1 Introduction

Over the past decade, entertainment and communications in consumer electronics have moved to digital formats. Full HDTV, 3D gaming, 3D video, 4K x 2K screens, internet video, and IP-based video conferencing all require more bandwidth, increased memory, and improved connectivity between devices.

As the digital ecosystem evolves, innovative interfaces are emerging in response to the new digital vistas that are opening up. Many of these interfaces are often driven by a single company or a small group of companies and are crafted in a way that, sooner or later, will require customers to pay royalties.

DisplayPort is a VESA (Video Electronics Standards Association) interface standard for high-speed, high-definition audio and video. It has been developed by the VESA committee, with contributions from over 60 people from numerous diverse sectors: chip makers, cable makers, connector manufacturers, and computer and consumer electronics manufacturers.

DisplayPort is free of charge and any VESA member can contribute towards its evolution. No fees, no royalties, just advanced technology.

DisplayPort has become well known since its wide adoption by Apple, Dell, and HP; however, many people talk about DisplayPort without really knowing the underlying aspects of this standard. This article details what DisplayPort offers and helps readers understand why and how this evolving interface will co-exist with existing digital video and audio interfaces.
2 Why was DisplayPort created?

The personal computer is increasingly becoming a media hub for the home. High-definition video and high-quality audio requirements have always gone hand-in-hand with the home entertainment/broadcasting segment but only recently have these requirements become more desirable in the computer realm. These two segments are converging, driven by growing entertainment content channeled via broadband IP connections.

As the home entertainment/broadcasting and computer segments draw closer and closer together, VGA and DVI no longer satisfies the needs of consumers wanting to view and hear high-definition content using their computer. A simple, highly evolved solution has become a necessity—a fact underlined right from the beginning by PC graphic chip makers Intel, NVIDIA, and AMD—a single interface between computer and monitor is required.

DisplayPort was created to replace the ageing VGA and DVI standards, and at the same time offer the increased functionality necessary for a true HD multimedia link. It is a response, by the computer world, to the HDMI interface developed by Silicon Image and the HDMI consortium—a response that also resolves some technical limitations of HDMI.

Not only does DisplayPort fill a need for consumers, but as digital process technologies move towards 32nm and 28nm, the voltages required by old interfaces are being phased out. Utilizing DisplayPort, designers can remove VGA and DVI functionalities from silicon and support legacy interfaces through adapted dongles (i.e. DisplayPort to VGA, DVI, or HDMI).

With DisplayPort, VESA is taking a quantum leap into the future, allowing for the easy transfer of high-resolution video and audio on a single cable.

DisplayPort's initial physical configuration comprises of 4 main lanes for video (see below), however only one or two can be used depending on the needs.

Figure 1. DisplayPort physical layer
The table below reveals the video transfer capabilities of DisplayPort depending on the number of lanes.

### Table 1. DP1.1 and DP1.2 video transfer capabilities

<table>
<thead>
<tr>
<th>Lanes/Channel</th>
<th>DP1.1</th>
<th>DP1.2</th>
</tr>
</thead>
<tbody>
<tr>
<td>1x lane</td>
<td>1.62 - 2.7 Gbps</td>
<td>1.62 - 2.7 - 5.4 Gbps</td>
</tr>
<tr>
<td>2x lanes</td>
<td>3.24 - 5.4 Gbps</td>
<td>3.24 - 5.4 - 10.8 Gbps</td>
</tr>
<tr>
<td>4x lanes</td>
<td>6.48 - 10.8 Gbps</td>
<td>6.48 - 10.8 - 21.6 Gbps</td>
</tr>
<tr>
<td>Auxiliary channel</td>
<td>1 Mbps</td>
<td>1 Mbps or optional 720 Mbps</td>
</tr>
</tbody>
</table>

## 3 DisplayPort and the personal computer: a love story

The main push for DisplayPort comes from the computer segment. The revolution has already begun.

DisplayPort has been identified as the next computer/monitor interface by VESA, while DVI, HDMI, and VGA will be supported by external means (e.g. on-board converter chip or dongle). This trend began as the key GPU providers (Intel, NVIDIA, and AMD) started to progressively replace their existing VGA/DVI chipsets with ones that comprised of DisplayPort output only. All new roadmaps from our GPU vendors show DisplayPort-only outputs.

Apple has already switched all of its iBook product line to DisplayPort with a miniDisplayPort connector. Companies such as Dell, HP, and Acer are quickly following suit. Looking at the market for 2011 to 2013, all new computers will have at least one DisplayPort output.

On the monitor side, due to the arrival on the market of new DisplayPort-enabled chipsets and the rapid adoption of DisplayPort as the main interface on laptops and desktops, market analyst projections show that DisplayPort adoption could be as high as 90% in 2013.

Additional reasons of DisplayPort's attractiveness can be found in its exceptional performance in the following areas:

- **Video quality:**
  - DisplayPort can support superior video quality, high frame rates, high color capability (12 bits per pixel), and can support 3D video up to 120 Hz per eye.

- **Audio support:**
  - DisplayPort supports native audio. DP1.2 supports up to 8 uncompressed channels (i.e. 7.1 PCM, 192 kHz) and supports the well-known Dolby True-HD and DTS HD Master compressed audio formats.
  - DisplayPort supports audio transmission without video allowing you to have a quality sound system digitally connected to your PC with your monitor daisy-chained to your sound system.
  - DisplayPort supports different streams for different displays, enabling a more immersive 3D gaming experience.
Daisy-chaining and multi-streaming (featured in DP1.2):
- DisplayPort architecture allows for the daisy-chaining of displays, which efficiently maximizes space utilization. Multiple screens can be easily set up in public workspaces (to increase productivity) or at home (for an more immersive gaming experience).
- DP1.2 has built-in support for multi-streaming—a single cable can output two WQXGA (2560x1600) displays or four WUXGA (1920x1200) displays at full frame rate.
- DP1.2 with 4 lanes @ 21.6 Gbps supports up to 63 video streams over one cable.

Cable length:
- While HDMI and DVI need to employ a repeater for long distances, DisplayPort can send full HD video and audio over 15m (49 ft.) without any issues. This feature allows you, for example, to have an additional monitor in one room while your computer is located in another.
- The long cable length enables new and effective applications (e.g. advertising displays in shops).

Fast-Aux (featured in DP1.2):
- The adoption of DP1.2 in January 2010 and its optional 720 Mbps auxiliary channel opens new doors. With a theoretical throughput of 720 Mbps, one can achieve a 500 Mbps unidirectional transfer rate and a 400 Mbps full duplex transfer rate.
- With 400 Mbps, protocols over the DisplayPort Fast-Aux channel could be implemented, thus reducing the number of cables and simplifying yet again the computer's connectivity.
- Data transport over the DisplayPort Fast-Aux channel may, in the near future, introduce a multitude of innovative applications into the market. A prime example may soon be seen in docking station monitors whereby monitors operate similar to USB hubs (without the need of a USB cable between the monitor and the computer): one DisplayPort cable is connected from the computer to the monitor and all other USB peripherals (e.g. mouse, keyboard, webcam, or any other USB device) are connected directly to the monitor. All of this would be totally transparent for the user.

Electromagnetic emission reduction:
- The DisplayPort physical interface embeds the clock inside the signal which significantly decreases the amount of frequencies generated by the signal, thereby diminishing EMI (electromagnetic interference) and reducing the BOM (bill of materials) of desktops and laptops.

Royalty free:
- While manufacturers shipping devices with HDMI connectors are paying royalties, the VESA organization is happy to make the use of DisplayPort free. This represents substantial savings for equipment makers.
4 DisplayPort in the laptop: eDP

In addition to gaining huge momentum as an external interface, DisplayPort is gaining traction as an internal video bus from the CPU directly to the laptop screen.

Today, LVDS interfaces are used to drive laptop screens, requiring 19 wires to support a maximum resolution of 1280x800. For the common resolution of 1680x1050, or higher resolutions such as 1600x1200 and 1920x1200, a 29-wire interface is required.

Version 1.1 of eDP (embedded DisplayPort) was adopted by the VESA committee on October 23, 2009. A laptop utilizing eDP can support a resolution of up to 1680x1050 employing only 13 wires. With a 15-wire eDP interface, resolutions can be further extended to support 1600x1200 or 1920x1200. Not only does implementing eDP effectively reduce the number of wires needed, EMI is significantly decreased due to DisplayPort's embedded clocking.

Ultimately, all these advantages lead to a reduced BOM while improving performance and form factor—a result which can only lead to the customer’s satisfaction.

5 iDP (Internal DisplayPort)

DisplayPort has been pushed by TV panel makers to face the increased demand for higher resolution, higher bit-rate panels. With this in mind, iDP has been designed (and approved by VESA in 2010) to replace LVDS cables within TVs, connecting the TV controller SoC (System-on-Chip) to the TV panel timing controller.

While DisplayPort was initially conceived as an external connection, its flexibility gives a clear advantage. Applying a fixed rate of 3.24Gbps, a full HD video 120 Hz refresh rate (1080p, 10 bits per color) is achieved utilizing 4 lanes with iDP as opposed to 24 for LVDS. For a refresh rate of 240 Hz, only 8 lanes are required with iDP as opposed to the 48 needed for LVDS. Therefore, iDP allows panel makers to simplify their design, reduce their cost (i.e. reduced cost of connectors and wiring), and decrease EMI emissions.

STMicroelectronics and LG are the first to support iDP technology. However, iDP brings with it so many advantages that it is quickly gaining traction in the TV panel market—so much so that it is expected to see iDP implemented in a significant amount of 120 Hz and 240 Hz TVs from a variety of TV manufacturers within the next couple of years.
6 DisplayPort and copy protection

The technological shift to full digital content in our society has highlighted the need for copyright protection mechanisms. DisplayPort fully embraces the well-established HDCP copy protection scheme (irrespective of the number of lanes used). DisplayPort currently supports the latest specification of HDCP (HDCP 1.4) and, with its superior flexibility, future revisions of HDCP will be supported as well.

DisplayPort’s copy protection capabilities introduces new business opportunities for mobile equipment manufacturers, telephone operators, and digital content providers, as it ensures that their content will always be fully protected.

7 Conclusion

DisplayPort will certainly be the next interface for computer display connections, and has huge potential in the consumer segment as well. This innovative and free-to-use interface will definitively change the way we use audio and video and many exciting new applications will appear in the short term.

DisplayPort is the only high-definition interface that is free to use while its specification is open, meaning that any VESA member can bring their own ideas and added value to the specification.

STMicroelectronics is one of the key contributors in defining the specification of DisplayPort and its next standard revisions. STMicroelectronics also has one of the largest DisplayPort product portfolios and is leading the way in DisplayPort IP development.

STMicroelectronics is currently one of the market leaders for DisplayPort monitor controllers and converters featuring DP1.1a and is already developing DP1.2-compliant products.

8 References

For further information on DisplayPort, please visit or review the following references:
● DisplayPort website (www.displayport.org)
● VESA website (www.vesa.org)
● VESA DisplayPort Standard Version 1, Revision 2, January 5, 2010
● VESA DisplayPort Standard Version 1, Revision 1A, January 11, 2008
● VESA embedded DisplayPort Standard Version 1, Revision 1, October 23, 2009
● Intel Display Roadmap, DisplayPort Guidance and Compliance Certification Process, IDF2009, Session ID VCD007
● VESA DisplayPort Press Event at CES 2010
9 Revision history

Table 2. Document revision history

<table>
<thead>
<tr>
<th>Date</th>
<th>Revision</th>
<th>Changes</th>
</tr>
</thead>
<tbody>
<tr>
<td>23-Jun-2010</td>
<td>1</td>
<td>Initial release.</td>
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