

HDMI: IT'S NOT JUST CABLE LENGTH

And the role EDID and HDCP encryption will play.

BY ROB CARTER

The promise of the High-Definition Multimedia Interface (HDMI) is great. One cable carries uncompressed digital HD video and audio; what's not to like? But mention HDMI to an AV integrator and you're likely to get an expletive in response. A quick search of online forums and industry trade pubs will uncover a slew of HDMI-related complaints, ranging from annoying switching delays and screen flashing to complete audio and video failure.

Two Reasons For Problems

There are two primary reasons for HDMI problems: bandwidth and complexity. Uncompressed HD video requires enormous digital bandwidth, which is notoriously difficult to push down copper wire. Add popular features, such as 1080p resolution and Deep Color, and the problem gets worse. Products are cropping up on the market that attempt to address this issue, some of which actually work quite well. But the under-discussed issue is the sheer complexity of HDMI.

HDMI is a full-duplex digital communications interface. HDMI takes advantage of its digital nature and adds several communications mechanisms that are designed to control and encrypt the content automatically. Unfortunately, the engineers who designed HDMI weren't thinking about the custom

installation industry, and the design doesn't scale well. Compounding the problem is the fact that digital control is relatively new to most of the major AV distribution players, so the learning curve has been pretty steep.

Though much more complex than analog, HDMI isn't nearly as complicated as home automation, Ethernet or any of the myriad wireless protocols. Companies with experience in these fields are in a position to implement HDMI in environments that the designers hadn't anticipated.

Here, we'll address the need for the move to HDMI and explain the new features that HDMI supports. We'll demystify the "handshaking" that occurs between HDMI sources, repeat-

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ers and displays. We'll also explore the cause of some common problems seen in the field.

Say Goodbye To Analog

Before we get too involved in the technical details, there's an important question to address: Why do we need HDMI? As much as a lot of us would love to stick with tried-and-true analog distribution, for much of the market, it's on its way out. Content providers such as television producers and movie studios love the fact that HDMI supports the High-bandwidth Digital Content Protection (HDCP) protocol. HDCP allows them to encrypt content while it's on the wire so it can't be copied and pirated easily. They're pushing hard on the consumer electronics industry to move from analog AV to HDMI, and they're getting their way. For the unconvinced, here are a few harbingers of analog's demise:

- **Image Constraint Token:** The Blu-ray specification has a built-in time bomb that's yet to go off: the Image Constraint Token (ICT). This disc-specific flag forces players to downgrade video on analog outputs to 540p, half the 1080i resolution of the current analog maximum. Movie studios are waiting for more widespread HDMI and Blu-ray adoption before shipping discs that implement this limitation, and reportedly have decided not to do so until 2010 or 2012.¹
- **Content provider support:** SkyHD, a popular European satellite service, is already shipping HDMI-only set-top boxes. In the United States, the MPAA is petitioning the FCC for permission to block certain movies from being transmitted on set-top box analog outputs.²

Feature Support

- **Feature support:** The latest and greatest features are supported only by HDMI. The aforementioned 1080p and Deep Color formats, for instance, aren't available over analog, and they never will be. Early adopters, the bread-and-butter for much of the custom installation industry, will need to move to HDMI.

Any analog distribution system that carries commercially created content

runs the risk of becoming obsolete over the next several years. Now is the time for the consumer electronics and custom installation industries to embrace the transition.

HDMI's complexity becomes obvious when you compare its cables to those of analog audio and video. Analog cables typically consist of one to three wire pairs, depending on the format, and they simply carry an audio or video signal. In contrast, the HDMI cable consists of 19 wires, which carry the following digital signals:

- **TMDS:** The digital audio and video data is encoded into three Transition Minimized Differential Signaling (TMDS) channels. TMDS is the transport protocol used by HDMI to reduce transmission problems. Embedded in the video data are InfoFrames, which are data packets that carry information about the AV content. The three TMDS channels correspond to the three channels of RGB or YCbCr (the digital equivalent of YPbPr), depending on the format. Audio and InfoFrame data is spread across the three channels during blanking periods in the video. These three channels and a TMDS clock are carried over four pairs of wires in the cable.

Data Display Channel

- **DDC:** The Data Display Channel (DDC) is a two-way communications interface between the source and the downstream repeater or display device. Originally, this channel was provided to communicate device capability information, which is encoded in a structure known as Extended Display Identification Data (EDID). HDMI devices use the EDID to indicate what audio and video formats they support. This is discussed in more detail later. The DDC interface is also used to set up and maintain HDCP encryption.

- **Hot Plug Detect:** The downstream device, or sink, indicates its presence to the source with the Hot Plug Detect (HPD) signal. The sink can toggle the Hot Plug Detect signal to reset the HDMI connection, which resets the HDCP session and triggers an EDID read.

There are more control signals asso-

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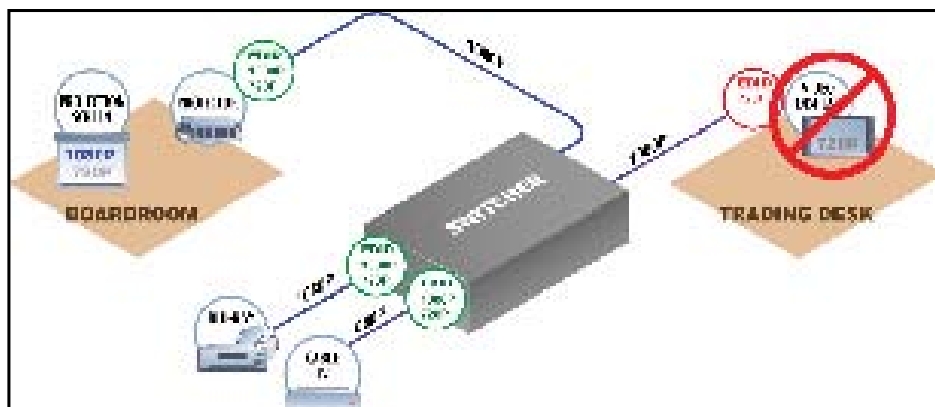


Figure 1.

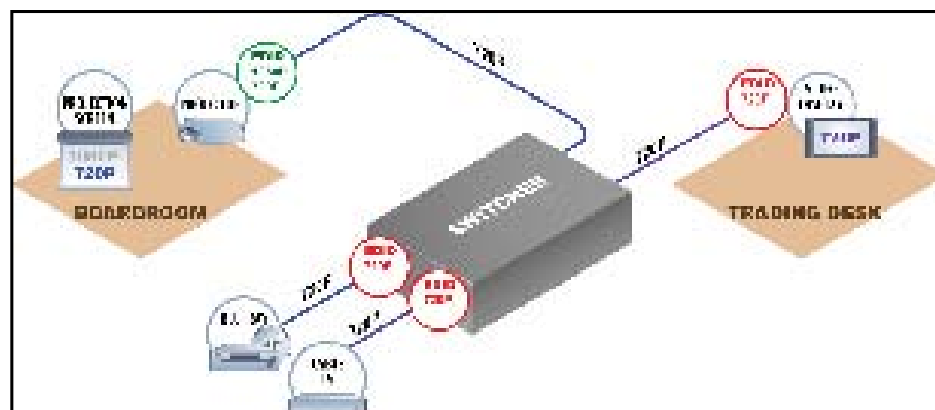


Figure 2.

ciated with HDMI, but they are beyond the scope of this article.

Every HDMI installation consists of at least one content source, such as a cable box or Blu-ray player, and a sink, such as a TV or projector. Most custom installations will also involve at least one repeater, which is a device that accepts and retransmits HDMI content. Repeaters include simple devices, such as switches and distribution amplifiers, as well as more feature-rich devices, such as audio and video processors.

EDID

- **EDID:** HDMI display and AV processing devices use the EDID to advertise their capabilities. For instance, a television may use the EDID to indicate support for the standard HD resolutions plus 1080p and Deep Color. Another TV may max out at 720p/1080i resolution. One audio processor may support Dolby TrueHD, whereas another only supports standard Dolby. And most TVs only support basic stereo audio or none at all. All of this information is stored in the EDID.

The EDID exists in a memory chip on the display or AV processing device. The content source reads the EDID over the DDC interface and analyzes it to decide what formats to send. It is the responsibility of the content source to send only formats that the downstream devices can support. HD players, such as Blu-ray players, must include a video scaler to re-scale the video on the disc to match the capabilities of the television or projector. Likewise, the source must provide a supported audio format.

In the simplest installations with one television and an audio processor, the EDID protocol works reasonably well. Multi-room installations, on the other hand, quickly can become much more complicated. Several televisions may be connected to several sources through one or more HDMI switches. The switches are responsible for collecting the televisions' EDIDs and providing one unified EDID to the source. Neither the HDMI nor the EDID specifications offers guidance in this scenario, so different switches be-

have in different ways. Combining the EDIDs can be a complicated issue, so it's worth researching how a given switch handles EDIDs before installation.

Consider a simple system you might design for a financial services firm. The client has a 1080p Deep Color projector with a surround sound processor in the boardroom and a 720p LCD with integrated speakers at the trading desk. The 1080p projector also supports 720p but, obviously, the cus-

tomer would prefer 1080p when possible. How should the switch combine the EDIDs?

Some devices on the market simply copy the EDID from the first output, as depicted in Figure 1. In our scenario, 1080p Deep Color video and surround-sound audio will be sent to the trading desk LCD, which supports neither. At best, this will result in no audio or video and, at worst, in damage to the LCD display or speakers.

Smarter Switch

A slightly smarter switch may take a "best common" approach and generate an EDID that advertises formats that both rooms support. This scenario is shown in Figure 2. The merged EDID will limit the content to 720p video and stereo audio. Now, both rooms support the content, but the client's lavish boardroom isn't getting the topnotch content that justifies the expense. Extrapolate this scenario to the installation with five or 10 rooms, and this simplistic solution becomes completely insufficient.

What's required is a system in which the installer can make intelligent design decisions, pictured in Figure 3. Perhaps the client watches Blu-ray content only in the boardroom, but watches TV in both the boardroom and at the trading desk. With the proper switch, the installer can configure its input EDIDs independently. Now, the Blu-ray player may send the full 1080p Deep Color surround sound signal to the boardroom.

The cable box, which must support both rooms, is limited to 720p. This isn't much of a sacrifice, because cable companies don't actually transmit 1080p content anyway (though some cable boxes will upscale to 1080p). A really nice switch will accept surround audio for the boardroom, and downmix it to basic stereo for the trading desk.

When designing multi-room HDMI installations, be sure to select equipment with intelligent EDID control. If necessary, consider switches with audio downmixing support as an upgrade.

- HDCP:** HDCP encryption is another complicating factor in HDMI installations. The HDCP system first authenticates HDCP devices and then encrypts the content. Authentication occurs over the DDC interface and ensures that all devices receiving the

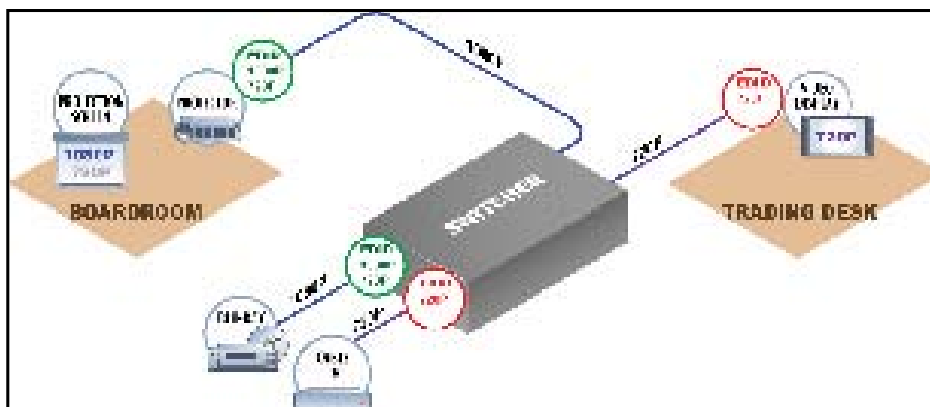


Figure 3.

content are licensed and authorized to do so. After successful authentication, the TMDS data streams are encrypted to prevent other devices from eavesdropping on the content during transmission.

A single point-to-point HDCP link can involve only one HDCP transmitter chip and one HDCP receiver chip. If a repeater device requires access to the content, it must feature an HDCP receiver for decryption. The repeater must then re-encrypt the data with an HDCP transmitter on each of its outputs. The repeater informs the upstream device of its downstream connections, but it is the repeater's responsibility to maintain those connections.

HDCP has caused a lot of interoperability issues in HDMI installations. Clients have been plagued with flashing and snowy screens, long authen-

tication times, disabled outputs and complete system failure. Implementing HDCP is a complicated process, and there's plenty of room for error.

But problems can occur even on well-implemented devices. During the last step of authentication, repeaters must inform the content source of the downstream connections. Every HDCP device has a unique ID, known as a KSV, which must be passed up to the source. Unfortunately, all sources have a hard limit on the number of KSVs they'll accept. The HDCP specification allows for up to 127 devices, but sources usually support far fewer. Many support fewer than 10 devices, and at least one popular cable box in the field only supports one television!

If a repeater presents a source with more KSVs than it supports, the source will stop transmitting content. Unfor-

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DOWN TO BUSINESS

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there is value and fulfillment from working in this industry; otherwise, we would be doing something else.

In order to broaden our workforce, the industry requires more outreach and recruitment...more development at the local level. We need to attract more people to the industry by creating awareness and incentive. Both NSCA and InfoComm International have training and certification programs, and educational foundations, but these initiatives focus mainly on those of us already in the industry. We have to reach outside of our known circles and bring in

new talent potential. There are some resources set aside for this activity at both organizations, but they require each of us to be a part of their use and there doesn't seem to be a visible, formal program of development.

In general, labor markets tend to right themselves based on supply and demand, but this often takes years, and sometimes never occurs in a local economy. The shortage we are experiencing will not reverse itself quickly, but we can help it by doing what we can as individuals to help bright minds to consider the industry as an opportunity. ■

FLIGHT OF IMAGINATION

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entertainment designers to work on projects, the opportunity to integrate advanced AV systems into what at one time might have been a more straightforward application continues.

"Certainly, developers are aware of all that is out there," claimed Edwards. "They look at all aspects of a project, and want to make sure that everything not only achieves the project's main mission, but also works to make them money in the process." That means that AV designers must be more involved in the project to ensure that the AV components all support the main narrative in the project. In addition to being knowledgeable in the technical specifications, AV designers, as Brian Edwards likes to say, have to "use the other side of their brain" to embrace the creative component.

Because, if one thing is certain, it's that people will still want to be entertained and told a story, whether it is in a theme park, museum or even a corporate

center or retail development. Steve Thorburn has made it one of his goals as TEA president to ensure that developers are well aware of the benefits themed entertainment providers can produce.

Thorburn stated, "We will be working hard to let everyone know that the themed entertainment industry, including architects, writers, designers, fabricators and AV specialists, is necessary to create the best immersive and interactive experiences of tomorrow." ■

For more information about the companies supplying information here, contact:

–Maris Ensing, Mad Systems, maris@madsystems.com

–Dan Jamele, MediaMation, danj@mediamat.com

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HDMI: NOT JUST CABLE LENGTH

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Unfortunately, KSV limits typically aren't an advertised feature. Clients won't even realize they have a problem until they try to route a given source to too many repeaters and displays. Audio and video drop inexplicably in all connected

rooms, typically without so much as an error message.

Again, a solution is required that allows installers to make intelligent design decisions. Professional switches will allow the installer to test the KSV limits of each source,

and set appropriate limits on the switch. If the client attempts to route the content to too many devices, content will only drop out in the excess rooms. Furthermore, the client will be presented with an informative error message.

Installers must be aware of KSV limit issues in any HDMI installation that involves more than one display. Be sure to research how your equipment handles scenarios that violate source KSV limits.

Like it or not, HDMI is here to stay. There are many pitfalls in store for the uninformed installer, especially in larger installations. And the problems aren't limited to cable-length issues. Processing EDIDs and managing HDCP requires microcontrollers running complex state machines, even

AV LINKS

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positioned for ease of use," noted White. "The racks look great, with just the right ratio of equipment-to-blank panels. All signal cables and power cords enter at the top and are artfully dressed. We've used rule-book cable management right down to the Mylar wire tags."

All rack items are labeled and a set of laminated system drawings and network assignments are clipped inside a rear door.

Beyond AV

The basic tour of the USGA Museum is enhanced with rich media that is excellent in both production and presentation. Also part of the tour is the Hall of Champions where, organized by year, engraved bronze plaques trace the

more so when several rooms are involved. Switching systems must be easily customizable to handle HDCP and EDIDs intelligently. Be sure to choose a vendor with a proven track record managing bi-directional digital communications, and one who can offer a personal level of technical support for any problems that may arise. ■

References

¹ "Hollywood reportedly in agreement to delay forced quality downgrades for Blu-ray, HD DVD," by Ken Fisher. Ars Technica: <http://arstechnica.com/news.ars/post/20060521-6880.html>.

² "MPAA wants to stop DVRs from recording some movies," by Matthew Lasar. Ars Technica: <http://arstechnica.com/news.ars/post/20080608-mpaa-wants-to-stop-dvrs-from-recording-some-movies.html>.

wins of American champions.

A 30-minute guided tour of the Research and Test Center reveals to guests the sophisticated performance testing procedures of clubs and golf balls in demonstrations of the COR Test, Indoor Test Range and Iron Byron robotic test golfer.

Scheduled to open this month, The USGA Museum Putting Course, a 16,000-square-foot green with humps and swales, will offer passionate golfers a unique and challenging experience as they putt with replica antique clubs and balls.

A visit to the new USGA Museum, with its powerful interactive exhibits and unparalleled collection of memorabilia, promises to renew your golfing spirit and elevate your game. ■

HOW: BUSINESS

(Continued from 30)

their attention, and you increase the chances for youth to retain the messages you are communicating.

- Media use seems to be sewn into teenagers' DNA. Train them to use technologies appropriately. Then allow them to participate with the media team during youth services and during services in the main auditorium (adult services). Allowing teens to participate will provide an ad-

ditional sense of purpose in life and place in the ministry.

I believe that communication technologies are effective channels for communicating with teenagers. I also believe that understanding the use of communication technologies in youth ministry will create new opportunities for you to conduct business with houses of worship. But what do you believe? ■