



Creating and Optimizing OpenCL* Applications with Intel OpenCL Tools

Webinar #3 in the
Three-part OpenCL Webinar Series

July 25, 2012

All Webinars in the Series Will be Available Online



- Watch all webinars online (will be uploaded soon)
 - July 11 - [Getting Started with Intel® SDK for OpenCL Applications](#)
 - July 18 - [Writing Efficient Code for OpenCL Applications](#)
 - July 25 - [Creating and Optimizing OpenCL Applications](#)
- Meet us at **SIGGRAPH 2012**:
 - August 5-9 | Los Angeles, California | Los Angeles Convention Center

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About the Presenters



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Intel® SDK for OpenCL® Applications 2012



SDK Package

Development Environment

- Supports Both CPU and Intel HD Graphics

Development Tools

- Offline Compiler *Updated!*
- Kernel Builder *New!*
- CPU Kernel Debugger *Updated!*

Documentation and Samples

- Getting Started guide
- Optimization Guide

Drivers and Support

Runtime/Drivers

- Intel® HD Graphics Driver with support for both CPU and Graphics
- Intel® SDK for OpenCL® – CPU only runtime package 2012

Online Resources

- Code Samples
- Support Forum
- Tech Articles, and more.

Optimization Tools

- Intel® VTune™ Amplifier XE *Updated!*
- Intel® Graphics Performance Analyzers (Intel® GPA)

Intel SDK for OpenCL Applications 2012 Makes Development Faster and Easier

Contents

- **Developing an OpenCL® Application Workflow**
- **Intel® SDK for OpenCL® Applications 2012 Tools Overview**
 - Offline Compiler, Kernel Builder, Kernel Debugger
- **Tuning with Intel® Graphics Performance Analyzers (Intel® GPA)**
- **Tuning with Intel® VTune™ Amplifier XE**
 - Presenter: Alexei Alexandrov

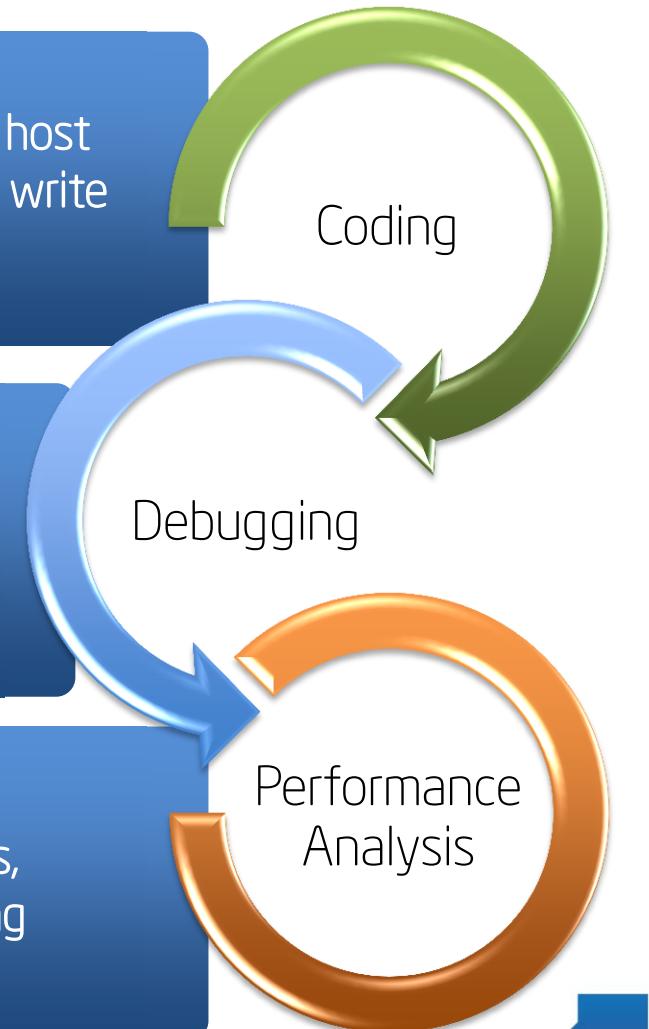
Developing an OpenCL® Application Workflow



Begin the coding phase of the OpenCL® kernels and application's host development – select data types, maximizing memory efficiency, write code that is highly parallel, etc.

Debug your kernels to verify code correctness and proper memory interactions between host/OpenCL devices and other content and to facilitate proper handling of data.

Perform API tracing and hotspots analysis to identify bottlenecks, analyze the heavy kernels performance through sampling profiling

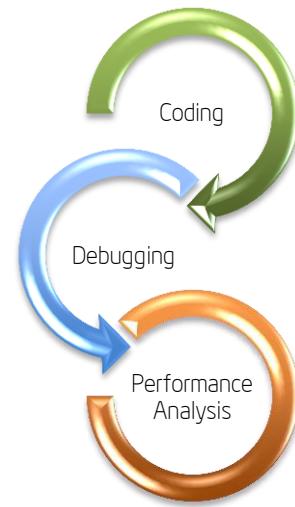


Using Intel® SDK for OpenCL® Applications 2012

Tools for Effective Programming



A Comprehensive Environment for the Build, Debug, and Tune Stages of OpenCL Applications



Tool Name	Used for	Included with the SDK for OpenCL	Supported devices and operating systems:		
			Windows* OSs		Linux* OSs
			CPU	GPU	CPU
Kernel Builder (Standalone) - With Offline Compiler features	Create and Build				
Offline Compiler (Microsoft Visual Studio* plug-in)	Create and Build				
Step by Step Kernel Debugger	Debug				
Intel® VTune™ Amplifier XE	Tune	For purchase on intel.com			
Intel® GPA System Analyzers	Tune	For free download on intel.com			
Intel® GPA Platform Analyzers with OpenCL Traces Views	Tune	For free download on intel.com			

- The Intel® VTune™ Amplifier XE 2011 is available for download at <http://software.intel.com/en-us/articles/intel-vtune-amplifier-xe/>
- Intel® Graphics Performance Analyzers 2012 (Intel® GPA) is available as a free download at www.intel.com/software/gpa
- New features to be available in next SDK releases

Code Samples

Source code examples, accompanied with whitepapers to aid you in coding with Intel® SDK for OpenCL® Applications 2012

The screenshot shows the Intel Visual Computing Source website's samples section. The left sidebar includes links for Dashboard, Samples, Learn, Tools, Forums, Blogs, Research, and Intel AppUp. The main content area displays several sample cards:

- Graphics Tech Samples**: 0 ITEMS
- Product Samples**: 10 ITEMS
- Sample for HDR Rendering with God Rays Using OpenCL®***: Visually demonstrates how to use develop an HDR rendering / god rays (crepuscular rays) effect with OpenCL®.
- Bitonic Sorting Sample**: OpenCL®-based command line application that illustrates how to develop a bitonic sorting algorithm.
- Sample for Median Filtering Using OpenCL®***: OpenCL®-based command line application that illustrates how to develop a median filter algorithm.
- Sample for HDR Tone Mapping Using OpenCL®**: Visually demonstrates how to use OpenCL®. Based on the advanced tone mapping developed by the OpenEXR® community.

- Available with different level of complexity
 - Novice, Intermediate, Advanced
- Target both CPU and Intel® HD Graphics
- Support different domains
 - Media,
 - Graphics
 - Compute
- Available for download in 2 options
 - Separate package per sample
 - One package for all samples

software.intel.com/en-us/articles/vcsource-samples/

Kernel Builder

OpenCL® Kernels Design and Optimization Tool



The screenshot shows the Intel SDK for OpenCL Kernel Builder interface. It includes:

- A code editor window showing C++ OpenCL kernel source code.
- An execution details window showing measurements, revision numbers, and execution times.
- A performance analysis window showing a timeline of argument handling.
- A build/compile options dialog.
- A device selection dialog.
- A system information window showing platform details.
- The Intel Kernel Builder logo at the bottom.

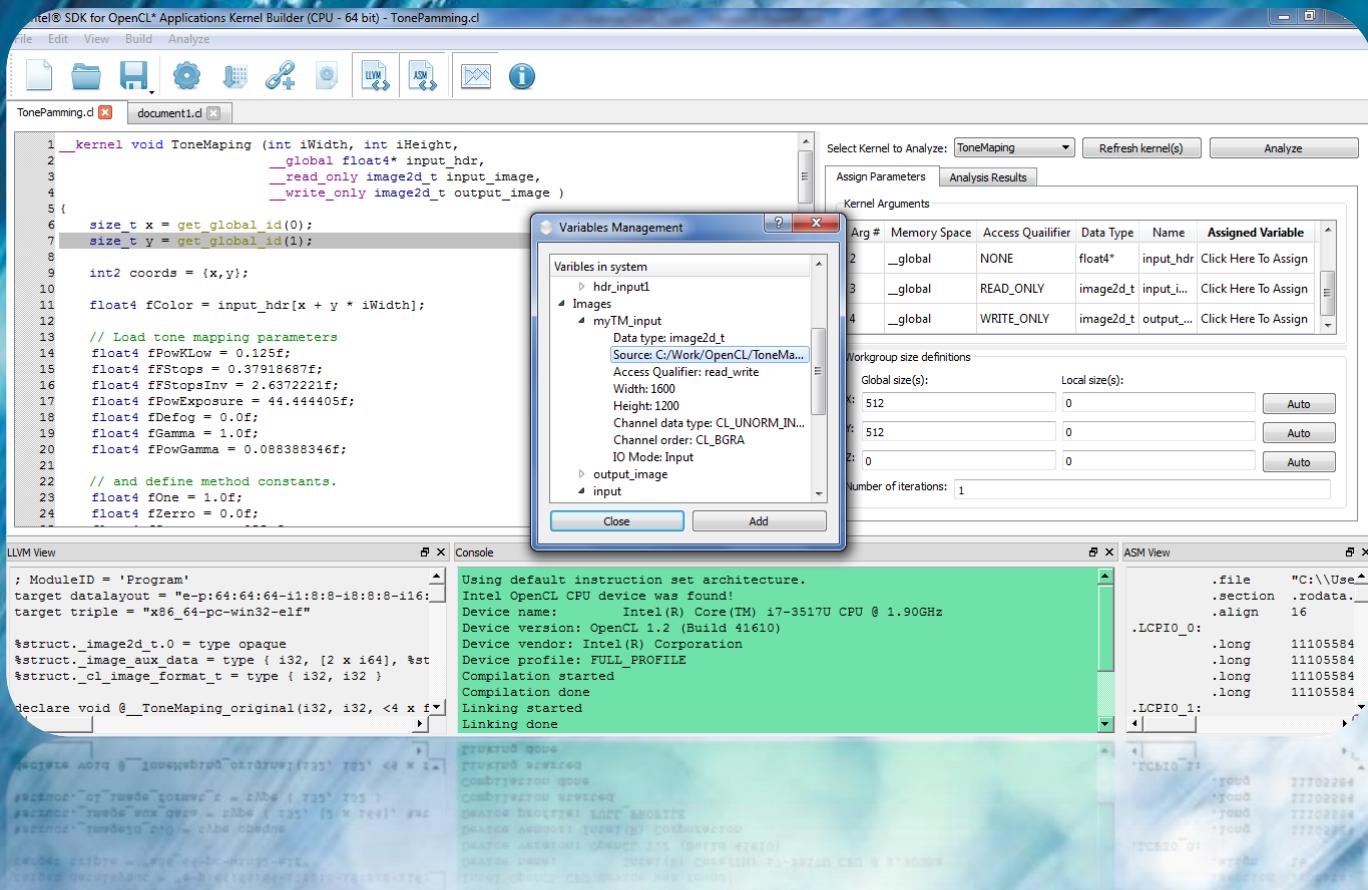
- Offline Compiler with Separate compilation and linking support (OpenCL 1.2 feature)
- Supports future Intel® CPU architectures (Advanced Vector Extension 2)
- Assign variables to the kernel and test its correctness
- Analyze kernel performance based on:
 - group sizes
 - Optimization build options
 - device used

Easy development of OpenCL Kernels for the CPU and Intel® HD Graphics

* New features to be available in next SDK releases

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Kernel Builder Demo



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The Intel® SDK for OpenCL® - Offline Compiler



Full offline OpenCL Language Compilation

The screenshot shows the Intel® SDK for OpenCL® Offline Compiler interface. On the left, there is an 'OpenCL Code' editor window displaying C++ code for a 'Crop' operation. On the right, there is an 'Assembly View' window showing the generated assembly code for the same operation. Below these windows, there is a 'Debug' window showing the command-line build process for 'DCT' and 'DCTd' projects. The 'DCT' project is built successfully, while 'DCTd' is still building. At the bottom, there is a 'Memory' dump window showing memory contents for variables like 'groupIdx', 'temp', and 'i1'.

- OpenCL syntax checker
- Cross-hardware compilation support
- Low Level Virtual Machine (LLVM) viewer
- Assembly language viewer
- Intermediate program binaries generator.
- Microsoft Visual Studio® Integration
 - syntax highlighting
 - project wizards.

Easy development of OpenCL Kernels for the CPU and Intel® HD Graphics

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The Intel® SDK for OpenCL® - Debugger (Windows)

Step-by-Step Debugging Capabilities for OpenCL Kernels on the CPU with Microsoft® Visual Studio



The screenshot shows the Microsoft Visual Studio interface with the 'DCT (Debugging)' project selected. The 'DCT.cpp' file is open, displaying the OpenCL DCT kernel code. A 'Watch 1' window is visible at the bottom, showing variable values for 'groupIdx', 'groupIdx', 's0', 'temp', 's1', 's2', 's3', 's4', 's5', 's6', and 's7'. An 'OpenCL Debug Configuration' dialog box is also visible, with the 'Enable OpenCL Kernel Debugging' checkbox checked.

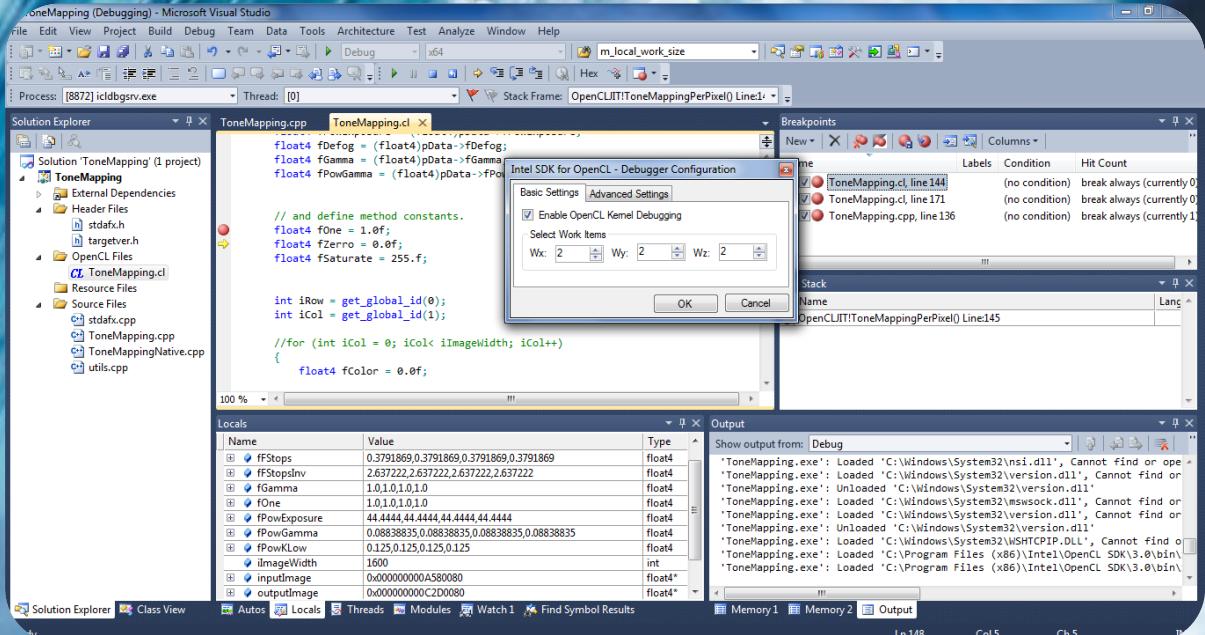
The screenshot shows the Microsoft Visual Studio interface with the 'DCT (Debugging)' project selected. The 'Call Stack', 'Breakpoints', and 'Output' windows are visible at the bottom of the IDE.

- Steps into OpenCL kernels running on the CPU.
- A Microsoft Visual Studio® plug-in
- Supports existing debugging windows
 - Breakpoints
 - Memory view
 - Watch variables – including OpenCL types like float4, int4, etc.
 - Call stack
 - Auto and local variables views

Debug OpenCL Kernels on the CPU first. Target kernels to the execution device when code development is done.



Offline Compiler & Debugger Demo



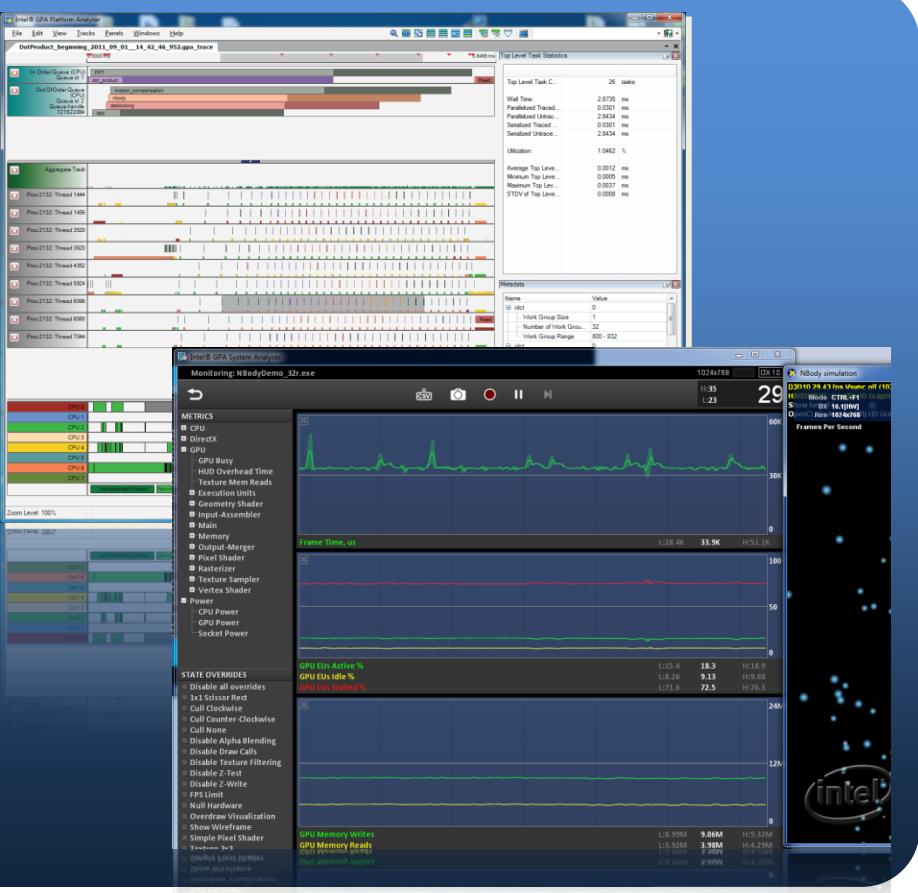
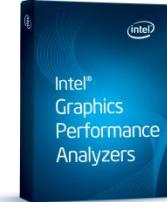
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Intel® SDK for OpenCL® Applications 2012 and Intel® Graphics Performance Analyzers

Trace OpenCL Commands with Intel® Graphics Performance Analyzers (Intel® GPA)



Platform Analyzer

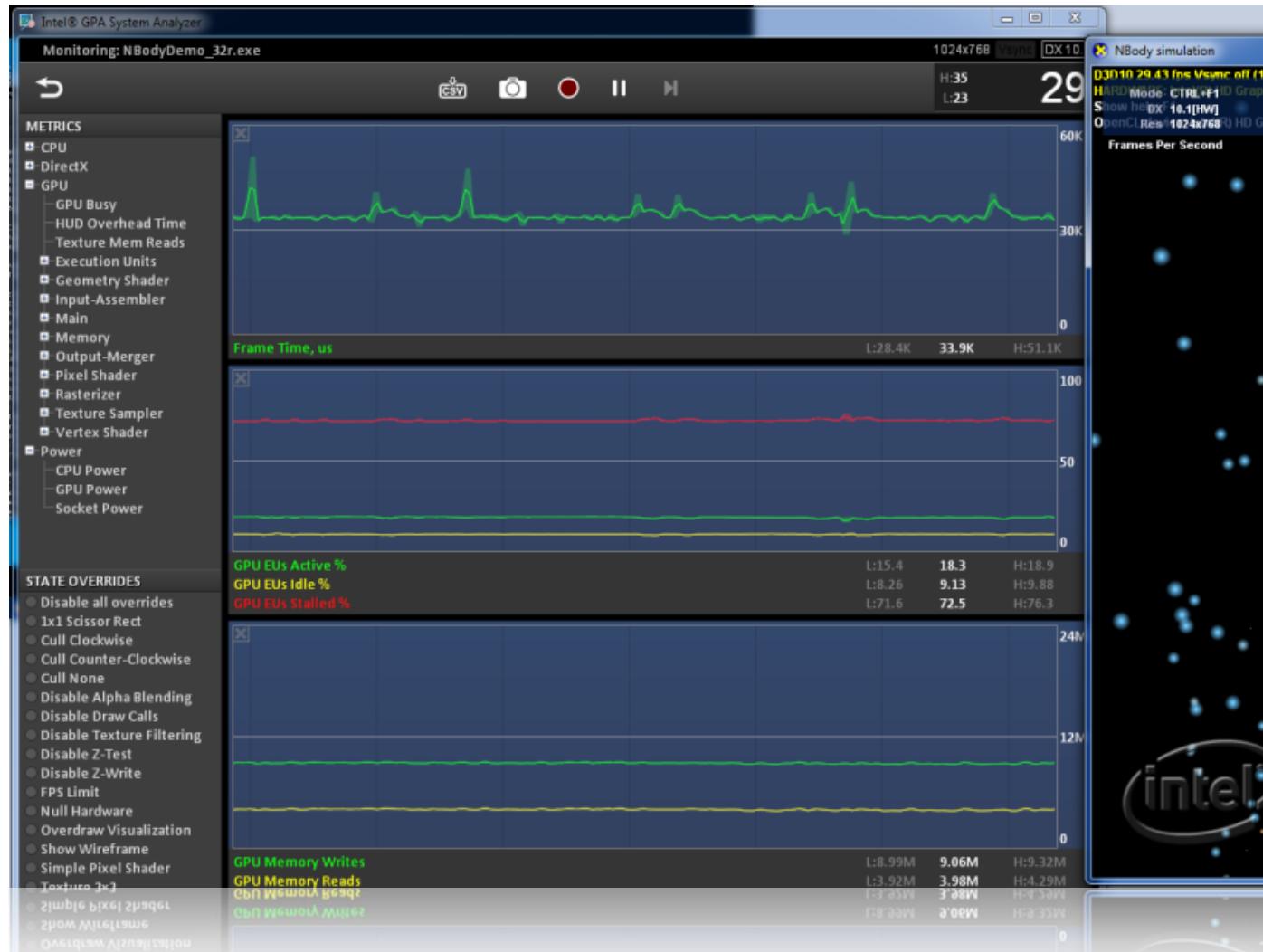
- Profile execution of OpenCL tasks:
 - Distribution of commands
 - Flow of commands
 - Capture and measure API calls

Systems Analyzer (CPU and Intel® HD Graphics)

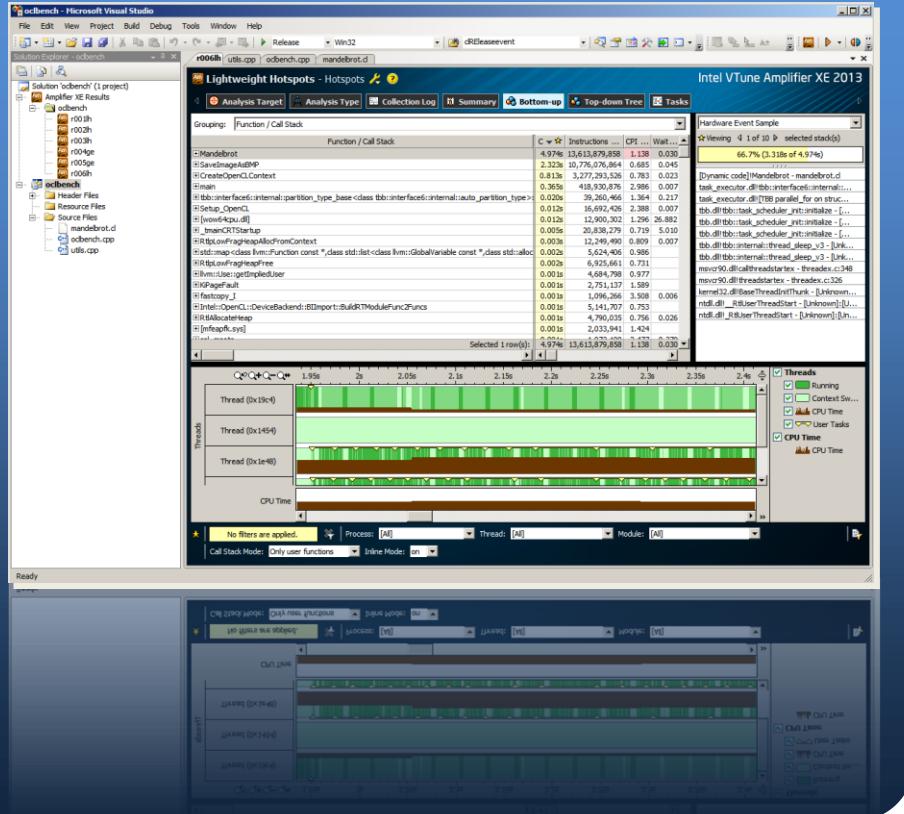
- Graphics and Processor utilization
- Power metrics
- Memory metrics

Tune and optimize visual computing applications

Intel® GPA System Analyzer



Analyze OpenCL® Applications with Intel® VTune™ Amplifier XE



Universal Profiling Tool

- Easy, low-overhead Hotspots analysis
- Focused analysis: u-arch, parallelism, memory
- Timeline to understand your data
- Interactive source/assembly
- Filter, group and sort your data
- Smooth Visual Studio® integration
- Windows, Linux, Java, .NET, OpenCL®, ...

Special OpenCL support

- Understand how your kernel performed and why
- Optimize according to guidelines available with the Performance Guide

Optimize OpenCL-based compute workloads running on the CPU



Intel® VTune™ Amplifier XE with OpenCL* Profiling

Insight into how the code is executed

- OpenCL complier on the CPU generates and executes dynamic just-in-time compilation(JIT) code
- Intel® VTune™ Amplifier XE profiles kernel scheduling and execution
- Performance metrics are attributed back to kernel code

Use specific Intel® VTune™ Amplifier XE analysis types

- “Hotspots” for general time-based profile
- “Lightweight Hotspots” for accurate hotspots analysis
- “Concurrency” for threading performance analysis
- “General Exploration” for finding u-arch bottlenecks
- Define “CL_CONFIG_USE_GPA” variable for tasks

* New features to be available in next SDK releases

Intel® VTune™ Amplifier XE with OpenCL* Speed Triage Strategy



Overall optimization strategy for CPU code

- 1. Hotspot / Concurrency Analysis:** For high-level triage
 - Understand breakdown between host code and OpenCL* code
 - Verify CPU time vs. wait time and make sure utilization is high
- 2. Lightweight Hotspots Analysis:** For kernel deep-dive
 - Verify the vectorization level of generated assembly JIT code
 - Refer to Optimization Guide for hints on possible changes
- 3. General Exploration Analysis:** For u-arch bottlenecks
 - Look for cache miss, resource starvation issues
 - Branch misprediction is usually not an issue (predicated code)

Let's see how this can be applied to real code!

* New features to be available in next SDK releases

Workflow Showcase - Intel® VTune™ Amplifier XE with Intel® SDK for OpenCL* Applications 2012



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JULY 11 Getting Started with Intel® SDK for OpenCL Applications

JULY 18 Writing Efficient Code for OpenCL Applications

JULY 25 Creating and Optimizing OpenCL Applications

Intel® OpenCL

1 2 3 4 5

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June 27, 2012 NEW Per-Vertex Defocus Blur for Stochastic Rasterization We present user-controllable and plausible defocus blur for a stochastic rasterizer. We modify circle of confusion coefficients per vertex to express more general defocus blur, and show how the method can be applied to limit the foreground blur, ...

May 24, 2012 Intel® VTune™ Amplifier XE Intel® VTune™ Amplifier XE is a powerful threading and performance optimization tool for developers who need to understand an application's serial and parallel behavior to improve performance and scalability.

May 21, 2012 Intel® Graphics Performance Analyzers

- Free Downloads of Intel® Visual Computing Tools
- Code Samples
- Tech Articles
- Case Studies
- Forums
- Beta Programs

intel.com/software/vcsource
[Intel.com/software/opencl](http://intel.com/software/opencl)



Webinar Series Will Be Available Online

- Watch webinars online
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 - July 18 - [Writing Efficient Code for OpenCL Applications](#)
 - July 25 - [Creating and Optimizing OpenCL Applications](#)

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The screenshot shows a list of archived online events. At the top, there is a header with the text "Archived Online Events" and "2 ITEMS". Below the header, the first event listed is "Webinar: Getting Started with Intel® SDK for OpenCL* Applications", which took place on Wednesday, July 11, 2012. The description for this webinar states: "Developing parallel applications that take advantage of all the compute resources available on the underlying system is not a trivial task, and doing that across multiple devices in a standard manner is even more difficult." Below this, the second event listed is "Webinar: Writing Efficient Code for OpenCL Applications on 3rd Generation Intel® Core™ Processors", which took place on Wednesday, July 18, 2012. The description for this webinar states: "Writing efficient code for OpenCL applications involves knowing not only the right programming methods but which APIs can be used to help you get even more performance from that application."

Meet us at SIGGRAPH 2012

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SIGGRAPH 2012



August 5th-9th 2012
Convention Center
Los Angeles, CA
Booth #317

Come see us at SIGGRAPH 2012

We are really looking forward to SIGGRAPH this year! We have a great lineup of technical talks, theater presentations, booth demos, and prizes!!!

Intel at Booth #317!

From 8/7-9, join us at Booth 317 for demos and theatre sessions about the latest advances in computer graphics. Intel engineers are presenting talks highlighting advances in Intel HD Graphics, showing how to optimize your graphics on Ultrabook devices, and how to publish your games on Intel AppUp for a wider consumer distribution. Prizes will be awarded at the end of each day. The booth demos are open on 8/7-9.

On Wednesday 8/8, mark your calendars for a full day of Technical Talks and other tech-ertainment in Room 402B. Tech Talks on a variety of subjects run from 10:45 AM until 3:00 PM. From 12 Noon until 1:00 PM join us for the Intel Software Open House Sponsored Lunch with a chance to meet and talk with Intel Engineers. From 1:00 to 2:00PM its Cappuccino time in Room 402B with a Cappuccino Cart and specialty cold beverages to get you through the afternoon.

This site is your one-stop shop to experience the entire Intel showcase at SIGGRAPH 2012. Bookmark this page to get any "last minute" updates on what Intel has planned for SIGGRAPH 2012.

- Intel at Booth #317
- Intel Sponsored Sessions (Room 402B on Wednesday, August 8th)
 - TweetUp w/ Espresso Bar
 - **Tech Talk: The Future of OpenCL* for Graphics, Film Applications on Intel Platforms**
 - **Tech Talk: Optimizing Film, Media with OpenCL* and Intel® Quick Sync Video**
- Khronos OpenCL BOF

software.intel.com/en-us/articles/siggraph-2012



Q&A

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- Download Intel® Graphics Performance Analyzers 2012 at No Cost
- Download and try Intel® VTune™ Amplifier XE 2011
- Join us at upcoming events (SIGGRAPH, IDF, SC12)
- Follow us on Twitter: [@IntelOpenCL](https://twitter.com/IntelOpenCL)
- Join our users forum and post your questions

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