HIGH-DEFINITION MULTIMEDIA INTERFACE

HDMI 2.0

The Evolution of a Winner

Evolving from the digital visual interface (DVI) specification and competing with rival interfaces such as DisplayPort, the High-Definition Multimedia Interface (HDMI) is now one of the most successful consumer electronics standards.

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In 2002, the High-Definition Multimedia Interface (HDMI) was promoted as a solution for HDTV needs, replacing old analog standard connectors such as VGA and SCART and solving the many issues created by the first digital attempt, the DVI.

Fourteen years have passed since the original HDMI 1.0 specification was published. In 2009, the market widely adopted the latest HDMI 1.4a standard published, updated to 1.4b in 2011. Now, the HDMI Forum has announced the new HDMI 2.0 specification, which is designed to meet the bandwidth requirements of the forthcoming Ultra HD or 4K televisions while using existing cabling for backward compatibility. The new specification significantly increases bandwidth to 18 Gbps, supports Ethernet on the same cable, adds support for 32 audio channels, and features up to 1,536-kHz audio sample frequency and simultaneous delivery of video and audio streams to multiple users.

The HDMI was developed in the late 1990s to solve many of the problems originated by the DVI. Maybe one of the least successful initiatives in the consumer electronics (CE) and IT industries, DVI was intended to replace the dated analog VGA connection, which unfortunately remains in use today.

The HDMI 1.0 specification, published in April 16, 2002, tried to solve the connections needs of HDTV equipment, maintain backward-compatibility with the DVI connector, and respect the high-bandwidth digital content protection (HDCP) and digital rights management technologies primarily imposed by Hollywood studios. Video was always the focus for the HDMI's initial efforts. Its widespread adoption in television receivers and many types of LCDs and set-top boxes explains its success.

Another reason for the HDMI specification's success has to do with the standard connector design (Type A, 19 pins) and features, even though several variations have been proposed. This was the first truly "digital age" connector and its implementation history could be a topic for another article.

One of the best examples of the HDMI connector's success is its recent implementation by Apple, which used the connector in its MacBook Pro laptop computer series. Apple has never been a company to settle for standard connectors, especially if they compromised the design of its own products. That was the reason why Apple was a strong promoter of the smaller DisplayPort rival interface, from the Video

Electronics Standards Association (VESA) and the reason why the company pushed the Mini-DisplayPort connector version forward, to manufacture even thinner computers. Currently, the DisplayPort connection is even integrated in the Thunderbolt interface developed in collaboration with Intel. But still, Apple understood that the consumer wanted a standard option to connect to any television set or common display. The company does this with its Apple TV device. In 2012, Apple decided to bring back an HDMI connector on its MacBook Pro computers.

An entire book could be written about the story of the HDMI connector and its implementation in the industry and another book could be written about HDCP. The truth is, HDMI is an interface we all have to deal with and we'll be doing so for quite some time. Even though its evolution has been primarily dictated by video, its audio capabilities are worth mentioning, especially now that HDMI 2.0 has introduced a new set of specifications and there is increasing interest in high-resolution audio.

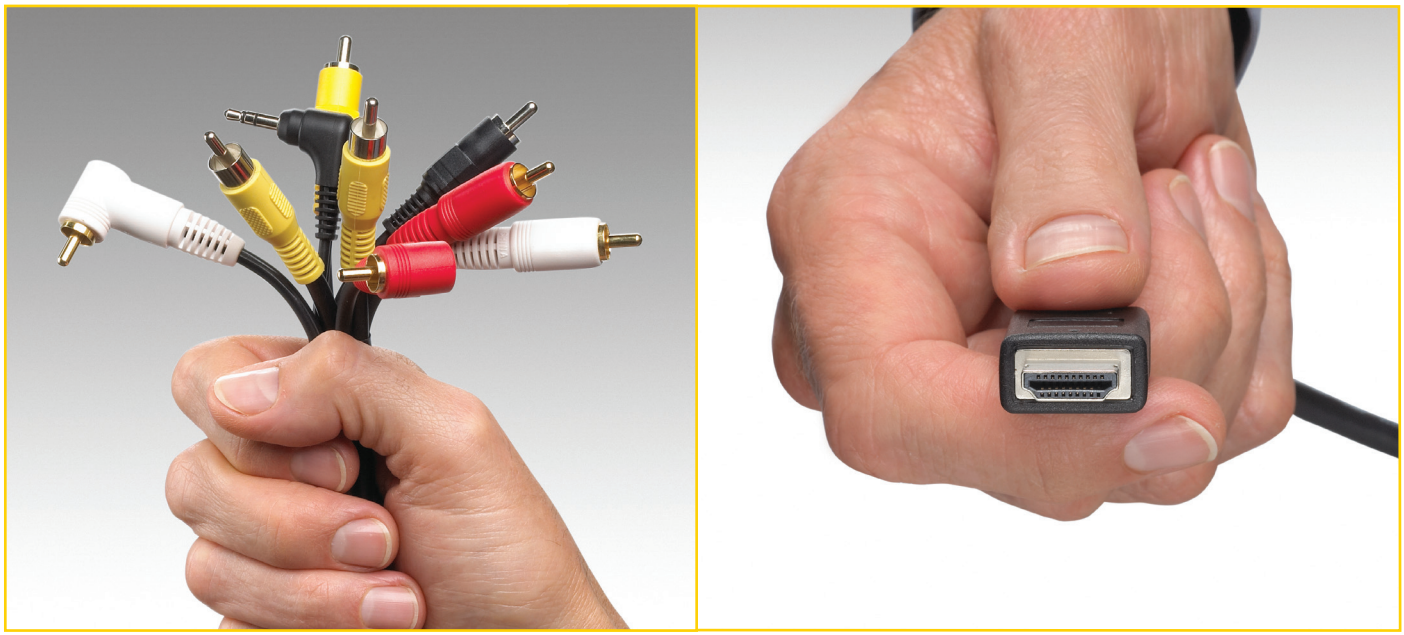
HDMI's Evolution

With HDMI 1.0, the specification considered the integration of digital audio in line with the same CD standards as a foundation, requiring a minimum of two pulse code modulation (PCM) channels. Other audio formats (e.g., Dolby Digital 5.1) were an option, supported by up to eight-channels of 192-kHz/24-bit audio (PCM). Basically the interface was designed to enable the transmitter and receiver end to define the type of format they would be exchanging, creating a two-way communication port. The Display Data Channel (DDC)—based on the I^2C bus specification—exchanges data about what audio/video formats they are supporting/exchanging. The same DDC is also used for HDCP protection, including content-protected audio and content protection for prerecorded media (CPPM) and content protection for recordable media (CPRM) licensing.

The HDMI 1.2 update, announced in 2005, added support for one-bit delta sigma audio or direct stream digital (DSD), which coincided with the need to support the ongoing Super Audio CD (SACD) industry efforts. Certainly the one-bit audio and expanded sampling frequency introduced by that update made HDMI an extremely valid and robust solution for the current needs of the high-resolution audio applications—independently of the SACD format demise.

Next in line was the expansion of multichannel (e.g., 6.1 and 7.1) audio formats, with Dolby Digital Plus, Dolby True HD, and DTS-HD being supported with high bit rate and a set of specifications that finally enabled a single-cable solution for any audio source.

All HDMI cables are made of 19 individual wires. Many of these wires perform multiple tasks and transmit large amounts of data, so the quality of the conductors, precision of the geometry, and the quality of the termination all affect the ability for the cable to properly implement its tasks.



HDMI is considered the best generic interconnection for audio surround formats and one of the only reasons to invest in best cable materials, enabling for reduced jitter and lower error rates.

Another important decision was to mandate that HDMI 1.2 support low-voltage sources, enabling an important convergence with the PC market and in particular converging with the PCI Express interface.

In 2006, the HDMI 1.3 specification introduced support for the lossless audio codec formats Dolby TrueHD and DTS-HD Master Audio output streams for external decoding by AV receivers. The audio used on HD-DVDs and Blu-ray Discs could be externally decoded in uncompressed audio for up to eight channels.

It took almost another four years to bring HDMI 1.4 to the market, but this version focused on support for Ethernet over HDMI and the all-important Audio Return Channel, which means that an HDMI-connected TV with a built-in tuner can actually send audio data "upstream" to a surround audio system. The specification eliminated the need for a separate audio cable or enabled users to access something not previously available, since many TVs don't even have a dedicated audio output. The CE industry promoted 1.4 mainly for the 3-D stereoscopic support, and the arrival of 4K × 2K resolution and additional expanded-color standards. Effectively, it was the Ethernet over HDMI support that received interest from the AV install community, which was already interested in proposals from rival DisplayPort and networked technologies (e.g., HDBaseT).

HDMI 1.4 received an additional revision "b" in 2011, a time when the HDMI Forum was already examining valid commercial requirements for another "major" update. In 2013, it initiated the HDMI 2.0 specification.

HDMI 2.0

The HDMI 2.0 specification enables the support of 4K-resolution video at 50/60 frames per second (fps) and up to 32 audio channels along with dynamic auto lip sync, among several other new features.

As with previous standard revisions, HDMI 2.0 is backward compatible with earlier HDMI versions, and doesn't require new plugs or new cables (existing high-speed Category 2 cables with 19-pin connectors support the increased bandwidth).

The new HDMI specification is the result of intensive work carried out by the HDMI Forum member companies, expanding the support of 4K pictures beyond the 24/25 fps limit to 50 or 60 fps and increasing bandwidth from 10.2 to 18 Gbps. And it will probably not stop there, since another specification revision is expected to support the Japanese 8K ultra-high definition (UHD) standard and up to 120 fps, which will probably require a major revision in terms of hardware support.

It is important to note that, as with previous iterations, the upgrade of existing equipment from HDMI 1.3 or 1.4 to 2.0 will require dedicated firmware and some form of hardware upgrade. Therefore, the HDMI Forum is aware of the need to quickly define a stable set of industry specifications to avoid unnecessary consumer confusion.

With HDMI 2.0, the increased bandwidth can already be used to send high-quality dual-video streams (good quality 3-D in 50/60 fps), expand color depth to 10 or 12 bits, and even support the 21:9 aspect ratio video in high-quality and high-frame rates.

In the audio domain, the HDMI 2.0 specifications introduces a margin to grow and implements new services (e.g., new multichannel formats—there is support for up to 32 channels, instead of the previous 8). It also enables different multichannel signals to be sent to different devices and multiple users (up to four).

The support for 1,536-kHz audio is obviously extremely important to accommodate future high-resolution audio options without any compromise. Even though such an extreme sampling frequency may seem hard to understand until we see practical industry implementations. However, it is already obvious that DSD and DXD format support will benefit from those capabilities. In simple terms, any manufacturer can implement eight uncompressed audio channels at 192 kHz with this new specification.

The HDMI 2.0 specification opens a world of new possibilities in line with the current market trends. In the same way, the SACD support provided additional capabilities that became useful for completely different reasons than initially considered, now that HDMI 2.0 has been completed, we can expect to see practical implementations and they don't necessarily only have to do with 4K televisions.

While HDMI is clearly a consumer-oriented technology, HDMI 2.0 makes it possible to also implement some specific new production applications and exciting new signal distribution possibilities, particularly for residential and some commercial installations. As long as great lengths of cable are not involved, which is the reason why the installation industry is moving to Cat5e/6 cable and fiber, HDMI 2.0 can always be considered. HDMI and technologies like HDBaseT complement each other and the 2.0 specifications provide many complementary approaches for consumer-oriented applications.

According to the HDMI Forum website, HDMI Specification Version 2.0 with bidirectional 100-Mbps Ethernet support will inspire manufacturers to implement many features currently implemented in a proprietary way, such as finally expanding the Consumer Electronic Control (CEC) application between systems from different brands, as originally intended.

The Ethernet feature, used primarily for audio control, is the only one in the HDMI specification that requires a special HDMI cable. The HDMI Ethernet Channel (HEC) uses two pins in the standard connector plus a special cable – a single 100-Mbit/s Ethernet channel is implemented.

Sources

HDMI Forum, www.hdmiforum.org.

HDMI Licensing, www.hdmi.org.