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Enabling the Mobile HD Video Ecosystem

October 2010

Introduction

The mobile entertainment experience is evolving rapidly as the lines between smartphones, cameras, camcorders, and portable game devices increasingly blur and the platforms become ever-more capable and powerful. A growing number of mobile devices now support the recording and viewing of high-definition (HD) video content, offering new ways for consumers to experience and share mobile video; however, the small form-factor of the mobile device, while convenient, limits the quality of the HD viewing experience. To meet consumers' expectations for portability while providing the full HD experience, video and audio need to be optimized and easily available on either mobile devices or large-screen HDTVs – taking advantage of the best screen and sound available.

This whitepaper discusses how products from Silicon Image incorporate standards-based solutions to enable the connected mobile HD ecosystem.

Current Trends

The Rapid Evolution of Mobile Devices

According to market research firm Parks Associates, the number of smartphone users is expected to quadruple, exceeding 1 billion worldwide by 2014.¹ Increasing processing power, high-speed 3G and 4G networks, and the proliferation of full-fledged operating systems have transformed phones into powerful connected processing platforms.

Smartphones have become more entertaining to use as well as more practical for business, and are taking a central role in how consumers stay connected and productive. Other mobile devices have followed suit. Many cameras now include HD video recording, and some can upload photos wirelessly to the Internet. Tablets have been introduced with mobile broadband access that can browse the Internet anywhere there is cellular reception, and cameras are now built into many portable gaming devices.

In 2010, a number of smartphones were introduced with integrated 5- or 8-megapixel cameras and the ability to record 720p HD video. According to industry analysts at Forward Concepts, mobile phones with integrated cameras

will reach over 87 percent penetration by 2013.² The ability to seamlessly capture, edit, and view HD video is leading to an explosion in user generated content.

Media companies such as Netflix, Hulu, and YouTube have all developed applications that further extend their reach by making TV shows, movies and user generated content available on smartphones and tablets. Pyramid Research forecasts over 534 million mobile video subscribers worldwide by 2014 thanks to the rapidly improving video performance of mobile phones combined with the rise of “app stores”.³ This is creating yet another business model for mobile content discovery and consumption.

Since the introduction of DTVs, HD has become standard in the home. The mobile market is responding to consumers’ appetite for HD by providing more ways to create and consume HD content. The rapid pace of development in the mobile market requires solutions based on flexible, robust standards to support interoperability between mobile devices and the broader CE ecosystem.

¹ Parks Associates (March 23, 2010). “Number of smartphone users to quadruple, exceeding 1 billion worldwide by 2014”. Press release.
http://www.parksassociates.com/press/press_releases/2010/mar23-smartphone.html

² Forward Concepts Report #9030, Cellular Handset & Chip Markets, 2009.

³ Pyramid Research (June 4, 2009). “Mobile Video Service Subscriptions to Grow Five-Fold by 2014, Pyramid Research Says”. Press release.
http://www.pyramidresearch.com/pr_prlst/PR060409_VIDEO.htm

Industry Standards for Mobile Connectivity

Portable devices are now providing consumers with HD content; however the small form-factor of the mobile device, while convenient, limits the quality of the HD viewing experience. Small screen sizes offer reduced resolution, and the higher power requirement of HD can quickly drain battery life. To meet consumers' expectations for portability while providing the full HD experience, video and audio should be optimized and easily available on either mobile devices or large-screen HDTVs – taking advantage of the best screen and sound available.

Silicon Image is bringing its extensive experience and proven successes in developing digital connectivity technologies and products in the DTV, home theater, and personal computer spaces to the mobile market. Silicon Image has been active in the creation of industry standards and is a founding member of the HDMI[®] (High-Definition Multimedia Interface), MHL[™] (Mobile High-Definition Link), and SPMT[™] (Serial Port Memory Technology) standards organizations.

HDMI Solutions for Mobile Products

Since its introduction in 2003, HDMI has become the de facto worldwide standard for transmitting HD digital content, with over 1.5 billion HDMI products worldwide having been sold to date.

The HDMI Consortium now has over 1,000 licensed HDMI adopters who are expected to ship nearly 500 million HDMI-compliant products in 2010 alone. HDMI technology already connects a wide array of CE devices including set-top boxes, DVD players, Blu-ray Disc™ players, HD camcorders, desktops, video game consoles, A/V receivers, computer monitors, and televisions. A growing number of mobile devices including smartphones, cameras, camcorders, laptops, and netbooks also use HDMI to connect to HD home entertainment systems.

HDMI Founders include Hitachi, Ltd., Panasonic Corporation, Philips Consumer Electronics International B.V., Silicon Image, Inc., Sony Corporation, Technicolor S.A. (formerly known as Thomson), and Toshiba Corporation.

Silicon Image HDMI Transmitters for Mobile Products

Silicon Image's ultra-low-power HDMI transmitters with integrated HDCP enable consumers to share their user-generated and premium content securely in full high-definition quality on an HDTV. Resolutions from standard definition 480p to HD 720p, 1080i, and 1080p (the highest resolution supported by today's HDTVs) and all PC resolutions up to UXGA are supported.

The built-in Consumer Electronics Control (CEC) connection allows HDMI devices to control each other; it also allows the user to operate multiple devices with one remote control handset. Integrated hardware arbitration logic reduces local CPU overhead. Silicon Image's HDMI transmitters are suitable for mobile phones, cameras, personal media players, laptops, netbooks, and the emerging tablet market.

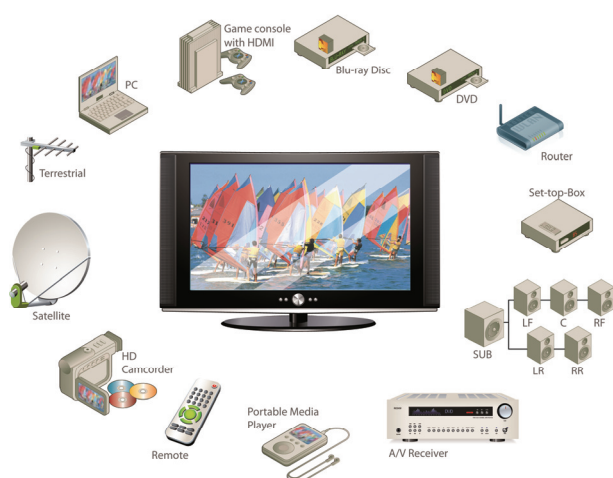


Figure 1: Multimedia devices

MHL (Mobile High-Definition Link)

Physical space on mobile devices is often extremely limited due to the small form factor. Mobile device manufacturers increasingly prefer to have a single connector that can accommodate power charging, data transfer, and video.

MHL is a low-pin count, high-definition audio and video interface for connecting portable electronics devices to HDTVs and other displays. MHL devices can output digital 1080p (full HD) resolution video and 8-channel audio while receiving continuous power from a display, charging the mobile device while connected. A control line allows remote control commands to be sent from the television to the phone, enabling users to directly control their content on the large screen. MHL supports all this functionality over a single cable with five wires, and can utilize existing connectors on the device.

The MHL Consortium was formed in April 2010 to oversee and administer the drafting, adoption, licensing, and promotion of the MHL Specification. The MHL Specification Version 1.0 was released in June 2010. MHL Consortium Promoters include Nokia Corporation, Samsung Electronics Co., Ltd., Silicon Image, Inc., Sony Corporation, and Toshiba Corporation.

Silicon Image MHL Solutions

MHL Transmitter

MHL transmitters from Silicon Image are designed for mobile devices, such as smartphones, outputting digital 1080p video and 8-channel digital audio in a low-

power, low-pin count package. Incorporating the latest generation of Transition Minimized Differential Signaling (TMDS) core technology allows MHL transmitters to connect either directly to MHL-enabled TVs or to non-MHL TVs using an MHL bridge.

MHL-enabled Port Processor

Port processors located inside the DTV intelligently manage multiple HDMI sources. Silicon Image's MHL-enabled port processors allow mobile devices with MHL to connect directly to the television.



Figure 2: MHL-enabled phone connecting to MHL-enabled HDTV

MHL Bridge (MHL-to-HDMI)

Silicon Image's MHL bridge device is a low-pin-count, low-power, MHL-to-HDMI bridge, designed for accessories such as docking stations, converters and adapters.

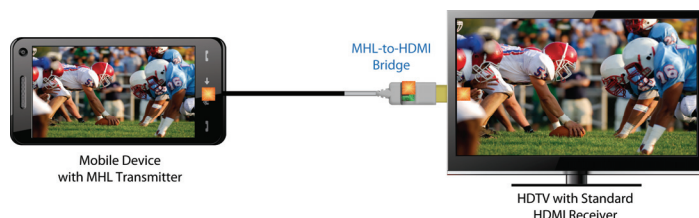


Figure 3: MHL transmitter, bridge and HDMI receiver implementation

Intellectual Property (IP) Cores for Mobile HD

Consumers are increasingly producing HD still and video content on their mobile devices. Silicon Image also provides IP solutions for integrating powerful camera functions into mobile devices.

camerIC-18

Mobile phones with integrated cameras are already packed with features that allow novices to shoot professional-looking pictures. Features such as auto white balance, auto focus, and auto exposure are necessities for digital cameras. Adding these features to mobile devices requires a camera pipeline architecture that can cope with both the bandwidth and processing power to accommodate higher CMOS sensor resolutions, new automated features, and 60 fps 1080p camcorder video streams. Achieving these objectives within the confines of mobile device cost, power consumption, and form factor requirements presents a formidable challenge.

The Silicon Image camerIC-18 IP core integrates into SoC applications to support both parallel and serial input interfaces to almost any CMOS sensor as well as several systems interfaces to the CPU and memory. camerIC-18 is designed for mobile devices such as phones, portable media players, netbook PCs, video camcorders, and still cameras. It features low power consumption, very low CPU overhead, and built-in image signal processing with image effects, stabilization, wide dynamic range, up to 18MP resolution, pixel correction and noise reduction, and various input/output

options for maximum connectivity. The camerIC IP core is the ideal solution for mobile device OEMs who want to deliver cutting-edge imaging capability within the constraints of cost, size, power consumption, and ease of integration.

SPMT (Serial Port Memory Technology)

Silicon Image is a founding member of the SPMT Consortium and a promoter of the emerging SPMT memory interface standard. Serial Port Memory Technology delivers next-generation memory performance to mobile and consumer electronics manufacturers seeking ways to satisfy the increasing consumer demand for media-rich features with lower pin counts, longer battery life, and reduced cost. SPMT addresses the memory requirements for mobile and CE devices.

DRAMs based on parallel interface technologies are rapidly exhausting their ability to meet these new demands due to pin count constraints, as well as performance and power limitations. In order to meet future mobile requirements, a new type of memory is required that takes DRAM performance to a new level.

SPMT with SerialSwitch™ technology features a memory interface architecture that employs both serial and parallel interfaces that offer the best of both worlds: the low start-up latency and low power consumption in low-bandwidth environments of a parallel interface combined with the ultra-high performance, low pin count, and low power in high-bandwidth environments of a serial interface. Serial Port Memory Technology delivers four times the bandwidth pin-for-pin at half the power of existing memory solutions, and enables smooth, low-cost migration from parallel to serial memories.

The SPMT Consortium was formed in May 2009. The organization's founding members define and implement Serial Port Memory Technology for broad market adoption as an industry standard memory interface. The Consortium released the SPMT Specification with SerialSwitch technology in June 2010. SPMT Consortium Promoters include ARM, Hynix Semiconductor, Inc., LG Electronics, Marvell, Samsung Electronics Co., Ltd., and Silicon Image, Inc.

A Complete Mobile Connectivity Solution

Silicon Image's commitment to advancing mobile connectivity through industry standards facilitates broad adoption and wide interoperability of its solutions throughout the CE space. By enabling a full mobile HD ecosystem with transmitters, bridges, and port processors, Silicon Image is making MHL technology instantly accessible to a wide audience. By leveraging its expertise in DTV connectivity and with its market leading port processors, Silicon Image can quickly enable DTVs to natively support both HDMI and MHL.

Silicon Image is providing a complete end-to-end HD solution for mobile devices that delivers the "must have" features and performance benefits required by today's consumers.

- ♦ HDMI transmitters for mobile devices allow consumers to connect their mobile devices to large-screen HDTVs and home entertainment systems to view their personal or premium HD content in its original quality.
- ♦ MHL-enabled transmitters, bridges, and port processors enable mobile devices and DTVs to deliver HD content while also charging the mobile device over a single five-wire cable.
- ♦ camerIC-I8 IP core brings true HD imaging and video capability combined with advanced image processing and effects capabilities to mobile devices, allowing consumers to create personal true-HD content anytime they like.

- ♦ Serial Port Memory Technology delivers an industry standard memory interface capable of delivering the bandwidth flexibility, scalability, reduced pin count, and low power required by future generations of consumer electronics and mobile devices.



Figure 4: End-to-end HD solution for mobile applications

Silicon Image is bringing its proven experience in HD connectivity to the mobile market. As devices continue to evolve and grow ever more capable, standards-based solutions from Silicon Image will ensure that they are able to connect to the broadest mobile HD video ecosystem.

Learn More

For more information about Silicon Image semiconductor products and IP offerings, visit www.siliconimage.com.

For more information about HDMI LLC, MHL LLC and SPMT LLC, visit the respective Consortium websites:

- ♦ www.hdmi.org
- ♦ www.mhlconsortium.org
- ♦ www.spmt.org

About Silicon Image, Inc.

Silicon Image is a leading provider of advanced, interoperable connectivity solutions that enable the reliable distribution and presentation of high-definition (HD) content for consumer electronics, mobile, and PC markets. The company delivers its technology via semiconductor and intellectual property (IP) products that are compliant with global industry standards and also feature industry leading Silicon Image innovations such as InstaPort™. Silicon Image's products are deployed by the world's leading electronics manufacturers in devices such as desktop and notebook PCs, DTVs, Blu-Ray Disc™ players, audio-video receivers, as well as mobile phones, tablets, and digital cameras. Silicon Image has driven the creation of the highly-successful HDMI® and DVI™ industry standards, as well as the latest standards for mobile devices - SPMT™ (Serial Port Memory Technology) and MHL™ (Mobile High-Definition Link). Via its wholly-owned subsidiary, Simplay Labs, Silicon Image offers manufacturers comprehensive standards interoperability and compliance testing services.

