DisplayLink™

Monitors Made Easy with USB

How a new technology that dramatically improves the user experience and economics of multi-monitor computing can bring added productivity benefits office workers and frequent travellers.

Whitepaper

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Introduction

The benefits of multiple monitors have been clearly stated for years by computer and financial professionals. With the present low cost of LCD panels, the benefits of the multi-monitor desktop are now within the reach of every organization - even for the home office. A new breakthrough in display connectivity technology from DisplayLink makes USB connected monitors a reality, making adding additional monitors very easy, cost effective, and practical for even mainstream consumers. DisplayLink brings the simplicity of the universal USB connector to monitors for the first time, with maximum expandability, to desktop and to notebook PC users.

The Future of the Computer Desktop

In the information-saturated world of today's knowledge worker the new measure of productivity is no longer computer processing power - it's the area of their displays. Moreover, multiple large displays are both more cost effective and more functional than a single ultra-high resolution one. This trend is compounded for road warriors who may compromise on screen size to get a lightweight laptop, but require easy access to large monitors when working at the office.

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PC World Senior Reviews Editor Tom Mainelli summarized the benefits of multi monitor desktops: "I would have to say that this second display has changed the way I compute more profoundly than any single upgrade since, oh, maybe Microsoft Windows 95. And no, I am not kidding. The dual-monitor setup has changed the way I do a large percentage of my job. Not only does it make doing many tasks more pleasant, but it also lets me do them more efficiently. I can't think of a single desktop hardware upgrade that could pay for itself faster than adding a second monitor."[1]

There are significant and measurable productivity benefits to moving to a multi-monitor configuration. Microsoft Research has found a consistent 9 percent productivity increase by adding a second display, with up to a 50 percent increase in productivity for tasks such as cutting and pasting.[2] An investigation done by Jon Peddie Research found an estimated productivity improvement of 42%.[3]

In a comprehensive study of multi-monitor computing at the University of Utah, researchers found that "Multi-screens fared significantly better than single screen on time and number performance measures. Respondents got on task quicker, did the work faster, and got more of the work done with fewer errors in multi-screen configurations than with a single screen. They were 6 % quicker to task, 7 % faster on task, generated 10 % more production, were 16 % faster in production, had 33 % fewer errors, and were 18 % faster in errorless production."[4]

Consider the workflow of a Webmaster. In the design of a single Website, one application would be dedicated for HTML coding, another to create and tweak the graphics. Email and a word processor are needed for content, and then a browser is needed to view the output of the work. If there is a need to view the work at different screen resolutions to emulate various user environments, then there is the time-consuming process of setting and resetting the monitor in all resolutions. Even the largest display today, costing several thousands of dollars, can't provide space for multiple user environments - but several smaller displays could.

Repeat this exercise with more typical knowledge workers - someone in finance, marketing or management - and the situation is the same, only the applications change. Similarly, home users are also inundated with data and applications, and may need at any one time, office productivity suite, browser, IM, digital music player, digital photo software, and digital movie software.

The productivity benefits of multi-monitor computing are clear, and have been touted for years by researchers and members of the press. But apart from select financial environments, most users are still confined to a single display, as the current state of display technology is inhibiting the uptake of multiple monitors to the general public.

Held Back by Display Connectivity

Jon Peddie Research found a significant increase in multi-monitor productivity, but that same report also found that only 1.9% of all PCs shipped with two or more displays in 2002.[3] The report shows the market opportunity for such systems, but that general lack of awareness of such products, difficulty and cost of installation and poor performance is holding the market back.

A DisplayLink analysis of monitor shipments shows that with a fundamental change in key performance factors and usability, the market for USB-connected monitors that can be used in a multiple monitor mode could reach nearly $1.6 billion by 2010.

The market shift starts with re-thinking the way a monitor is connected to a PC. Today, this happens using a VGA or DVI connector, which limits a PC to a 1-to-1 relationship with a monitor. Desktop users need to add a graphics card to a PC to enable multi-monitor computing, a task that is expensive and involves opening up the PC. Notebook PCs have only one VGA port available and most solutions for adding additional displays to notebook PCs are expensive and proprietary. Many users balk at the cost and complexity of such upgrades, and the complexity and cost is worse for wide-scale deployment of multiple monitors in enterprise environments.

The solution to the complexity and cost of today's display connections requires a new display connector that is inexpensive, compact, and universal. For every other peripheral on the PC, similar connectivity problems have been solved in the form of the standard USB connector. The USB 2.0 interface, paired with DisplayLink

technology, makes it is possible to connect a high-resolution and high quality display, allowing the monitor to become the last major peripheral to make the switch to USB.

The Universal Connector

USB 2.0 is now available as a standard feature on every PC purchased today. Notebook PCs routinely ship with 2 USB 2.0 ports and Desktop PCs with an average of 6. The number of factory installed USB ports is constantly increasing and additional ports can be obtained at any time by adding a USB hub.

Today, nearly every peripheral is connected to the PC via USB2.0, from the traditional mice and keyboards to printers, scanners, speakers, and docking stations. USB 2.0 flash drives are the standard replacement to floppy discs for file transfers between individuals. The USB 2.0 interface is a well understood connector by nearly every computer user today. USB offers many benefits over legacy peripheral connections for all peripherals, but there are some unique features of USB that make it an ideal choice for display connectivity.

The reasons for the massive popularity of USB are clear to see. It is a small connector, allowing several USB ports to be added to every notebook PC. It is easy to use, with plug-and-play for a wide range of devices, and a connector without pins to bend or the need for a large bulky cable. USB also offers a low-cost alterative to legacy connection methods for peripheral manufacturers.

Better VGA than VGA

The USB interface offers true plug-and-play connectivity, for exceptional ease-of-use. On the surface, the USB connector is easier to connect to a PC, and avoids the problem of a large clunky cable and bent pins that affect VGA. But USB goes further to improve the entire user experience of connecting and disconnecting a display. Notebook users have the problems of enabling the external VGA display, through commands that differ from brand to brand, but usually involve hotkeys such as Fn-F7 or Fn-F5. And if the configuration of one location is different than another, a user has to modify the display settings with each reconnection.

A USB connected monitor, in contrast, remembers all of its settings, allowing the user to connect a laptop to the right of the monitor at home and the left of the monitor in the office. The USB connected monitor will activate immediately, without special hotkeys, allowing for true plug-and-play connectivity.

Another issue with the VGA connector is picture quality. The resolution of an LCD is very precise, with an optimal picture quality at the “preferred resolution” that corresponds exactly to the number of LCD pixels on the display. A VGA connector isn’t guaranteed to display the monitor at its preferred resolution, which can result

in jaggy edges onscreen. Additionally, VGA is an analog signal which is susceptible to noise and interference and requires a conversion from digital to analog and back to digital for display on an LCD. The result can be a poor picture quality especially on high-resolution digital displays.

USB monitors will always detect the proper resolution, ensuring the picture is the best quality available on the LCD. USB is also a purely digital connection, resulting in a noise-free perfect picture for onscreen text and graphics.

For a wide range of applications, from office applications to DVD playback, a DisplayLink USB 2.0 connected solution offers an experience nearly indistinguishable from a standard VGA connection from a performance perspective, with all of the benefits of USB 2.0 economics, connectivity, and quality.

The History of Multi-Monitor Solutions

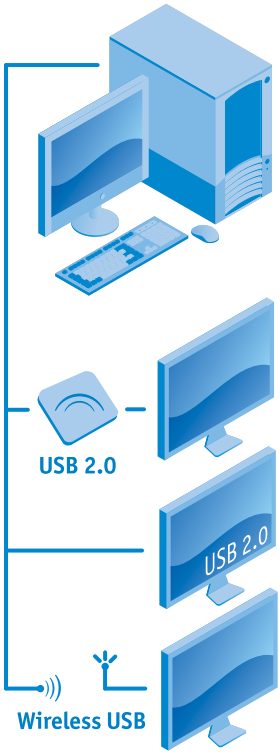
With the obvious benefit to multi-monitor computing, it comes as no surprise that there have been many previous attempts to develop multi-monitor solutions, including USB to VGA dongles, but none has delivered the right performance at the right cost point.

Dual-headed graphics cards are another solution that, in contrast from the previous examples, offer very high image performance. However, this solution suffers from high cost and technical complexity - requiring a user to crack open a PC case to install, which may even invalidate the warranty. While corporate IT administrators may be well versed in these upgrade procedures, it can be a time consuming and expensive proposition to perform these upgrades across a large user base. While Desktop PCs sometimes have the ability to add a new graphics card, notebook PCs offer very little opportunity for upgrades. Notebook-specific multi-monitor solutions often plug into the VGA connector, adding additional complexity and cost, with several significant limitations on resolution and monitor size.

First-generation VGA-USB laptop docks and connectors have suffered from performance issues, with users complaining of long delays, image ghosting and very slow refresh rates. DVD and other video playback has been impossible or of extremely poor quality. Resolutions are often limited to only 800x600 or only to 16-bit color, resulting in a significantly inferior experience and quality to a standard VGA monitor. To send a computer display across a USB 2.0 connection with the performance and quality that users demand, several technical challenges must be met.

The technical limitations of sending high resolution graphics and video across a USB connection have kept the benefits of USB connected monitors out of the reach of users, and have kept the monitor as the last major peripheral to benefit from the improvements of USB. DisplayLink has developed software and chip platforms to enable high-performance USB connected displays, allowing monitor and peripheral manufacturers to deliver easy to use USB display solutions with the performance that users expect.

The DisplayLink Solution

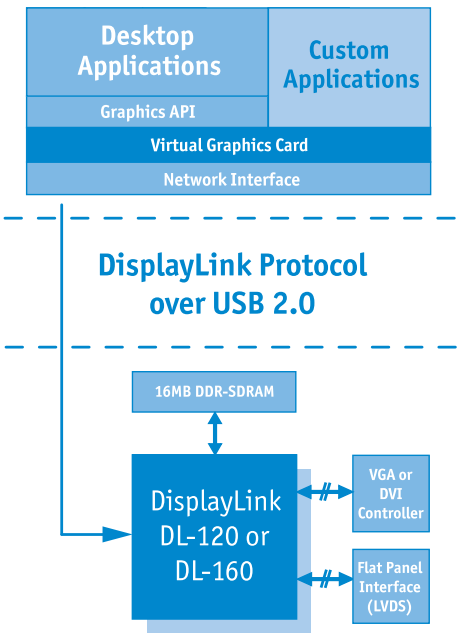


DisplayLink was founded in 2003 by Dr. Quentin Stafford-Fraser and Martin King, both accomplished technologists and entrepreneurs, and who shared an interest in re-thinking the connection between monitors and PCs. The founders recruited a talented management and engineering team and built up deep expertise in graphics technologies. DisplayLink is funded by Atlas Venture, Benchmark Capital and Esprit Capital and to date has raised over $22 million to commercialize the technology.

The challenge facing DisplayLink developers is to take the large amount of data that comes from a high-resolution graphical PC display and transport it over a USB 2.0 connection with limited bandwidth. This led the company to develop its lossless graphics transport protocol that maintains low latency while sending high quality images from the PC to the monitor.

DisplayLink has solved this challenge by taking a system-level approach. The solution is made up of two major components: a software application that runs on the host PC (Virtual Graphics Card) and a high-speed decode chip on the display side (Hardware Rendering Engine - DL-120 or DL-160).

The Virtual Graphics Card, or VGC, is an application and driver that is installed on a host desktop or notebook PC that converts the pixel stream into the lossless transport protocol and transports these frames across the USB 2.0 link. This software is nearly invisible to the user. It is installed using Microsoft digitally signed drivers and runs in the background allowing users to make adjustments to their monitor properties using the standard Windows Display Properties control panel.



The VGC is composed of two key elements. The first part is a driver that communicates with the PC's graphics API to accept the pixel stream. The second component is a Windows service that manages connected displays, remembers display configurations, and converts data to the DisplayLink lossless transport protocol to send over USB 2.0. The standard Windows USB interfaces are used to connect, disconnect, and send data over the USB 2.0 interface.

The hardware component is the Hardware Rendering Engine (HRE) a silicon chip that decodes the USB graphics stream into a pixel stream for display on a monitor. The HRE can be used in a wide range of system designs, from USB docking stations to USB to VGA or USB to DVI adapters. The HRE can also be embedded directly into a monitor or projector for a device that can obtain the full easy of use benefits of a true USB connected display.

The performance of the HRE drives the high-quality images delivered by the DisplayLink solution. DisplayLink offers two HRE chips, the DL-120 and the DL-160. Both chips offer high quality USB 2.0 graphics connections, smooth 30 frames-per-second DVD playback, and VGA, DVI or direct flat panel interface options. The DL-120 will support resolutions up to 1.5 megapixels (including 1280x1024 and 1440x1050) and the DL-160 will support resolutions up to 2 megapixels (including 1600x1200 and 1680x1050). Both chips support up to 32-bit color at their highest resolution, and both are now in mass production.

	DL-120	DL-160
Target Market	Standard display users	Performance users
Video Output	VGA or DVI	VGA or DVI
FPI (LVDS)	✓	✓
USB 2.0	✓	✓
Maximum Resolution	SXGA (1280 x 1024) SXGA+ (1400 x 1050) [up to 1.5 megapixels]	UXGA (1600 x 1200) WSXGA+ (1680 x 1050) [up to 2 megapixels]
Color Depth	32 bit True Color	32 bit True Color
Availability	Now	Now

DisplayLink technology provides the flexibility to support the full range of multiple and remote monitor applications. Up to six USB-enabled monitors can be connected to a single notebook or desktop PC using DisplayLink technology. It is also offers dramatic simplicity - leveraging all the benefits of a USB connection with the intelligent software to deliver a consistent and high quality solution. Future products will support other high-speed networks and wireless protocols, opening up new applications in remote display and wireless monitor applications.

Conclusion

If multi-monitor computing is to be the next wave in productivity-boosting computing, then it must offer the same user experience as single-monitor computing. Interactivity response, image quality and ease-of-use are all essential elements in the user experience that must be combined to make the solution appropriate for the mainstream market of knowledge workers and business travellers.

USB 2.0, when paired with DisplayLink technology, is an ideal connection method for multiple monitor computing. DisplayLink allows for unparalleled ease of use, high image quality, and smooth DVD playback over a universal and easy to use USB connection. DisplayLink allows even notebook users to add up to six additional displays to their PC without complicated and expensive upgrade options and without having to open their PCs. This allows for a cost-effective roll-out to corporate employees, and an easy upgrade for home office users.

The DisplayLink technology breakthrough makes this performance a reality and the DL-120 and DL-160 makes this technology cost effective and practical notebook docking stations, USB monitor adapters, and USB-enabled monitors. DisplayLink allows manufacturers to deliver significant benefits of multi-monitor computing to come to every computer user.

1. "Double Your Fun With a Second Monitor," Tom Mainelli, PC World
2. "Two Screens Are Better Than One," Suzanne Ross, Microsoft Research
3. "The Multiple Display Market and Consumer Attitudes," Jon Peddie Research
4. "Productivity and Multi-Screen Computer Displays," Janet Colvin, Nancy Tobler, & James A. Anderson, Rocky Mountain Communication Review Volume 2:1, Summer, 2004

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DL-WP-USBM-0207.