DigitalMedia™ White Paper

Ten Essentials for a Digital AV Solution

Introduction:

There's a crucial change going on in audio visual technology—a move away from analog devices using VGA and component video connectors to high definition digital devices supporting the HDMI standard.

Because computer manufacturers are in the process of phasing out support for VGA, and because the manufacturers of Blu-ray players and other video devices are eliminating models with component, S-video or composite video outputs, it's imperative that commercial, educational and home media users understand and embrace this change.

As you consider the move from analog to digital systems, there are ten crucial questions you should ask about your supplier and the technology they offer.

1. Is it a proven, complete digital solution?
Creating a comprehensive digital audio video solution is not an easy process, yet a successful digital implementation is crucial to your success if you are in charge of the AV system.

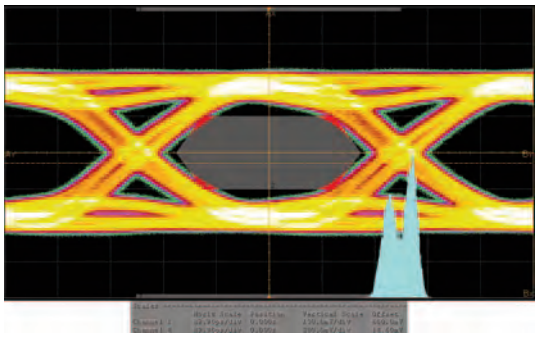
Crestron, the first company to offer such a solution, has had its DigitalMedia™ technology under development since 2006 and on the market since early 2009. Thousands of organizations use DigitalMedia today, including the majority of Fortune 500 companies, hundreds of universities, the federal government and the military. With this huge installed base, Crestron has had the opportunity to address and resolve thousands of issues, including irregularities with third party devices (DigitalMedia systems have connected to virtually every kind of device) and problems inherent to the HDMI standard itself.

Crestron has used this experience to produce an extremely stable, cost-effective and scalable platform together with the training and support necessary to making it run smoothly.

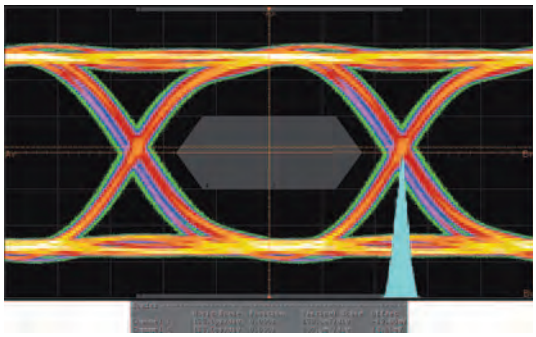
How DigitalMedia was developed

Crestron engineers recognized by 2006 that the world was going to need to change to digital distribution of audio and video media. They also understood that analog would not disappear overnight and that any new technology would need to be backwards-compatible to older standards.

Because of its adoption by the makers of computers, displays, Blu-ray players and other devices, as well as the creators of movies and other consumer media, it seemed obvious that HDMI should be the basis of any new media distribution system. HDMI has limitations to the distance that signals can be transmitted, problems managing EDID, or "electronic display identification," from multiple monitors or projectors, and complications involving HDCP copy protection, which is there to protect copyright but can cause confusion and compatibility problems.



To pass the HDMI signal test, the signal (shown in red, magenta, cyan, yellow and orange) must never pass inside the keep-out region (represented by the gray hexagon).



Section of jitter measurement chart, showing a scope image of a bit pattern run through a DigitalMedia system. The gray hexagon in the middle is defined by the HDMI spec, and any signal in this region is a violation of the spec.

Pass	# Failed	#Trials	Test Name	Actual Name	Actual Value	Spec Range
✓	0	1	Cable Clock Jitter	110mTbit	63.3 %	Value 300mTbit
✓	0	1	D0 Cable Mask Test	0.000	50.0 %	No Mask Failures
✓	0	1	D0 Cable Data Jitter	167m	44.3%	0.3Tbit
✓	0	1	D1 Cable Mask Test	0.000	50.0 %	No Mask Failures
✓	0	1	D1 Cable Data Jitter	176m	41.3 %	0.3Tbit
✓	0	1	D2 Cable Mask Test	0.000	50.0 %	No Mask Failures
✓	0	1	D2 Cable Data Jitter	181m	39.7 %	0.3Tbit

A table showing the results of tests of DigitalMedia for jitter and HDMI mask test results (DM performs at specification or better).

Crestron engineers also saw the desirability of integrating their new media distribution system with high speed networking and control. They set out with the goal of building a product line based on IP network standards, which would run on CAT5e cable, mix analog and HDMI-based audio and video and transmit RS-232, IR, USB and the new Consumer Electronics Control (CEC) signals. That proved to be a much more complicated project than they first realized.

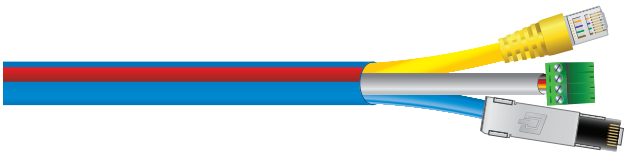
The first generation DigitalMedia product

One of the early problems the Crestron engineers encountered ha ppened even before they began developing DigitalMedia. In creating prototypes for the company's early AMS-AIP HDMI-based AV receiver, they discovered that powering display "X" on or off would cause temporar y video dropouts on display "Y." This was due to the HDCP specifica tion itself, which failed to consider scenarios involving more than one display . Crestron worked with DCP (creators of the HDCP specification) to develop a technique for a voiding this issue. This QuickSwitch HD technology maintains a constant HDCP connection with ever y device in the system, eliminating the need to re-authentica te each time a different route is crea ted. Today you will find this fea ture implemented not only across Crestron's HDMI products, but by most of their competitors as well.

EDID proved to be another sticky problem. In simple terms, you can think of EDID as a television or AV receiver holding up a sign tha t reads, "Here are the resolutions I am ca pable of." It is up to the source device to read this sign and supply the best signal tha t the TV or receiver can accept. This is fine when you ha ve a single display or even an AV receiver in the mix adding its o wn audio capabilities. But what do you do when your video switch is connected to 32 different displays, each with its own capabilities? In response, Crestron developed automated "best common" and "best overall" EDID algorithms. These techniques allow a DigitalMedia system to determine what capabilities are shared by all the displays in the system and present each source with a list of ca pabilities guaranteed to work.

The EDID configuration screen for a single input on a DM system. In "Auto" mode (as shown), the user creates an "EDID group," which is the list of displays whose capabilities will be considered when crea ting an automatic EDID table. On the left is the video configuration and on the right the audio.

To overcome HDMI's distance problems, Crestron engineers developed hardware to transmit uncompressed HDMI audio and video plus control da ta over a category-style copper cable or multimode fiber optics. Unfortunately, in 2006, the technology did not exist to transmit this much da ta over unshielded CAT5e cable. Therefore, they developed the original "classic" DigitalMedia cable, which combined one shielded 4-twisted pair cable, one CAT5e unshielded 4-twisted pair cable, and one DMNet control and po wer cable within a single plenum-rated jacket.

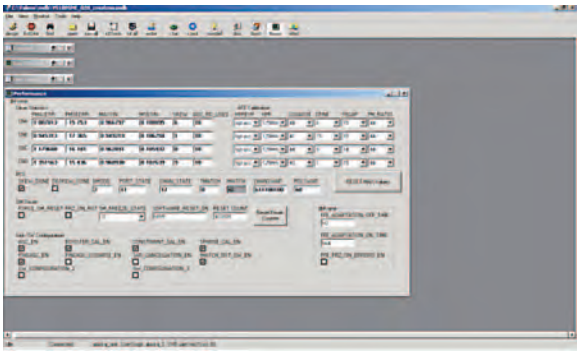


Crestron introduced the first DigitalMedia transmitters, receivers and switchers, which could be used with this three wire cable or fiber, in March 2009, and their dealers began using it in customer installa tions.

The second-generation product: DigitalMedia 8G

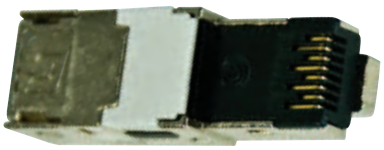
After Crestron developed and began selling this technolog y, they were approached by Valens Semiconductor, who showed them an early prototype of a new technolog y that allowed transmission of lossless high-resolution AV and high speed Ethernet data over a single CAT5e cable. The two companies quickly partnered to develop this technology and bring it to market in Crestron products.

Crestron engineers were impressed by the technolog y, but in subjecting the signals to real-world conditions in their lab, they found that the signals were susceptible to various types of interference when transmitted on unshielded cable. To overcome this limitation, Crestron developed their own high-performance twisted-pair cable and matching connector system, which together are highly resistant to environmental electrical interference.



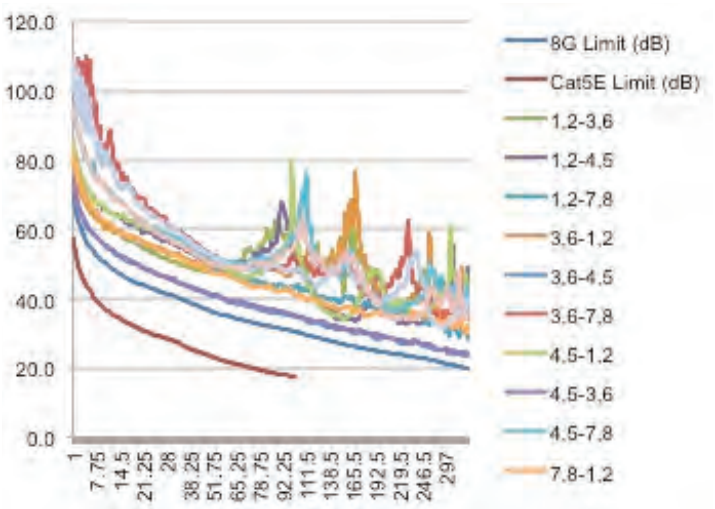
A screen shot of a signal quality-measurement tool developed by Valens. It provides all the details a vailable about the quality of a cable link. Crestron engineers use this tool to compare the performance of different cables and connectors for manufacturing variance, temperature sensitivity, or EMI/ESD sensitivity.

The new technology had two major advantages over the original. First, using the same coding, modulation and noise cancellation techniques developed for very high speed Ethernet applications, it was able to transmit eight gigabits of data per second, which was a significant improvement over the original DM cable. Second, with only a single twisted-pair cable, rather than three, it was less expensive to buy and considerably faster and less expensive to install.



DM-CONN

DM-8G-CONN



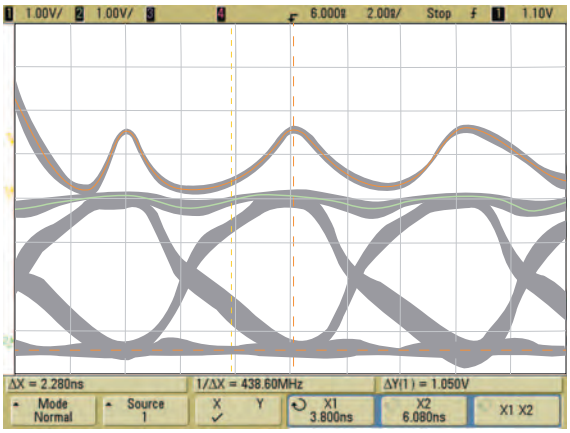
Network cable certification test conducted with a Fluke DTX-1800 Cable Analyzer. The lowest (maroon) line shows the crosstalk performance of CAT5e cable. The next (blue) line shows the significantly higher performance of Crestron 8G shielded cable.

The new twisted-pair copper cable could transmit signals reliably up to 330 feet. For longer distances, Crestron introduced an 8G version of its multimode fiber, which could transmit up to 1,000 feet, or longer distances using fiber optic repeaters.

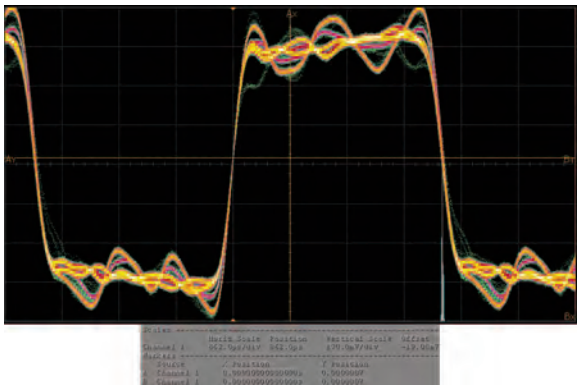
Crestron upgraded their transmitters, receivers and switchers to take advantage of the change, introducing the DigitalMedia 8G product line in July, 2010.

The third generation product: DigitalMedia 8G+ ™

Although DigitalMedia 8G was a very successful product, Crestron and Valens engineers continued to work together to develop a technology that would deliver uncompressed HD audio and video over a single, unshielded twisted pair. After several months of co-development, they produced a new firmware version that would pass Crestron's rigorous standards.



Comparison of a pixel clock extracted from an HDMI TMDS transmission (top section of the graphic), with the actual video data (bottom). The data should be stable (a clear 1 or a clear zero) when the clock has a rising edge, as it is in this image—never in transition (between 1 and 0) when the clock is rising.



Graphic illustrating the detailed integrity of a DigitalMedia clock signal. Note the clean, sharp edges when the clock rises or falls. In a digital system, all that matters are 1's and 0's, with clean transitions between them. The "ripples" seen here at the top and bottom of the signal have no effect on the digital signal – clean edges are what matter.

The new version, DigitalMedia 8G+, enables transmission of uncompressed 1080p/60 digital video up to 330 feet using standard unshielded CAT5e wire.

DM 8G+
Up to 330ft (100 m)
Single CAT5-type

Yes

DM 8G Fiber
Up to 1000ft (300 m)
Simplex multimode fiber

Yes

3rd Party Cable Type Type	Original DM	DM 8G+
CAT 5		
CAT 5e (unshielded)		✓
CAT 5e (shielded)		✓
CAT 6 (unshielded)		✓
CAT 6 (shielded)		✓
CAT 7 and better		✓

It's important to note that the introduction of 8G+ in May, 2011 did not involve any changes to existing 8G hardware. Users of DigitalMedia 8G were automatically provided with 8G+ with a simple firmware upgrade.

There was another important improvement introduced in 2011: DigitalMedia cards, transmitters and receivers for single-mode fiber, allowing the transmission of AV, Ethernet and control signals up to 7.5 miles.

	DM CAT Technology using DM Cable (DM-CBL, DM-CBL-8G)	DM 8+ Technology using DM 8G Cable (DM-CBL-8G)	DM 8+ Technology using 3RD Party CAT5e UTP/STP	DM 8+ Technology DM8G Multi-Mode Fiber (CRESFIBER-NP)	DM 8G+ Technology using 3rd Party CAT5e UTP/STP
Up to 1080i, 720p & 1080p 24Hz	200 ft (60 m)	330 ft (100 m)	330 ft (100 m)	1000 FT (304 M)	7.5 mile (km)
1024x768 60Hz	200 ft (60 m)	330 ft (100 m)	330 ft (100 m)	1000 FT (304 M)	7.5 mile (km)
1280x1024 60Hz	150 ft (45 m)	330 ft (100 m)	330 ft (100 m)	1000 FT (304 M)	7.5 mile (km)
1080p 60Hz	150 ft (45 m)	330 ft (100 m)	330 ft (100 m)	1000 FT (304 M)	7.5 mile (km)
1080p 60hz deep color	50 ft (15 m)	330 ft (100 m)	330 ft (100 m)	1000 FT (304 M)	7.5 mile (km)
1920x1200 60Hz	150 ft (45 m)	330 ft (100 m)	330 ft (100 m)†	1000 FT (304 M)	7.5 mile (km)
1600x1200 60Hz	125 ft (38 m)	330 ft (100 m)	330 ft (100 m)†	1000 FT (304 M)	7.5 mile (km)

2 What level of technical support can I expect?

With any new or complex technology, the quality of the product itself is only one part of the equation. No matter how carefully it's designed and tested, something will inevitably go wrong in the field.

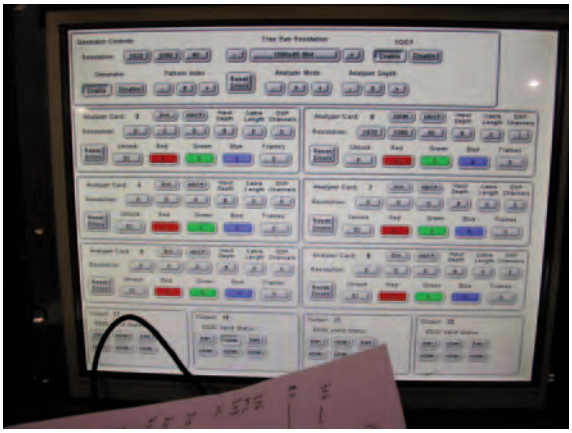
That's especially true with a digital audio and video network, because there are so many products that may be interfaced, and because integrators constantly create custom applications that have not been tried before.

Crestron has approached this issue on three fronts.
First, they offer extensive training for system design consultants and integrators. The Crestron DigitalMedia Designer certification class teaches the fundamental difference between analog and digital systems and the unique design considerations needed to ensure reliable digital system operations. The hands-on DigitalMedia Technician certification course teaches the fundamentals of installing DM networks, including working with Crestron hardware and installing and terminating category cable, 8G cable and fiber optics. The DigitalMedia Engineer certification program details every aspect of system design, installation and commissioning, plus hands-on lab work. To be certified at each level, students must pass a written and/or practical exam. Over 10,000 people have been DM certified to date.

Second, Crestron offers 24/7 phone support for clients, consultants and integrators from their headquarters campus in Rockleigh, New Jersey and its 57 offices worldwide. This support has proven highly effective. Approximately 95% of all issues are resolved by remote support, with roughly half of those resolved within two minutes or less.

Third, when an issue cannot be resolved remotely, Crestron will send a technician to the site – and, in fact, they routinely fly support staff to installation sites all over the world at no charge.

Working behind the scenes is Crestron's Quality Engineering Lab, where the company keeps a constantly updated selection of over 100 displays and sources connected to multiple DigitalMedia systems. Crestron engineers test each new DM code release for compatibility with all of these sources and displays. If any issues are discovered in the field, they work with their AV partners to get the problematic HDMI device in house quickly and resolve them.



A screen shot of Crestron's own video tester, used to control a DM switch running special firmware. The switch can generate arbitrary video patterns, send those patterns through a system under test, then measure the output signal vs. the input, counting individual bit errors. The HDMI specification allows one bit error per ONE BILLION bits transmitted. Crestron meets this standard, and further requires that a device allows zero errors in a three minute test.

Fast resolution is possible because of the DigitalMedia system architecture, which ensures that every video path includes an HDMI transmitter and receiver with a field-programmable ga te array (FPGA) that can be updated with a firmware change. Most often the problem is some unexpected beha vior of a new third party device. These surprise behaviors occur because, although HDCP and CEC are 'standard' protocols, there can be gray areas, open to individual manufacturers' implementation. Each connection between devices is unique and not necessarily predictable. To resolve an issue, Crestron engineers leverage this flexibility to create a new firmware-level driver that accommodates the problematic device and works around its unique issue. Once the issue is resolved, the new code is included in Crestron's next DigitalMedia firmware update. The process ensures that other DM customers do not experience the same problem.

3 – Is it a fully-integrated system?

It's crucial that any digital audio/video solution be based on the HDMI standard and be fully compliant with its requirements.

HDCP compliant systems that are not managed carefully can run into serious problems. For example, if you connect a Blu-ray player licensed to support ten displays and then connect an eleventh, your entire system can go black. It's also crucial to manage EDID handshaking, CEC control communications and other features and requirements of the HDMI standard, as the DigitalMedia system does, in a way that ensures reliable, high-quality results.

DigitalMedia is also fully compatible with other digital AV standards, including DVI, DisplayPort, Apple Thunderbolt, SDI and 3G-SDI as well as analog standards inc luding VGA, component video, S-video and composite. Because you never know what kind of device a guest speaker may bring into your conference room or classroom, it can be extremely helpful to accept such standards.

DigitalMedia is Ethernet-based as well. All DM links include an Ethernet data channel making it possible to configure a DigitalMedia network to handle Internet and computer traffic as well as audio and video signals. Because of this compatibility, IT departments are able to manage their DigitalMedia networks with the same tools they use for their data networks, even if they keep the data and DM networks separate.

DigitalMedia is compatible with all of the major control/communications protocols, including RS-232, USB/HID, IR, and CEC and carry their signals on the DigitalMedia network wiring. That means, for example, that if you need to communicate via USB with a PC in another room, you can do it with a wired or wireless keyboard and mouse connected to the USB port on the DigitalMedia room box.

DigitalMedia is also compatible with high definition video and audio streaming devices, carrying webcasts, multicasts and Crestron's own real time high definition AV capture and streaming solution, CAPTURE-HD.

4 – Is it a complete, engineered digital solution?

One of the problems that AV integrators often face is the need to combine components built by a wide variety of manufacturers into a single, coherent whole. It's always a challenge, with compatibility issues, lack of control over product updates, the need to build troubleshooting time into every project, and after-sale service issues as components change or are unexpectedly discontinued.

This is a problem that many control and media distribution system manufacturers face as well, since they do not build all of the key components of their own products themselves.

Crestron DigitalMedia is a different story. All DigitalMedia components are built by Crestron and designed to work with one another. In addition, Crestron builds a wide variety of other system components, including control systems, video processors, audio processors, amplifiers, structured wiring, even thermostats, dimming systems and building automation hardware and software. Crestron offers a single point of responsibility for all of your media network components and the most important pieces of your entire AV system, with comprehensive quality control, warranty coverage, dealer training and technical support.

In addition, DigitalMedia is a modular solution, with card-based switchers and a variety of wall plates and tabletop transmitters built to accommodate the wide variety of devices you may choose to include in your audio/video system. Infinitely customizable, DigitalMedia allows you to build the system you need today, then upgrade or expand it tomorrow to meet your changing needs and ongoing changes in computer and multimedia technology.

5 – Does the solution integrate copper and fiber outputs on the same platform?

It's important to make sure that your digital signal transport system can utilize a variety of wiring options, including copper wire for smaller, more economical rooms and fiber optics for larger systems.

A crucial part of DigitalMedia's modular design is the ability to use:

- Standard CAT5eor CAT6 network cable for distances up to 330 feet
- Crestron 8G twisted-pair copper cable for up to 330 feet
- Multimode fiber, which transmits up to 1000 feet
- Single mode fiber, which transmits up to 7.5 miles

This flexibility allows DigitalMedia to scale easily to large and small networks, as well as to use existing CAT5e wiring plants in remodeling projects, thereby avoiding the cost of tearing out drywall and other building materials to install new wire.

6 – Does it provide an integrated digital presentation system?

Not every project requires a large, fully-customized AV distribution system. If you're just building a single room, whether it's a boardroom, auditorium or video conferencing room, it's best to base its AV system on the same solid platform and technology as all of your other digital systems.

Crestron's DMPS-300-C is a complete, high-definition control and signal routing solution that integrates a control system, multimedia matrix switcher, microphone mixer, audio DSP and amplifier all into one three-space rack-mountable package. Based on Crestron's popular MPS integrated platform, the DMPS provides a fast, clean digital installation with much lower material and labor costs than comparable systems. Because it's fully integrated, it's very reliable, with fewer potential points of error, and support is easier as well.

7 – Does it provide full HDCP management?

While HDCP copy protection is an important part of the HDMI standard, every manufacturer implements it differently. It's impossible to build an HDMI-compatible product based on any single test or connection point.

For example, Apple's implementation of HDCP does not work seamlessly with many of the latest high definition video conferencing systems. If you try to make a presentation during a video conference using a MacBook or an iPad, you may find that it doesn't work. The problem is not with the Apple product, but the way the video conferencing system or the digital transport system is expecting it to work. There are such a large number of devices that can be plugged into a digital network that it's very difficult to test them all.

This is a case where Crestron's extensive track record proves its value. Crestron has tested and certified more than 500,000 unique connections points with DigitalMedia technology, including the use of Apple computers and tablets with all major video conferencing systems.

8 – Does it feature a variety of matrix sizes for both small and large projects?

An important consideration for any media transport system is scalability. Will the system you choose be appropriate for your organization's smallest as well as its largest applications?

Crestron offers a variety of switching solutions appropriate for systems from the very simple to extremely complex. Their economical DM-MD6x1 switcher offers six inputs and one output, perfect for connecting a variety of digital and analog source devices to a single monitor or projector.

Crestron also offers economical DM6x4 and 6x6 matrix switchers, allowing the connection of multiple inputs to any combination of outputs, plus card-based DM8x8, 16x16 and 32x32 matrices. These switchers can be used in combination for extremely complex systems up to 160 inputs by 160 outputs.

And because the card-based switchers can be reconfigured with the change of an interface card, they will not become obsolete when standards or connectors change.

9 – Does the solution support surround multi-channel audio and DSP-based stereo down mixing?

While surround and other multi-channel audio formats have become an important part of many theaters and conference centers, two-channel stereo is still the standard. Yet, an HDMI connection can transmit either multi-channel or two-channel sound from a given source, but not both at the same time. It's very helpful that your digital signal transport system overcomes this limitation, as DigitalMedia does.

Why is this important? In your home, you may be watching a big game in your living room theater with surround sound, while other family members watch in the kitchen and want to listen with your high-end stereo speakers. At work, you may make an important presentation using HD video and multi-channel audio in your auditorium, yet need to send the signals to overflow rooms or breakout rooms with only two-channel sound. Only Crestron DigitalMedia makes these scenarios possible.

The reason this is possible is that the card-based DM matrices actually contain two completely independent matrix switches, one handling high-resolution video and audio plus an additional down-mix audio matrix. All of the DM HDMI input cards accept the high resolution audio of HDMI and pass that through to the HDMI matrix. The DSP cards go one step farther, passing through the high-res audio while simultaneously creating a two-channel down mix, which is fed into the dedicated, secondary audio matrix for switching. The system automatically sends the appropriate mix to each audio device, depending on that device's capabilities.

10 – Does it include built-in CEC device control?

CEC, or "Consumer Electronics Control," is embedded in the HDMI signal, offering a single, low-cost control interface for an entire chain of HDMI devices, even those that do not include RS-232 or infrared (IR) inputs.

In practice, nearly all control system manufacturers ignore the potential benefits and advise integrators to disable CEC, arguing that it is confusing, poorly documented and more likely to cause trouble than to help. In addition, CEC assumes that no system will include more than one display and never more than 16 devices, making it impractical for larger installations. Crestron takes a different approach, making it possible to manage CEC with any Crestron control processor connected to the HDMI chain through DigitalMedia.

To do so, DigitalMedia breaks all of the direct CEC links from device to device, giving control system programmers complete control over CEC signals. They can utilize, or choose not to utilize, standard CEC commands (for example, switching the input on a monitor or projector to Blu-ray when a Blu-ray player is turned on), translate non-standard CEC codes to and from devices from different manufacturers, and even write their own CEC commands to trigger events they specify. The benefit is the reduction or elimination of serial cables and IR emitters and receivers from the system, making its design cleaner and installation easier and less expensive.

Conclusion

If you're considering a change to a digital audio and video platform, the questions you ask can be crucial.

Is the system you are considering proven in the field? Is it complete, fully-integrated and fully engineered, with the options you need now and the ones you will need in the future? If you run into any problems with your new system, what kind of support can you expect?

Only Crestron DigitalMedia is proven in the field, with more than five years of continuous development, including three years of installation at client sites. While other manufacturers are introducing their first digital signal transport systems, DigitalMedia is now in its third generation, with over 500,000 unique connection points covering almost every conceivable combination of sources, displays and other devices.

Only Crestron offers the highest-level technical support, with over 10,000 professionals certified for DM system design, engineering and/or installation, 24/7 phone support and, when necessary, worldwide on-site technician travel, all backed by a Quality Engineering Lab able to test and resolve compatibility issues.

Only DigitalMedia is a fully-integrated system, based on the HDMI standard plus IP network protocols, fully compatible with all of the major digital and analog AV standards and able to support, transport and manage RS-232, USB, IR and CEC control signals.
Only DigitalMedia is a complete, engineered, modular digital solution, with all components designed and built by Crestron, able to integrate copper and fiber outputs on the same platform, supporting all implementations of HDCP management, featuring a variety of switcher options plus an integrated, one-piece digital presentation system, and able to support multi-channel audio and DSP-based stereo down mixing.

No wonder it's the first choice of the majority of Fortune 500 companies plus thousands of smaller businesses, schools, universities and non-profits, plus government and military facilities.