

Introducing the 4th Generation Intel® Core™ Processor (code-named Haswell)

Abstract: Intel is launching the 4th generation Intel® Core™ processor, code-named Haswell. Its capabilities build on the 3rd generation Intel® Core™ processor graphics. This introductory article provides a glimpse into the 4th gen processor, with an overview of highlights like the Intel® Iris™ graphics, performance enhancements, low power options, face recognition capabilities, and more. Microsoft Windows* 8 developers will also learn about capabilities available to both Desktop and the Modern UI environments and how to take advantage of the 4th generation processor capabilities.

Key 4th generation processor features

The new processor builds on the processor graphics architecture first introduced in 2nd gen Intel® Core™ processors. While they were built with the 32 nm manufacturing process, both 3rd and 4th generation processors are based on the 22 nm technology. The following paragraphs describe the key differences between the 3rd and 4th gen processors.

First ever System on Chip (SoC) for a PC

The 4th gen Intel® Core™ processor is the first ever SoC for a PC. System on Chip, or SoC, integrates all the major building blocks for a system onto a single chip. With CPU, Graphics, Memory, and connectivity in one package, this innovative modular design provides the flexibility to package a compelling processor graphics solution for multiple form factors.

Enhanced battery life

The 4th gen processor provides up to 9.1 hours of HD video viewing compared to 6 hours on the 3rd gen one. The latest processor also provides 10-13 days of standby power (with refreshed email and social media notifications) compared to 4.5 days of standby power on 3rd generation processors.

Table 1: Battery life comparison between 3rd Generation and 4th generation Intel® Core™ Processors.

	3 rd Generation Core™ Processor  Intel® Core™ i7-3667U processor 20W TDP (17+3)	4 th Generation Core™ Processor  Intel® Core™ i7-4650U processor 15W TDP
HD Video Playback	6.0 hours	9.1 hours
MobileMark* 2012	6.1 hours	8.3 hours
Standby with fresh data	4.5 days	10-13 days
Performance - MobileMark* 2012	138	155

Battery life is calculated based on measured platform power assuming a 50 Watt-Hour battery capacity.

[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. Configurations⁽¹⁾ For more information go to <http://www.intel.com/performance>.]*

Note: TDP, Thermal Design Power, represents worst-case system power.

Intel® Iris™ Graphics

Intel Iris Graphics allows you to play the most graphic intensive games without the need for an additional graphics card. The graphics performance on the 4th gen processor nearly doubles the performance relative to the previous generation of Intel® HD Graphics.

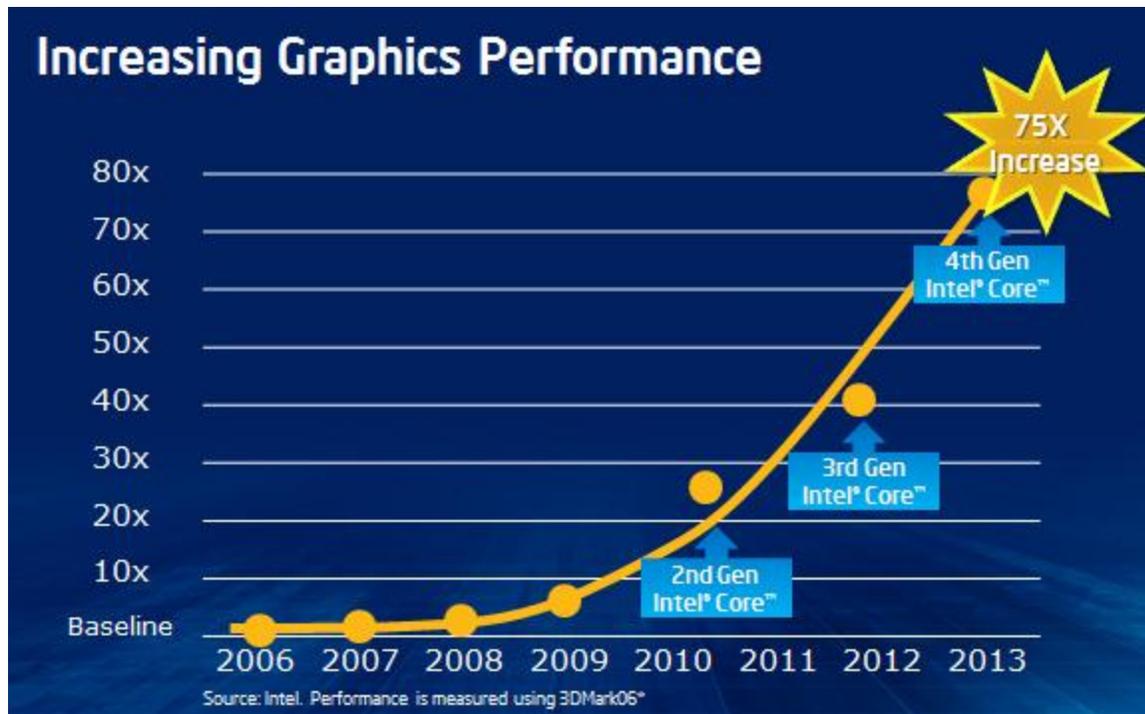


Figure 1: Comparison of graphics performance of 4th gen Intel® Core™ with previous generations

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Additionally, the Intel Iris Pro Graphics with integrated eDRAM provides close to double the performance of the 3rd generation HD graphics GPUs on Ultrabook™ devices. Both GPUs operate at higher than 28W Thermal Design Power (TDP) compared to the 17W TDP of 3rd generation graphics making them more suited for high performance operations on Desktop/AIO/Laptop form factors [Source: <http://arstechnica.com/gadgets/2013/05/intels-iris-wants-to-change-how-you-feel-about-integrated-graphics/>]

Intel Iris Graphics also support Direct3D* 11.1, OpenGL* 4.1 and OpenCL* 1.2, Intel Quick Sync Video encoding engine, Intel® AVX 2.0, and DirectX Extensions.

4th Generation Intel® Core™ processor variants

Multiple packages of the 4th generation processor are available to cater to the needs of the growing types of systems: Workstations, Desktops, Ultrabook systems, All-In-Ones, Laptops, and Tablets. While the higher end variants targeted for Workstations and Desktops provide higher performance, they also consume higher power compared to the more power optimal mobile variants. The table 2 below provides a comparison of the variants for different form factors and usages.

Table 2: 4th Generation Intel® Core™ Processor Variants

Mobile Processors	• H - Series: Quad Core with Intel® Iris™ Pro graphics
	• M - Series: Quad Core and Dual Core 2-chip
	• U - Series: SoC with Intel® Iris™ graphics option
	• Y - Series: Lowest power SoC for detachables
Desktop Processors	• K - Series: Enthusiast unlocked processors
	• Performance and mainstream quad core/dual core
	• Low power S-Series, T-Series

The U and Y series are designed for Ultrabook devices, convertibles, and detachable form factors.

The 4th gen processor line provides the flexibility to match power requirements with graphics performance. While the high end provides substantially better graphics performance, the lower end is suitable when lower graphics performance is required.

For a detailed analysis of graphics capabilities, please refer to the [Graphics Developers Guide](#).

Intel® AVX 2.0

Intel® Advanced Vector Extensions (Intel® AVX) 2.0 is a 256-bit instruction set extension to Intel® Streaming SIMD Extensions (Intel® SSE). Intel AVX 2.0 build on version 1.0 and provides features like Fully Pipelined Fused Multiply Add on two ports thus providing twice the floating point performance for multiply-add workloads, 256-bit integer SIMD operations compared to older 128-bit gather operations and bit manipulation instructions. These capabilities enhance usages such as face detection, pro-imaging, high performance computing, consumer video and imaging, increased vectorization, and other advanced video processing capabilities.

More resources on Intel AVX 2.0:

- [Intel® Advanced Vector Extensions](#)
- [Intel® 64 and IA-32 Architectures Software Developer Manuals](#)

Intel Iris Graphics Extensions to DirectX API

An added feature with 4th generation processor graphics is the API set for DirectX extensions. Two APIs are available that provide for pixel synchronization and instant access. Pixel synchronization lets you effectively read/modify/write per-pixel data, which makes the tasks of programmable blending and order independent transparency (OIT) more efficient. Instant access lets both CPU and GPU access the same memory for mapping and rendering. These APIs work on DirectX 11 and above.

For more detailed information, please refer to the [Graphics Developers Guide](#).

Security

Ultrabook systems with 4th gen processors come with enhanced security features like Intel® Platform Trust Technology, Intel® Insider, and Intel® Anti-Theft technology⁽ⁱⁱⁱ⁾. The processors also feature Intel® Identity Protection Technology^(iv), which provides identity protection and fraud deterrence.

Developer Recommendations

Developers looking to take advantage the new features explained above can use the following guidelines for programming on 4th gen processors with Windows 8.

1: Optimize apps for touch: Ultrabook systems with 4th gen processors all include touch screens. Developers should visit these UX/UI guidelines to optimize their app design and enable touch.

More resources:

- [Ultrabook Device and Tablet Windows Touch Developer Guide](#)
- [Designing for Ultrabook™ Devices and Touch-Enabled Desktop Applications](#)
- [Developing with Desktop Natural User Interface APIs for Developers](#)
- [Handling touch input in Windows* 8 Applications](#)

2: Optimize apps with sensors: 4th generation processor-based platforms come with several sensors: GPS, Compass, Gyroscope, Accelerometer, and Ambient Light. These sensor recommendations are aligned with the Microsoft standard for Windows 8. Use the Windows sensor APIs, and your code will run on all Ultrabook and tablet systems running Windows 8.

More resources:

- [Ultrabook™ and Tablet Windows* 8 Sensors Development Guide](#)
- [Detecting Ultrabook sensors on Windows 8](#)

3: Optimize apps with Intel platform features: While Windows 8 allows for both Desktop and Windows Store apps, there may be a difference in how platform capabilities are exposed for each type. For Desktop applications, key features are Intel® Wireless Display (WiDi)^(v) and security features such as Intel

Anti-Theft Technology and Intel Identity Protection Technology while HD Graphics is available for both types of apps. Please refer to resources below for more information on each.

More Resources:

- [Building Intel® WiDi Apps for Ultrabook](#)
- [Enabling Intel® WiDi on Windows* 8 Consumer Preview](#)
- [Graphics Developers Guide](#)
- [Intel® Anti-Theft Technology](#)
- [Intel® Identity Protection Technology](#)

On the Windows UI mode, key enablers are Connected Standby, HD Graphics, stylus input to support tablet usages and camera. Please refer to resources below for more information on each:

More Resources:

- [Developing for Intel Smart Connect Technology](#)
- [Windows* Desktop Touch Camera Sample Abstract](#)

4: Optimize for visible performance differentiation: Desktop apps can be optimized to take advantage of Intel AVX 2.0. Intel Quick Sync Video encode and post-processing for media and visual intensive applications. Note that the Intel Media SDK and Intel Quick Sync Video are available for Windows Store apps to take advantage of as well.

More Resources:

- [Intel® Media SDK:](#)
- [Intel® Advanced Vector Extensions](#)
- [Intel® 64 and IA-32 Architectures Software Developer Manuals](#)

5: Optimize apps with capabilities from the Intel® Perceptual Computing SDK: The Intel AVX 2.0 capabilities built into the 4th gen processor provide for face recognition, voice recognition, and other interactive features that provide very compelling usages for Desktop apps.

More resources:

- [Intel® Advanced Vector Extensions](#)
- [Intel® 64 and IA-32 Architectures Software Developer Manuals](#)
- [Intel® Perceptual Computing SDK](#)

6: Optimize app performance with Intel® tools: Check out the Intel® Composer XE 2013 and Intel® VTune™ Amplifier XE 2013 for Windows Desktop. These suites provide compilers, Intel® Performance Primitives and Intel® Threaded Building Blocks that help boost application performance. You can also

optimize and future-proof media and graphics workloads on all IA platforms with the Intel® Graphics Performance Analyzers 2013 and Intel Media SDK that are available for both Desktop and Windows Store apps.

More resources:

- [Visual Computing Source](#)

About the Author

Meghana Rao is a Technical Marketing Engineer with the Developer Relations Division. She helps evangelize Ultrabook™ and Tablet platforms and is the author of several articles on the Intel® Developer Zone.

(i) 3rd Gen Intel® Core™i7-3667U processor, Intel HD Graphics 4000, Tacoma Falls 2 reference design platform, 2x4GB DDR3L-1600, 120GB SSD, 13.3" enhanced display port panel with 1920x1080 resolution, 50 WHr battery, Windows* 8.

4th Gen Intel® Core™i7-4650U processor, Intel HD Graphics 5000, pre-production platform, 2x2GB DDR3L-1600, 120GB SSD, 13.3" enhanced display port panel supporting panel self refresh with 1920x1080 resolution, 50 WHr battery, Windows* 8.

(ii) 3rd Gen Intel® Core™i7-3687U processor, Tacoma Falls 2 reference design platform, Intel HD Graphics 4000, Intel HD Graphics driver 15.31.3063, 2x2GB DDR3L @ 1600MHz, 120GB SSD, 13.3" enhanced display port panel with 1920x1080 resolution, 50 WHr battery, Windows* 8.

4th Gen Intel® Core™i7-4770R processor, pre-production platform, Intel 5200, Intel HD Graphics driver 15.31.3071, 2x2GB DDR3L @ 1600MHz, 160GB SSD, Windows* 8.

(iii) No system can provide absolute security under all conditions. Requires an enabled chipset, BIOS, firmware, and software with data encryption, and service activation with a capable service provider. Consult your system manufacturer and service provider for availability and functionality. Service may not be available in all countries. Intel assumes no liability for lost or stolen data and/or systems or any other damages resulting thereof. For more information, visit www.intel.com/content/www/us/en/architecture-and-technology/anti-theft/anti-theft-general-technology.html.

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(v) Requires an Intel® Wireless Display enabled PC, compatible adapter, and TV. 1080p and Blu-Ray* or other protected content playback only available on 2nd generation Intel® Core™ processor-based PCs

with built-in visuals enabled. Consult your PC manufacturer. For more information, see www.intel.com/go/widi.

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