

DISPLAYPORT VERSUS HDMI: Do we really need two digital-display-interface standards?



DisplayPort proponents bill this digital-video-I/O standard as a no-royalties, scalable, extensible, open-standard interface that reduces connector footprint and cable clutter, lowers power consumption and cost, eliminates the need for some circuitry, and unifies interfaces in the boxes that connect to the home network. VESA (Video Electronics Standards Association), which introduced DisplayPort in 2006, last year ratified DisplayPort version 1.1a. Silicon is beginning to appear in PCs, LCD monitors, and cable assemblies, as well as in some motherboards and graphics cards. PC makers initially developed DisplayPort to address computing-world concerns and replace the external,

box-to-box, analog-VGA (video-graphics-array) interfaces in PC and LCD monitors, as well as in CE (consumer-electronics) equipment, but it also targets the external DVI (digital-visual-interface) connectors you find mostly in CE systems. It even promises to replace the internal, board-to-display, LVDS (low-voltage-differential-signaling) links in both PC and CE devices.

During the past couple of years, however, while VESA was hashing out the standard and getting working DisplayPort chips and systems operating and certified, manufacturers began shipping high volumes of silicon for the older, external-only, HDMI (high-definition-multimedia-interface) digital-video-interface standard. The designers of HDMI created it to replace DVI and based it on DVI's legacy raster-scan CRT architecture. Despite the \$5000 to \$10,000 annual fee and royalty structure of 4 cents per device, HDMI ports now see use in several hundred million digital TVs and other CE equipment that incorporates digital video, such as game consoles, DVD (digital-video-disc) players, Blu-ray-disc players, and digital-set-top boxes. Perhaps more important to DisplayPort supporters, HDMI has also begun to appear in graphics cards, PCs, and monitors to enable connectivity to HDTVs (high-definition televisions).

According to Brian O'Rourke, principal analyst for In-Stat, although manufacturers will ship limited amounts of DisplayPort-enabled products during 2008, shipments will grow to more than 600 million units in 2012. Most

of these shipments will be PCs and PC peripherals (Figure 1). "I don't see DisplayPort really gaining significant market share in the consumer-electronics world in the next five years," says O'Rourke. "During that time, it will dominate the PC and PC-peripheral world, and HDMI will dominate the consumer-electronics world. HDMI has buy-in from the big consumer-electronics manufacturers, and they tend to be conservative. The key for DisplayPort in the PC segment is that you can get rid of both the DVI controller and the VGA silicon." In 2007, manufacturers included DVI in 13% of desktop PCs, 28% of desktop PC monitors, about 16% of LCD-notebook-PC monitors, and all after-market graphics cards.

One reason HDMI ports are growing so fast is the increasing port density in PC displays and TV monitors, says Randy Lawson, iSuppli's senior analyst for display electronics. Multifunction PC monitors are becoming more common, typically with two ports, and HDMI is replacing the old DVI port. "Some PC-flat-panel-monitor makers are very pro-HDMI, especially outside the U.S., where people often use their PC monitors as displays for video," says Lawson. "Perhaps surprisingly, this is one area where there will be real competition between HDMI and DisplayPort." In fact, iSuppli expects HDMI's adoption rate in PC monitors to outpace DisplayPort's until 2010, when DisplayPort will dominate desktop and notebook PCs. To some extent, this situation will also occur because of the higher initial cost



DISPLAYPORT SILICON IS BEGINNING TO APPEAR IN PCs, LCD MONITORS, AND GRAPHICS CARDS. BUT IT WILL PROBABLY BE AT LEAST FIVE YEARS BEFORE PRICES FALL AND VOLUMES RAMP ENOUGH TO CHALLENGE HDMI IN CONSUMER ELECTRONICS.

of first-generation DisplayPort silicon. The HDMI-enabled-equipment market will expand even more as designers of additional consumer equipment, such as high-definition camcorders and video-game consoles, move to support high-definition video.

DIGITAL AUDIO/VIDEO AT HOME

This competition is heating up because the proliferation and distribution of digital-video and -audio content are driving product development in both computing and CE, as well as in communications, and they're all converging in the home network. There's also the advent of high-definition video and content-protection and DRM (digital-rights-management) issues.

The developers of the HDMI standard, now in its fourth generation, designed it primarily as an external interface for digital TVs, especially HDTVs. DisplayPort's developers designed it from the ground up as a general-purpose internal and external display interface for computing equipment. Both standards digitize analog-video signals but in different ways (Table 1, available in the Web version of this article at www.edn.com/080918cs). Because HDMI's designers based its raster-scan architecture on the serial-TMDS (transition-minimized-differential-signaling) protocol, it sends each color over a separate data channel, plus another lane for the dedicated TMDS clock. Therefore, it always requires the use of all four lanes. Audio transfers occur during

AT A GLANCE

■ VESA (Video Electronics Standards Association) finalized the DisplayPort digital-video-I/O specification in April 2007, and silicon has appeared this year in PCs, LCD monitors, and cable assemblies, as well as in some motherboards and graphics cards.

■ Products employing DisplayPort include Lenovo's ThinkPad, Hewlett-Packard's DreamColor LCD monitor, several AMD ATI graphics cards, AMD's 780G chip set, and Intel's 45 Express chip set for Centrino 2.

■ The HDMI (high-definition-multiplexed-interface) standard has more than 800 adopters, and shipments of HDMI-enabled units reached 192 million in 2007.

■ Semiconductor analysts are relatively bullish on DisplayPort's ability to penetrate PC-system markets, but whether and to what extent it can also make its mark in CE (consumer-electronics) equipment remains to be seen.

horizontal- and vertical-display-blanking periods. HDMI also uses two additional channels: a bidirectional auxiliary-control/status channel, and a high-level device-control channel. For DRM, it relies on the HDCP (high-bandwidth-digital-content-protection) scheme, currently HDCP 1.3.

In contrast, DisplayPort combines audio, video, and control data into packets, such as those in data networks. This

packet-based architecture lets you use one, two, or four data channels to trade off screen resolution, pixel depth, frame rate, and additional data, such as audio or DRM information. A 1-Mbps, bidirectional auxiliary channel provides link management and device control. DisplayPort's embedded clock eliminates the need for extra circuitry and streamlines its already-scalable design, making it easier for designers to increase data rates in the future. The embedded clock also helps avoid common frequency conflicts between an LVDS clock and other clock sources, such as radios.

Although DisplayPort supports content protection through the DPCP (DisplayPort Content Protection) encryption protocol, adopting the HDCP scheme, the standard does not require it. It does efficiently encrypt DisplayPort packets and the HDMI signal in one HDCP 1.3 block, says Pericom Semiconductor's Abdullah Raouf, product-marketing manager for switch and interface marketing and a member of VESA's DisplayPort Task Group. VESA anticipates that all consumer applications of DisplayPort will include content protection, which will require specifications and license agreements separate from the DisplayPort spec.

"The major advantage of DisplayPort's packet architecture is the variable possible number of wires in the cable," says Bruce Montag, chairman of the DisplayPort Task Group and senior technical-staff member at Dell. As notebook computers continue to get smaller, their display resolution and color-bit depth increase, and designers add communication capabilities by routing antennas through the notebook's hinge, where reducing the number of wires becomes a primary concern. DisplayPort enables thinner, smaller-form-factor monitors because the signal can go directly from the PC to the glass in the monitor in direct-drive, end-to-end configurations that replace LVDS with DisplayPort. In addition, the LVDS auxiliary channel is one-way, whereas DisplayPort's bidirectional channel provides the ability to perform additional functions, such as notebook-backlight control.

Direct-drive monitors that remove the scalar from the mix can save 15 to 20% in overall monitor BOM (bill-of-materials) costs, including the PCB (printed-

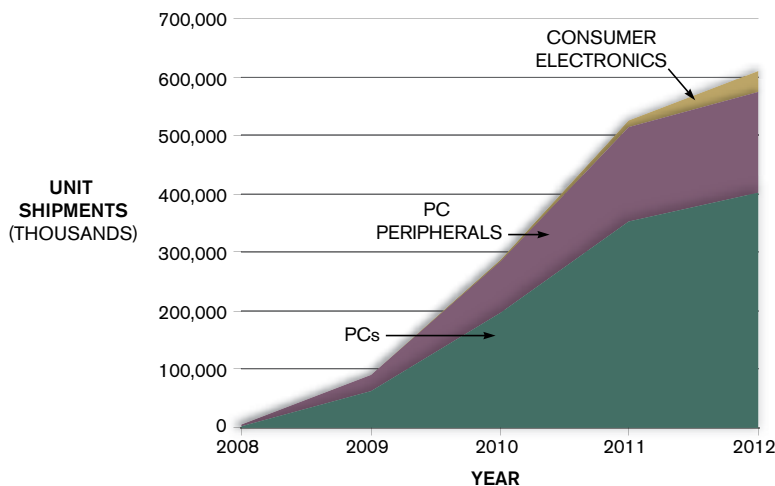


Figure 1 Total DisplayPort-enabled device shipments will grow to just over 600 million in 2012 (courtesy In-Stat).

circuit board), processor, capacitors, and resistors, says Ji Park, vice president and general manager of the digital-display operation of IDT (Integrated Device Technology). It also means an opportunity to integrate the display's timing controller with the DisplayPort receiver, as IDT has done in its PanelPort timing-controller silicon, which targets monitor, notebook, and LCD-HDTV panels.

Even without also replacing the external video interface, however, DisplayPort's potential for replacing the embed-

ded, multipin internal LVDS interface in an LCD panel may hold the key to the standard's market penetration, especially in notebook PCs and LCD TVs, says iSuppli's Lawson. The company forecasts shipments of more than 600 million mobile PCs and 550 million LCD TVs between 2008 and 2011.

DISPLAYPORT-SILICON ISSUES

As process geometries get smaller, DisplayPort is also easier than HDMI to integrate and implement in silicon. Al-

an Kobayashi, director of R&D for the DisplayPort/TV/monitor division of ST-Microelectronics' home-entertainment and displays group, wrote the original draft of the DisplayPort spec during his tenure with Genesis Microchip, which STMicroelectronics recently acquired. "Although LVDS is very well-accepted in the industry, as semiconductor processes shrink, it's not the most optimal technology," he says. For LVDS to handle 1920x1200-pixel resolution and 8 bits per color, it needs 10 high-speed

INTEROPERABILITY AND BACKWARD-COMPATIBILITY ISSUES

To ensure interoperability among devices from multiple vendors that contain external DisplayPort interfaces, VESA (Video Electronics Standards Association) has instituted a DisplayPort-compliance, -testing, and -certification program. You can now connect DisplayPort-enabled boxes compliant with multimode DisplayPort to other display interfaces in current or legacy TVs and other PC or CE (consum-

er-electronics) equipment through adapters, or dongles (Figure A). The VESA DisplayPort Interoperability Guidelines, which the association released in 2007, address DisplayPort-to-DVI (digital-visual-interface) and DisplayPort-to-HDMI (high-definition-multimedia-interface) adapters. VESA is working on other types of adapters, such as DisplayPort-to-VGA (video-graphics array), and is evaluating the

need to certify embedded implementations of the spec.

"DisplayPort has been designed with backward compatibility in mind," says Devang Sachdev, Nvidia's technical-marketing manager and a member of the VESA board of directors. "There's already a large installed base for VGA and DVI, and these interfaces will be around for quite some time. That's why the DisplayPort standard

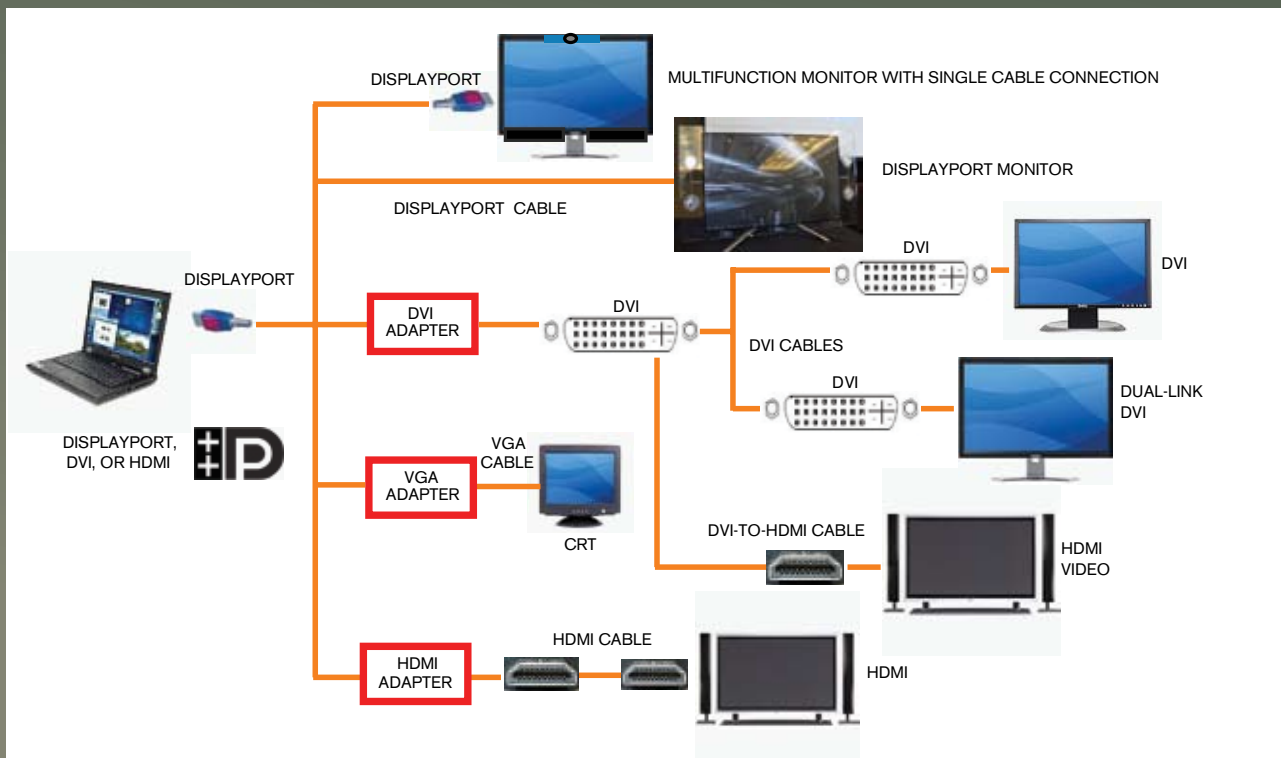


Figure A VESA DisplayPort-multimode-interoperability guidelines enable connectivity to other display interfaces (courtesy Video Electronics Standards Association).

differential-signal pairs, or 20 wires. For the same function, DisplayPort reduces this requirement to only two pairs, or four wires. An LVDS implementation requires at least 3.3 or 2.5V, so it's becoming increasingly difficult at 45-nm and smaller process geometries.

Because DisplayPort is ac-coupled, instead of dc-coupled like HDMI, it has a lower voltage swing and a different termination scheme. You must terminate HDMI only at the receiver and pull it up to 3.3V, says Pericom's Raouf. But

you can terminate DisplayPort at both the source and the receiver, and it can never exceed 2V, per the spec, helping to lower power consumption. HDMI's I/O-voltage limitation becomes more of a constraint with shrinking process geometries, increasing cost and die size. DisplayPort's lower voltage swing also helps reduce EMI (electromagnetic interference).

DisplayPort transmitters are in all of the newer north-bridge chip sets' integrated graphics, as well as in discrete

GPUs (graphics-processing units) on graphics cards, according to VESA's Montag. "Older GPUs can use a discrete DisplayPort-transmitter chip, but the need for that [part] is diminishing," he says. Although vendors such as Analogix Semiconductor and STMicroelectronics will offer discrete DisplayPort silicon in 2008, "the market is quickly moving toward the integration of DisplayPort IP [intellectual property] into a north-bridge or a discrete-graphics solution," says In-Stat's O'Rourke.

Intel and AMD have announced support for both DisplayPort and HDMI in chip sets for some of their latest processors: Intel's 45 Express chip set for Centrino 2 and AMD's 780G chip set. "Our next-generation discrete GPUs, as well as motherboard GPUs, will support a myriad of connectivity options, including HDMI, DVI, VGA, and, of course, DisplayPort," says Devang Sachdev, Nvidia's technical-marketing manager and a member of the VESA board of directors. "This [approach] affords our partners and customers the greatest flexibility."

enables interoperability between DisplayPort-capable devices and DVI/HDMI-capable devices through the use of adapters," he says.

The DVI and HDMI adapters include a chip that performs voltage-level shifting but does not perform format conversion from DisplayPort to DVI or HDMI, says Bruce Montag, chairman of VESA's DisplayPort Task Group and senior technical-staff member at Dell. The adapters don't need to perform format conversion because multimode DisplayPort GPUs (graphics-processing units), which also support DVI/HDMI signaling, detect the presence of these adapters and transmit signals in the format compatible with the display to which they connect. This ability is key for systems, such as ultrathin notebook computers, that have enough space for only one display connector but must connect to a variety of displays.

Voltage-level-shifting chips, which run on power from the DisplayPort connector's power pin, are available from vendors such as Pericom Semiconductor. Pericom's chips provide the electrical bridge that converts the low-swing, ac-coupled DisplayPort signal to the dc-coupled TMDS (transition-minimized-differential signaling) that HDMI and DVI use. They also include a circuit to eliminate jitter, which increases with rising transmission speeds, says Abdullah Raouf, Pericom's product-marketing manager for switch and interface marketing.

DisplayPort also supports longer cables than most available today for DVI or HDMI—as long as 15m for a source and a display that are both DisplayPort-compliant. This capability is important for several uses, such as digital projectors. The connector is latchable to avoid cable falloff, which can occur with heavier cables. Although DisplayPort runs over Category 5 cable, HDMI requires the more expensive Category 2 type. However, other options include cables equipped with Gennum's ActiveConnect-receiver silicon, which enable reaches as long as 100m at maximum bandwidth for either HDMI or DisplayPort.

One of HDMI's major shortfalls is its inability to daisy-chain multiple monitors in a single HDMI connection—the fault of its TMDS protocol, says Ji Park, vice president and general manager of the digital-display operation of IDT (Integrated Device Technology). Therefore, you need multiple graphics cards for multiple monitors, he says. "But DisplayPort's extensible architecture lets you assign each monitor a certain address or a certain lane and hence support multiple monitors with a single source device."

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DUAL STANDARDS, MARKETS

HDMI's presence in notebook computers and in TVs and other CE equipment means that HDMI is quickly becoming the method of convergence. Although consumers may be converging PC and CE equipment in their own home networks, however, many manufacturers see the two as separate markets. DisplayPort backers now talk about coexistence, with HDMI leading in CE and DisplayPort leading in PCs (see sidebar "Interoperability and backward-compatibility issues"). In the early days of the spec's development, however, the debate was more heated. In particular, some suppliers of HDMI silicon for the CE market, especially for large digital-TV OEMs, see little value in DisplayPort.

New consumer features should differentiate DisplayPort from HDMI, says Doug Bartow, strategic-marketing manager for the advanced-TV segment at Analog Devices, who participated in DisplayPort standards development. "In our view, there are no consumer features in DisplayPort that distinguish it over HDMI," he says. "As an engineer, I think that DisplayPort is a well-constructed display standard, and, if it were available three to four years ago, we'd all be using



it. But HDMI is already here, and it will provide significant headwinds for market penetration of DisplayPort.” Analog Devices makes silicon for DVI, VGA, and HDMI for the top 20 TV manufacturers. Although the company has implemented DisplayPort test chips, it has found insufficient demand from customers to fund the chip development, adds Barstow.

The need for systems and silicon that deliver digital content is growing even beyond the traditional home network, at least on the CE end. “There’s been a big switch out there in the manner of delivering digital content,” says Dale Zimmerman, vice president of worldwide marketing for Silicon Image. The company co-founded the HDMI specification, manufactures HDMI silicon, and licenses HDMI cores under its wholly owned subsidiary, HDMI Licensing. This explosion has happened for a number of reasons, he says. In particular, there are multiple sources of digital-video content and broadening distribution channels for delivering it. For example, one of the newest content sources is the mobile phone, and far more people own one of these devices than own a PC.

The size of the CE market is several times that of the PC market; there are more types of boxes, and many more people have them. Adding mobile devices could double the size of that market. “CE manufacturers are not interested in another standard or another connector on the back of the TV,” says Zimmerman. Silicon Image has announced product development for mobile-high-definition-link chips that address PDAs (personal digital assistants) and mobile phones. But VESA has not yet finalized the mobile-display-digital-interface standard for external DisplayPort-display connectivity to cell phones and other portable devices.

Although DisplayPort’s potential in the CE market is less certain than its future in the PC market, there’s some opportunity for replacement of the high-pin-count connectors that connect digital-TV boards to panels inside the TV, says In-Stat’s O’Rourke. “That doesn’t necessarily mean there will also be DisplayPort ports on the outside of those TVs,” he says. “Still, that’s a foot in the door, a Trojan horse, for DisplayPort. If you’re in the digital TV, you’re in the center of the living room.” In-

⊕ For an analysis of DisplayPort’s partitioning and how it differs from TMDS-based architectures, see www.edn.com/article/CA6574650.

⊕ For details on how display interfaces work, as well as a discussion of the history and politics behind the development of the DisplayPort and HDMI standards, go to www.edn.com/article/CA6402885.

⊕ For more articles by this author, see “10-GbE in the mainstream,” www.edn.com/article/CA6553621, and “The 802.11n standard: grown up at last,” www.edn.com/article/CA6470826.

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Stat expects that, by 2009, digital TVs will begin adopting DisplayPort as an internal feature, resulting in its appearance in some external ports, especially in higher-end digital TVs, the following year. DisplayPort ports will then be able to migrate to other digital-CE products, including Blu-ray players and recorders and set-top boxes. **EDN**

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