HIGH DEFINITION MULTIMEDIA

INTERFACE (HDMI)

A SEMINAR REPORT

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ABSTRACT

HDMI (**High-Definition Multimedia Interface**) is a compact audio/video interface for transmitting uncompressed digital data. It represents a digital alternative to consumer analog standards, such as radio frequency (RF) coaxial cable, composite video, S-Video, SCART, component video, D-Terminal, or VGA. HDMI connects digital audio/video sources—such as set-top boxes, upconvert DVD players, HD-DVD players, Blu-ray Disc players, AVCHD camcorders, personal computers (PCs), video game consoles such as the PlayStation3, Xbox360, and AV receivers—to compatible digital audio devices, computer monitors, and digital televisions.

HDMI supports, on a single cable, any uncompressed TV or PC video format, including standard, enhanced, and high-definition video; up to 8 channels of compressed or uncompressed digital audio; and a Consumer Electronics Control (CEC) connection. The CEC allows HDMI devices to control each other when necessary and allows the user to operate multiple devices with one remote control handset.

HDMI is electrically compatible with the signals used by Digital Visual Interface (DVI), no signal conversion is necessary, nor is there a loss of video quality when a DVI-to-HDMI adapter is used. As an uncompressed connection, HDMI is independent of the various digital television standards used by individual devices, such as ATSC and DVB, as these are encapsulations of compressed MPEG video streams (which can be decoded and output as an uncompressed video stream on HDMI). The HDMI standard was not designed to include passing closed caption data (for example, subtitles) to the television for decoding.

HDMI products started shipping in late 2003. Over 850 consumer electronics and PC companies have adopted the HDMI specification (HDMI Adopters). In Europe, either DVI-HDCP or HDMI is included in the HD ready in-store labelling specification for TV sets for HDTV, formulated by EICTA with SES-Astra in 2005. HDMI began to appear on consumer HDTV camcorders and digital still cameras in 2006.

ACKNOWLEDGEMENT

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1. INTRODUCTION

The HDMI Founders are Hitachi, Matsushita Electric Industrial, Philips, Silicon Image, Sony, Thomson (RCA), and Toshiba. The HDMI Founders began development on HDMI 1.0 on April 16, 2002, with the goal of creating an AV connector that was backward-compatible with DVI. The first Authorized Testing Centre(ATC), which tests HDMI products, was opened by Silicon Image on June 23, 2003, in California, United States. The first ATC in India was opened by Philips on June 12, 2008, in Bangalore.

The High-Definition Multimedia Interface is provided for transmitting digital television audio-visual signals from DVD players, set-top boxes and other audio visual sources to television sets, projectors and other video displays. HDMI can carry high quality multi-channel audio data and can carry all standard and high definition consumer electronics video formats. Content protection technology is available.

HDMI is the interface for convergence of PC and consumer electronics definition movies and multi-channel audio formats. HDMI is the only interface enabling connections to both HDTVs and digital PC monitors implementing the DVI and HDMI standards.

HDMI can also carry control and status information in both directions. This specification completely describes the interface such that one could implement a complete transmission and interconnect solution or any portion of the interface.

A device that is compliant with this specification is interoperable with other compliant devices through the configuration and implementation provided for in this specification. Mechanical, electrical, behavioural and protocol requirements necessary for compliance are described for sources, sinks and cables.

2. WHAT IS HDMI?

HDMI (High-Definition Multimedia Interface) is an interface standard used for audio visual equipment such as high-definition television and home theatre systems. With19 wires wrapped in a single cable that resembles a USB wire, HDMI is able to carry a bandwidth of 5 Gbps(gigabits per second). This is more than twice the bandwidth needed to transmit multi-channel audio and video. This and several other factors make HDMI much more desirable than its predecessors, component video, S-Video and composite video.

HDMI is the first & only industry supported, uncompressed, all-digital audio/video interface. HDMI provides an interface between any A/V source, such as a set-top box, DVD player, or A/V receiver and an audio and/or video monitor, such as a digital television (DTV), over a single cable. HDMI supports standard, enhanced, or high-definition video, plus multi-channel digital audio on a single cable. Transmits all ATSC HDTV standards and supports 8-channel, 192kHz, uncompressed digital audio, all currently-available compressed formats & lossless digital audio formats with bandwidth to spare to accommodate future enhancements and requirement.

Fig 2.1 HDMI Connector

3. OVERVIEW OF HDMI

HDMI can deliver high quality sound or vision without the risk of quality loss due to the conversion or compression of a video or audio signal.

HDMI pictures are smoother and sharp. Sound is also crisp and taut, without any distortion. And of course, using the single cable HDMI can get rid of a lot of messy cables snaking around your home theatre kit.

Because of its digital nature, HDMI also works well with fixed-pixel displays such as LCD, plasma or DLP screens and projectors. A HDMI cable allows you to exactly match pixel-by pixel the native resolution of the screen with whatever source device you've got connected. HDMI systems will also automatically convert a picture into its most appropriate format, such as 16:9 or 4:3. HDMI signals are digital in nature while conventional TVs and radios operate on analog signals, on the contrary HDTVs works on digital signals. HDMI has some built-in smarts that allow you to control any device connected via HDMI through the one remote.

Fig 3.1 HDMI Plug And Port

4. HOW HDMI WORKS

HDMI uses transition minimized differential signaling (TMDS) to moveinformation from one place to another. TMDS is a way of encoding the signal to protect it from degrading as it travels down the length of the cable.

Transition Minimized Differential Signaling(TMDS) is a technology for transmitting high-speed serial data and is used by the DVI and HDMI video interfaces, as well as other digital communication interfaces. This standard codes an eight-bit data into a 10-bit signal and transfers them using differential transmission.

The sending device, such as an HD-DVD player, encodes the signal to reduce the number of transitions between one (on) and zero (off). Think of each transition as a sharp drop-off -- as the signal travels, this drop-off can begin to wear away, degrading the signal. The encoding step helps protect signal quality by reducing the number of chances for the signal to degrade.

One of the cables in the twisted pair carries the signal itself. The other carries an inverse copy of the signal.

The receiving device, such as an HDTV, decodes the signal. It measures the differential, or the difference between the signal and its inverse. It uses this information to compensate for any loss of signal along the way.

•follow all of the rules for an HDMI Sink and HDMI Source.

•four differential pairs that make up the TMDS data and clock channels.

•DDC is used for configuration and status exchange between a single Source and a
 single Sink.

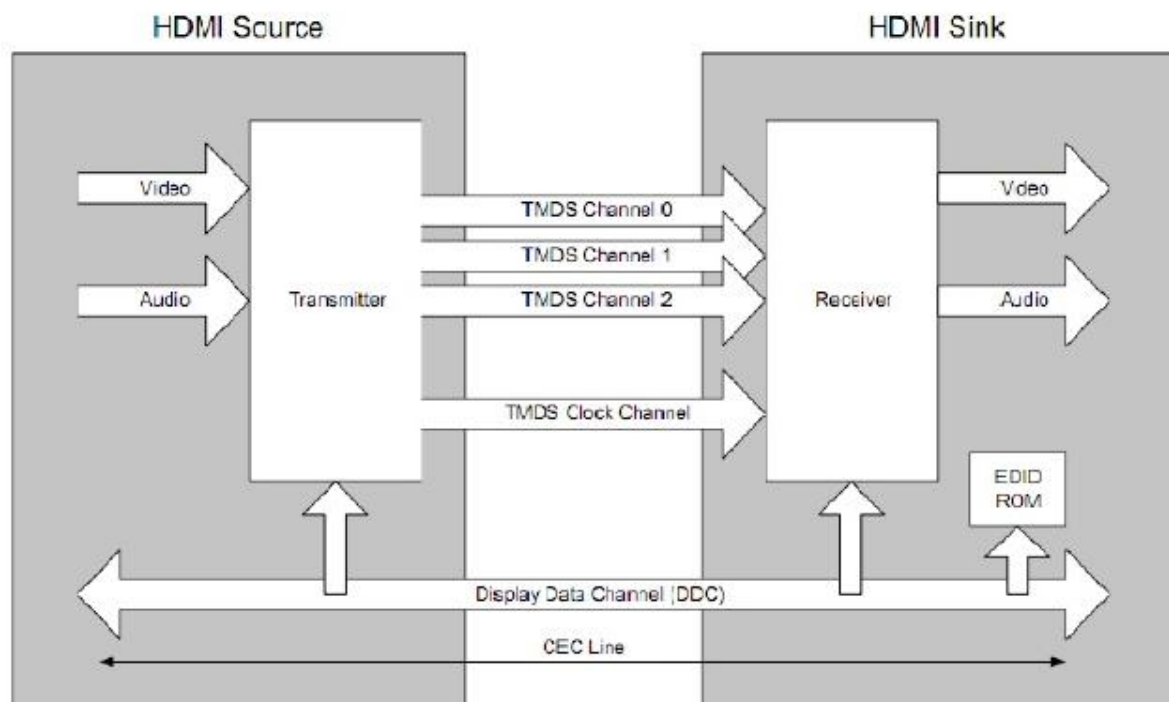•CEC protocol provides high-level control functions.

Fig 4.1 Block Diagram Of HDMI

5. HDMI FOR HDTV'S

If you've shopped for an HDTV, a PlayStation 3, or an HD-DVD or Blue-ray player, you've probably heard about HDMI. It can seem like just one of many connections on televisions or home-theater receivers. But HDMI is more than a port on the back of a TV (and the often expensive cable that fits inside). It's a set of rules for allowing high-definition electronic devices to communicate.

Before the development of high-definition televisions, most TVs displayed pictures in what is now known as standard definition. The picture was roughly square -- its aspect ratio was 4:3. Its resolution, or the number of dots that make up the picture on the screen,was about 704 x 480 pixels. The picture was interlaced -- each piece of the moving image was really half a picture, but the pictures changed quickly enough that the human brain didn't really notice. Finally, older TVs relied on analog signals, which travel as a constantly varying electrical current.

HDTVs, on the other hand, are digital. They use information in the form of ones and zeros. This information travels through cables as distinct electrical pulses. HDTVs have an aspect ratio of 16:9, so the picture is rectangular. They also have a higher resolution --current HDTV standards allow for resolutions of up to 1920 x 1080 pixels. HDTV signal scan also be progressive, meaning that the each frame of the moving image is a whole picture rather than half of one.

So, compared to standard TVs, HDTVs have a wider screen, more pixels and a faster refresh rate. Often, HDTVs can display more colours than older sets. This means that HDTVs need more data and need it a lot faster than standard-definition TVs do. If an HDTV can receive this information digitally, it also doesn't have to spend time or processing power converting the signal from an analog format.

6. APPLICATIONS

• For Connecting HD-TVs, Digital Flat-Panel Displays and Other Components with HDMI™ Connections to Digital DVD Player, Digital A/V Receiver and Other Equipment with HDMI™ Connections.

• Entertainment Center: DVD Player, DTV, Camcorder, Computer Display Devices, especially LCD Panels/monitor.

• Blue ray disc video and HD DVDs.

• HDMI interface is most useful when used with digital audio or video devices including gaming consoles such asPS3 and Xbox 360 as well asBlue-Ray players and set top boxes. HDMI cable supports single cable interface aswell as any major PC/TV video format. Best use of HDMI cable is observed withhigh-definition video with up to eight digital audio channel.

7. HDMI VERSIONS

7.1 HDMI Version 1 :

It specifies the basic audio/video HDMI interconnect. It supports a maximum TMDS bandwidth of 4.95 Gbit/s-with a maximum allotted video bandwidth of 3.96 Gbit/s (165 MHz) supporting up to 1080p/60 Hz video 24 bit color depth, and 36.86 Mbit/s maximum audio bandwidth for up to 8 channels of 192 kHz 24-bit audio resolution.

In addition, HDMI version 1.0 also supports Blue Ray disc video and audio at full resolution and CEC - short for Consumers Electronics Control. The latter is often branded differently by different manufactures and enables the user to control HDMI connected devices via a single control unit.

However, while CEC was included with HDMI version 1, yet it wasn't before the release of Version 1.2a that all relevant CEC features, command sets, and CEC compliance tests were eventually specified to the full.

7.2 HDMI Version 1.1 :

This added support for DVD Audio while HDMI Version 1.2 added support for One Bit Audio as used on Super Audio CD's for up to 8 channels, this apart from additional features related to supported color space by PC sources. And as stated in the previous paragraph, Version 1.2a fully specified for the first time the Consumer Electronic Control (CEC) support.

7.3 HDMI Version 1.3 :

This has brought about significant enhancements to the original HDMI specifications – with the most important being increasing the single-link bandwidth to 340 MHz or 10.2 Gbit/s data stream.

It also supports Deep Color with 30-bit 2560x1600p75, 36-bit 2560x1600p60,and 48-bit 1920x1200p60 color space compared to the original 24-bits RGB or specified in previous HDMI versions.

Other optional features include output of Dolby True HD and DTS-HD Master Audio streams for external decoding by AV receivers; it incorporates automatic audiosyncing or auto lip sync capability; and as indicated earlier on, Version 1.3 has broughtwith it definitions for HDMI Cable categories 1 and 2 - this apart from defining a newmini HDMI connector (Type C) for portable devices.

HDMI versions 1.3a, 1.3b, 1.3b1, and 1.3c mainly updated the list of CEC commands, and added HDMI compliance tests.

7.4 HDMI Version 1.4 :

Released in 2009 - has so far completed the relatively long list of HDMI versions and with it, there came a number of major additions to the already important additions brought about by Version 1.3. The most important additions related to version 1.4 are the addition of a 100 Mb/s HDMI Ethernet Channel(HEC) between HDMI connected devices and an increase in the supported resolution to up to4096x2160p24 or 3840x2160 at up to 30Hz.

In addition, Ver. 1.4 also introduces support for 3D over HDMI – supporting common 3D formats and resolutions up to 1080p, an expanded support for color spaces designed specifically for digital still cameras like sYCC601 and Adobe RGB, an Audio Return Channel for upstream audio transfers over the same HDMI cable, a Micro HDMI Connector – that is almost half the size of a standard 19-pin HDMI connector, sort of equivalent to a mini USB connector, and an Automotive Connection System for better in-vehicle HDMI use.

HDMI ver. 1.4 introduced three additional HDMI cables :

•Standard HDMI Cable with Ethernet – includes Ethernet connectivity.

•High Speed HDMI Cable with Ethernet – includes Ethernet connectivity.

•Automotive HDMI Cable – allows the connection of external HDMI-enabled devices to an in-vehicle HDMI device.

Actual formats:

480p = 640 x 480 pixels progressive

480i = 640 x 480 pixels interlaced

576p = 720 x 576 pixels progressive

576i = 720 x 576 pixels interlaced

720p = 1280 x 720 pixels progressive

720i = 1280 x 720 pixels interlaced

1080p = 1920 x 1080 pixels progressive

1080i = 1920 x 1080 pixels interlaced

8. HDMI VS DVI

Digital Video Interface, or DVI, is actually a predecessor of HDMI. Digital Video Interface was made by the Digital Display Working Group (DDWG). The original design for DVI included conversion of analog signals by converting analog into a digital signal. This was done so that both analog and digital signal monitors could be accommodated by DVI. Data is transmitted by the use of transition minimized differential signaling(TMDS) protocol and provides a digital signal from a PC's graphics subsystem to the display unit.

There are actually three types of DVI. There is DVI-A and this type of DVI is usedf or analog signals like VGA. The second type of DVI is DVI-D. This type of DVI is used for digital signals, and this type of signal is the one that all home theatre products use and that are intended for consumer home use. DVI-I is the third type of DVI. This type is a combination of DVI-A and DVI-D.

Two levels of performance are supported by DVI-I. These levels are single link and dual link. Currently all home electronics products are designed around the single link standard. A dual link cable, however, is 100 % compatible with a single link cable plus the dual link cable offers the benefit of adaptability in the future for any wide band width applications. DVD-I is a complete, fully digital video transport protocol that is supportive of all digital video formats including 480p, 480i, 540p, 720p,1080p, and 1080i.

High Definition Multimedia Interface is the only uncompressed, all digital audio/video interface that is supported by the industry. Founders of HDMI include manufacturers of leading consumer electronics Panasonic, Phillips, Hitachi, RCA, Sony, Toshiba, and Silicone Image. HDMI is also supported by motion picture producers Universal, Fox, Disney, and Warner Brothers, as well as system operators EchoStar and DirecTV. High Definition Multimedia Interface provides an interface in between any video/audio source, like an A/V receiver, digital television, and DVD player over one cable total, instead of one cable for video and one cable for audio. HDMI will support high definition video, standard video, and /

or enhanced video plus multiple channels of digital audio on one single cable. HDMI will also transmit every ATSC HDTV standard and will support eight channel digital audio.

HDMI and DVI actually are more alike than they are different. Both of these support the transmission of digital signals. Both DVI and HDMI are based on specifications that are similar, because HDMI specification was derived from the specification for DVI.

There are two important differences between DVI and HDMI. The first difference is that HDMI technology incorporates content security that is called High Definition Content Protection, also known as HDCP. The other huge difference between Digital Video Interface and High Definition Multimedia Interface is that DVI can only support digital video, and HDMI can support audio and video on the same cable.

This leads to another big difference between HDMI and DVI. The number of cables that need to be used and run during installation. With Digital Video Interface atleast two cables are needed. One cable is needed to support the video signal, and one cable or cord is needed to support the audio signal, because DVI can only support video, not audio. With HDMI only one cable is needed for the installation. This is because the HDMI can support all formats of digital video plus it can support multiple channels of audio signal as well.

The good news is that despite their differences, a backward compatibility for video exists between HDMI and DVI. Because HDMI evolved from DVI, they are both identical when it comes to video. But remember, DVI cannot support digital audio. A good example is an older DVI connection on the source and an HDMI connector to the display. In this case, all that is needed to see the video is an HDMI to DVI cable. However, a separate cable for audio is needed to carry the digital audio so the sound can be heard.

Fig 8.1 HDMI and DVI Ports

9. SUPPORT FOR HDCP

HDCP stands for High-Bandwidth Digital Content Protection and was developed by Intel Corporation. It's nothing more than a security feature requiring compatibility between the sender and receiver, like HD cable set-top box and the TV. By compatibility, I mean HDCP technology built into both devices. HDCP helps bring high-definition digital content to consumers by providing copy protection over HDMI.

It works by encrypting a digital signal with a key that requires authentication from the transmitting and receiving product. If authentication fails then the signal fails, which means no picture on the TV screen.

Fig 9.1 HDCP in HDMI

10. FEATURES OF HDMI

•HDMI technology eliminates unnecessary signal conversions.

•HDMI technology supports standard, enhanced, or high-definition video at 24 bits/pixel, 165MHz max clock frequency.

•HDMI technology supports up to 8 channel digital audio on a single cable eliminating costly A/D signal conversions.

•HDMI offers Bi-directional control signal transfer.

•HDMI offers 5 Gbps bandwidth, 55% spared for future expansion.

•HDMI offers 1 simple, user-friendly connector.

•HDMI technology is backward compatible to DVI hot plug enabled assemblies up to 5 meters in length.

•Long lengths available, ATC tested up to 12M and up to 40 M when using EQ Technology.

11. BENEFITS

•High-Definition Audio and Video: HDMI is the only interface in consumer electronics that can carry both uncompressed high-definition video and uncompressed multi-channel audio in all HD formats including 720p, 1080i, and 1080p. An uncompressed, all-digital signal translates into the highest quality video and audio, direct from the source.

•Simple Connectivity: A single, all-digital cable connection means no more confusing wires and no more mess. With an HDMI connection, you can connect any HD audio or video device to your system with a single input, for a streamlined system and no confusing cables behind your components.

•Integrated Control: With an HDMI connection, it's easy to integrate all your audio and visual devices into a single remote control. HDMI has built-in sensors that automatically recognise and configure your AV devices on demand. With the click of a button, your remote control knows which components to turn on to watch a DVD, listen to music, or watch TV programmes.

•Automatic Format Adjustment: An HDMI connection automatically configures the visual format of your display to match the content. Whether you're watching TV programmes, sports, films, or video games, you'll see everything as it's meant to be seen.

•PC Compatibility: HDMI PC-compatibility makes it easy to connect your PC to your HDTV, so you can display PC gaming or PC entertainment contents.

12. ADVANTAGES OF HDMI

•Higher Quality: HDMI enables loss-less transmission and better quality video at low brightness scenes at higher resolutions. So, the video quality is much better than their analog counterparts as there is no conversion involved either. High contrast details like text etc. are displayed more sharper.

•Intelligence: Two way communications between video sources are enabled by HDMI Interface, which enables automatic configuration (between 480p or 720p,16:9 or 4:3 for example). So, external intervention to identify the best resolutions and audio formats is minimized. This is accomplished by using a standard known as EDID – Extended Display Identification Data.

•Authentication and Encryption: HDMI standard supports authentication to ensure that the devices are authorized to receive the content sent by the HDMI enabled sources. They also enable authentication to make sure that people cannot tap in to the cables to copy or pirate content sent through them.

•Signal Integrity: They enable digital signals to be stored, transmitted and viewed without changes from the original (unlike other media which require analog to digital conversion) and hence the signal degradation is not prominent. So, it is better to transmit HD content.

•Single Cable: This is truly a single cable solution as there is only a single cable that carries audio, video and control information. So, the complexity of implementing an audio video control system is lesser.

•Deep Colors: HDMI supports 10 bit, 12 bit and 16 bit color depths which can render over one billion colors in good detail.

•No Compression: Since HD signals are not compressed while transmission, there is no de-gradation in signal quality.

•Compatibility with DVI: Since it is backward compatible with DVI interface, DVI enabled PC's can send HD content to display devices.

•Supports multiple audio and video formats: Multiple audio and video formats like standard stereo, multi channel surround sound, 720p, 1080i, 1080p, NTSC,PAL etc. are supported by HDMI standard.

•Hot Plug Detect: The sink device (display unit) can indicate its presence to a source with a hot plug detect signal to identify when a cable has been connected and to start authentication.

•CEC: Consumer Electronics Control is a communication link that enables devices connected via HDMI to talk to each other. For example, multiple DVD players from a single manufacturer can communicate with each other so that only one plays at a time. Some video sources can also send a power-off signal to turn off certain displays connected to it.

•Display port compatibility: Display port is a parallel technology for audio/video interface like HDMI and HDMI devices are compatible with Display Port interfaces.

•Dolby/DTS: HDMI supports Dolby/DTS-8 channel audio streams for highest quality.

13. DISADVANTAGES OF HDMI

•Distance Limitations: Maximum distance for HDMI Cat1 cables is up to 35meters (approx) for full capacity and maximum distance for HDMI Cat2 cables is up to 10 meters (approx) for full capacity. Beyond this limit, they need extenders. There are extenders like UTP cable extenders for HDMI, HDMI cable extenders, Fiber extenders for HDMI and Coaxial extenders for HDMI. Even Switches, Distribution amplifiers, audio/video processors act as repeaters. But extending HDMI cables this way has its limitations.

•Switching Delays: Sometimes, blank screens can be caused due to authentication delays. There can also be screen flashing errors.

•Field Termination: There are limitations to field terminations of HDMI cables.
They cannot be easily terminated in the field like their analog counterparts.

•Costly: DMI cables are more expensive (per meter) than their analog counterparts.

•Multiple locations: They are difficult to run in multiple applications spanning various locations. There are more complexities in such situations than just the distance limitations.

•EDID: One such complexity is with EDID(Extended Display Identification Data) which is used in automatic identification of resolutions and audio formats. Both HDMI and EDID specifications offer limited guidance in multiple location deployment scenarios.

•CEC: The Consumer Electronic Format which enables the different devices to talk to each other becomes a problem when there is a central control system to control all the connected audio/video devices. It causes confusion when the devices themselves change their configuration as they might get undetected by the control systems.

•Multi-Channel Audio: While HDMI sources can transmit multi-channel audio sources, they cannot transmit multi-channel and standard two channel stereo signals at the same time (simultaneously). This becomes a problem with multi-room installations that has various devices supporting different audio formats.

•DVI Compatibility: HDMI devices are compatible with DVI interfaces but require a separate audio cable as DVI carries only video signals. It also needs a HDMI-DVI connector in such scenarios.

14. HDMI DRAWBACKS

•Manufacturing, non-approved HDMI cables can produce poor results.

•Poor installation, long cable runs, improper active devices, lack of knowledge.

•Conglomerations of circuit boards, twisted cables, interconnects, connectors, and electronic components can create a maze of signal loss.

15.CONCLUSION

HDMI is constantly evolving to meet the needs of the marketplace. The standard is constantly adding more and more features that manufacturers can implement if they desire. But HDMI does not require manufacturers to implement everything that HDMI can do. HDMI provides a menu of capabilities and allows the manufacturer to choose which of those features make sense for its product line. As you upgrade and purchase new audio and video components, you will notice HDMI becoming more of a standard connection option with increasing capabilities.

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