Network display technology breaks through VGA/DVI limitations

By Jason Slaughter

Standard display interfaces such as VGA and DVI have been a good thing for the industry, allowing monitors to connect to computers quickly and easily. However, this 1:1 ratio of ports in close proximity is changing with the popularity of docking stations for laptops, multiple monitor configurations, and monitors physically separated from the computer. The next generation of USB display solutions shows potential for surmounting these new challenges.

GRAPHICS DISPLAY GLOSSARY	
DVI	Digital Visual Interface
HDMI	High-Definition Multimedia Interface
HRE	Hardware Rendering Engine
LCD	Liquid Crystal Display
LVDS	Low Voltage Differential SCSI
PAN	Personal Area Network
VGA	Video Graphics Array
VGC	Virtual Graphics Card

Since the development of the PC, developers have used graphics cards with VGA-like connectors as the primary means of connecting displays to host computers. Now, the industry is at a crossroads – one path is a continuation of this technology with DVI, DisplayPort, and HDMI; the other path is a new connectivity method that uses network display technology. Network displays use standard network interfaces – USB 2.0, Ethernet, Wi-Fi, Wireless UWB, and WiMedia – to connect displays to computers and offer new capabilities for small form factor designs and the rest of the computing industry.

Traditional display connector technology requires a dedicated graphics card for each display unless a costly multiheaded graphics card is used. Small form factor and notebook displays are even more limited in their display expansion possibilities because of space constraints. The cost and complexity of today's display connection technology has inhibited updates to multimonitor computing, despite the proven productivity benefits of using multiple monitors. The most promising possibility for bridging this complexity gap comes from display connections over Personal Area Networks (PANs). In a PAN configuration, displays are connected using point-to-point or close-range network technologies such as USB, Wireless USB, and WiMedia.

A market for secondary PC displays is emerging with new technologies such as DisplayLink's multimonitor solution, which can demonstrate up to six monitors attached to a PC through one USB 2.0 connection. Each USB 2.0 connected display can run its own application or extend the Windows desktop over six monitors (seven including a VGA-connected monitor). This configuration is ideal for increasing productivity through extended screen real estate or for monitoring separate applications across a virtual video wall of monitors. This technology furthers the growing secondary display market by allowing multiple monitors to be added economically without additional graphics cards. Elimination of the bulky VGA port and cable is an especially important feature for small form factors and notebook designs because the monitor can be connected through an existing USB port and displays can be daisy-chained up to 15 meters through USB 2.0 hubs using lightweight and inexpensive USB cables.

Network display technology takes off

The market for network display technology has recently gained momentum with the debut of second-generation USB 2.0 products with VGA-like image quality and DVD-quality video playback. This core technology has fueled the development of new products including USB-to-VGA dongles, universal notebook docking stations, and even USB-connected monitors such as the Samsung Ubisync 940UX. The market is poised for a slew of new capabilities, including wireless connectivity through Wireless USB and WiMedia using the same basic architecture.

This generation of network display technology overcomes the significant limitations of first-generation USB and Ethernet-connected displays. Until now, displays connected wirelessly or over USB 2.0 were marked by problems with poor display responsiveness to mouse and keyboard input, poor image quality, and no support for DVD video playback. Resolutions were frequently limited to 800 x 600 and only 16-bit color, resulting in a significantly inferior experience and quality to a standard VGA monitor.

When considering a second-generation USB display solution, developers should consider three key factors:

- **Display quality:** The optimal solution should support the ability to show smooth, full frame rate DVD-quality movies without ghosting or jittering playback. The technology should also offer resolution and color depth comparable to a high-quality VGA-connected display, meaning crisp graphics at 1600 x 1200 resolution and support for 32-bit true color.
- **Interactivity:** Screen response to mouse movements and input via the keyboard must be instantaneous, usually less than 5 ms over USB 2.0. Without an adequate real-time response, mouse movement and data input become cumbersome and divert attention from working to watching what appears on the screen to ensure tasks were done correctly.
- **Ease of use:** The product should support quick hot plugging and unplugging of displays through a simple USB cable, but ease of use should go a step beyond. While the VGA cable is relatively simple, intelligence is not built in. A USB-connected display can be smarter, which should be apparent in any second-generation display device. When connecting a new monitor, the optimal resolution should be

automatically selected based on the monitor's extended display identification data to ensure the best picture possible. When a device is unplugged, the windows on that screen should automatically return to the primary display, for instance, when a notebook PC is undocked. Most importantly, when plugging in a previously used USB monitor, the location of the monitor should return to wherever it was last used. For example, if a user has a USB docking station at home with a monitor to the right and two USB monitors at work on the left, these exact locations should be maintained when moving from one location to another. This allows for a significantly improved experience when moving locations, hot desking, or docking and undocking a notebook PC.

Resolving technical difficulties

The challenge 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. A high-resolution monitor requires several gigabits of data per second compared to USB 2.0, which offers a maximum of 400 Mbps of bandwidth, and Wireless USB or WiMedia, which offers a typical data rate anywhere from 70-400 Mbps depending on network conditions. Delivering a quality image across a standard network interface requires a very high-performance and low-latency compression algorithm to deliver the immense amount of image data across the more limited data links.

DisplayLink solves this challenge by taking a system-level approach with two major components: a software application that runs on the host PC called the *Virtual Graphics Card (VGC)* and a high-speed decoder chip on the display side called the *Hardware Rendering Engine (HRE),* shown in Figure 1.

The VGC is an application and driver installed on a host PC that converts the pixel stream into the lossless transport protocol and transports these frames across the network link. Nearly invisible to the user, this software is silently installed using Microsoft digitally signed drivers and runs in the background, allowing users to adjust 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 Windows 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 a 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, ensuring compatibility across a range of standard interfaces including Wireless USB.

The hardware component, the HRE, is a silicon chip that decodes the graphics stream into a pixel stream for display on a monitor. In a typical board design, the HRE is connected on the far side of the network interface, allowing it to be used over both wired and wireless networks. The chip also supports a keyboard, mouse, or touch-screen ports. The HRE can be used in a wide range of system designs, from USB docking stations to a Wireless USB or USB to VGA/DVI dongle. The HRE also can be embedded directly into a monitor or projector by connecting either through a monitor scaler or directly to the LCD panel or projector lamp through LVDS.

Most importantly, the VGC/HRE architecture makes the connection agnostic. While the primary target for secondary network displays today focuses on the USB 2.0 connection, the same architecture can be applied to alternative PAN interfaces including wireless. WiMedia is quickly becoming the preferred wireless standard for reliable point-to-point network connections, and the VGC/HRE technology has been demonstrated over Wireless USB with an underlying WiMedia connection. As WiMedia and Wireless USB interfaces become increasingly abundant, network displays will enable a wide range of new applications requiring wireless displays.

Making the link

This type of network display technology provides a COTS alternative to VGA/DVI technology when multiple monitors are needed or when the design must replace video, keyboard, and mouse ports with a single USB port. As PC/104 designs are often ruggedized or deployed in the field, attaching a VGA monitor can be inconvenient because of the fragile connector pins and thumbscrews on the connector.

Figure 1

A USB connection is a robust and easy connection method through a connector that is often already available.

Network display technology breaks the 1:1 computer-to-display barrier imposed by traditional display technology while at the same time meeting the important performance and image-quality metrics. USB connectors allow for an easier, cheaper, and quicker alternative for multiple monitor connections, and Wireless USB and WiMedia provide a path to wireless over the same basic architecture. As PC/104 systems evolve into data-intensive applications where display connectivity is important, network display solutions offer a good option that saves space and cost while maintaining great performance. ➤

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