting to see creative decisions. When a client has to wait a long time to view a creative decision, fewer iterations will be attempted, and less creative effort will go into the piece. The compute platform that performs fastest makes higher quality visual content at the Studio.

Significance of Real-Time Effects

Real-Time Effects are visible immediately. No rendering is required. The Avid Nitris DX supports several real-time effects, including Real-Time Titles. For this reason, the “Single Text Title over Moving Video” and “Two Text Titles over Moving Video” were completed immediately. The bar chart in Figure 24 indicates that the effect took one second, for illustration only.

Cost Savings with Real-Time Effects

The significance of Real-Time Effects can not be over-stated. Billable time is saved each and every time a Real-Time effect is used. If 10 Real-Time “Title” effects are used in a session, 30 minutes of cost savings might be realized. If 20 sessions are running concurrently, real-time effects might save the facility 10 hours of billable time per day, or more than 200 billable days per year.

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In some cases where there are many effects in an edit session, the system that is able to deliver these effects in real-time is able to save billable client hours. This may be a significant cost savings that may offset the incremental purchase price of a real-time system. Real-time effects that do not require rendering may increase productivity allowing editors to work on more billable jobs per day.

Creation of More Compelling Content with Real-Time Effects

Real-time effects may allow editors to make more iterations of an effect, allowing them to create more compelling content. If the editor and client do not have to wait to view effects, it is easier to “tweak” effects to make them “just right”. This iterative process of making edit decisions and then waiting for them to render that is vastly improved by real-time effects, helping to improve the quality of the work that is done.

Significance of Real-Time Previews

In some cases, real-time previews of effects are supported. While this does not save time during the rendering phase of the project, it allows the Producer and Editor to collaborate by seeing the effects of their creative decisions immediately. This immediate feedback may lead to a higher quality piece, as creative decisions can be made and changed efficiently, without waiting extended periods of time before viewing the changes.

Significance of Matte and Fill Test Results

Single-Layer Matte and Fill Tests

On the Avid Nitris DX system, all Single-Layer Matte and Fill Effects render in roughly the same time, regardless of complexity, thanks to the Nitris DX hardware acceleration. On the Apple Final Cut Pro system, the speed of Matte and Fill Effects is highly correlated to the complexity of the Matte and Fill Effect. Single-Layer Matte and Fill Effects on the Apple Final Cut Pro system require between 4 and 12 minutes to render. The Avid Adrenaline system requires between 1.5 and 3 minutes to render the same Single-Layer Matte and Fill Effect. In all three Single-Layer Matte and Fill Effect tests, the Avid Nitris DX requires less than one minute to render.

Four-Layer Matte and Fill Tests

In the Four-Layer Matte and Fill Effects Tests, the Apple Final Cut Pro system requires between 4 and 20 minutes to render. For the same Four-Layer Matte and Fill Effects Tests, The Avid Adrenaline system requires between 4 and 6 minutes to render. In all three Four-Layer Matte and Fill Effects tests, the Avid Nitris system requires less than two minutes to render. Four-Layer Matte and Fill Effects are a very common effect at the Studio. Time savings of between 2 and 18 minutes for every 60 seconds of Matte and Fill Effects can be realized when using the Avid Nitris DX system.

Test and Measurement – List of Production Platform Attributes

This section of the document contains a list of Attributes of Production Platforms. In order to create this list, Interviews were conducted with Engineering staff. In these interviews, Engineers were asked to identify the important technical attributes of production platforms in list form. Responses were wide-ranging, as illustrated. The List of Attributes follows. A brief explanation of each Production Platform Attribute is given where required. Items were culled from this list for timed analysis in the earlier part of this section.

- **Matte and Fill (1 minute) Render Time**
 - This is the time taken to do a typical “picture in picture” Matte and Fill effect.
- **4 Layer Matte and fill (1 minute) Render Time**
 - This is the time taken to do a typical 4 Layer Matte and Fill effect, where 2 different pictures are inserted into the video program, cut out by 2 different mattes.
- **Dissolve (30 Frame) Render Time**
 - Dissolve to Black
 - Fade to Black
 - Wipe to Black
 - Cross-Dissolve (one sequence to another)
 - Cross-Wipe (one sequence to another)
- **Sapphire (2 layer effect) (1 minute) Render Time**
 - Sapphire Blur Effect
 - This is the time taken to do a typical 2 Layer Sapphire effect of one minute in duration.
- **Sapphire (1 layer effect) (1 minute) Render Time**
 - This is the time taken to do a typical 1 Layer Sapphire effect of one minute in duration.
- **Motion Effect (slow down scene by 50%) (1 Minute) Render Time**
 - This is the time taken to do a typical scene slow down effect, taking 1800 frames of video and creating 3600 frames of video from the source frames.
- **Text Graphics (30 seconds) Render Time**
 - Single Layer
 - Two Layer

Section VI – Test and Measurement

Test and Measurement - Import / Export Time

Import QuickTime File (30 seconds)

- SD High resolution QuickTime Animation CODEC
- HD High resolution QuickTime Animation CODEC

Import OMFI File (15:1s 1 minute)

- audio
- no audio

Import DNX220X File (1 minute)

- audio
- no audio

Export QuickTime File (30 seconds)

- SD High resolution QuickTime Animation CODEC
- HD High resolution QuickTime Animation CODEC

Export Audio File (1 minute)

- 4 tracks of audio
- 12 tracks of audio

Export MXF File (15:1s 1 minute)

- audio
- no audio

Export OMFI File (15:1s 1 minute)

- audio
- no audio

Export 1 Minute Screening Room File Time (1 minute)

- Typical Screening Room job

File Copy Performance

Copy 100GByte file from local storage to SAN (seconds)

Copy 100GByte file from SAN to local storage (seconds)

Project Archive

Copy project to "archive workspace" (seconds)

Users and Groups Features

- Number of editors working on same edit project (for workgroup support)
 - Shared storage solutions will limit the number of editors that can concurrently access media. What is the limit on number of editors that can edit the same footage on the same time line?
- Number of Users Supported by System
 - How many users (unique user id's are supported by the system? This speaks to the number of users who can be registered users of the system, not the number of users who can edit material at the same time
- Number of Groups Supported by System
 - How many unique groups (unique group ids) are supported by the system? This speaks to the number of groups who can be registered on the system.
- Role-based authentication (user is a member of digitizer group that has specific "digitize" access to system)
 - Can users be limited by their roles in the system? This may be tied to group authentication (eg. can a user be a member of a group and have that group's privileges be assigned to the user by virtue of his membership in the group?)

Sequence/Timeline Support

Multiple video formats / resolutions supported in same timeline?

Mixed bitrates / sample rates supported in same timeline?

Software Development Kit and Application Programming Interfaces

- Software Developers Kit
 - What Software Developers Kits are provided with the product?
 - Is sample code provided?
 - Is the Software Developers Kit available for download at no charge?

- Application Programming Interfaces
 - What Application programming interfaces are provided with the product
 - XML
 - Web Services
 - Java
 - .net
 - Vendor Proprietary APIs
 - Are the Application Programming Interfaces well documented?

General Storage Features

- Speed of individual drive used in RAID subsystem (block mode copy using vdbench or iозone)
 - What is the maximum speed of an individual drive used in the RAID sub-system supplied by the vendor?
- Rotational speed of drive used in RAID subsystem (eg. 5400,7200,15K)
 - How fast do the vendor's drives spin? The faster the rotational velocity, the more data that can be moved on and off of the drive per second
- Technology of drive used in RAID (eg. SATA, FC, SCSI)
 - Some technologies provide more robust data detection and correction features, for example Fibre Channel, while other technologies provide more data capacity at the expense of individual drive speed. Further, faster individual drive speed may or may not be the most important feature in a video editing application.
- Number of simultaneous users on HD Online system
 - How many users can be logged in to the shared system for HD editing?
- Bandwidth reservation for clients? List available bandwidths in mbits per second.
 - Can specific bandwidth be reserved for any one user of the system so that the individual user's disk performance is guaranteed?
- Is Central Ingest of Media Supported?
 - Can a "digitizing" staff member ingest video to shared storage for later use by a craft editor (performing the traditional assistant editor function)?
- Number of disk drives per chassis
 - How many disk drives does each of the vendor's chassis' hold?
- Total Available Bandwidth per Chassis (MB / sec)
 - What is the rated speed for the vendor's disk chassis?
- Total Available Bandwidth for total solution (MB / sec)
 - What is the rated speed for the vendor's total solution?

Section VI – Test and Measurement

Shared Storage (locking)

- LUN Level
 - Is data protection available for the entire LUN (the entire disk drive) so that only one user at a time can write to the disk unit? (LUN-level locking)
- File Level
 - Can an individual file be locked for access so that only one user can write to a file at a time?
- Byte Range Level Locking
 - Can a range of bytes be locked in a file so that multiple users can write to the file at the same time, as long as they do not write to the same part of the file?

Storage Protection

- RAID 0 No data protection, this is simply “striping” across two disks
- RAID 1 Mirroring
- RAID 3 1 drive reserved for parity information
- RAID 5 Parity information spread across drives
- RAID 6 Diagonal parity protection – horizontal and vertical
- RAID 10 A striped mirror. First RAID1 is applied to several drives, then the users data is striped across the RAID1-protected LUNs
- Other Any proprietary data protection not listed above?

Storage Rebuild Time

- Rebuild Time (1 failed drive)
 - When a drive fails, how much time does it take to rebuild that failed drive on another spare (if a cold spare, after the cold spare is inserted into the RAID system)

Audio and Video Features

Video Features

Number of video tracks that can be played down at once

CCIR 601 Color Space supported

CCIR 709 Color Space supported

Audio Features

Channels – Number of Audio Channels supported in the box

16 bit word

24 bit word

32 bit word

48 KHz sample rate

96 KHz sample rate

192 KHz sample rate

Number of audio tracks that can be played down at once

Audio Application Integration

Pro-Tools Integration – what is the level of integration with the ProTools application? Can ProTools work with native media from the application? Can ProTools “drive” the edit application to enable audio editing while referencing the original edit material? See Feature Overview section for more information regarding advanced integration between ProTools and the Avid edit applications.

Soundtrack Pro Integration – what is the level of integration with the Soundtrack Pro application? Can media from the production platform be used natively in Soundtrack Pro? Is there integration between the edit application and Soundtrack Pro? Can Soundtrack Pro “drive” the edit application? See Feature Overview section for more information regarding advanced integration between Final Cut pro and Soundtrack Pro.

Msoft Integration – what is the level of integration with the MSoft application? Can Msoft clips be “sent” to the application via a native Msoft player?

Audio Plug-Ins – what Audio plug-ins are available on this platform?

Section VI – Test and Measurement

Video I/O

SD SDI – capable of SD I/O via Serial Digital Interface

HD SDI – capable of HD I/O via Serial Digital Interface

4:4:4 Dual Link – capable of HD RGB I/O via Dual Link HD Serial Digital Interface running at 1.5Gbits/second

4:4:4 3G – capable of HD RGB I/O via Single Link HD Serial Digital Interface running at 3 Gbits/second

HDMI

Firewire

ASI – capable of demultiplexing an ASI stream, selecting a single channel from the stream, and ingesting the stream

Analog Composite

S-Video

Analog Component (YUV)

Analog Component (RGB)

Audio I/O

Embedded Audio Support

Analog Audio Support

AES

Number of Audio I/O Channels supported via AES

Number of Audio I/O Channels supported via Embedded

Connectivity

LAN Access (storage or upload/download)

Aspera

Gigabit Ethernet

SMB

NFS

AFP

iSCSI Initiator available for platform

FTP native (no third party software required)

rcp native (no third party software required)

scp native (no third party software required)

Physical Connectivity

2 Gig Fibre Channel

4 Gig Fibre Channel

8 Gig Fibre Channel

Gigabit Ethernet

10 Gig Ethernet

Infiniband

Accessibility of LAN Resources

Able to access files via Windows Share?

Able to access files via NFS Share?

Able to access files via FTP natively?

Media Support

Media Format (internal)

MXF Native

OMF Native

QuickTime Native

AVI Native

Video Format Support

59.94i

50i

23.98psf

Technical Support and Training

Does Vendor offer Certified Technicians?

Does Vendor have an in-house Professional Services Organization?

Does Vendor offer Online Training?

Does Vendor offer 24 x 7 Support?

Does Vendor offer Elite Support?

Media Management

Project Archive

Media Archive

Cataloging

Proxy Support

Section VI – Test and Measurement

Hardware

CPU Type

CPU Number of Cores

CPU Speed

Computer Vendor

PCI Bus Type

PCI Bus Number of Slots

PCI Slot Speed

Software

Operating System Major Rev

Operating System Minor Rev

Linux Support

Windows Support

OS/X Support

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Technical Support

Tech Support Hours

Tech Support Days of the Week

Response time from initial contact for case number.

Response time from initial contact for engineer to arrive on site.

Spare parts stocked at HBO?

Time in days for replacement of failed drive removed from system.

Can HBO's techs be certified in this platform?

Ancillary Data Support

SD timecode in VBI

HD timecode in VANC

HANC Support

V-Chip support

Ratings Support

CGMS Support

CC support

Display Graphics

Number of Graphics Displays Supported

Resolution (Max) Per Display

Pixel Bit Depth (Max)

Native CCIR-601 Color Space

Native CCIR-709 Color Space

Polygons per Second Display Rate (per second)

Max Polygon Fill Rate (per second)

LUT Support

Log Color Support (eg. Cineon, DPX)

Section VII – Vendor Partnerships

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Vendor Partnerships – Apple Platform Partner Landscape

The platform partner landscape includes the various components that make up the production platform. The platform partner landscape can be illustrated as shown below:

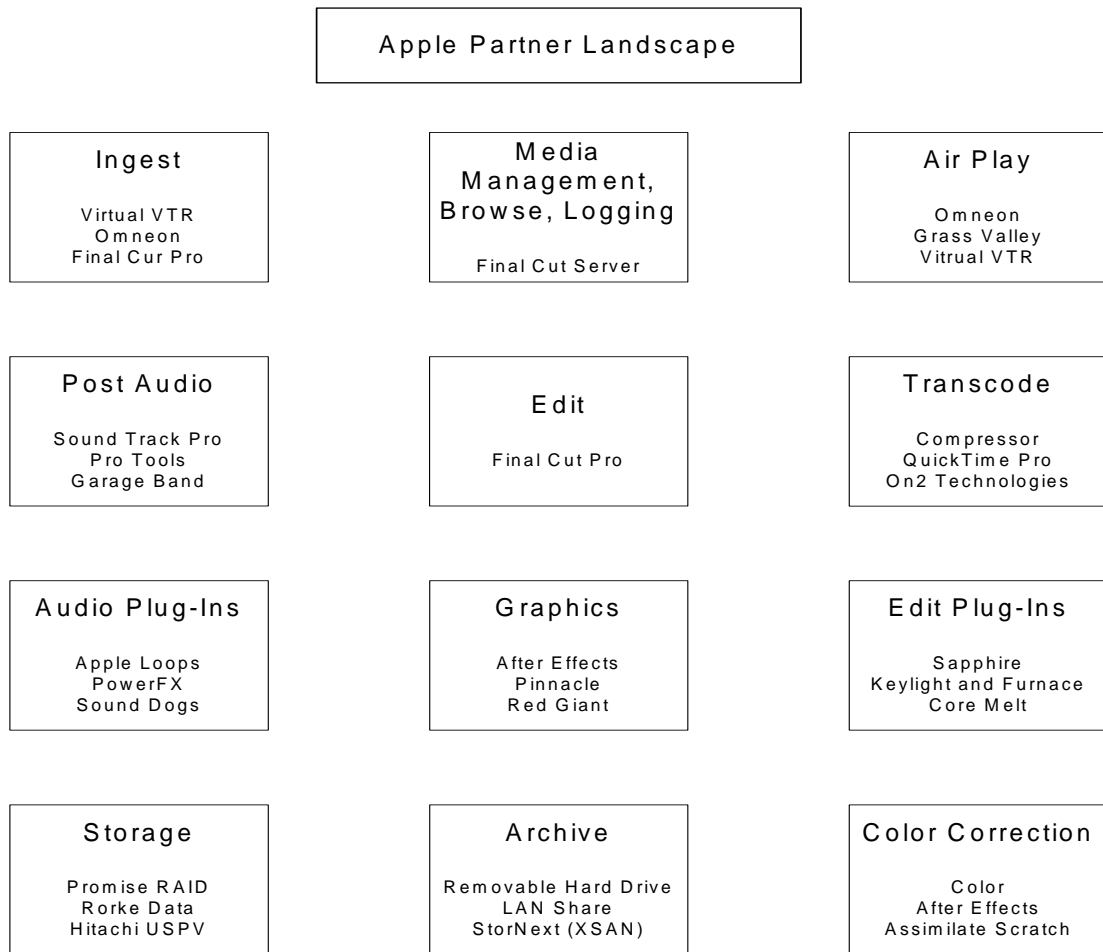


Figure 30 : Vendor Partnerships: Apple Partner Landscape

Section VII – Vendor Partnerships

Vendor Partnerships – Avid Platform Partner Landscape

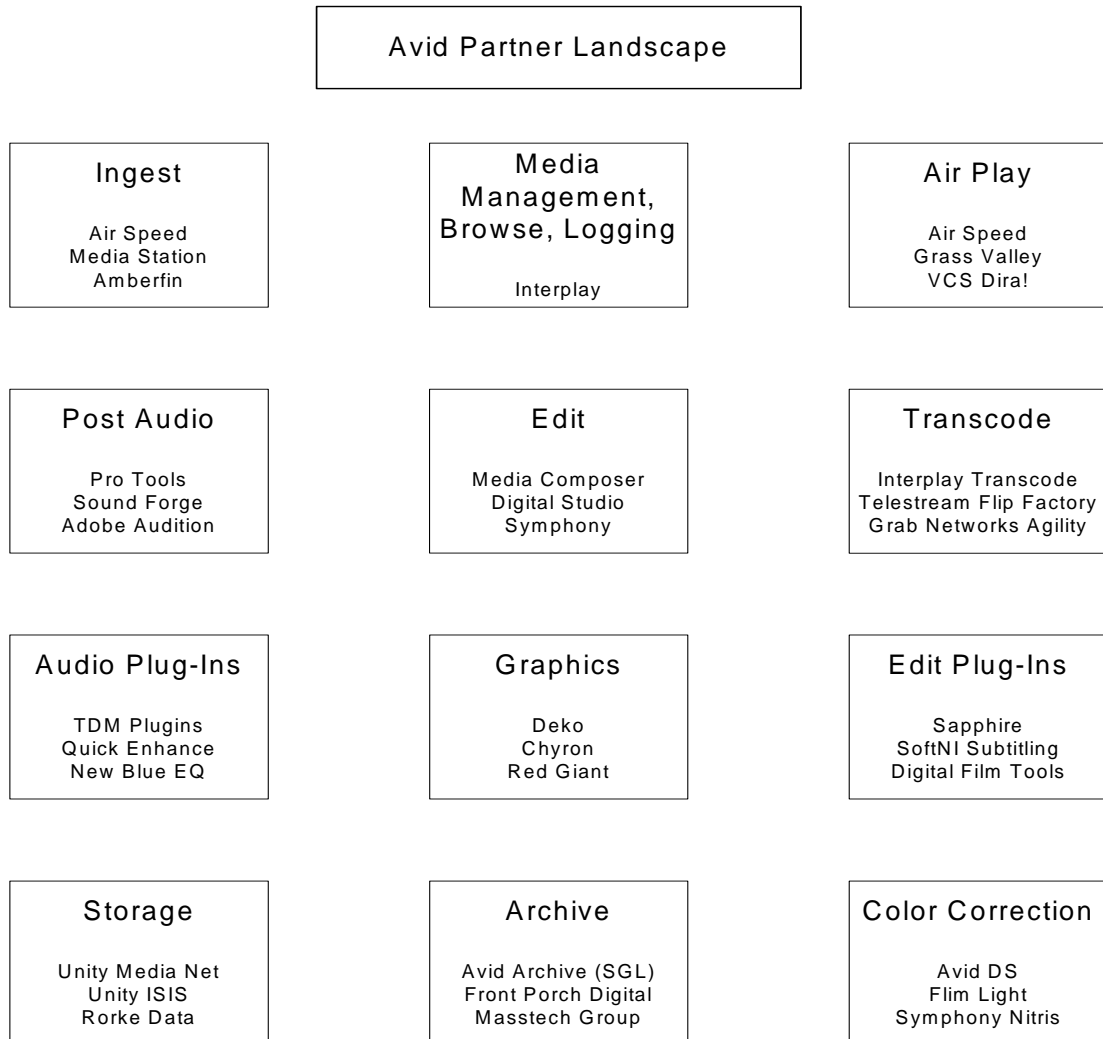


Figure 31 : Vendor Partnerships: Avid Partner Landscape

Section VII – Vendor Partnerships

Vendor Partnership – Software Plug-Ins and Helper Applications

Both Apple and Avid platforms are extensible via a “plug-in” feature. Software developers are able to produce applications that can run along with the platform software to help with common production issues such as audio and video effects, graphics, titles, for example. A brief review of the Apple and Avid Web Sites shows the plug-ins and helper software below.

Vendor Partnership - Apple Audio Units Plug-ins (pg1)

[AudioEase](#) Altiverb 6 is a convolution reverb plug-in efficiently producing a wide array of special effects.

[Bias](#) Products include Peak, Peak LE, Deck, Soundsoap Pro, and Soundsoap audio tools.

[Granted Software](#) ReVision and ReMIDI.

[iZotope](#) Audio processing technology, tools, and plugins. Products include Ozone 3, iDrum and more.

[Native Instruments](#) Absynth, FM7, Intakt, Kontakt and Pro-53.

[Ohmforce](#) Effects, instruments, bundles and demos. Products include Frohmag, OhmBoyz Delay and more.

[Roger Nichols](#) Products include the Detailer, Inspector XL, and Dynam-izer, plus many others.

[SFX Machine](#) Products include SFX Machine Pro, which lets you create your own audio effects from scratch.

[Smartelectronix](#) Ambience, LiveCut & Fire.

[TC Electronic](#) PowerCore, PCI-based hardware emulation, an array of powerful tools right out of the box.

[Destroy FX](#) Products include geometer, scrubby, bufferoverride, transverb and more.

[expert sleepers](#) Ping-pong Delay and Crossfade Loop Synth.

[Steinberg](#) Steinberg products support musicians and producers in creatively realizing their ideas.

[u-he.com](#) Zebra is a next-generation virtual synthesizer plug-in - and more. Freeware downloads also available.

Vendor Partnership - Apple Audio Units Plug-ins (pg2)

[Unique Recording Software \(URS\)](#) Immaculate re-creations of classic console and standalone EQs.

[Universal Audio](#) UAD-1 hardware-accelerated plug-ins.

[Virsyn](#) Cube and Tera.

[Waves](#) Production bundles including L3 Ultramaximizer and S1 Stereo Imager.

Section VII – Vendor Partnerships

Vendor Partnership - Content and Stock Footage Libraries

[12 Inch Design](#) 12 Inch Design creates and sells royalty-free libraries of professional motion graphics.

[All4DVD](#) all4DVD creates ready-to-use professional quality themes for use with your DVD Studio Pro projects.

[Artbeats](#) Artbeats specializes in creating high quality, professional footage.

[Blue Sky Footage](#) Blue Sky Stock Footage offers 35mm, 16mm and high definition contemporary stock footage.

[CHV-Electronics](#) CHV offers a variety of high-quality royalty free animated video footage on DVD.

[Designer Templates by Ripple Training](#) Professionally-designed motion graphics templates for use in both Final Cut Pro and Motion.

[DVD ThemePak](#) Creative templates, drop zones, shapes and backgrounds for professional menu design.

[HD DV Cuts](#) Download high quality stock footage movie clips to edit into video projects right away.

[iStockphoto](#) Millions of royalty-free pictures, sounds, and footage of everything you'll ever need.

[Letter Parts LiveFonts](#) Image-based alphabets you can use to create striking visual titles for your video projects.

[LiveType Central](#) Expansion Packs for LiveType include Templates, LiveFonts, Textures, Effects, and Animated Elements.

[Mammoth HD](#) Unique Collection of High Definition stock footage, 3D animation and motion graphics in 1080, 720 and HD Vertical formats. Plus select footage in RED 2K, 3K and 4K formats.

[motionVFX](#) motionVFX offers ready-to-use HD (1920x1080) customizable templates for Motion.

[Recipe4DVD](#) Several packs to choose from that each offer fully-authored and completely functional DVD projects.

[Screen Caffeine](#) LiveFonts for LiveType & Motion.

[World Clips](#) Royalty-free video and HDV stock footage offering convenience for production professionals.

Vendor Partnership - Apple Final Cut Pro Import Software

[Sony XDCAM EX](#) Plug-in lets you import XDCAM EX media through the Final Cut Pro Log and Transfer interface.

[Sony XDCAM HD & SD](#) Standalone software enables importing of all popular XDCAM SD and HD formats.

[RED](#) Plug-in lets you import R3D media through the Final Cut Pro Log and Transfer interface.

[Panasonic AVC-Intra](#) Plug-in lets you import AVC-Intra media through the Final Cut Pro Log and Transfer interface.

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Vendor Partnership - Apple Soundtrack Pro Loops & Sound Effects

[AMG](#) Apple Loops: "Dark Side of the Groove," "Ultramagnetic Beats" and "DirtBag" samples.

[APM Music](#) Professional production music over the internet.

[BlastWave FX](#) Provider of high-quality, royalty-free sounds in high definition.

[Editor's Construction Kit](#) Huge range of music beds, effects and atmospheres designed specifically for video editors by world renowned Boosey & Hawkes Production Music

[Kill the Silence](#) Royalty-free, customizable music library, sound effects and more.

[The Hollywood Edge](#) Sound effects libraries.

[PowerFX.com](#) Online provider for audio loops, sound effects and additional Soundtrack Pro content.

[Pro Sound Effects](#) The audio professional's one-stop source for over 400 royalty-free sound effects libraries.

[Serafine Collective](#) Deep collection of royalty-free sound effects from Academy Award-winning sound editor Frank Serafine.

[Sony Creative Software](#) 16-bit and 24-bit royalty-free sample libraries, along with professional grade sound effects collections from Sony Pictures. 10% off for Final Cut Studio users using the link above.

[Sound Dogs, Inc.](#) More than 54,000 effects and royalty-free music files.

[Sound Ideas](#) Sound effects and royalty-free music.

[Sound Vision Library](#) High-quality, royalty-free library of stock music in a variety of themes and formats.

Section VII – Vendor Partnerships

Vendor Partnership - Apple Platform Plug-Ins Software

[Automatic Duck](#) Products include Pro Import FCP, Pro Export FCP, Pro Import AE and free XML Exporter.

[Belle Nuit Subtitler](#) Spot, edit and render your subtitles and import them into the Final Cut Pro or DVD Studio Pro timeline.

[Boris FX](#) A leader in the world of motion graphics, Boris FX offers plugins for Final Cut Pro and Motion.

[CGM DVE](#) Plugins for Final Cut Pro. Demo versions available for download.

[CoreMelt](#) CoreMelt designs GPU-accelerated plug-ins for editors and motion graphics artists. ImageFlow includes a variety of plug-ins for instantly creating photo montage animations, and PolyChrome offers dozens of high precision transition effects for Final Cut editors.

[CHV-Electronics](#) Offering FxPlug plugins such as Magic 3D Effects, Filmstrip 3D, Morphing FX and Towers of Film 3D.

[CRAM for Compressor](#) CRAM improves your Compressor workflow with finely tuned presets for creating sharp web videos and superior DVDs.

[Digital Anarchy](#) All Digital Anarchy video plug-ins, including the popular Psunami and Text Anarchy, are now owned and distributed by Red Giant Software.

[Digital Heaven](#) Wide selection of plugins and utilities for Final Cut Pro and Motion. Several free plugins for download.

[Dixie Unlimited](#) Three FxPlugs to add atmosphere to your Final Cut Studio projects either soft and easy or loud and noisy.

[DVDAfterEdit](#) DVDAfterEdit modifies DVDs after they have been built, without requiring the original assets.

[dvGarage](#) Known for its training and the wide range of plugins and other products that work great with Motion.

[Eureka!](#) Created with FXScript, includes elegant effects and transitions, and special tools for filmmakers.

[FXPlugfx](#) The home of GPU-accelerated plugins for Final Cut Pro & Motion. Resources, tutorials and more.

[Flip4Mac](#) Professional MXF Components for Final Cut Pro — An all-digital, file-based media workflow.

Vendor Partnership - Apple Platform Plug-Ins Software (pg2)

[The Foundry](#) The Foundry is a leading developer of visual effects and image processing technologies. Keylight and Furnace plug-ins provide award-winning keying and visual effects capabilities for Final Cut editors.

[Gee Three](#) The SlickFX collection for Final Cut includes over 60 plug-ins, adding a wide range of text effects, transitions, filters and generators to your video toolbox.

[G-Technology](#) Manufacturing the industry's most comprehensive line of external disk storage solutions.

[GenArts](#) A premier provider of visual special effects software for the film and video industry. Sapphire Plug-ins for FCP and Motion provide over 200 state-of-the-art image processing and synthesis effects.

[Imagine Products](#) Video logging solutions for any format, any workflow, customizable to your needs.

[Industrial Revolution](#) Volumetrix light spill plugin for Final Cut Pro and Motion. Free 15 day trial version available.

[Joe's Filters](#) Utility and effects plugins for Final Cut Pro, created with FXScript and FXBuilder. Free trial version.

[KB Covers](#) Final Cut Pro keyboard shortcut covers for laptop and desktop keyboards.

[Lyric Media](#) Motion tracking and stabilization, drawing and matte tools and other unique plugins for Final Cut Pro.

[Nattress](#) Plugins and utilities for Final Cut Pro, Motion and Color, including Film Effects and more.

[NewBlueFX](#) NewBlueFX offers hundreds of visual effects and transitions, including 3D Transformations, 3D Explosions, Art Blends, Art Effects, Video Essentials, Film Effects, Time Effects, Motion Blends and Motion Effects.

[Noise Industries](#) Noise Industries unleashes the full potential of the FxPlug architecture with FxFactory.

[On2 Technologies](#) Powerful 2-pass VP6 Flash video encoding, editing, masking, and skinning features.

[PixelTools](#) Makers of HDPro QT™, which exports MPEG HD video with transport from Final Cut Pro timeline or any QuickTime enabled product.

Vendor Partnership - Apple Platform Plug-Ins Software (pg 3)

[Radiance](#) Moving video file across networks? Radiance Technologies provides immediate solutions.

[Red Giant Software](#) Popular products include Magic Bullet, Knoll Light Factory, Trapcode, and former Digital Anarchy tools. Create stunning motion graphics, green screen with ease or enhance the look of any video. Trial versions available for download.

[RE:Vision Effects](#) RE:Vision Effects are Academy Award-winning plug-in specialists. Their broad range of FxPlugs include DE:Noise for fixing frame-to-frame defects and Twixtor for processing high-quality speed and frame rate changes.

[River Rock Studios](#) Effects for Final Cut Pro. Downloadable demo plugins available, as well as freeware plugins.

[Tiffen](#) Dfx digital filter software, available as a standalone application or Final Cut Pro plug-in, allows you to apply award-winning filters to stills and video.

[Toolfarm](#) Online resource and one-stop pluginshop for Final Cut Pro and Motion plugins.

[Trapcode](#) All Trapcode plug-ins, including popular tools like Particular, 3D Stroke, and Shine, are now sold exclusively by Red Giant Software.

[wondertouch](#) wondertouch Particle Emitters include more than 300 preset particle effects.

[Zaxwerks](#) One of the first plugin developers to use Motion's FXPlug architecture with GPU hardware acceleration.

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Vendor Partnership - Avid Plug-In Software

A brief review of the Avid Web Site shows the following plug-in and add-on software available. A good deal of the software listed is available for both Windows and Macintosh computers.

[Boris FX Box Set](#)

Get the Entire Collection of Avid AVX Plug-ins from Boris FX (Win and Mac)

[Digital Audio Corporation QuickEnhance® / AS Forensic Audio Tools](#)

Turn your Avid into a Forensic Audio Clarification System (Win)

[Digital Film Tools DFT Keyer Bundle](#)

Superior Visual Effects Tools (Win and Mac)

[GenArts Sapphire Plug-ins](#)

The Standard in High-end Visual Effects (Win and Mac)

[NewBlueFX](#)

Featuring more than 893 Presets in 71 Native Filters and Transitions (Win)

[proDAD HeroGlyph](#) AVX Plug-in for Stunning Trailers, Animated Handwriting and Videotitling! (Win)

[proDAD VitaScene](#) AVX Plug-In for Realtime Transitions and Filters. Maximum Quality. Fully interactive handling. (Win)

[Red Giant Software | Plug-ins for Avid](#)

Magic Bullet Suite 2007, Trapcode 3S Pack, and Knoll Light Factory Pro (Win and Mac)

[SoftNI Avid NLEtitler Series](#)

SoftNI Subtitles + Avid NLEs = Best NLE Subtitling! (Win)

[SpeedSix Monsters & Raptors](#)

BIG Visual Effects and Motion Analysis Plug-ins for Avid DS (Win)

Vendor Partnership - Avid Complementatry Software

[DVFilm Raylight MXFX](#) Multi-Purpose Panasonic-MXF File Converter (Win and Mac)

[eyeon Fusion® 5.2](#) Fusion® is your every tool, every day. (Win and Mac)

[FilmLight Baselight](#) Making the Grade -- Baselight, the fast, creative non-linear grading system (Mac)

[Masstech Group MassStore™ WAM™](#) Bridging the Avid World Into the Transmission Environment (Win)

[PowerProduction StoryBoard Artist 4.2](#) Industry Standard Storyboarding for Media Production (Win and Mac)

[ROOT6 ContentAgent](#) Makes Working with Files a Breeze

[SGL](#) SGL: the only fully qualified archive management solution for Interplay available directly from Avid

[SmartSound Sonicfire Pro 5](#) The Industry's Most Flexible & Creative Music Library Solution (Win and Mac)

[Telestream FlipFactory](#) Powerful Workflow Automation Applications (Win)

[Thomson Grass Valley K2-Avid Transfer Manager Plug-in](#) Seamless Integration into Avid Workgroups (Win)

[VCS Engineering Dira! for Television](#) Integrated Content Management, Production and Playout solutions (Win and Mac)

Section VIII – Configuration Comparison

Section VIII – Configuration Comparison

Configuration Comparison Introduction

The Configuration Comparison section of the document contains representative configurations for shared storage and media management (production asset management) solutions from Apple and Avid.

The vendors' configurations illustrate the similarities and differences in Apple's and Avid's shared storage solutions. Careful scrutiny of the configurations show that the two vendors have different approaches to shared storage and Storage Area Networks (SANs).

Configuration Comparison Section Overview

HBO Studios Production Engineering requested configurations from Apple and Avid for hardware and software to provide 100 Terabytes (TB) of usable shared storage. The shared storage was to be accessed by 10 existing edit workstations concurrently. The vendors were asked to provide media management software to be used by the 10 editors in support of the shared edit environment. Vendors were asked to include all of the necessary hardware and software components to be added to the existing workstations to allow them to access the vendors shared storage and media management application.

The technology used in the shared storage solutions from Apple and Avid is Storage Area Network (SAN) technology. This technology allows for the creation of multiple Logical Units (LUNs) that appear as local hard disks to each attached production workstation. The Apple and Avid SANs were to be configured as primary edit storage, meaning all 10 editors would access the storage LUNs concurrently, in block mode, as local disks, with real-time throughput demands. All 10 editors might be ingesting video from video tape at once, outputting video to video tape at once, or performing editing operations, all at the same time.

Configuration Comparison Audience

The configuration comparison section was written for Engineering and Operations management.

Configuration Comparison Assumptions

The reader is assumed to be familiar with computer storage and with storage area Networks (SANs) specifically, including general SAN concepts such as disk partitions and logical units. Knowledge of the demands real-time storage sub-systems and the issues involved in providing Input/Output (I/O) throughput guarantees is assumed. Familiarity with the components from Apple's Edit, shared storage and media management suite including Fibre Channel cards, Promise™ RAID sub-systems, and Apple Final Cut Server™ is assumed, as is familiarity with components from Avid's edit, shared storage and media management suite including Unity™ storage products, MEDiArray™ storage sub-systems, and Avid Interplay™ software. The reader is assumed to understand data storage and protection concepts including RAID0, RAID1, RAID3, RAID5, RAID6, RAID10, and RAID50 and the associated overhead when using each RAID level.

Configuration Comparison Company alignment

What strategic initiative is supported by this analysis?

The Desktop Initiative, DETE, and HD Post Production initiatives are supported by this analysis.

How does this analysis line up with the strategic initiative?

This analysis highlights similarities and differences between Apple's and Avid's production platforms regarding shared storage features of importance to broadcasters.

Why is this analysis important to the initiative?

This analysis highlights the technical differences in shared storage for the Apple and Avid production platforms. Selection of a production platform is a multi-faceted endeavor. The decision is based on features and functions, look-and-feel of the component software, aesthetics, and technical attributes. This analysis focuses strictly on the technical attributes that are discovered when building a system for a facility that might be overlooked or misunderstood in a casual comparison.

Which departments or groups benefit?

The groups that use the Studios for post-production benefit from this analysis. This analysis helps to determine the "best-fit" shared storage and media management solution for use at the Studio.

Configuration Comparison Summary Overview

Who did the analysis?

Reynold Rossi requested similar configurations from Apple and Avid for baseline shared storage and media management solutions including clients on both Fibre Channel and Gigabit Ethernet. Robert Zimmelman built charts for feature comparison.

What is being analyzed?

Apple's and Avid's shared storage and media management solutions are analyzed. Specific features of the shared storage solutions of importance to broadcasters are analyzed such as Project (Timeline) Sharing and Bandwidth Guarantees.

When and where did this analysis take place?

This analysis took place in June, 2009 at HBO Studios.

How was the analysis done?

This analysis was done by requesting configurations from vendors for similar usable shared storage and media management software and then comparing features of the vendors' offerings. Where features were both present in both products, details of the features were compared. Features that were only present in one vendor's product were highlighted.

Why did we do the analysis (what is the objective or purpose)?

One objective of this analysis is to go through the process of configuring a solution from each vendor in order to identify features and complexities of the vendors' offerings and to discover which features and

Section VIII – Configuration Comparison

functions may be provided by one vendor and overlooked by another. Another objective is to discover components of each vendor's solution that are not readily apparent during initial inquiries. When going through the process of configuring the components, one gets to understand the vendor's approach to the solution and to see all of the pieces that are required to make the solution work. By attempting to build a solution with each vendor's components, Engineering is better able to discover implementations that are more elegant or more targeted to HBO's use case than others.

What was the method used in the analysis?

Shared Storage Features for each platform were compared in this analysis.

What were the additional details (if any) of the analysis process?

This analysis was different than most because in some cases, only one vendor offers a particular feature. Bandwidth guarantees are an example of this, offered by Avid but not by Apple at this time. Sophisticated data protection is another example, offered by Apple but not by Avid at this time.

What processes are improved by learning the results of this analysis?

The production platform shared storage procurement process is improved by the results of this analysis. After reviewing the various components of the vendor-provided solutions, the reader is more able to understand the parts, design goals, strengths and weaknesses of Apple's and Avid's solutions.

Technical Analysis: Apple/Avid Production Platforms

Section VIII – Configuration Comparison

Apple / Avid Configuration Comparison Table

	Configuration 1	Configuration 2	Configuration 3	Configuration 4
	Apple XSAN / FC Server	Apple XSAN / FC Server / StorNext FX	Avid ISIS / Interplay	Avid MediaNet / Interplay
Client Operating Systems	Macintosh Clients Only	Mac & PC Share Media *1	Mac & PC Share Media	Mac & PC Share Media
Edit Client Software / Macintosh	Apple Final Cut Pro	Apple Final Cut Pro / No PC Edit Client	Any Avid Pro Products	Any Avid Pro Products
Edit Client Software / PC	No PC Edit Client Software *	No PC Edit Client Software *	Any Avid Pro Products	Any Avid Pro Products
Clients (# of Users in Base Configuration)	10	10	10	10
Maximum Number of Connected Clients	64 Connected Computers	64 Connected Computers	330 +	46 +
Maximum Number of Real-Time Clients *3	N/A	N/A	330 Real-Time Clients	46 Real-Time Clients
Real-Time Clients (Guaranteed #) *4	No Guaranteed Clients * 4	No Guaranteed Clients * 4	48 Dual Stream 220X *5	26 Dual Stream 220X *5
Tested Configurations	4 clients *6	4 clients *6	48 clients *6	26 clients *6
Capture Resolution	ProRes422HQ	Mac - ProRes422HQ / PC - n	DNX220x	DNX220x
Storage (Protection)	RAID 5	RAID 5	RAID 1	RAID 1
Storage (Raw)	128TB (16 TB x 8 chassis)	128TB (16 TB x 8 chassis)	224TB (32 TB x 7 chassis)	224TB (16 TB x 14 chassis)
Storage (Useable)	102TB (20 % overhead)	102TB (20 % overhead)	112TB (50 % overhead)	112TB (50 % overhead)
Raw Storage (Scalable)	Yes	Yes	Yes	Yes
Raw Storage (Maximum Scalable Size)	2048 TB Volume Size Limit *7	2048 TB Volume Size Limit *7	384 TB / Media Engine *8	128 TB / Media Engine *8
Sharing Media	Yes	Yes	Yes	Yes
Sharing Projects	No	No	Yes	Yes
Supports Competitor's Edit Client	No	No	Yes	Yes
Storage Bandwidth Guarantee Method	No Storage Guarantees	No Storage Guarantees	Media Engine *7	Media Engine *7
Real-Time Guaranteed Streams / Client	No Guaranteed Streams	No Guaranteed Streams	3 Streams/Client	3 Streams/Client

Table 6 : Apple / Avid Configuration Comparison Table

1. StorNext FX software for PC is required to use XSAN partition.
2. Apple does not offer Edit Client software for the PC
3. Real-Time Clients are the number of clients that perform editing operations with no skipped frames, pauses, or hesitation
4. Guaranteed # of clients refers to clients that the storage system allows to use the real-time storage. When the number of clients exceeds the guaranteed number, they are prevented from accessing the storage. Storage systems that do not support a guaranteed number of clients are noted.
5. Streams refer to one HD video program worth of data playing from the storage in real-time, with no skipped frames, pauses, or hesitation
6. Avid's documentation refers to guarantees with 26 or 48 clients accessing two streams of video concurrently. Apple's documentation refers to testing with 4 clients.
7. Source: Apple XSAN2 Technology Overview - March 2008
8. The Avid Media Engine acts as a mediator between clients and storage to support guaranteed Input Output per client and per chassis.
9. Without guaranteed Input and Output there will be skipped frames, pauses, or hesitation in video and audio playback.

References for Apple / Avid Configuration Comparison Table (Table 6)

Avid Unity Storage Brief: http://www.avid.com/resources/briefs/unity_sb.pdf
 Apple XSAN Performance Document - <http://www.apple.com/xsan/deployments/video.html>
 Apple XSAN Technology Overview - http://images.apple.com/xsan/docs/L363053A_Xsan2_TO.pdf

Section VIII – Configuration Comparison

Configuration Comparison Results

A Request for Information (RFI) was sent to Apple and Avid for systems with 100 Terabytes (TB) of shared storage plus media management software to support a group of 10 editors. Avid responded to the RFI directly and provided configurations. Apple responded to the RFI indirectly ; Apple does not configure turn-key solutions directly. Turn-key solution configurations are provided by Apple resellers who specialize in the particular vertical market that the solution is to be implemented for. Apple configurations from the RFI were provided by TekServe™, a local reseller with specialists in video systems. Vendors were asked for systems capable of expanding to an Enterprise deployment. Responses to the RFI were reviewed and analyzed. Features and functions were compared. Similarities and differences were highlighted and are discussed below.

Similarities Between the Apple and Avid Shared Storage Solutions

Apple's and Avid's shared storage solutions have some similarities. Both vendors offer media asset management software. Both disk subsystems can use Fibre Channel infrastructure for edit client attachment. Both vendors shared storage solutions allow multiple computers to access shared workspaces concurrently. On the surface, the two systems look similar. The similarities are only on the surface however.

File Sharing Among Production Computers

The shared storage solutions from Apple and Avid are similar in that they both allow production computers to share files.

True Storage Area Network Technology

Apple and Avid offer true Storage Area Network (SAN) technology. SANs support sharing disks or Logical Units (LUNs) in a Disk Subsystem as if the disks are locally attached to each computer.

Block-Mode Access to Storage

All of the computers using Apple's or Avid's SANs access the disks in block mode, which is the fastest method of accessing a shared disk by client computers. Block-mode access is usually limited to one computer accessing a disk at a time, and is normally used by a computer accessing its own local hard drive. The SAN software (Apple's XSAN or Avid's Unity) allow multiple computers to access the disk at the same time while still using the fast block mode method.

Computers that use network shares such as AppleTalk or Windows File Services access the storage in "file mode", which is the slowest method of accessing a shared disk. This file-mode access method is typical of computers accessing a file server.

Capable of supporting Video Input and Output (I/O)

Apple and Avid both offer production Storage Area Networks (SANs) that are capable of supporting video Input and Output (I/O) as well as editing operations.

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Cross-Platform Filesystems

Both Apple's XSAN and Avid's Unity offer cross-platform filesystems. Clients accessing either Apple's or Avid's shared storage solutions access files using the same filesystem whether the client is running Windows Operating System or the Apple Macintosh Operating System.

Disk Performance in Standalone Systems and in Storage Area Networks

Before we highlight the differences in the systems, we introduce the following shared storage purchase scenario. When faced with the purchase of disk storage, the first question one may ask is:

1. How much storage is required (in Gigabytes, for example)?

With more experience, one will ask the following question:

2. How many Megabytes per second does the storage read and write (how fast is it)?

With even more experience, one may ask the following question:

3. Is that number of Megabytes per second a burst transfer rate or a sustained transfer rate (is it fast for a long time or just a split second)?

This question speaks to the fact that a disk drive can absorb data very quickly into its RAM cache buffers (data from controller to RAM), but once they are full, the drive may perform more slowly (data from RAM to disk).

When one is purchasing storage for an edit system, and assuming that one has been quoted the sustained transfer rate of the disk drive, one must ask another question:

4. Can the storage maintain consistent performance for an extended period of time without ever dropping below my Megabytes per second requirement (can it perform sustained I/O at my required speed without introducing any dips below that speed)?

This is an entirely different question than we've been asking up until now. This does not ask how fast the drive is in one moment in time (burst transfer rate) or how fast the drive is for a few seconds or one minute (sustained transfer rate). This question speaks to the fact that disk drives and disk sub-systems must occasionally perform "housekeeping" functions, or may need to adjust reads because of heat build up (thermal recalibration) that may affect the drive's performance when capturing 30 minutes of video, and when no temporary loss of performance is allowed.

Next, when purchasing a Storage Area Network (SAN), one must ask:

5. What is your means of "lock management"?

This question asks the storage vendor how the "shared" storage will be accessed by multiple users. With some SANs, only one user can write to a shared disk (or to a shared LUN) at a time. With other SANs, multiple users can write to a shared disk (or to a shared LUN) at the same time. This is the case

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with both Apple's XSAN and Avid's Unity SANs. In both cases, another computer (or pair of computers) called Metadata Controllers (MDCs) mediates the shared access to the disks (or LUNs). Before a workstation writes to the shared disk, it requests "write access" from the MDC. If another user is writing, the MDC denies write access until the other user is done writing. If no other users are writing, the MDC grants write access until the write is complete.

When purchasing a SAN, in order to provide adequate storage performance, one asks the question:

6. How many computers can do the I/O concurrently?

A smart storage vendor will ask you what kind of data is being read and written to the drives, and can tune the storage sub-system to handle the number of users that will be performing the specific I/O that is required. With most Storage Area Networks including Apple's XSAN, there are no guarantees that when a computer needs access to the shared disks that the disks will be ready at that instant.

You might now ask the question:

7. What is your means of performance management (bandwidth guarantees)?

With Avid's Unity SAN, the guarantees of available I/O are added to the MDCs functionality. Avid calls its MDCs "Media Engines". When a user wants to write to a shared Avid Workspace, the user requests write access from the Media Engine. If another user is writing to the disk OR there is not adequate performance available because other users are reading from the disks, the user is denied access until the other user is done writing OR performance becomes available. If no other user is writing at the time AND there is adequate performance available, the user is granted write access.

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Differences Between the Apple and Avid Shared Storage Solutions

There are some fundamental differences in the systems. Some of the major differences are storage data protection, the ability to support project sharing (sharing the same project file and output timeline), bandwidth (disk subsystem performance) guarantees, availability of edit software for both PC and Macintosh computers, and the number of concurrently attached edit systems in typical vendor-tested configurations.

To the casual reader, the first-time production assistant, or to a very small facility, the shared storage solutions from Apple and Avid are nearly identical. It is only when one considers real-world performance scenarios that are often overlooked that one realizes the fundamental differences between the systems.

Differences in Bandwidth Guarantees

Smaller production groups may not require bandwidth guarantees. A small group of editors working in one or two rooms can coordinate their efforts when capturing or outputting video in order to minimize skipped frames. Larger, enterprise production groups are not able to coordinate their efforts as well and so may find bandwidth guarantees necessary.

For a small facility with a group of four editors working on an independent film or a small episodic production, the Apple XSAN and Avid Unity solutions might both work well. While Apple's XSAN does not explicitly allocate "streams" of disk storage bandwidth to clients, this may be mitigated by the fact that the facility may have only one VTR, and so only requires one user to perform real-time Input/Output (I/O) at a time. The I/O of these four editors may be manually coordinated in a small enough facility.

For a slightly larger facility with a group of 8 editors, the rules may be different, and the coordination of I/O on the SAN must be automated, or mediated in some way, in order to provide I/O when required by each client. Several clients may have real-time I/O requirements at the same time. The I/O of 8 editors can not be manually coordinated, so the system that can support multiple real-time I/O operations more gracefully by mediating the I/O through a storage engine is the better system.

For a group of 25 editors working in an enterprise-class model (working on multiple projects), the rules become clear. Only the system with real-time bandwidth guarantees is worthy of consideration. Using a system without real-time bandwidth guarantees for this number of editors will be problematic at best. HBO Studios fits within this enterprise model. For a group of 50 editors with 10 Video Tape Recorders performing I/O for 10 hours per day, then the system with real-time bandwidth guarantees is required.

General Purpose Storage Area Network vs Dedicated Video Storage Area Network

Apple's XSAN is deployed for multiple purposes across many industries. During a recent XSAN for Pro Video course offered by Apple, attendees came from various industries including Medical Imaging and Industrial Design, where real-time I/O and bandwidth guarantees are not as important as in video applications. Avid's Unity SAN is designed from the ground-up for video.

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Different Approach to Shared Storage Metadata Control

Apple and Avid have different approaches to shared storage. Apple's shared storage system is called XSAN™, which is an OEM product from Quantum corporation. XSAN is the StorNext filesystem, a general-purpose shared filesystem developed in the media sector for providing high-speed access to data that was formerly maintained on single computer systems or shared using file-servers. Avid's shared storage system is called Unity™, which was developed by Avid engineers and contractors for use by Avid edit systems.

Apple's XSAN is a cross-platform Storage Area Network (SAN) with file-level locking via a dedicated Ethernet Network, mediated by Metadata Controllers (MDCs) that control concurrent access to the disks. These metadata controllers prevent the corruption that would be caused by two computers writing data to the disks at the same time. Avid's Unity provides file-level locking in its cross-platform SAN via the Fibre Channel network, mediated by "media engines" that also prevent multiple computers from writing data to the disks at the same time, but also perform a bandwidth-guarantee function.

Philosophy of selling Disk Storage in units of "Streams"

Avid sells disk storage in units of "streams". Configuration of Avid shared storage is a complicated and elaborate undertaking that takes into account each client's I/O needs and builds storage "workspaces" capable of supporting the number and type of client. When configuring Avid's Unity shared storage sub-systems, one must consider the data rate of the media being edited as well as the number of concurrent streams required by each production client accessing the "workspace". Then the workspace is created for the specific I/O pattern required by the clients accessing the storage.

Without the storage knowing about "streams" of video I/O, it is always possible to encounter performance bottlenecks. The awareness of "streams" of video I/O is a complex undertaking, and while it may severely hinder the use of the Avid's Unity storage as general-purpose shared storage for cost and complexity reasons, Avid's Unity is designed for Audio / Video performance guarantees, and performs its function well.

Interconnect Infrastructure Differences

Apple and Avid differ in available choices for interconnect infrastructure. While both vendors offer shared storage solutions that use Fibre Channel interconnect, Avid offers a shared storage solution that uses Ethernet for interconnection of workstations and disk sub-systems (Unity ISIS™). Apple does not offer a similar Ethernet-based shared storage solution for comparison.

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Sophistication of Storage Protection

Avid offers less sophisticated storage protection (and therefore a higher overhead of raw storage to usable storage) than Avid. Apple resells a storage product from Promise that is also available direct from the manufacturer. The XSAN user is not required to use Promise RAID. XSAN is storage subsystems agnostic, but is packaged with Promise RAID on Apple's web site. Promise offers sophisticated storage data protection on their Promise RAID, including RAID 0 (striping across two disks with no protection), RAID1 (mirroring), RAID5 (one parity disk), RAID6 (two parity disks), RAID50 (striping across two RAID5 sets) and RAID60 (striping across two RAID6 sets). Avid currently offers only RAID1 (mirroring) protection in its storage sub-systems. Because of this, Apple disk storage can be purchased with as little as 20% overhead (Raw disk to usable disk) in a 10+2 RAID6 configuration.

Avid storage, on the other hand, supports only RAID0 (striping, with no protection) and RAID1 (mirroring), so it must be purchased with 100% overhead if storage protection is desired. While it is possible to configure the Avid storage with no protection using RAID0, this has been ruled out for practical reasons. Mirroring requires 200TB of disk to be purchased to support 100TB of usable space. Avid claims support for RAID5 in the near future, but is not shipping RAID5-based storage today.

Differences in the Number of Concurrent Edit Systems in Typical Configurations

The Apple documentation ⁴ refers to concurrent testing of XSAN with 4 users. The Apple documentation refers to the connection of four edit systems to their storage, having all 4 edit systems access the storage with no interruptions or hesitation. This is a very small number of concurrent users for an Enterprise-grade storage sub-system. The Avid system is configured and tested with the number of users quoted, up to 300+ users in a large Avid Unity ISIS system. This is a major difference between the two shared storage platforms.

⁴ Source: Apple XSAN2 Technology Overview - March 2008

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Differences in Bandwidth Guarantees in the Disk Storage Subsystem

Bandwidth guarantees are a part of the Avid Unity storage system. When configuring Avid's Unity shared storage system, workspaces are created based on the bandwidth of the media being used, the number of concurrent edit systems that will access the storage, and the number of real-time "streams" that each edit system will require. In this manner, all edit clients attached to the workspace are guaranteed to access the storage with no dropped frames, skips, or hesitation.

While bandwidth guarantees are not available on the Apple XSAN shared storage system, Apple's XSAN shared storage system provides performance "affinities" that tie a file folder's performance to faster or slower disks. Using storage affinities, some folders can be created on fast disks that are used for editing applications, and some folders can be created on slower disks that are used for other, less demanding applications. Files can be moved from "slow" folder to "fast" folders very simply with storage affinities. Affinities do not provide bandwidth guarantees however.

In the Apple edit platform, performance testing is left to the vendor of the video Input / Output (I/O) card. Readers may be familiar with the AJA Kona Speed Test, where disk I/O is performed in the same increments that are used for video I/O, and disk performance can be tested to see if the application will be likely to drop frames during a video capture. This is not a bandwidth guarantee. It is only a benchmark test. Several computers can be attached to the XSAN shared storage running the benchmark test concurrently to see how the SAN will perform during concurrent video I/O, but this is still not a bandwidth guarantee.

Differences in Availability of Macintosh and PC Edit Clients

Avid provides edit clients that run on Apple Macintosh computers running OS/X and PC computers running Windows. Apple provides edit clients that run on Macintosh computers only.

Differences in "Open-Ness" of Apple's and Avid's SANs

When considering a Storage Area Network (SAN) for an enterprise, it is important to understand how open or closed the SAN is. An "open" SAN can be used by many different production systems from different vendors. A "closed" SAN can be used with one specific vendor's production systems. A SAN that can be utilized by all of the computers in the production pipeline is better than a SAN that can only be used by some of the computers in the production pipeline. Apple's XSAN is a multi-platform SAN that can be accessed by computers running many operating systems. In some cases, Apple's Metadata Controllers (MDCs) must be replaced by StorNext filesystem MDCs for cross-platform access to the SAN.

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Differences in Support for Competitors Edit Clients by Shared Storage

Avid's Unity™ version 5.1.2⁵ shared storage system fully supports clients running Apple Final Cut Pro. This includes detailed configurations in Unity™ of specific numbers of "streams" of guaranteed bandwidth for Apple's Final Cut Pro systems running ProRes422 and ProRes422HQ CODECs, which run at different data rates. In the Unity shared storage system, the specific disk I/O needs of the CODEC (whether Avid's or Apple's) and application (whether Avid's or Apple's) are taken into account in order to deliver a guaranteed number of streams of video to the application. The Apple Final Cut Pro application accesses the Unity shared storage exactly like an Avid Edit client. Workstations running Final Cut Pro and Avid edit applications can not share the same workspace (disk volume), but can be attached to the same centralized SAN.⁶

Apple's XSAN does not support Avid's edit clients in the same way that Avid's Unity supports Apple's Final Cut Pro clients. XSAN does not provide any bandwidth guarantees, so there is no ability to configure workspaces to support a particular number of real-time streams for a particular application. Regardless of this fact, in Avid's case, the edit client wants to "own" the storage if it is not using an Avid-supported shared storage solution. So, Avid's edit clients are not supported on Apple XSAN because they are not aware of Apple's XSAN shared storage solution.

Differences in Support for Shared Projects ("Project Sharing")

Avid offers support for project-sharing, where two editors can work on the same output timeline at the same time. This feature is not available from Apple. Avid's Unity shared storage system and edit clients can support shared projects, where several editors can work on the same output program and timeline concurrently. This feature requires the Avid Unity workspace to be configured specifically to support project sharing. Apple's XSAN shared storage system and edit clients do not provide this level of shared project functionality. There is no means of configuring Apple's XSAN shared storage solution to support project sharing in the Apple Final Cut system.

⁵ Source: Avid Unity MediaNetwork_ReadMe_v5_1_2.pdf

⁶ Source: Avid Unity MediaNetwork_ReadMe_v5_1_2.pdf

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Configuration Comparison - Conclusion

In conclusion, the Configuration Comparison Section has illustrated some similarities and differences between Apple's and Avid's shared storage solutions. Some features are similar, such as the ability for editors to share media contained in the shared storage system by clients running both Windows and Mac O/S operating systems.

Some features are quite different however. The differences are primarily around data storage protection, bandwidth guarantees and the ability to share projects among several editors. The other major differences are in data storage protection, the number of concurrent edit systems in a typical configuration, and the availability of bandwidth guarantees in the disk storage subsystem. The two systems differ in the availability of cross-platform (Macintosh and Windows) edit clients. Avid offers PC and Macintosh Media Composer edit clients, Apple offers only Macintosh Final Cut Pro edit clients. Support for the competitor's edit application is available from Avid (Avid supports Apple Final Cut Pro edit clients on its Unity shared storage system), but not from Apple.

Configuration Comparison Highlights

The Vendor Configurations reveal similarities, but also substantial differences between the two storage solutions. The most striking differences are:

1. Avid's RAID1 mirroring provides simple, high-performance data protection with 100% data redundancy and extremely fast access, as all clients can read all data from either mirrored copy of the data. RAID1 mirroring does require more raw storage overhead than some of the data protection options (RAID levels) available on Apple's Promise RAID (which can also use RAID1), but is a fast, elegant way of providing high performance and 100% redundancy.
2. Avid's Unity SAN is configured and sold to support guaranteed numbers of "streams" and "real-time clients" editing at specific data rates while Apple's is not. Avid's "media engine" metadata controllers mediate file access as well as client performance in order to provide bandwidth guarantees.
3. Avid's Unity SAN supports sharing of projects while Apple's XSAN does not.