Mobile High-Definition Link (MHL)

Technology White Paper

Introduction

In 2009, five key companies in the consumer electronic and mobile device market started work on a new standard and introduced the Mobile High-Definition Link (MHL®) specification version 1.0 in June 2010. The purpose of the specification was to transport high-quality uncompressed audio and video from a mobile source device to a sink display and at the same time provide power to the device. Since its launch, hundreds of millions of MHL products have shipped from more than 200 member companies and the technology has been designed beyond mobile devices and HDTVs to also include PC monitors, A/V receivers, Blu-ray Disc™ players, projectors, and a number of other device types. This establishes MHL as the de facto standard for video and audio output from a mobile device.

In August 2013, the MHL Consortium reached another milestone with the release of the MHL 3.0 specification, a quantum leap in technology. This version of the specification introduces a significant increase in video and audio performance to deliver 4K (Ultra HD), expanded functionalities including high speed data transfer and support for the latest content protection protocol, while maintaining backward compatibility with earlier versions of the specification. MHL 3.0 is here to meet the complex and growing demands of consumers and the industry with ease of implementation to continue to grow the product ecosystem.

To date there are three generations of specifications for MHL: MHL 1.x, MHL 2.x and MHL 3.0. This white paper provides an overview of the technology to future and existing consumer electronics and mobile manufacturers and presents an introduction to the consumer. The available features of all three versions of the MHL specification are also discussed to show the evolution of the technology and how MHL can benefit both consumers and manufacturers alike.

MHL Technology Overview

Familiar Signaling Technology

MHL is based on Transition Minimized Differential Signaling (TMDS) technology used in HDMI® and DVI, which are popular standards found in the consumer electronics and PC industries. Using a proven technology, disruptive issues such as Electromagnetic Interference (EMI) design issues and challenges are greatly reduced. The technology similarities also allow for straightforward conversion from MHL to HDMI through an adapter, inside a TV or a phone design.

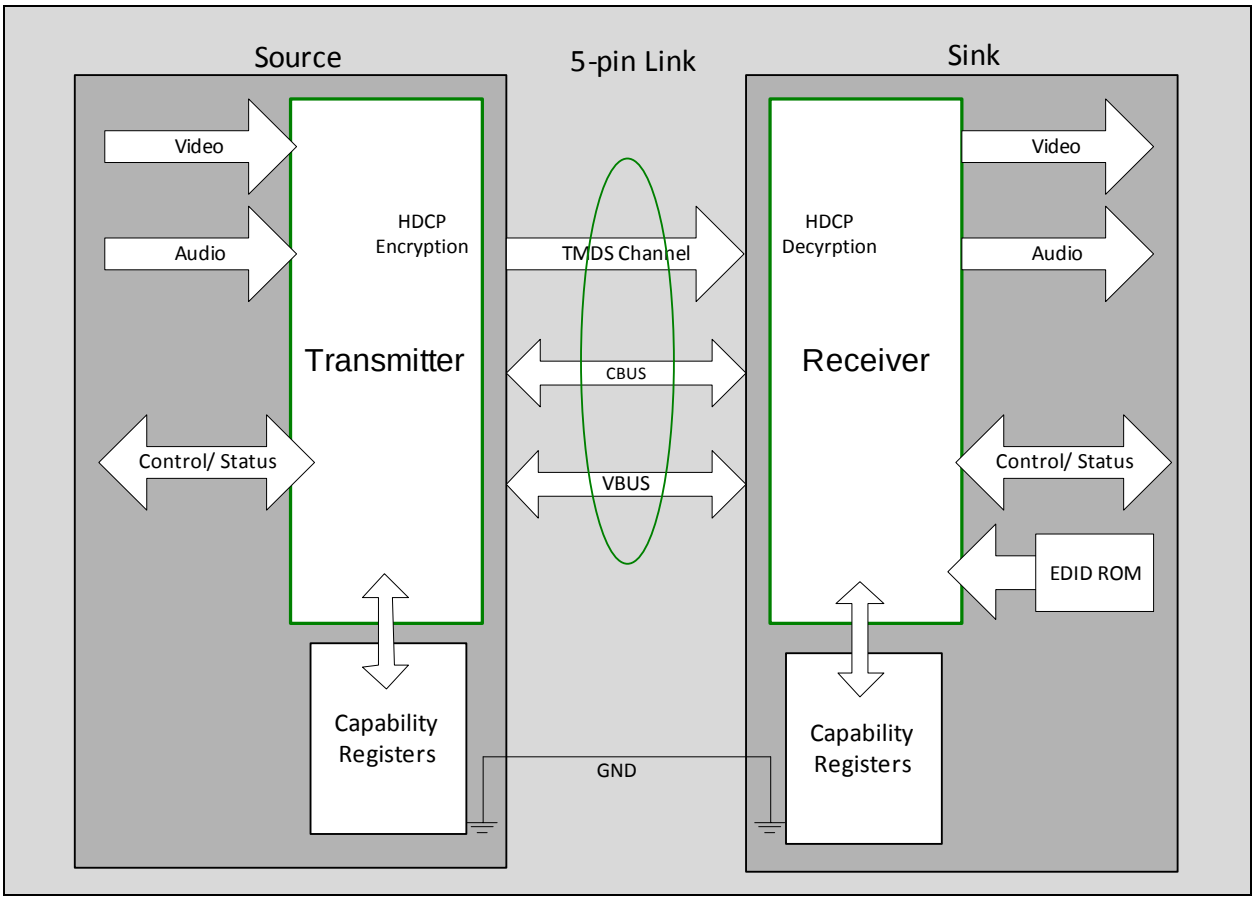

Figure 1. MHL Link Overview

The 5-Pin Solution

MHL is able to deliver all of its features using only five pins in all three generations of the specification. Figure 1 illustrates the five pins and the signals associated with MHL technology. Two of the five pins provide charging supply and ground. The charging pin Voltage Bus (VBUS) provides up to 10W of power in MHL 3.0 to charge an MHL source (for example a smartphone or tablet) from an MHL sink, such as a TV.

While the MHL source is charging, all TMDS signaling is carried on one differential pair. This signal pair carries video, audio, control data, and infoframes along with the pixel clock. Before transmission to the physical pins, the signals are encrypted with HDCP protocol.

The CBUS pin used in the 5-pin solution is a bi-directional control channel to carry data. Using this pin, an MHL source is first able to detect an MHL sink using a combination of impedance checking and discovery pulses. Once the MHL source and sink connection is established, this pin is for multiple functions including reading EDID data from an MHL sink, reading and writing register settings, and sharing device capabilities. In MHL 1.x and MHL 2.x, the speed for this pin is 1Mbps. In MHL 3.0, the speed on this single wire is increased to 75Mbps and is able to reach 750Mbps using a differential implementation. To support higher than 1080p60 resolutions, MHL 3.0 also uses the CBUS pin to carry the pixel clock so that the TMDS pins are dedicated to send the video and audio data signals via the

TMDS pair. With the increased speed, this pin is able to carry additional data including pixel clock or other non-MHL data payload.

Shared Source Connector

The MHL specification is connector agnostic and as such does not require specific connector usage. Since the five pins fit conveniently into a micro-USB and HDMI Type A connector, most MHL source and sinks devices use it. CE manufacturers can share signaling with other connectors as long as the MHL compliance requirements are met. This pathway provides a cost-effective and space saving solution on both MHL sources and sinks by eliminating the requirement for an additional connector dedicated for MHL usage.

MHL 3.0 Features and Benefits Upgrade

MHL 3.0 supports all the features of MHL 1.x and 2.x and is guaranteed to be backward compatible with the previous specifications. Table 1 provides an up-to-date feature support list for all three existing versions of MHL specification. The following benefits are the new advanced features supported by MHL 3.0.

Support for 4K Ultra HD Resolution

In addition to the 2D and 3D video resolutions, MHL 3.0 embraces the 4K revolution with the ability to display 3840x2160 (4K Ultra HD) 30fps resolution. With Hollywood studios and major consumer electronics manufacturers embracing the high-resolution format for upcoming movies and content, MHL 3.0 devices meet this challenge and support 4K Ultra HD. Consumers will be able to enjoy stunning video at the highest resolution using their future-proof MHL 3.0 device.

Higher Charging Power

Power requirement for mobile devices are increasing as higher powered processors and higher resolution screens for mobile phones are designed. To address the higher power requirement for smartphones and tablets, MHL 3.0 provides an option for higher power charging than earlier generations of MHL. In addition to providing a minimum of 4.5mW charging, sinks can now provide up to 10W. This ensures that even when the power hungry smartphone is operational, the battery is not depleted and can be charged at a faster rate.

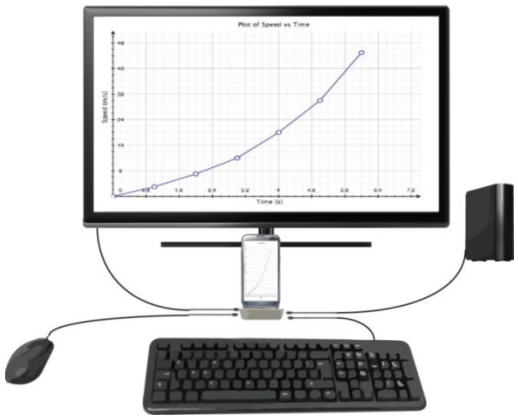

Figure 2. HID Device Support

Figure 3. Automobile console with touch screen and phone

Support for HID Components and Automobile Usage

Human Interface Devices (HID) shown in Figure 2 include classes such as mouse, keyboard, touch screen display devices and game controllers. With MHL 3.0, consumers will be able to connect their mouse and keyboards to their smartphones or tablets and perform productivity tasks that were commonly used with their personal computers. With the simple addition of a gaming controller, mobile devices can be transformed into gaming consoles.

By adding touch screen support, consumers have the unique ability to use their smartphone in an automobile dock where the car console touch screen (Figure 3) can be used to control the smartphone. This provides multiple benefits so that the consumer can access the app purchased on their phone, listen to their favorite music, and use the most current maps and GPS feature on their phones without interruption.

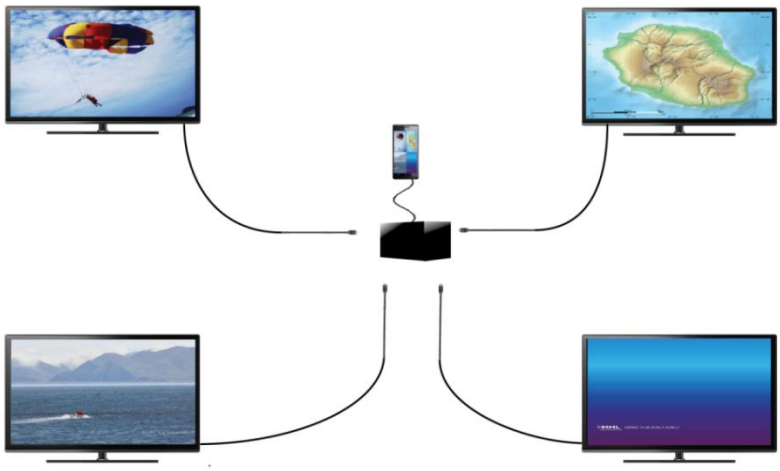

Figure 4. Multi-Display Support

Multi-Display Support

Consumer expectation and productivity has risen over time and users now expect to be able to connect to multiple monitors or displays for additional screen real estate. MHL 3.0 source devices can output to four independent displays using the same resolution. This includes the ability to send different audio transmission to each attached display. The image or video displayed can come from the master image, which can be mapped into the four displays, or each have an independent image that's unrelated to the other.

Content Protection

All MHL 3.0 devices have built in support for HDCP 2.2, which is the latest and most advanced version of the HDCP technology. HDCP 2.2 provides an advanced video and audio encryption with an AES 128-bit security encryption. When connected to an MHL 1.x or MHL 2.x device, MHL 3.0 devices are able to operate with HDCP 1.4 protocol, ensuring that the consumer viewing experience is uninterrupted. By employing the latest entertainment industry encryption standard, consumers using devices with MHL 3.0 can enjoy unrestricted, premium content including the latest Hollywood movies, television shows and music from their favorite artists.

Blu-ray Multi-Channel Audio Format Support

MHL 3.0 supports lossless Blu-ray audio formats allowing the transport of up to eight channels of lossless Dolby® TrueHD and DTS HD Master audio streams, producing an audio nirvana for consumers. This new feature closes the gap between HDMI Blu-ray audio capability and MHL portable sources so that consumers do not have to compromise on lower resolution audio from their smartphones or tablets.

Extended Color Space

Extended Gamut YCC (xvYCC) is an enhancement over the standard YCC encoding used in TVs and camcorders. With this new standard, consumers are able to view a wider color range up to 1.8 times better than the non-enhanced color scheme. MHL 3.0 provides full support for this new standard at the hardware level. When an MHL 3.0 source device is connected to an MHL 3.0 sink supporting xvYCC, consumers can experience color that's more true to life.

Table 1. MHL 1.x, 2.x and 3.0 Technology Features Matrix

Features	MHL 1.x	MHL 2.x	MHL 3.0
Guaranteed Charging Power	2.5W	4.5W minimum with up to 7.5W	4.5W minimum with up to 10W charging
Remote Control Codes (via RCP)	√	√	√
Up to 8 channel Audio	√	√	√
1080p60 Video	√	√	√
HDCP	1.4	1.4	1.4 and 2.2 (128-bit encryption)
Bidirectional Data (CBUS)	√(1Mbps)	√(1Mbps)	√(75Mbps, 750Mbps)
UCP	√	√	√
3D Video Modes		√	√
4K Ultra HD 30fps Video Modes			√
High Definition Blu-ray Audio			√
Multi-display Support			√
xvYCC			√
HID Support			√

MHL 1.x and 2.x Features and Benefits

Full HD and 3D Support with Zero Lag

MHL 1.3 and 2.x supports a multitude of CE friendly video resolutions up to 1080p/60Hz delivering uncompressed video playback. Since all video is sent uncompressed there is no lag. This ensures support for all HDTVs in the market. Additionally MHL 2.x can support multiple 3D formats to provide consumers with a thrilling multidimensional video experience.

Big Screen 3D Experience from Mobile Device

Figure 5. 3D Experience from MHL Source to MHL Sink

Multi-Channel Audio Format Support

MHL 1.x and 2.x can transport digital audio up to a 192 kHz sampling rate with as many as eight channels. With the proper application, users can send multi-channel sound from their MHL phone to an MHL A/V receiver or docking station.

Charging Capability

MHL specifies a minimum amount of power to be delivered through a dedicated five volt wire from an MHL sink to source. MHL 1.x requires a minimum of 2.5W, while MHL 2.x raises minimum power supply from the MHL sink to 4.5W for more power hungry MHL 2.x sources. By keeping the power on a separate wire, charging does not affect signaling and signaling does not affect charging. Guaranteeing a minimum charging power makes it easy for the design of source devices. This is especially important for devices where operation relies solely on the power delivery of the MHL connection, which includes direct-attach sources and other powered accessories.

Mandatory Remote Control Support

MHL includes a mandatory Remote Control Protocol (RCP) bus of over 80 unique commands. This protocol is carried by a parallel bi-directional control channel. MHL source and sink devices are required to support a minimum consumer friendly set of remote control codes, which means that users can count on this feature to access, playback and navigate content on the MHL source device using the TV remote control.

Content Protection

MHL provides perfect reproduction of source content such as movies, TV shows and other forms of audio/visual entertainment from all the major Hollywood studios. To protect copyrighted source material from duplication, the entertainment industry has mandated a strong protection mechanism using a technology called HDCP. MHL 1.x and 2.x have built-in support for HDCP 1.4 to block unauthorized transmission and reproduction of protected video and audio content. Consumers will be able to enjoy premium content without restriction on the MHL sources and sinks.

Character String Transport

Both MHL 2.x and MHL 3.0 provide a bi-directional protocol for sending not only text but the complete character set between an MHL source and sink. Using the UTF-8 Character Protocol (UCP) characters may be sent from a smartphone to a TV to pop-up messages such as "incoming phone call" or an MHL phone may transmit strings – even Unicode international language strings – to a TV to render as closed captions on the screen.

A Thriving Ecosystem

Maturity of any standard is gauged by the number and types of devices offered by the market. The MHL ecosystem supports a diverse set of products with a growing installed base of hundreds of millions consumer devices and accessories. The MHL standard has been adapted to multiple device types including:

- Mobile devices such as smartphones, tablets
- Media Devices including Audio/Video receivers, automobile consoles
- Sink devices such as HDTVs, monitors, projectors
- Accessories such as adapters, docks, video processors, passive cables
- Media playback devices such Blu-ray players, set-top boxes

All devices can be found in major retail markets across the globe with components manufactured by the largest and most respected consumer electronics manufacturers. MHL technology is also Operating System (OS) agnostic, and as such the technology can be ported into any available system with or without an OS. MHL source and sink components with a different OS will work with one another without any compatibility issues, offering huge benefits to both consumers and manufacturers.

Compliance Testing

Compliance testing of products before they launch is especially important for connectivity standards such as MHL. To that end, the MHL Consortium has established Authorized Test Centers (ATC) worldwide to perform compliance testing of products entering the market. Compliance on both sides of the link is critical to interoperability between MHL devices and provides a consistent consumer experience.

Each MHL member company must submit their device for testing and pass all of the mandatory tests in the MHL Compliance Test Specification (CTS) in order to be certified as an MHL-compliant product. Multiple test equipment companies have provided certified equipment to perform testing, including

electrical, protocol and system-level tests. Each product certified by the ATC is acknowledged by the MHL, LLC before it enters the market.

Summary

MHL technology was invented to transmit video/audio from a mobile source device while being charged. Basing the technology on TMDS and using a connector agnostic approach, MHL technology benefits manufacturers since it is easy and cost-effective to implement. While MHL 3.0 marks a significant upgrade, all versions of the MHL specification are backward compatible ensuring consumers will be able to use older MHL devices with new devices. The MHL standard is widely adopted with a large ecosystem of hundreds of millions of MHL devices and continues to grow. To ensure robust interoperability, there are Authorized Testing Centers across the globe for members to test their products before reaching consumers. MHL technology is a standard that continues to evolve to stay ahead of the technology curve and bridges the gap between mobile devices and non-mobile devices.