Intel® Iris™ Graphics Quick Sync Video
Innovation Behind Quality and Performance Leadership

Dr. Wen-Fu Kao and Dr. Ryan Lei
Intel Visual & Parallel Group Media Architecture
INFORMATION IN THIS DOCUMENT IS PROVIDED IN CONNECTION WITH INTEL PRODUCTS. NO LICENSE, EXPRESS OR IMPLIED, BY ESTOPPEL OR OTHERWISE, TO ANY INTELLECTUAL PROPERTY RIGHTS IS GRANTED BY THIS DOCUMENT. EXCEPT AS PROVIDED IN INTEL'S TERMS AND CONDITIONS OF SALE FOR SUCH PRODUCTS, INTEL ASSUMES NO LIABILITY WHATSOEVER AND INTEL DISCLAIMS ANY EXPRESS OR IMPLIED WARRANTY, RELATING TO SALE AND/OR USE OF INTEL PRODUCTS INCLUDING LIABILITY OR WARRANTIES RELATING TO FITNESS FOR A PARTICULAR PURPOSE, MERCHANTABILITY, OR INFRINGEMENT OF ANY PATENT, COPYRIGHT OR OTHER INTELLECTUAL PROPERTY RIGHT.

A "Mission Critical Application" is any application in which failure of the Intel Product could result, directly or indirectly, in personal injury or death. SHOULDN'T YOU PURCHASE OR USE INTEL'S PRODUCTS FOR ANY SUCH MISSION CRITICAL APPLICATION, YOU SHALL INDEMNIFY AND HOLD INTEL AND ITS SUBSIDIARIES, SUBCONTRACTORS AND AFFILIATES, AND THE DIRECTORS, OFFICERS, AND EMPLOYEES OF EACH, HARMLESS AGAINST ALL CLAIMS COSTS, DAMAGES, AND EXPENSES AND REASONABLE ATTORNEYS' FEES ARISING OUT OF, DIRECTLY OR INDIRECTLY, ANY CLAIM OF PRODUCT LIABILITY, PERSONAL INJURY, OR DEATH ARISING IN ANY WAY OUT OF SUCH MISSION CRITICAL APPLICATION, WHETHER OR NOT INTEL OR ITS SUBCONTRACTOR WAS NEGLIGENT IN THE DESIGN, MANUFACTURE, OR WARNING OF THE INTEL PRODUCT OR ANY OF ITS PARTS.

Intel may make changes to specifications and product descriptions at any time, without notice.

Iris™ graphics is available on select systems. Consult your system manufacturer.

All products, dates, and figures specified are preliminary based on current expectations, and are subject to change without notice.

Intel processors, chipsets, and desktop boards may contain design defects or errors known as errata, which may cause the product to deviate from published specifications. Current characterized errata are available on request. Intel processor numbers are not a measure of performance. Processor numbers differentiate features within each processor family, not across different processor families: Go to: Learn About Intel® Processor Numbers

Any code names featured are used internally within Intel to identify products that are in development and not yet publicly announced for release. Customers, licensees and other third parties are not authorized by Intel to use code names in advertising, promotion or marketing of any product or services and any such use of Intel's internal code names is at the sole risk of the user.

Intel product plans in this presentation do not constitute Intel plan of record product roadmaps. Please contact your Intel representative to obtain Intel's current plan of record product roadmaps.

Performance claims: Software and workloads used in performance tests may have been optimized for performance only on Intel® microprocessors. Performance tests, such as SYSmark and MobileMark, are measured using specific computer systems, components, software, operations and functions. Any change to any of those factors may cause the results to vary. You should consult other information and performance tests to assist you in fully evaluating your contemplated purchases, including the performance of that product when combined with other products. For more information go to http://www.Intel.com/performance

Copyright © 2013 Intel Corporation. All rights reserved. Intel, Intel Inside, the Intel logo, Intel Core, and Ultrabook are trademarks of Intel Corporation in the United States and other countries. *Other names and brands may be claimed as the property of others.
Contents

- Intel® 4th Generation Core™ Processor Graphics Overview
- Video Encode Engine Deep Dive
- Quick Sync Video Quality Improvement
- Quick Sync Video Performance and Power
- Summary
Basic Processor Graphics Architecture Building Blocks

Scalable Architecture partitioned into 6 domains:
1. Global Assets: Geometry Front-end up to Setup
2. Slice Common: Rasterizer, Level 3 Cache (L3$) and Pixel Back-end
3. Sub-Slice: Shaders (EUs), Instruction Caches (IC$) and Samplers
   - Scalable slices for performance and GFlop tuning
   - Two slices for premium skus (GT3)
4. Multi-Format Video CODEC Engine (MFX)
5. Video Quality Enhancement Engine
6. Displays

Sets the stage for Scale-up!!
**Processor Graphics-Media Block**

**Front-End Thread Dispatch/Management:**
- Support mixed kernels and thread-spawn threads
- Scoreboard controls thread execution order

**Multi-Format Codec:**
- Parallel engine
- High performance
- Video Decode and Encode

**Video Quality Engine**
- Video Processing
- Color Processing

**Media Optimized Execution Units:**
- Zero overhead thread switching
- Native media ISA
- Vector/Matrix oriented operations

**Media Accelerators**
- Video Motion Estimation Engine
Fully HW Accelerated Decoding Engine

- Highly efficient and power optimized multi-format codec engine
  - Support AVC, VC-1, and MPEG2 decoding.
  - Common function HW Blocks, such as Motion Compensation, Intra Prediction, CABAC, etc are shared between decoder and encoder.

- Expands the success of 3rd Generation Intel® Core™ processor codec acceleration with new formats
  - Native MVC
  - MJPEG Decode
  - Hardware decode acceleration of SVC (Scalable Video Coding)

- Supports large resolution content
  - Native 4kx2k support

- Improved decoder error handling
High-quality Video Processing Engine

• Dedicated video processing on newly designed Video Quality Engine (VQE)
• Color Control and Gamut Expansion are highly desired features by customers
• Haswell supports an extensive suite of video processing functions including:
  ▪ De-Noise (DN)
  ▪ De-Interlace (DI)
  ▪ Film-mode Detection (FMD)
  ▪ Skin Tone Detection (STD)
  ▪ Skin Tone Enhancement (STE)
  ▪ Total Color Control (TCC)
  ▪ Adaptive Contrast Enhancement (ACE)
  ▪ Advanced Video Scalar (AVS)
  ▪ Gamut Compression (GC)
  ▪ Gamut Expansion (GE)\(^1\)
  ▪ Skin Tone Tuned Image Enhancement Filter\(^1\)
  ▪ Image Stabilization (IS)\(^1\)

\(^1\)New on Intel 4th Generation Processor Graphics
Intel implements a flexible hardware design approach for encoding
- Hybrid of fix function HW and programmable EU array.
- Provides balance between performance, power and flexibility

“ENC” accelerated by Programmable EU Array and Media Sampler
“PAK” accelerated by Multi-Format Codec Engine
“ENC” and “PAK” may run concurrently for maximum throughput

Hybrid 2-Stage Video Encoder:

<table>
<thead>
<tr>
<th>Encode Solutions</th>
<th>Performance</th>
<th>Power</th>
<th>Flexibility</th>
</tr>
</thead>
<tbody>
<tr>
<td>GPGPU</td>
<td>Low</td>
<td>High</td>
<td>High</td>
</tr>
<tr>
<td>Traditional Fix Function HW</td>
<td>High †</td>
<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td>Flexible Intel Quick Sync Video</td>
<td>High</td>
<td>Low</td>
<td>Balanced</td>
</tr>
</tbody>
</table>

† Subject to actual implementation
Intel® Quick Sync Video Encoder in 4th Gen Core™ Processor

- Continued improvement of encoder architecture with newer codec support
  - Fully HW accelerated MPEG2 encoder
  - Hardware encode acceleration of SVC

- AVC Encoder support H.264 High Profile up to level 5.2 (4K at 60 fps).

- Focused more on encoder quality improvement through several hardware new features and algorithm improvements.
  - **Multiple reference**: generic encoding quality improvement.
  - **Multi Predictor**: generic encoding quality improvement.
  - **Trellis Quantization**: high bit rate encoding quality improvement.
  - **B frame as reference and B Pyramid**: generic encoding quality improvement.
  - **Look Ahead BRC**: significantly for improves quality at scene change.
  - **MB BRC**: improve visual quality base on video content.

- Fine grained quality vs. performance tradeoff control
4th Gen Core™ Processor AVC Encoder Quality Improvement

Data captured with internal test app on Intel® standard 4th Gen Core™ reference platform and 3rd Gen Core™ reference platform over more than 160 test clips.

Software and workloads used in performance tests may have been optimized for performance only on Intel microprocessors. Performance tests, such as SYSmark and MobileMark, are measured using specific computer systems, components, software, operations and functions. Any change to any of those factors may cause the results to vary. You should consult other information and performance tests to assist you in fully evaluating your contemplated purchases, including the performance of that product when combined with other products.
Intel® HD Graphics 4000 vs. Intel® Iris™ Pro Graphics 5200

HD Graphics 4000 (3rd Gen)  
Iris™ Pro Graphics 5200 (4th Gen)

• Frame 2794 of Intel Demo Clip transcoded with Intel internal test application with 2Mbps bitrate encoding.
• Same encode quality on Intel® 4th Gen™ Core Processor with HD 4200/4400/4600, Iris™, and Iris™ Pro. Performance varies on different SKUs.
Intel® HD Graphics 4000 vs. Intel® Iris™ Pro Graphics 5200

• Frame 6541 of Intel Demo Clip transcoded with Intel internal test application with 2Mbps bitrate encoding.
• Same encode quality on Intel® 4th Gen™ Core Processor with HD 4200/4400/4600, Iris™, and Iris™ Pro. Performance varies on different SKUs
~5x faster encode speed with comparable quality

• Frame 6270 of Intel Demo Clip transcoded with HandBrake QSV enabled beta version. Quick Sync Video preset with Best Quality setting is used to compare with HandBrake High Profile preset with x264. Both were encoded with 2Mbps bitrate encoding.
• Same encode quality on Intel® 4th Gen™ Core Processor with HD 4200/4400/4600, Iris™, and Iris™ Pro. Performance varies on different SKUs
x264 vs. Intel® Iris™ Pro Graphics 5200

~5x faster encode speed with comparable quality

• Frame 8460 of Intel Demo Clip transcoded with HandBrake QSV enabled beta version. Quick Sync Video preset with Best Quality setting is used to compare with HandBrake High Profile preset with x264. Both were encoded with 2Mbps bitrate encoding.
• Same encode quality on Intel® 4th Gen™ Core Processor with HD 4200/4400/4600, Iris™, and Iris™ Pro. Performance varies on different SKUs
Flexible Target Usage Controls

- Each target usage provides different performance/quality tradeoff.
- Flexible for various types of applications.
- Additional encode options available through Intel® Media SDK API.
Intel® QSV Performance & Power

- 4x to 12x real-time AVC 1080p to AVC 1080p transcode speed depending on target usage
- Flexible slice power gating for better performance/power optimization
- Energy-efficient video playback up to 10 hours*
- Multi-stream HD (4K) Decode Capability
- Faster than real-time UHD (4K) Encode
- High performance encode solution at low power

*See http://www.apple.com/macbook-air

Internal measurements based on Intel Demo Clip using Cyberlink Media Espresso v6.7.3521 Fast Conversion Mode running on Intel® Core™ i7-4900MQ reference platform under Windows 7 operating system.
Video Playback/Streaming
Video Editing
Video Encode/Transcode
Video Broadcasting
Wireless Display
Quick Sync Video
Security Surveillance
Digital Photography
HD Video Chat
Summary

• Intel® Quick Sync Video is the leading HW encode solution to deliver speed, quality, and low power
• Flexible configurations for wide range of applications
• Brings consistent user experience for compute continuum
• References & Demos
  ▪ Intel® Media Demo Booth
    – Ultra HD (4K) Decode and Encode
    – HandBrake Quick Sync Video Enabling