Digital Video for Pro A/V Integration

The A/V industry is currently in the midst of a significant transition, from analog video to digital video technologies and applications. Every day, system designers face the challenge of integrating digital and analog video signals into new and previously-installed A/V systems. As digital video is associated with the cutting edge in A/V technology, there is an increasing desire by integrators and their customers to incorporate digital video into their systems. A wide array of digital video ports, including DVI, HDMI, DisplayPort, and HD-SDI, are present in some form on virtually every new component found in the market today. In addition, there is a very large installed base of analog hardware, as well as content, which must be kept viable even within new system designs. For the foreseeable future, then, most presentation environments will require mix of analog and digital video products and technologies.

LCD Monitor with Digital Inputs

Digital Video-It's More Than Just HDMI

Although the DTV digital transition is currently headline news, digital video is not new to the professional A/V industry. The broadcast, teleproduction, and rental/staging segments adopted serial digital video, SDI, more than 20 years ago, and HD-SDI has been in use for more than a decade now. In the medical, visualization, and computer graphics segments, DVI has been an established format since 1999. Continual evolution within the computer, broadcast, and now consumer electronics industries has brought digital signal connectivity to the forefront with the introduction of two, newer digital video standards – HDMI for consumer products and DisplayPort for computers and related technologies.

The prevalence of these various digital signal formats presents opportunities as well as challenges for integration of professional A/V systems. DVI and DisplayPort are common to PCs and laptops, and are standard on many professional displays and high-end projectors. HDMI is primarily found on HDTV-capable products such as Blu-ray Disc players, game consoles, and satellite and cable DVRs and receivers. While designed for consumer and residential applications, some HDMI-equipped products are now being utilized in commercial applications as well. High definition digital video has also found its way into many applications beyond the broadcast studio as a means to capture, distribute, and display high definition content, extending into to house of worship and rental and staging environments. Just about every display available today has some type of digital video capability. Whether it's a desktop PC display, ceiling-mounted

Computer System with Digital Outputs

Digital Video Formats Commonly Integrated in Professional A/V Systems

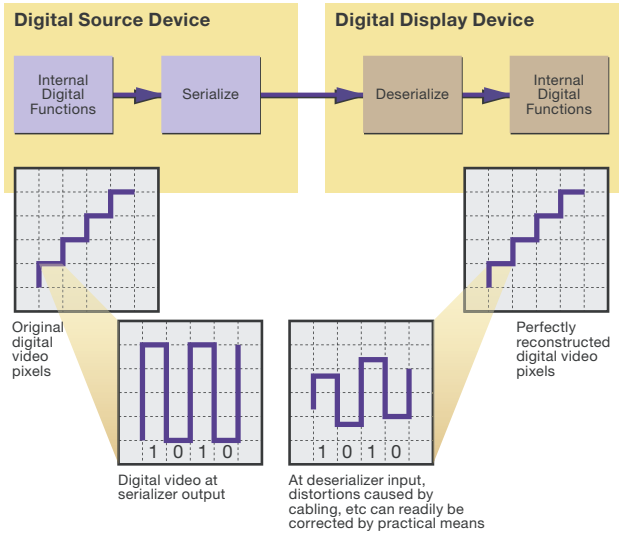
DVI

HDMI

DisplayPort

SDI

Digital Transmission Can Achieve Perfect Signal Reconstruction



A digital infrastructure can be designed to accommodate the high resolutions commonly found today, while also providing support for higher resolutions introduced in the future.

projector, or a large flat-panel LCD on a wall, chances are that a DVI, HDMI, or DisplayPort connector is available to accept incoming signals from digital source devices.

Why Digital?

The implementation of digital A/V technologies brings the promise of several distinct advantages over analog technologies. First, for the manufacturers of computers and displays, there is the potential of removing a considerable amount of processing circuitry from a device. Since signals are already digital within the electronics of virtually all A/V products, most if not all analog-to-digital and/or digital-to-analog conversion can be eliminated, resulting in lower manufacturing costs and allowing for more competitive pricing. Second, in comparison to analog-based devices and systems, digital signals are by nature, lossless, enabling the distribution of pixel-perfect and consistent, pristine quality images while reducing the time and effort required for system and display set-up (see Figure 1-1). Finally, a digital infrastructure can be designed to accommodate the high resolutions commonly found today, such as 1920x1200 and HDTV 1080p, and provide support for the higher rates on the horizon.

Network operations centers often use a fully digital signal distribution architecture to deliver high quality, high resolution images.

Making the Choice – Analog, Digital, or Both?

Part and parcel of any transition are uncertainty, the fear of the unknown and desire to look for expert help and assistance in making decisions. In your role as an A/V IT manager, consultant or A/V system integrator, your customers are depending on you to help them make the best choices. In the face of a wide array of products and disparate technologies, customers want advice during the design and implementation phases to ensure that A/V systems meet their requirements for functionality and performance, stay within budget and, ideally, provide for future growth and further changes in technology.

Complicating the decision is the knowledge that, while new A/V technologies and signal types are continually introduced, not all of them survive and the ones that do generally don't immediately replace the legacy formats. For example, many new digital source devices incorporate an assortment of analog video outputs, including composite video, S-video, and component video. Correspondingly, most new digital displays are still equipped with analog inputs. You might ask “why do manufacturers go to the extra effort, and additional expense, to provide a variety of connectors on their products?” In a word, compatibility.

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Most manufacturers realize that sources and displays are rarely replaced at the same time. New sources, such as Blu-ray Disc players and higher-end laptop PCs, need to maintain compatibility with older displays. New, high-resolution flat panel displays and projectors, on the other hand, need to remain compatible with older sources, such as VHS recorders and DVD players that are retained for use with legacy content.

System designs for typical training and presentation facilities, therefore, very often accommodate a hybrid mix of analog and digital capabilities, providing support for legacy analog video formats while incorporating newer signal types such as DVI, HDMI, DisplayPort and, in some cases, HD-SDI.

To Get the Right Answer, Ask the Right Question

The first question to be answered, then, is the most difficult, as it goes right to the core of the transition. Should you:

- Stick with a tried-and-true analog design for the time being?
- Build an digital/analog hybrid system that incorporates a mix of technologies?
- Or, build tomorrow's system today with an all-digital design and some provision for legacy analog products?

The System 208 D Supports digital and analog signals

The answer, as with so many decisions and choices to be made, is "It depends."

Some systems are likely to remain predominantly analog for some time, with signal converters added as needed to accommodate new digital displays or source devices. For example, technology budgets for K-12 classrooms typically do not allow the wholesale upgrade of a media system simply to accommodate a new technology. Integrating a new, HDMI-equipped playback source, however, may require nothing more than the appropriate digital extender and a direct connection to the digital input on the projector.

Others, such as in university lecture halls and corporate boardrooms, are beginning to incorporate digital video technologies on a broader, more systematic scale to accommodate the continuously evolving needs for digital media presentations while maintaining compatibility with existing stores of analog content and playback equipment. Digital input capability can be added by changing out the central switcher or scaler to one that accepts analog and digital signals; conversely, digital displays can be accommodated through the use of a switcher or scaler that outputs digital signals.

Finally, specialized applications such as visualization, simulation, military and medical imaging, and command and control, are adopting a fully digital approach that can deliver uncompromised, very high quality, very high resolution images – one of the major benefits of digital video. These system designs are based around an all-digital switcher or matrix switcher, with any legacy analog sources accommodated through the use of an analog-to-digital converter.

The bottom line is that, just as video replaced motion picture film and DVDs replaced VHS cassettes, digital technology in one or more forms will replace analog in the majority of applications over time. Typical corporate and educational presentation systems will move to a fully digital design in the future; for the time being, however, a hybrid system design that supports both analog and digital signals takes into account a wide range of presentation needs

College/University Classroom

and technologies and, in the long run, is the most prudent and cost-effective approach.

Matching Technology to Need

Before undertaking a system design, full knowledge of the customer's needs and expectations are necessary. Once the primary question – analog, digital, or both? – has been answered, many more questions remain to be asked.

- Is there a requirement for interoperability between digital and analog components? Depending on the source content, this may not be feasible due to digital rights management such as HDCP.
- Is this an upgrade to an existing system? If so, is there a need to support legacy devices while providing the flexibility to address future growth capability? System longevity is also a key consideration in determining the appropriate product solutions.
- Is the system expected to span a technology life of many years? If so, perhaps an all-digital infrastructure should be considered to support the continued evolution of video resolutions. System scope and size also determine operational practicality.

Understanding the true operational requirements of any system during the design phase will help control potential cost overruns later. For example, if there are HDCP requirements, does protected content have to be viewable on all displays within the system, or only in a few, select locations? Having an operational understanding of a system will go a long way in meeting the needs as well as the budget of the customer.

Going the Distance

A/V professionals face three primary challenges in the handling of digital signals and the management of their distribution to ensure robust, reliable operation. The first is to maintain full signal integrity from source to destination. Digital video signals are considerably different in comparison to analog. Digital video signals do not degrade linearly as with analog video. For analog signals, the effects of cable-related losses worsen gradually with cable length, but for digital signals the impact is usually far more noticeable and abrupt, with sparkles, flashing images, or complete image loss altogether, as cable length increases beyond a "digital cliff" threshold.

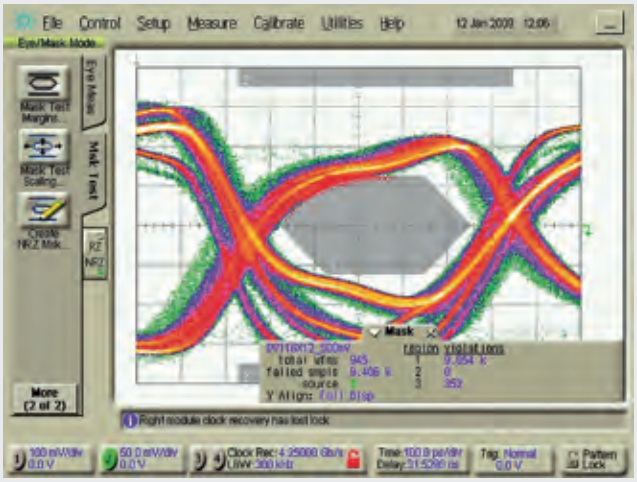
Technologies such as DVI, HDMI, and DisplayPort are primarily designed for short, point-to-point connections, for example from a computer to a desktop monitor, or from a Blu-ray Disc player to a flat panel television. Distances in these applications are relatively short and, in light of the very high data rates involved and a desire to

Digital Signal Conditioning

For DVI, HDMI, and DisplayPort, the proper "shape" of the RGB channels, also known as the "eye" pattern, is critical in ensuring proper image display. Losses in these channels will result in "sparkles" on-screen, or a complete loss of the image. They are attributable to long cable lengths, poor quality cables and terminations, and even certain source devices which output substandard digital video signals.

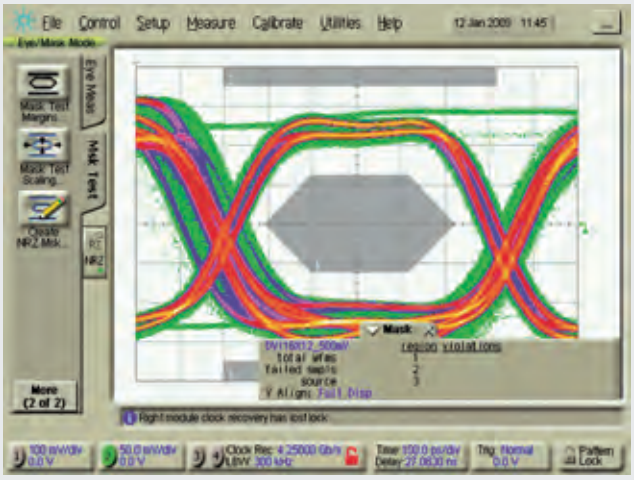
Many Extron digital video products feature input cable equalization, which actively conditions incoming signals, applying equalization to help reshape and restore RGB channels to proper levels. The clock channel is also regenerated to provide proper RGB channel alignment. As shown below, a compromised source-generated DVI signal is significantly improved when Extron signal conditioning is applied. Input cable equalization reshapes and restores the "eye" patterns to ensure high quality images at the display.

WITHOUT EXTRON INPUT CABLE EQUALIZATION



Direct DVI output from a source device. The signal quality is poor, and the "eye" pattern is significantly distorted.

WITH EXTRON INPUT CABLE EQUALIZATION



The same DVI output after Extron signal conditioning is applied. The "eye" pattern is fully restored.

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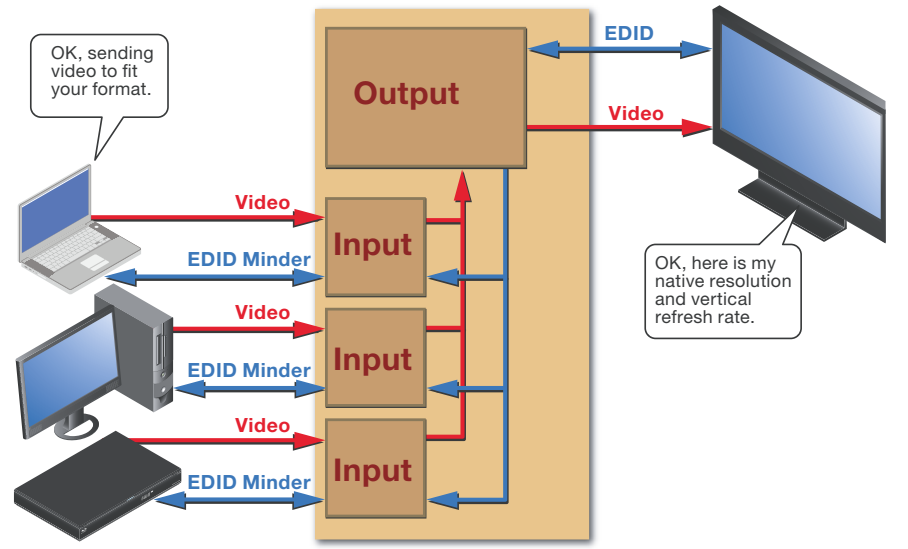


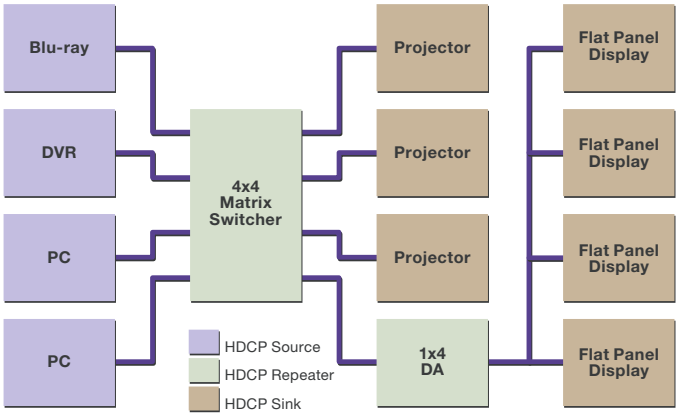
In digital video connections, the source relays EDID - Extended Display Identification Data to a display.

reduce cost and power consumption, digital source devices can rarely drive a signal more than a few feet. Use of high quality, high performance cables can help to a degree and, in some cases, can provide for reliable signal transmission up to 75 feet (25 meters) or so. While suitable for most consumer applications, this distance limitation can have a serious effect on professional A/V installations where signals must be routed many tens if not hundreds of feet, from source to destination. In order to compensate for this limitation, signal conditioning products such as equalizers can be used to recover and restore a signal to distances up to 200 feet (60 meters). For even longer cable runs, or to accommodate the need to run cable through conduit, digital signals can be converted and distributed using standard, shielded Category cable, or with fiber optic technologies.

Second, there are very specific performance and timing parameter requirements that need to be maintained throughout the entire signal path. For example, in HDMI, the RGB video lines, or channels, must be accurately synchronized in order to be accurately handled and reproduced throughout the system. Terms such as equalization, jitter, and reclocking in the digital world replace the familiar level and peaking terminology of the analog world. Signal conditioning requirements for digital signals are also different and must be understood accordingly before designing a system.

The third challenge in the successful integration of digital A/V systems is to be able to reliably switch, distribute, and route signals. Some digital video connections, including DVI, HDMI, and DisplayPort, require two-way communication between a source and a display. If this communication is interrupted, such as following a disconnection, source switch, or signal split, image display can be delayed, or even lost completely. In many cases, the content being used has a direct effect on this communication as well. For example, some early scaling DVD players with HDMI output did not allow the use of a repeater, and so the signal ended at the input of the switcher and was not passed through to the display.

Professional Digital AV System with HDCP



When sending signals from multiple sources to multiple destinations, it is important to select A/V integration products that are HDCP compliant and provide proper management of EDID communications.

Minding Your EDID

The two primary forms of two-way communication are EDID- Extended Display Identification Data and DRM - Digital Rights Management. Both are extremely important aspects of digital signal formats that can significantly impact system reliability if not properly accommodated and implemented.

In brief, EDID relates to the communication of a display's performance capabilities, such as its native and supported resolutions, to the source connected to it. EDID simplifies system setup, in that the display "tells" the source what pixel rate and resolution it prefers, and the source then outputs the optimum rate and resolution for the display, generally resulting in perfect images that are accurate on a pixel-for-pixel basis.
DRM is the protection of intellectual property, of which HDCP - High-bandwidth Digital Content Protection is the most widely implemented. HDCP encryption is found on commercially-recorded Blu-ray Discs, high-definition digital satellite and cable television, downloadable content, and more. DRM is a primary concern in residential applications, where content piracy is of great concern to copyright holders, such as motion picture studios, who stand to lose millions of dollars if content is made available through unauthorized replication.

For reliable presentation of protected content within a residential entertainment system, all relevant signal paths must be fully HDCP compliant and conforming to specific rules. This is relatively simple in the typical one-to-one scenario where a Blu-ray Disc player is connected directly to a flat panel display, but both commercial and residential A/V systems usually present the necessity of sending signals from multiple sources to multiple destinations (see Figure 1-2.) The primary difference, though, between residential and professional A/V systems, is the type of content that is being distributed and displayed on a regular basis.

EDID 101 D
EDID Minder

HDCP in the Home

In a home environment, virtually all content is derived from commercial, copyrighted sources: movies on Blu-ray, satellite broadcast, or streamed across the Internet; games on Blu-ray, DVD, or solid-state memory; and sports or other live entertainment from pay-per-view satellite or cable TV sources. In order to protect the rights of the legitimate owners of this content, digital rights management in general, and HDCP in particular, will become common.

HDCP in the Workplace

Content regularly used in professional A/V applications, on the other hand, is almost always locally generated. This mostly includes the display of Microsoft applications such as PowerPoint® or Excel; institutionally-produced video for training, demonstration, or sales presentations; and custom or proprietary software applications designed specifically for institutional operations or command-and-control needs. Very rarely is the content used in professional applications encrypted with HDCP. Typically, rights-managed content is limited to the occasional use of commercially-recorded materials, for example when a sales manager wishes to "rally the troops" by playing a scene from his or her favorite movie.

Applications Really Are Different

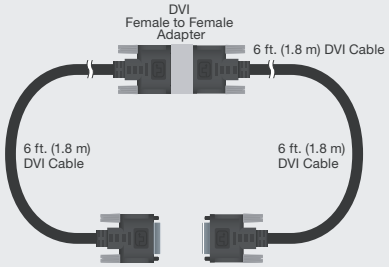
The key is to select digital products based on the day-to-day requirements of the application for which the system is being designed. In all applications, proper management of EDID communications is a must. For residential applications, compliance with a DRM scheme such as HDCP is also mandatory for all system components. And for commercial applications, DRM must also be considered within the system design to allow the occasional use of commercially-generated content, but may not be necessary for all system components or

The impact of a Gender Changer

Connecting two cables together for additional length is a very common practice in analog video and computer-video applications. The very high resolutions and signal frequencies common in digital video, however, are particularly susceptible to interruptions and discontinuities along the cable path.

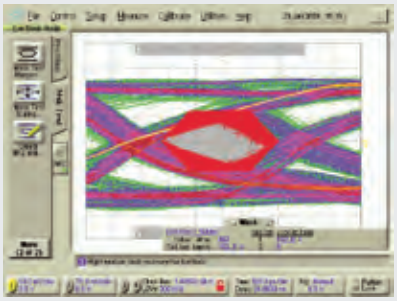
With digital signals, something as simple as the insertion of a coupler or gender changer between two cables can cause reflections which seriously degrade the signal.

Consider what happens to a high resolution digital signal when it's passed through two 6' (1.8 m) DVI cables connected female-to-female coupler.



EDID 101 D

The resulting "eye" in the eye diagram collapses, illustrating the signal degradation caused by the insertion of the DVI coupler.



When planning digital video systems, it is important to take into consideration signal interconnections and other design factors. Select signal routing and distribution products, including switchers, matrix switchers, and distribution amplifiers, with features such as input cable equalization, output reclocking, and other signal conditioning capabilities that help accommodate specific design challenges that may compromise digital video signal integrity.

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Digital Video for Pro A/V Integration — continued

for every signal path within the overall system design.

Extron Digital Solutions

Professional A/V systems are highly customized, each one designed to meet a particular set of presentation requirements. Overcoming the challenges presented by various technologies, customer needs, or environmental parameters is the goal of all system designers. The implementation of digital signals does not change the fact that projectors are mounted on ceilings with cables routed over long distances or run through conduit. Not every system involves matrix switching capabilities, but almost every A/V system is designed to accommodate the need to split or switch signals, or provide the signal conversion necessary to introduce analog signals into a digital system, or vice versa.

Extron offers a wide variety of product solutions that address the digital video needs of all market segments. The diversity of product lines brings flexibility and choice, giving designers the means to address systems at all levels. Augmenting a legacy system with digital inputs and distribution capability can help keep upgrade costs down, while still addressing customer needs. Mixed format systems are easily achievable and can be accommodated in small to large systems with short to extremely long distance requirements. An all-digital system can be designed with various levels of functionality, by utilizing products with performance features that address the exact needs required by the integrator.