Implementing Multiple Displays with IEGD Multi-GPU - Multi-Monitor Mode on Intel® Atom™ Processor with Intel® System Controller Hub US15W Chipset

White Paper

December, 2010
Executive Summary

This white paper serves as a complement to the Hybrid Multi-monitor Support Enabling new usage models for Intel® Embedded Platforms white paper published previously. Readers are urged to download and review the document found here: http://edc.intel.com/Link.aspx?id=3105.

Beginning with Intel® Embedded Graphics Drivers version 10.3.1 Multi-GPU - Multi-Monitor Mode (formerly known as Hybrid Multi-monitor) is an officially supported and validated graphics feature for platforms based on the Intel® Atom™ processor +Intel® System Controller Hub US15W graphics chipset. In conjunction with the IEGD 10.4 release, not yet available by this document's publication time, the Intel® Embedded Graphics Drivers, EFI Video Driver, and Video BIOS User Guide will include a Multi-GPU - Multi-Monitor Mode section containing additional technical details of this feature.
Implementing Multiple Displays with IEGD Multi-GPU - Multi-Monitor Mode on Intel® Atom™ Processor with Intel® System Controller Hub US15W Chipset

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Background

Official support of this feature lets customers increase the total number of simultaneously displayed outputs from their Intel® Atom™ Z5xx processor with Intel® System Controller Hub US15W-based platforms from two, to three or more. The first two outputs come from the US15W's internal LVDS and SDVO ports while additional outputs (and whether they are DVI, VGA, TV out, or DisplayPort) come from an external graphics card.

Prerequisites:

- Intel recommends using Windows* XP with latest Service Pack 3 (SP3) updates installed. Linux* Xinerama was not tested by Intel for Multi-GPU Multi Monitor mode functionality but it is expected to operate properly with correct configuration of Linux. OEMs/ODMs are welcome to attempt enabling of Multi-GPU - Multi-Monitor Mode on their US15W-based Linux platform.

- Ensure that at least 2 MB of DDR2-667 or DDR2-800 main memory is shipped within the US15W-based Multi-GPU - Multi-Monitor platform.

Customers can achieve additional transmission of unique display timings and display outputs to additional panels or monitors from the graphics card simultaneously with the US15W’s internal graphics using the steps below.

1. Choose a third-party graphics card successfully tested previously by Intel that uses a PCIe x1 port as a digital graphics interface. (See “Graphics Cards used for IEGD Multi-GPU - Multi-Monitor Mode Verification” on page 16.)

   Note: Selection of a graphics card not tested by Intel is acceptable so long as the Recommended Specifications described in Table 1 are met and thorough validation testing is done on the selected card within the Atom+US15W-based customer production system.

2. Plug in a verified, external, PCIe-compatible graphics card to the US15W platform’s PCIe x1 slot.

3. Install the IEGD 10.3.1 version 1550 graphics driver.

4. Select the special system BIOS or BIOS settings that enables the US15W’s PCIe port even when internal display outputs from US15W are operating.

5. Install the selected third-party graphics card’s driver that is no older than the driver version recommended in this document. For the latest driver, visit the graphics card manufacturer website.

6. Use the Windows* XP SP3 operating system display settings and sub-pages described later in this document to configure the resolution and ordering of the additional displays.
Tested Usage Models

Depending on the external graphics card’s capability, up to six display outputs can be transmitted simultaneously: two from the US15W via IEGD and up to four from the graphics card via its graphics driver.

Two usage models were comprehensively tested internally by Intel and are described as follows:

1. Usage Model #1:
   - Internal LVDS
   - Internal SDVO
   - External PCIe x1 graphics card:
     - Display Output #1 (VGA/DVI/HDMI/DisplayPort/TVOut)
     - Display Output #2 (VGA/DVI/HDMI/DisplayPort/TVOut)

2. Usage Model #2:
   - Internal LVDS
   - Internal SDVO
   - External PCIe x1 graphics card:
     - Display output VGA #1
     - Display output VGA #2
     - Display output VGA #3
     - Display output VGA #4

Usage Models #1 and #2 were both successfully tested by Intel internally to ensure Multi-GPU - Multi-Monitor Mode operates correctly. ODMs/OEMs are encouraged to configure their US15W production platforms to replicate the following configurations accordingly.
Usage Model #1: Four display outputs operating simultaneously in Multi-GPU - Multi-Monitor Mode

Output #1: LVDS from US15W

Output #2: LVDS/DVI/VGA/TV Out from US15W’s SDVO port via Chrontel or Silicon Image SDVO Conversion device, shown in green in Figure 1.

To obtain desired display output #2, choose from any of these SDVO devices:

- Chrontel CH7307* (DVI out),
- CH7308* (LVDS out),
- CH7315* (HDMI out),
- CH7317* (analog RGB VGA),
- CH7022* (Standard Definition NTSC/PAL and HDTV YPBPR 480p, 576p, 720p, 1080i and 1080p),
- CH7019* (dual-port DVI with HDCP),
- CH7320* (dual-port DVI)* or
- Silicon Image* SiI 1362 (DVI out without EEPROM interface; motherboard applications), SiI 1364 (DVI out with EEPROM interface (ADD2 card applications)).

Output #3: VGA/DVI-D from ATI*/Matrox*/NVIDIA* PCIe x1 Graphics Card

Output #4: VGA/DVI-D from ATI/Matrox/NVIDIA PCIe x1 Graphics Card

Figure 1. Illustration of Usage Model #1
Figure 2. Windows* XP Device Manager page - Usage Model #1 enabled with NVIDIA* Quadro* NVS 290 card
Figure 3. Windows* XP Device Manager page - Usage Model #1 enabled with AMD*-ATI* FireMV 2260 card
Usage Model #1 Results and Options

- Intel has successfully generated 2D and 3D graphics displays with this usage model at 1920x1080@60 Hz resolution for outputs #2 - #4. The LVDS output was also tested at 1024x768@60 Hz.

- All four monitors will have independent display images and timings on them only when Windows XP Extended mode is selected via Desktop Display Properties and after both IEGD and the graphics card’s driver are properly installed. The user can then switch to Extended Mode and configure which display is the Primary display and the layout of the displays via the Desktop Display Properties→Settings tab’s options.

- Mixed (Clone + Extended) display is possible. To clone Output #1 and Output #2, so each has the same display image and timing, go to Display Properties→Settings→Advanced→Display Config (IEGD) and choose “Clone.” Output #3 and Output #4, both controlled by the graphics card, will each have independent display images and timings as extensions from the cloned Output #1 and Output #2. Be sure that Display Properties→Settings shows the “Extend my windows desktop” check box as selected for Output #3 and Output #4. These check boxes on the Primary display will be unavailable (“grayed out”). The check box in the display layout area of the Primary display’s clone will also be unavailable.

- Switching off any of the four monitors is possible. This is controlled in Windows XP via the “Single” selection in the Display Properties→Settings→Advanced→Display Config page. Intel recommends the ODM/OEM create a dedicated application to avoid the need for a system restart for this purpose. (See “Usage Model #1 Limitations and Operating System considerations” on page 10).

Usage Model #1 Limitations and Operating System considerations

- **Lack of Hardware acceleration during video playback**: Intel’s testing has shown that hardware acceleration during video playback is not enabled with IEGD 10.3.1 on the current Windows Media Player (version 11 or 12) or on CyberLink* PowerDVD 10 player. There may be more information in a Specification Update. See a current copy for possible details.

H.264/VC-1/MPEG-2 HD video content via Output #1 and Output #2 will be played back using the CPU as the main decode engine. This manner of software video decoding consumes significantly more CPU bandwidth than using the US15W’s hardware for acceleration. As a result, customers deploying systems resembling Usage Model #1 are advised to limit video clips to bit rates of 10 Mbps and less and frame size to 720p and under on all four display outputs. This will ensure sufficient CPU utilization exists to play smoothly all four video streams simultaneously.
IEGD

- **Insufficient CPU bandwidth to support any 1080p and 1080i video decoding:** Due to lack of hardware acceleration support for US15W under IEGD in these tested players: CyberLink Power DVD (versions 8 and 10), Windows Media Player (version 11 or 12), and VLC Open Source Multimedia Framework and Player, 1080p and 1080i clips cannot be played back under Multi-GPU - Multi-Monitor Mode.

- **Smooth 720p or 360p video clip playback simultaneously on two or more display outputs may not be possible** – Intel’s internal testing has shown that while decoding a single 720p clip with Windows Media Player and PowerDVD8/10, the Atom Z530’s average CPU Utilization percentage resides between 15% with hardware video acceleration on to 50% for 720p content decoded without HWVA on. Playing more than a single 360p or 720p clip will be dependent on a number of factors including whether HWVA is on and if so, how many clips are being accelerated; the video player capabilities; and the amount and speed of main memory. The OEM/ODM must test on their US15W-/IEGD-based prototype how many 720p/360p clips can be played back smoothly at the same time. If software decoding is used for any of the clips, expect that no more than two 720p clips can be played back simultaneously.

- **Display Mode Switching:** Switching from Extended mode to Clone mode or vice versa and/or disabling one or more display outputs via the Display Properties ➔ Settings ➔ Advanced ➔ Display Config page typically requires a system restart under Windows XP SP3. To work around this inconsistency, a simple application could be generated to handle any switching which would occur and not rely on Windows XP to handle these scenarios. Alternatively, the application could make sure the system is restarted automatically by Windows XP when the end user switches using the IEGD Escape API. Intel has created IEGDGUI, an application for this purpose. Request this application or guidance on how to create a suitable mode-switching production application from your local Intel salesperson or FAE.

*Note:* IEGDGUI is based on IEGDInfo and that uses all the escapes found in the API.
Usage Model #2: Six display outputs operating simultaneously in Multi-GPU Multi-Monitor Mode
(two internal, LVDS + DVI; four external VGA)

Output #1 – LVDS from US15W

Output #2 – LVDS/DVI/VGA/TV Out from US15W’s SDVO port via Chrontel or Silicon Image SDVO Conversion device, shown in green in Figure 4. To obtain desired display output #2, choose from any of these SDVO devices:

- Chrontel CH7307* (DVI out),
- CH7308* (LVDS),
- CH7315* (HDMI),
- CH7317,* CH7022* (VGA),
- CH7019,* CH7320* or Silicon Image: Sil 1362* and Sil 1364* (DVI out)

Output #3: Matrox PCIe x1 M9120-E512LAU1F Graphics Card
Output #4: Matrox PCIe x1 M9120-E512LAU1F Graphics Card
Output #5: Matrox PCIe x1 M9120-E512LAU1F Graphics Card
Output #6: Matrox PCIe x1 M9120-E512LAU1F Graphics Card

Figure 4. Illustration of Usage Model #2
Usage Model #2 Results and Options

- Intel has successfully generated 2D and 3D graphics displays with this usage model at 1920x1080@60 Hz resolution for outputs #2 - #6. The LVDS output was also tested at 1024x768@60 Hz.

- All six monitors will have independent display images and timings on them only when Windows XP Extended mode is selected via Display Properties and after both IEGD and the Matrox M9120 graphics card’s driver are properly installed. The user can then switch into Extended Mode via the Display Properties→Settings page and configure which display is the Primary display and the layout of the displays via the Desktop Display Properties→Settings tab's options.

- After the Multi-GPU - Multi-Monitor Mode Usage Model #2 is enabled with IEGD on a platform based on the Intel® Atom™ Processor and Intel® System Controller Hub US15W chipset, the Display Properties page under Windows XP will look like Figure 5.

Figure 5. Windows XP Display Properties page - Usage Model #2 enabled with Matrox* M9120 Plus LP card
• Switching off any of the six monitors is possible. This is controlled in Windows XP via the “Single” selection in the Display Properties→Settings→Advanced→Display Config page. Intel recommends the ODM/OEM create a dedicated application to avoid the need for a system restart for this purpose. See Usage Model #2 Limitations and Operating System considerations.

Usage Model #2 Limitations and Operating System considerations

• Lack of Hardware acceleration during video playback: Intel’s testing has shown that hardware acceleration during video playback with this usage mode does not exist for Outputs #1 and #2. Furthermore, video acceleration from the Matrox GPU and hardware is limited to at most one stream, forcing the other three outputs from the M9120 to rely on limited Atom Z5xx CPU cycles to perform software video decoding.

• Smooth 720p or 360p video clip playback simultaneously on two or more display outputs may not be possible – Intel’s internal testing has shown that while decoding a single 720p clip with Windows Media Player and PowerDVD8/10, the Atom Z530’s average CPU Utilization percentage resides between 15% (with hardware video acceleration on) to 50% (without HWVA on). Playing more than a single 360p or 720p clip will be dependent on number of factors including whether HWVA is on and if so, how many clips are being accelerated; the video player capabilities; and the amount and speed of main memory. The OEM/ODM must test on their US15W-/IEGD-based prototype how many 720p/360p clips can be played back smoothly at the same time. If software decoding is used for any of the clips, expect that no more than two 720p clips can be played back simultaneously. ODMs/OEMs intending to deploy a US15W-based system into production with video playback are urged to test their chosen video player and overall system video playback capabilities when all > 2 displays are decoding video streams simultaneously. Intel’s testing has shown 480i and 360p video streams to decode satisfactorily with two and four outputs running, however, clips of more than 10 Mbps and/or 720p and higher bandwidths or frame sizes are not recommended.

• Insufficient CPU bandwidth to support any 1080p and 1080i video decoding: Any high definition output requires significant Atom processor CPU utilization. The lack of video hardware acceleration coupled with finite CPU bandwidth makes smooth decoding of even a single 1080i and 1080p content object impossible under this usage model.
Maximum monitor resolutions tested and supported by IEGD – US15W in Multi-Monitor Mode

- **US15W’s LVDS**: 1024x768 @ 60 Hz = maximum panel resolution tested and supported LVDS port limited to 112 MHz maximum pixel rate which equates to 1366x768@60 Hz

- **US15W SDVO to Analog VGA**: 1920x1200 @ 60 Hz = maximum monitor resolution tested and supported. SDVO port maximum pixel rate is 160 MHz. 1920x1080 @ 60 Hz successfully tested as well.

- **US15W SDVO to Digital DVI-D**: 1920x1200 @ 60 Hz = maximum monitor resolution tested and supported. SDVO port maximum pixel rate is 160 MHz. 1920x1080 @ 60 Hz successfully tested as well.

- **Third-party Graphics Card Analog VGA**: 1920x1200 at 60 Hz = maximum monitor resolution tested and supported. SDVO port maximum pixel rate is 160 MHz. 1920x1080 @ 60 Hz successfully tested as well.

- **Third-party Graphics Card DVI-D**: 1920x1200 @ 60 Hz = maximum monitor resolution tested and supported. SDVO port maximum pixel rate is 160 MHz. 1920x1080 @ 60 Hz successfully tested as well.
Based on successful testing results, Intel recommends using the following PCIe x1 graphics cards in customer platforms based on the Atom + US15W to enable use of Multi-GPU - Multi-Monitor Mode.

**Matrox M9120 Plus LP PCIe x1 Video Card: Enables Usage Model #1 or Usage Model #2**

- **Mfg. Part:** M9120-E512LAU1F
- **Description:** PCI Express x1, DDR2 SDRAM, Matrox GPU, 512 MB installed, 1920 x 1200 maximum digital resolution, 2048 x 1536 maximum analog resolution, two monitors (DVI-I or VGA (HD15)) supported or four monitors (4 X VGA (HD15)) supported depending on the adapter chosen
- **Driver version tested:** 1.2.4.11 (Date 9/16/2009)
- **Additional Display Cables Needed:**
  - For **Usage Model #1** (four display outputs simultaneously), the ODM/OEM does not need to order any additional display cable or adapter
  - For **Usage Model #2** (six display outputs simultaneously), the ODM/OEM must order the **Matrox 60 pin LFH (M) - HD-15 (F)** display cable which takes a proprietary 60 pin graphics output from the M9120 Plus LP Video Card and converts that to four independent VGA analog outputs

**NVIDIA Quadro NVS 290 Video Card: Enables Usage Model #1 only**

- **Mfg. Part:** VCQ290NVS-PCIX1PB
- **Description:** PCI Express x1, DDR2 SDRAM, NVIDIA GPU, 256 MB installed, 64-bit bus width, 2048 x 1536 maximum analog resolution, 1920 x 1200 max digital resolution, two monitors (DVI-I or VGA (HD15)) supported
- **Driver version tested:** 6.14.12.5981 (Date 9/26/2010)
ATI FireMV 2260 PCI Express Video Card: Enables Usage Model #1 only

- Mfg. Part: 100-505527
- Description: PCI Express x1, DDR2 SDRAM, ATI GPU, 256 MB installed, 2560 x 1600 maximum Display Port resolution, 1920 x 1200 max DVI-D resolution, two (Display Port or DVI-D) monitors (DVI-I or VGA (HD15)) supported
- Driver version tested: 8.475.0.0 (Date 3/18/2008)
- This graphics card includes DisplayPort outputs.

Other PCIe compatible graphics cards may be suitable for generation of Multi-GPU - Multi-Monitor Mode in an Intel US15W IEGD-based platform. ODMs/OEMs that do not want to use the three recommended graphics cards mentioned in this document may acquire another third-party graphics card and perform functional testing and validation on their system using US15W and IEGD. Make sure the chosen graphics cards meet the minimum set of technical specifications described in Table 1.

Table 1. Minimum Recommended Specifications for PCIe Graphics Card to Enable IEGD Multi-GPU - Multi-Monitor Mode on US15W Platform

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<th>Slot Required</th>
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<td>Installed Size</td>
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<td>Technology</td>
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<tr>
<td></td>
<td>DDR3</td>
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<table>
<thead>
<tr>
<th>Video Output</th>
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</thead>
<tbody>
<tr>
<td>Maximum Displays Supported</td>
<td>1 to 6</td>
</tr>
<tr>
<td>Maximum Resolution</td>
<td>2048 x 1536</td>
</tr>
<tr>
<td></td>
<td>1280 x 720</td>
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</tbody>
</table>

<table>
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<tr>
<th>System Requirements</th>
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<tbody>
<tr>
<td>Operating System</td>
<td>Microsoft Windows Vista, Microsoft Windows XP, Linux</td>
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<tr>
<td>Recommended Power Supply</td>
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<td>RAM Size for Main Board</td>
<td>2 GB</td>
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<td>Open Hard Drive Space</td>
<td>50 MB</td>
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<tr>
<td>Processor Type</td>
<td>Atom Z520</td>
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<td></td>
<td>Atom Z530</td>
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</tbody>
</table>

Authors
Chris Wojslaw is a Lead Technical Marketing Engineer with Embedded and Communications Group (ECG) at Intel Corporation.
Kirk Blum is Graphics Solution Architect with Embedded and Communications Group (ECG) at Intel Corporation.
Contributor
Larry Reznick is a contingent Technical Marketing/Applications Engineer with Embedded and Communications Group (ECG) at Intel Corporation.

Acronyms
Atom E6xx Intel® Atom™ Processor E6xx
FAE Field Applications Engineer
GPU Graphics Processing Unit
HWVA Hardware video acceleration
IEGD Intel® Embedded Graphic Drivers
ODM Original Design Manufacturers
OEM Original Equipment Manufacturer
US15W Intel® System Controller Hub US15W