DisplayPort Overview

Bruce Montag
Office of the CTO
Dell Inc.
One Dell Way, Round Rock, Texas, 78682
Bruce_Montag@dell.com

Abstract: *"DisplayPort" is a new, open, industry standard digital display interface, now under development within the Video Electronics Standards Association (VESA) Display Systems Committee. It is intended to provide an interface suited to a very wide range of applications, including both external ("box to box") and internal (e.g., notebook PC panel interface) connections. This paper provides an overview of the goals for this proposed standard, its basic technical details, and the schedule for its completion and adoption by VESA.*

Keywords: display; interface; bandwidth; industry standard; LCD; LVDS, DVI, HDMI, PC, HDTV; VESA; CEA

Introduction

As displays increasingly transition to higher performance flat panel and micro-electronic technologies, an extensible, open industry standard digital interface solution is also needed that can scale in performance as well. This scalable display interface should be capable of meeting the varied needs of business and enterprise users as well as consumers. DisplayPort is this next generation display interface, and it is designed to serve as a broadly deployable connectivity solution for PCs, monitors, panels, projectors, and high definition content applications. DisplayPort consolidates internal and external connection methods to reduce device complexity, support necessary features for key cross industry applications, and provide performance scalability to enable the next generation of displays featuring higher color depths, refresh rates, display resolutions, and advanced applications.

Current Display Interface Technologies

Displays are connected in varying ways today, depending primarily upon the type of application that the display is used for.

Embedded applications such as LCD panels used in notebook PCs and TVs primarily use Low Voltage Differential Signaling (LVDS) for connectivity to the display driver.

External PC monitor applications today use the legacy Video Graphics Array (VGA) analog interface for connectivity to PCs. Some premium monitors also include, in addition to VGA, a Digital Video Interface (DVI) connection to high end PCs.

TV applications use analog composite video for standard definition interlaced content, such as from a camcorder or VCR, and analog component video for standard definition progressive content such as from a DVD player. High definition TV applications are moving to the High Definition Multimedia Interface (HDMI), which additionally provides for audio transmission and content protection.

These different display connectivity methods result in design complexity in PCs though, and each technology has specific limitations. A display interface is desired by the PC industry that can reduce the design complexity associated with digital display technologies, and can scale to meet future business, enterprise, and consumer customer needs via an open and extensible industry standard.

Limitations of Current Interfaces

Display interface technologies in use today have specific limitations in many cases that inhibit scalability for future needs.

For instance, VGA is limited in its ability to scale to support higher resolutions and color depths, and does not have a means available to protect high definition content for consumer use.

LVDS technology can't extend beyond short distances and is clock limited, requiring a growing number of pins resulting in a wider cable to support transmission of higher resolutions and color depths. Emerging notebook PC applications that include new types of radios and multimedia devices are competing with LVDS for cable access through the notebook display panel hinge.

DVI technology is limited in that the DVI 1.0 specification is in essence frozen, and cannot be easily updated to support higher clock speeds, color depths, connector types, or new features.

DVI and VGA add complexity in flat panel monitors since the signals must be internally translated to LVDS, resulting in additional monitor circuitry and cost. In addition, the 3.3V required for DVI prevent implementation in the types of low voltage silicon applications that will be found in future PCs.

HDMI is well suited for its application to TVs, but HDMI falls short for broad application to high performance PC displays due to limitations in terms of performance scalability, and due to its primary focus being on consumer electronics box-to-box connectivity.

DisplayPort overcomes these limitations by providing an open industry standard that consolidates internal and external display signaling in a way that can be readily scaled for performance, and extended to accommodate new display features and applications.

DisplayPort Objectives

The DisplayPort specification defines a scalable digital display interface with optional audio and content protection capability for broad usage within business, enterprise, and consumer applications. The interface is designed to support both internal chip-to-chip and external box-to-box digital display connections. Potential internal chip-to-chip applications include usage within a notebook PC for driving a panel from a graphics controller, and usage within a monitor or TV for driving the display component from a display controller. Examples of box-to-box applications for DisplayPort include display connections between PCs, monitors, and projectors.

By consolidating the internal and external signaling methods, DisplayPort enables the introduction of "direct drive" digital monitors, resulting in the most efficient means possible for delivering flat panel display technology to end users.

DisplayPort is also suitable for connectivity between high definition content applications such as optical disc players, mobile devices, personal video recorders, and TVs. DisplayPort fills a necessary need as well to provide a future-PC friendly secure display interface. This capability will become increasingly important as protected content sources such as Blu-ray disc become mainstream PC features.

Key Industry Needs for DisplayPort

DisplayPort addresses key industry needs by defining an electrical and protocol specification that may be readily implemented in panel timing controllers, graphics processors, media processors, and display controllers. Some of these key industry needs addressed by DisplayPort include:

1) Ensure broad industry adoption via an open and extensible industry standard. Ensure

2) Drive maximum application and re-use of digital technology to enable reduced device costs associated with implementing a digital display connection.

3) Enable a common signaling methodology for both internal and external display connections to reduce device complexity and promote commoditization.

4) Enable an extensible architecture that supports an optional robust content protection capability that meets content owner requirements, and may be economically implemented.

5) Enable high quality optional digital audio transmission capability.

6) Enable higher levels of silicon integration and innovation within rendering and display devices to reduce device complexity and enable digital interface commoditization as the PC architecture transitions to low voltage components. Examples of potential DisplayPort integration capability include transmitter integration within a graphics or display controller, and receiver integration within a timing controller on a panel.

7) Simplify cabling for internal and external digital display connections.

8) Address performance concerns with existing technologies by providing higher bandwidth over fewer wires.

9) Provide performance scalability by supporting a variable number of lanes, and the ability to scale in link operating frequency.

10) Apply embedded clock architecture to reduce EMI susceptibility and physical wire count.

11) Provide a small form factor external connector that can be plugged in by feel, and whose design will enable four connectors to be placed on a full height PCI card bracket.

Technical Objectives for DisplayPort

Functionally, DisplayPort provides a forward drive channel that is scalable from 1-4 lanes, and implements a micro-packet architecture that can support variable color depths, refresh rates, and display resolutions. A bi-directional return channel is defined that also implements micro-packet architecture for flexible delivery of control and status information. This micro-packet architecture enables future extensibility to additional content types and applications, and isn't limited to raster scan data only.

The DisplayPort specification also includes a mechanical specification that defines a small, user-friendly external connector with an optional latch on the plug for robust connectivity with long cable lengths. The connector includes four forward lanes and is optimized for use on thin profile notebooks in addition to allowing up to four connectors on a graphics card. A standard panel connector for internal applications is also defined within the mechanical section of the specification.

Other key technical objectives for DisplayPort include:

1) Provide a high bandwidth forward transmission link channel, with a bi-directional auxiliary channel capability.

2) Provide application support for up to 10 Gbps forward link channel throughput to address long term

PC industry needs to support greater than QXGA resolution and greater than 24 bit color depths.

3) Provide application support for up to 1 Mbps auxiliary channel throughput with a maximum latency of 200 micro-seconds
4) Support variable color depth transmission (6, 8, 10, 12, 16 bits per component)
5) Support EMI compliance to FCC B standard with 6db of margin
6) Support existing VESA and Consumer Electronics Association (CEA) standards where applicable.
7) Do not preclude legacy transmission support (e.g. DVI, VGA, and LVDS) to and from DisplayPort components.
8) Support hot plug and un-plug detection and link status-failure detection
9) Support full bandwidth transmission via direct drive over a 3 meter cable.
10) Support reduced bandwidth transmission via direct drive over a 15 meter cable. DisplayPort supports a minimum of 1080p resolution at 24bpp, 50/60 Hz over 4 lanes at 15 meters.
11) Support audio skew of less than 1ms
12) Support a bit error rate of 10^{-9} for raw transport per lane, and 10^{-12} audio symbol error rate for audio and control data after ECC encoding / decoding.
13) Support sub 65 nanometer process technologies for integration in source devices, and support .25 micron process technologies for integration in sink devices.

Legacy Interoperability

DisplayPort will co-exist with legacy interfaces, and interoperability with these existing interface types will be very important to customers who wish to use DisplayPort source devices (such as a PC) with existing equipment that includes current interfaces (such as a monitor or TV). In consideration of this need, DisplayPort includes protocol provisions for the transmission of traditional raster scan data and control signals, and supports protocol connectivity with devices that comply with the CEA's uncompressed DTV transmission profile, CEA-861B.

Although interoperability at the specification level with legacy devices cannot be provided through the DisplayPort specification, it is technically feasible to achieve interoperability at the product level. The DisplayPort specification includes the following feature support for product level interoperability with existing interface types:

1) Deliver digital audio concurrent with display data as an optional feature.
2) Provide support for maintaining synchronization for delivery of audio and video data to within +/- 1ms.
3) Provide architecture support for an optional robust content protection capability that meets content owner requirements and may be economically implemented.
4) Support the functionality defined in the feature set of CEA-861-B for the transmission of high quality uncompressed audio-video content, and CEA-931-B for the transport of remote control commands between sink and source devices.
5) Support variable audio formats, audio codings, sample frequencies, sample sizes, and audio channel configurations. Support up to 8 channels of LPCM coded audio at 192 kHz with a 24 bit sample size.
6) Support variable video formats based on flexible aspect, resolution, and refresh combinations based on the VESA DMT and CVT timing standards.
7) Support reading of the display EDID whenever the display is connected to power, even an AC-trickle power.
8) Support DDC/CI and MCCS command transmission when the monitor includes a display controller.
9) Support industry standard colorimetry specifications for consumer electronics devices including RGB and YCbCr. 4:2:2 and YCbCr 4:4:4.

VESA Standardization Process

The DisplayPort specification is currently in the process of review and final development within the VESA Display Systems Committee. It is anticipated that the final version of the DisplayPort 1.0 specification will be approved and published by VESA by the beginning of 2006. A compliance program for assuring interoperability between DisplayPort devices is also anticipated as part of the standardization activity.

References

1. VESA, "DisplayPort Proposed Standard," Version 1.0, August 15th, 2005.
2. CEA, "A DTV Profile for Uncompressed High Speed Digital Interfaces, CEA 861-B," May 2002.