Login   **Register**

ABOUT   BENCH   FORUMS   PODCAST

PC COMPONENTS ▼   **SMARTPHONES & TABLETS** ▼   **SYSTEMS** ▼   **ENTERPRISE & IT**   **GUIDES** ▼   **DEALS**

TRENDING TOPICS   CPUS   INTEL   AMD   MOBILE   GPUS   SMARTPHONES   STORAGE   LAPTOPS   Follow

Home > CPUs

The Intel Broadwell Review Part 2: Overclocking, IPC and Generational Analysis

121
Comments

by Ian Cutress on August 3, 2015 8:00 AM EST

Posted in   CPUs   Intel   Broadwell   Crystal Well   14nm   Desktop

COMPARING IPC: MEMORY LATENCY AND CPU BENCHMARKS   ⌄

Comparing IPC: Memory Latency and CPU Benchmarks

Being able to do more with less, in the processor space, allows both the task to be completed quicker and often for less power. While the concept of having multiple cores has allowed many programs to be run at once, such as IM, web, compute and so forth, we are all still limited by the fact that a lot of software is still relying on one line of code after another, pegging each software package to once core unless it can exploit a mulithreaded list of operations. This is referred to as the serial part of the software, and is the basis for many early programming classes – getting the software to compile and complete is more important than speed. But the truth is that having a few fast cores helps more than several thousand super slow cores. This is where Instructions Per Clock (IPC) comes in to play.

The principles behind extracting IPC are quite complex as one might imagine. Ideally every instruction a CPU gets should be read, executed and finished in one cycle, however that is never the case. The processor has to take the instruction, decode the instruction, gather the data (depends on where the data is), perform work on the data, then decide what to do with the result. Moving has never been more complicated, and the ability for a processor to hide latency, pre-prepare data by predicting future events or keeping hold of previous events for potential future use is all part of the plan. All the meanwhile there is an external focus on making sure power consumption is low and the frequency of the processor can scale depending on what the target device actually is.

For the most part, Intel has successfully increased IPC every generation of processor. In most cases, 5-10% with a node change and 5-25% with an architecture change with the most recent large jumps being with the Core architecture and the Sandy Bridge architectures, ushering in new waves of super-fast computational power. As Haswell to Broadwell is a node change with minor silicon updates, we should expect some gain but the main benefit should be efficiency by moving to a smaller node.

PIPELINE STORIES   + SUBMIT NEWS

AMD Fixed the STAPM Throttling Issue, So We Retested The Ryzen 7 8700G and Ryzen 5 8600G

AMD CEO Dr. Lisa Su to Deliver Opening Keynote at Computex 2024

Arm and Samsung to Co-Develop 2nm GAA-Optimized Cortex Cores

Crucial T705 Gen5 NVMe SSD: A 14.5 GBps Consumer Flagship with 2400 MT/s 232L NAND

GlobalFoundries to Receive $1.5 Billion In Funding from U.S. CHIPS Act

GlobalFoundries: Clients Are Migrating to Sub-10nm Faster Than Expected

ASML to Ship Multiple High-NA Tools in 2025, Expands Production Capacities

For this test we took Intel's high-end i7 processors from the last four generations and set them to 3.0 GHz and with HyperThreading disabled. As each platform uses DDR3, we set the memory across each to DDR3-1866 with a CAS latency of 9. From a pure cache standpoint, here is how each of the processors performed:
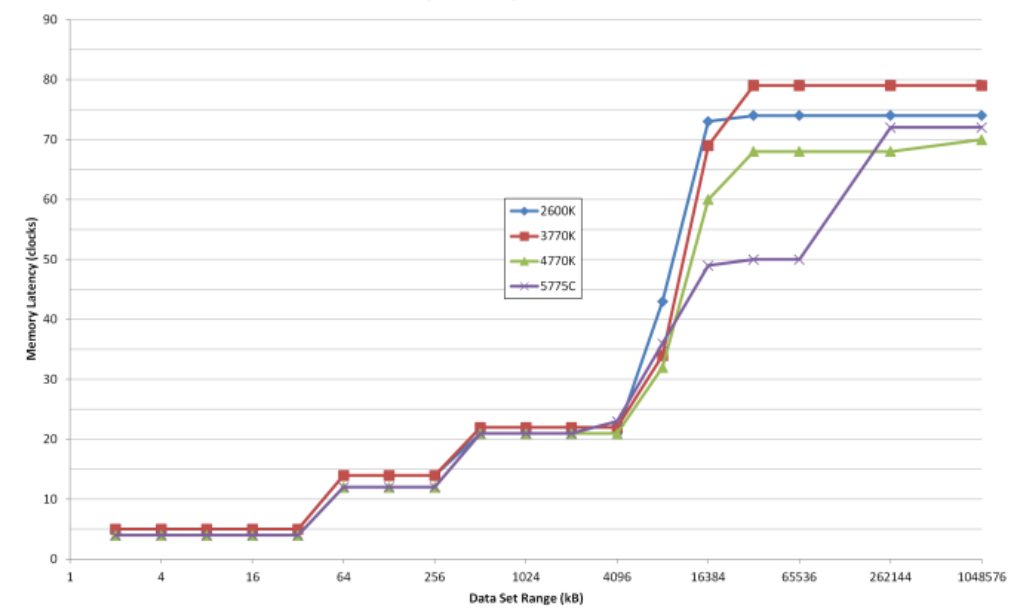
Both Haswell and Broadwell have a small lead through the Level 1 Cache (32kB) and Level 2 Cache (256kB). It all changes from 6MB onwards as a result of the different cache levels between the processors. As the Broadwell based i7-5775C only has 6MB of L3 cache, this seems to effect the 4MB data set range, but between 8MB and 64MB values, the memory latency for Broadwell is substantially lower than any other Intel processor. This comes down to the eDRAM, which sticks around until 128MB.

Most memory accesses happen at lower data set ranges as the system attempts to predict the data needed. When data is not in the L1 cache, it is considered a cache miss and looks for the data in L2. When not in L2, look in L3. When not in L3, look in eDRAM/DDR3. From this perspective, the Broadwell based processors should have a slight advantage when it comes to large amounts of data accesses. Based on our previous testing, this means integrated graphics or high intensity CPU/DRAM workloads such as databases or matrix operations.

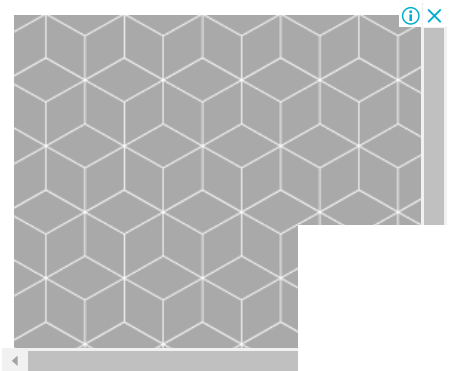Here are the CPU results at 3.0 GHz:

Dolphin Benchmark: link

Many emulators are often bound by single thread CPU performance, and general reports tended to suggest that Haswell provided a significant boost to emulator performance. This benchmark runs a Wii program that raytraces a complex 3D scene inside the Dolphin Wii emulator. Performance on this benchmark is a good proxy of the speed of Dolphin CPU emulation, which is an intensive single core task using most aspects of a CPU. Results are given in minutes, where the Wii itself scores 17.53 minutes.

Dolphin Emulation Benchmark
Time in Minutes (Lower is Better)

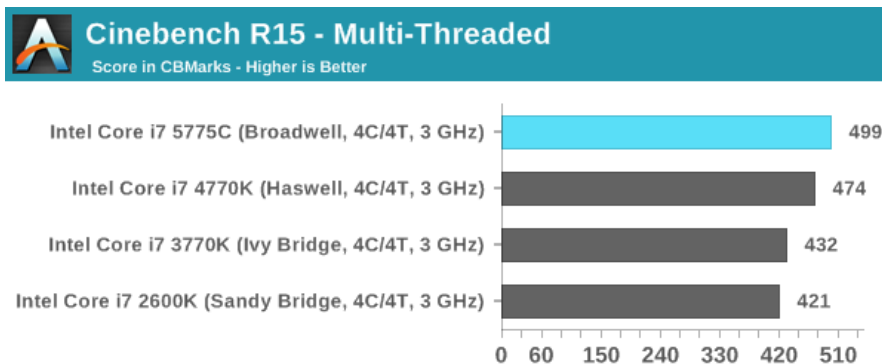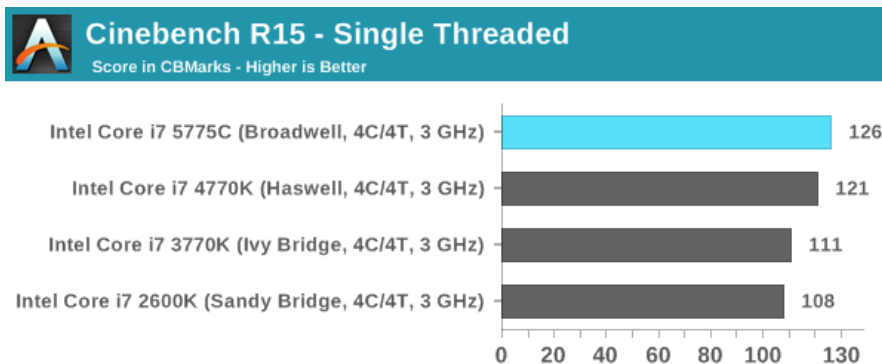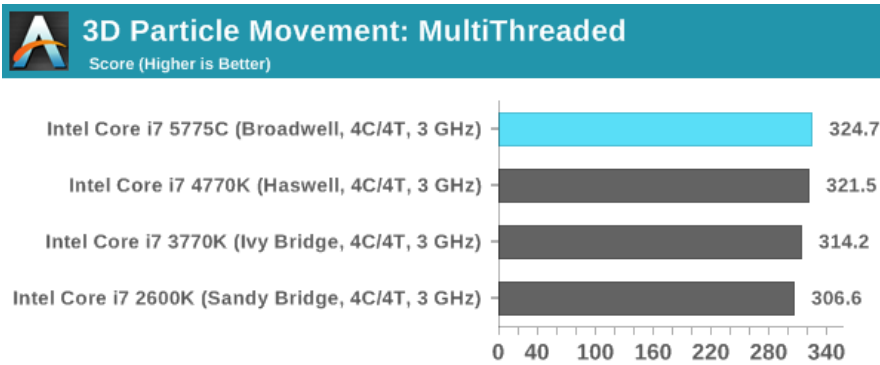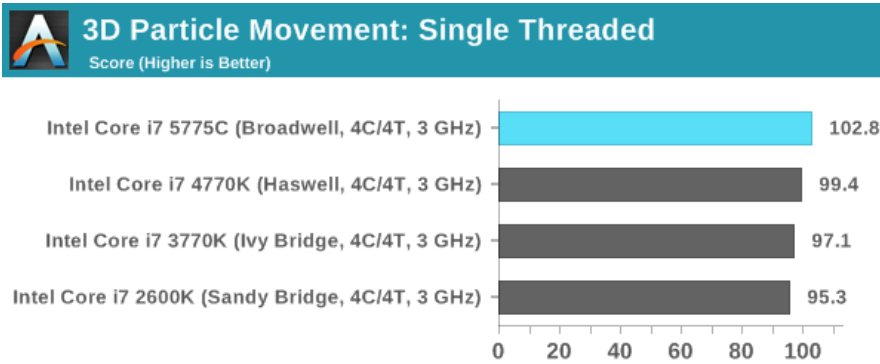| CPU	Score
Intel Core i7 5775C (Broadwell, 4C/4T, 3 GHz)	9.82
Intel Core i7 4770K (Haswell, 4C/4T, 3 GHz)	10.12
Intel Core i7 3770K (Ivy Bridge, 4C/4T, 3 GHz)	13.63
Intel Core i7 2600K (Sandy Bridge, 4C/4T, 3 GHz)	15.52
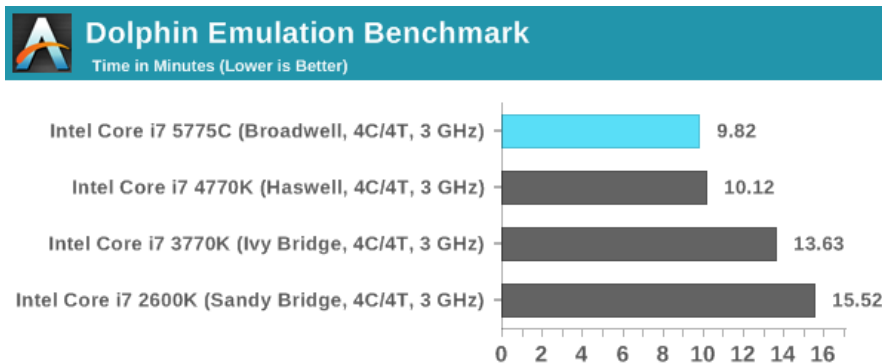
Cinebench R15

Cinebench is a benchmark based around Cinema 4D, and is fairly well known among enthusiasts for stressing the CPU for a provided workload. Results are given as a score, where higher is better.

Cinebench R15 - Single Threaded
Score in CBMarks - Higher is Better

CPU	Score
Intel Core i7 5775C (Broadwell, 4C/4T, 3 GHz)	126
Intel Core i7 4770K (Haswell, 4C/4T, 3 GHz)	121
Intel Core i7 3770K (Ivy Bridge, 4C/4T, 3 GHz)	111
Intel Core i7 2600K (Sandy Bridge, 4C/4T, 3 GHz)	108

Cinebench R15 - Multi-Threaded
Score in CBMarks - Higher is Better

CPU	Score
Intel Core i7 5775C (Broadwell, 4C/4T, 3 GHz)	499
Intel Core i7 4770K (Haswell, 4C/4T, 3 GHz)	474
Intel Core i7 3770K (Ivy Bridge, 4C/4T, 3 GHz)	432
Intel Core i7 2600K (Sandy Bridge, 4C/4T, 3 GHz)	421

Point Calculations – 3D Movement Algorithm Test: link

3DPM is a self-penned benchmark, taking basic 3D movement algorithms used in Brownian Motion simulations and testing them for speed. High floating point performance, MHz and IPC wins in the single thread version, whereas the multithread version has to handle the threads and loves more cores. For a brief explanation of the platform agnostic coding behind this benchmark, see my forum post here.

3D Particle Movement: Single Threaded
Score (Higher is Better)

CPU	Score
Intel Core i7 5775C (Broadwell, 4C/4T, 3 GHz)	102.8
Intel Core i7 4770K (Haswell, 4C/4T, 3 GHz)	99.4
Intel Core i7 3770K (Ivy Bridge, 4C/4T, 3 GHz)	97.1
Intel Core i7 2600K (Sandy Bridge, 4C/4T, 3 GHz)	95.3

0   20   40   60   80   100

3D Particle Movement: MultiThreaded
Score (Higher is Better)

CPU	Score
Intel Core i7 5775C (Broadwell, 4C/4T, 3 GHz)	324.7
Intel Core i7 4770K (Haswell, 4C/4T, 3 GHz)	321.5
Intel Core i7 3770K (Ivy Bridge, 4C/4T, 3 GHz)	314.2
Intel Core i7 2600K (Sandy Bridge, 4C/4T, 3 GHz)	306.6

0   40   100   160   220   280   340

Compression – WinRAR 5.0.1: link

Our WinRAR test from 2013 is updated to the latest version of WinRAR at the start of 2014. We compress a set of 2867 files across 320 folders totaling 1.52 GB in size – 95% of these files are small typical website files, and the rest (90% of the size) are small 30 second 720p videos.
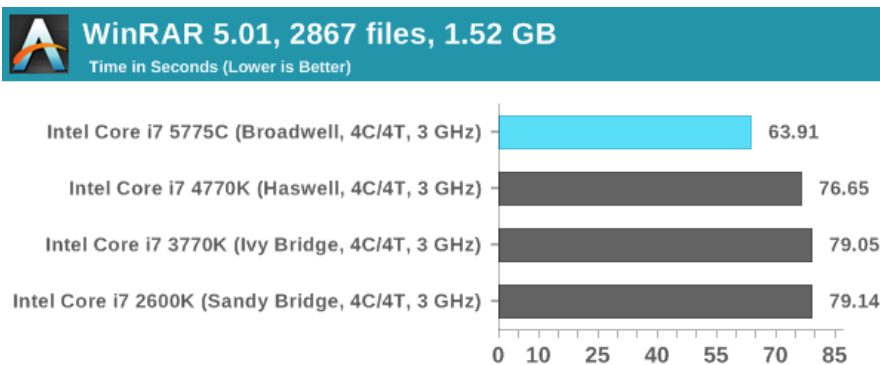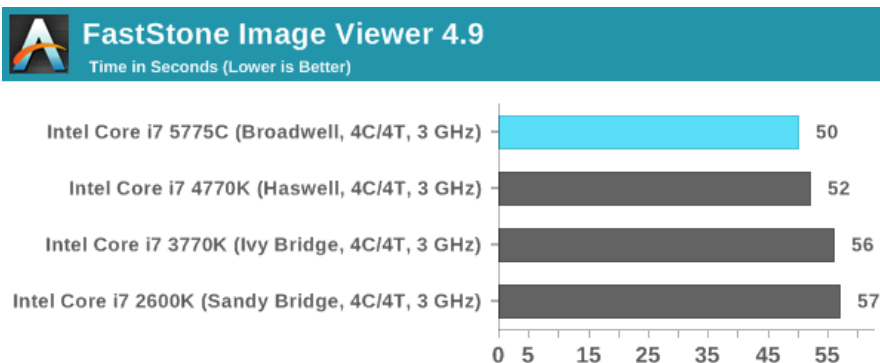
WinRAR 5.01, 2867 files, 1.52 GB
Time in Seconds (Lower is Better)

CPU	Time
Intel Core i7 5775C (Broadwell, 4C/4T, 3 GHz)	63.91
Intel Core i7 4770K (Haswell, 4C/4T, 3 GHz)	76.65
Intel Core i7 3770K (Ivy Bridge, 4C/4T, 3 GHz)	79.05
Intel Core i7 2600K (Sandy Bridge, 4C/4T, 3 GHz)	79.14

0   10   25   40   55   70   85

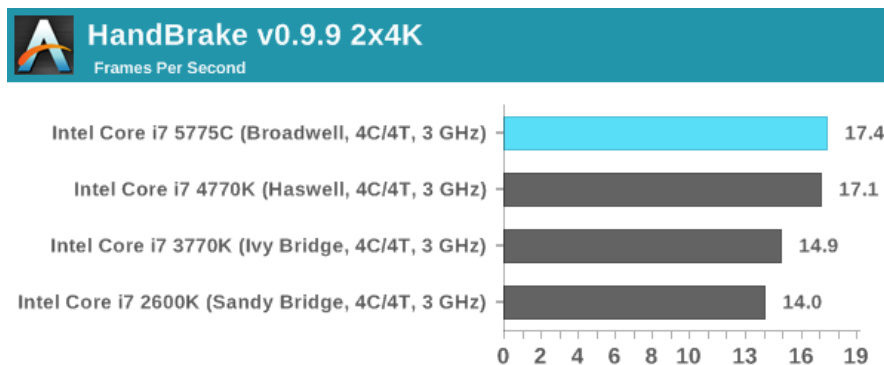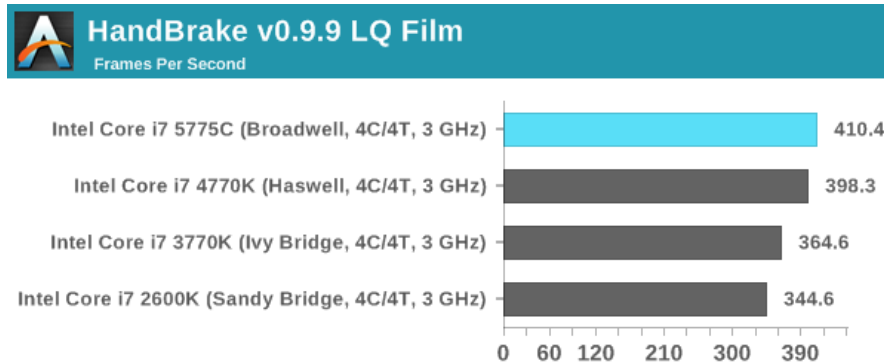**Image Manipulation – FastStone Image Viewer 4.9: link**

Similarly to WinRAR, the FastStone test us updated for 2014 to the latest version. FastStone is the program I use to perform quick or bulk actions on images, such as resizing, adjusting for color and cropping. In our test we take a series of 170 images in various sizes and formats and convert them all into 640x480 .gif files, maintaining the aspect ratio. FastStone does not use multithreading for this test, and thus single threaded performance is often the winner.
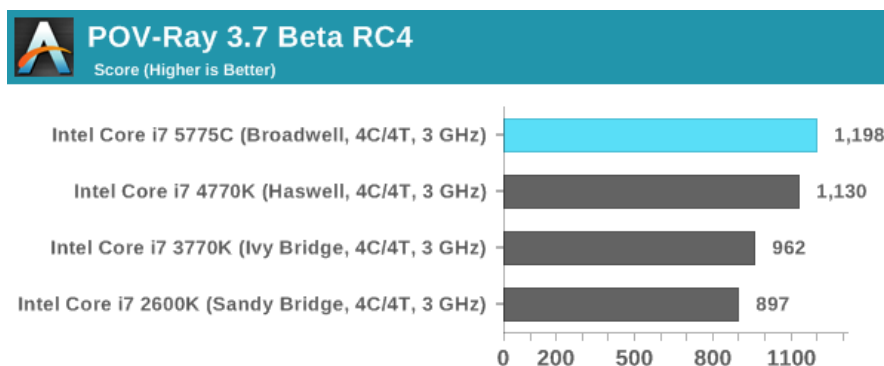
FastStone Image Viewer 4.9
Time in Seconds (Lower is Better)

CPU	Time
Intel Core i7 5775C (Broadwell, 4C/4T, 3 GHz)	50
Intel Core i7 4770K (Haswell, 4C/4T, 3 GHz)	52
Intel Core i7 3770K (Ivy Bridge, 4C/4T, 3 GHz)	56
Intel Core i7 2600K (Sandy Bridge, 4C/4T, 3 GHz)	57

0   5   15   25   35   45   55

Video Conversion – Handbrake v0.9.9: link

Handbrake is a media conversion tool that was initially designed to help DVD ISOs and Video CDs into more common video formats. The principle today is still the same, primarily as an output for H.264 + AAC/MP3 audio within an MKV container. In our test we use the same videos as in the Xilisoft test, and results are given in frames per second.
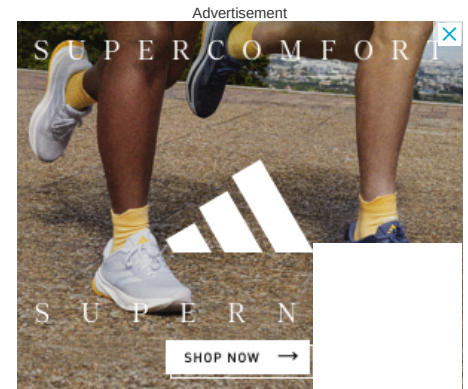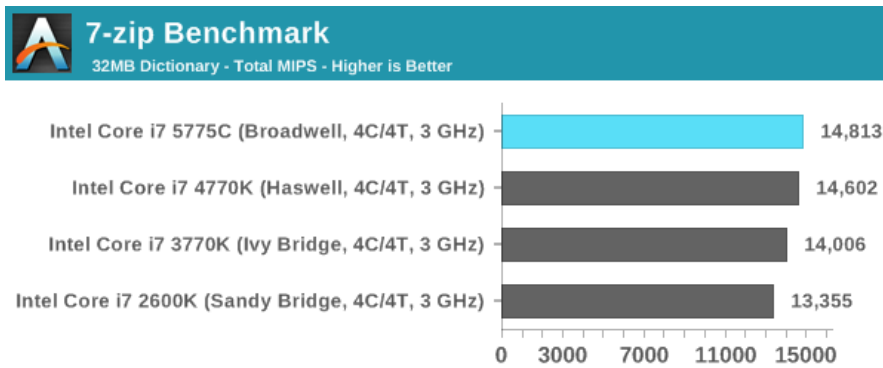
HandBrake v0.9.9 LQ Film
Frames Per Second

CPU	FPS
Intel Core i7 5775C (Broadwell, 4C/4T, 3 GHz)	410.4
Intel Core i7 4770K (Haswell, 4C/4T, 3 GHz)	398.3
Intel Core i7 3770K (Ivy Bridge, 4C/4T, 3 GHz)	364.6
Intel Core i7 2600K (Sandy Bridge, 4C/4T, 3 GHz)	344.6

HandBrake v0.9.9 2x4K
Frames Per Second

CPU	FPS
Intel Core i7 5775C (Broadwell, 4C/4T, 3 GHz)	17.4
Intel Core i7 4770K (Haswell, 4C/4T, 3 GHz)	17.1
Intel Core i7 3770K (Ivy Bridge, 4C/4T, 3 GHz)	14.9
Intel Core i7 2600K (Sandy Bridge, 4C/4T, 3 GHz)	14.0

Rendering – PovRay 3.7: link

The Persistence of Vision RayTracer, or PovRay, is a freeware package for as the name suggests, ray tracing. It is a pure renderer, rather than modeling software, but the latest beta version contains a handy benchmark for stressing all processing threads on a platform. We have been using this test in motherboard reviews to test memory stability at various CPU speeds to good effect – if it passes the test, the IMC in the CPU is stable for a given CPU speed. As a CPU test, it runs for approximately 2-3 minutes on high end platforms.

POV-Ray 3.7 Beta RC4
Score (Higher is Better)

CPU	Score
Intel Core i7 5775C (Broadwell, 4C/4T, 3 GHz)	1,198
Intel Core i7 4770K (Haswell, 4C/4T, 3 GHz)	1,130
Intel Core i7 3770K (Ivy Bridge, 4C/4T, 3 GHz)	962
Intel Core i7 2600K (Sandy Bridge, 4C/4T, 3 GHz)	897

**Synthetic – 7-Zip 9.2: link**

As an open source compression tool, 7-Zip is a popular tool for making sets of files easier to handle and transfer. The software offers up its own benchmark, to which we report the result.

7-zip Benchmark
32MB Dictionary - Total MIPS - Higher is Better

Intel Core i7 5775C (Broadwell, 4C/4T, 3 GHz)	14,813
Intel Core i7 4770K (Haswell, 4C/4T, 3 GHz)	14,602
Intel Core i7 3770K (Ivy Bridge, 4C/4T, 3 GHz)	14,006
Intel Core i7 2600K (Sandy Bridge, 4C/4T, 3 GHz)	13,355

Overall: CPU IPC

*When this section was published initially, the timed benchmarks (those that rely on time rather than score) were caluclated incorrectly. The text has been updated to reflect the new calculations.

Removing WinRAR as a benchmark that obviously benefits from the eDRAM, we get an interesting look at how each generation has evolved over time. Taking Sandy Bridge (i7-2600K) as the base, we get the following:

IPC Gains over Sandy Bridge (3 GHz, 4C/4T, DDR3-1866 C9)
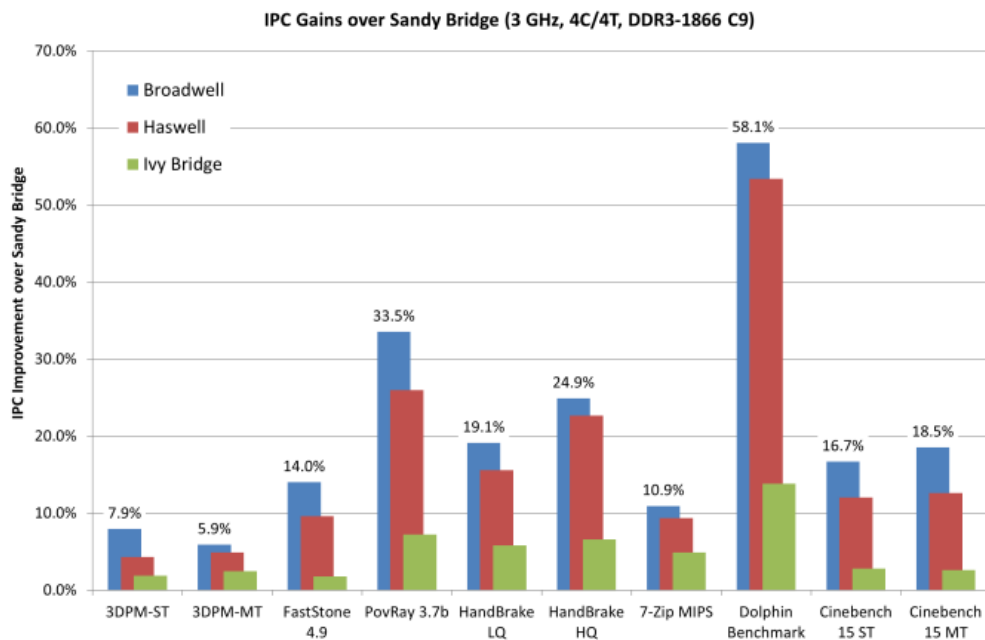
As we can see, performance gains are everywhere although the total benefit is highly dependent on the benchmark in question. Cinebench in single threaded mode for example gives a 16.7% gain from Sandy Bridge to Broadwell, however Dolphin which is also single threaded gets a 58.1% improvement. Overall, a move from Sandy Bridge to Broadwell from an IPC perspective gives an average ~21% improvement. That is an increase in pure, raw throughput before considering frequency or any differentiator in core counts.

If we adjust this graph to show generation to generation improvement:
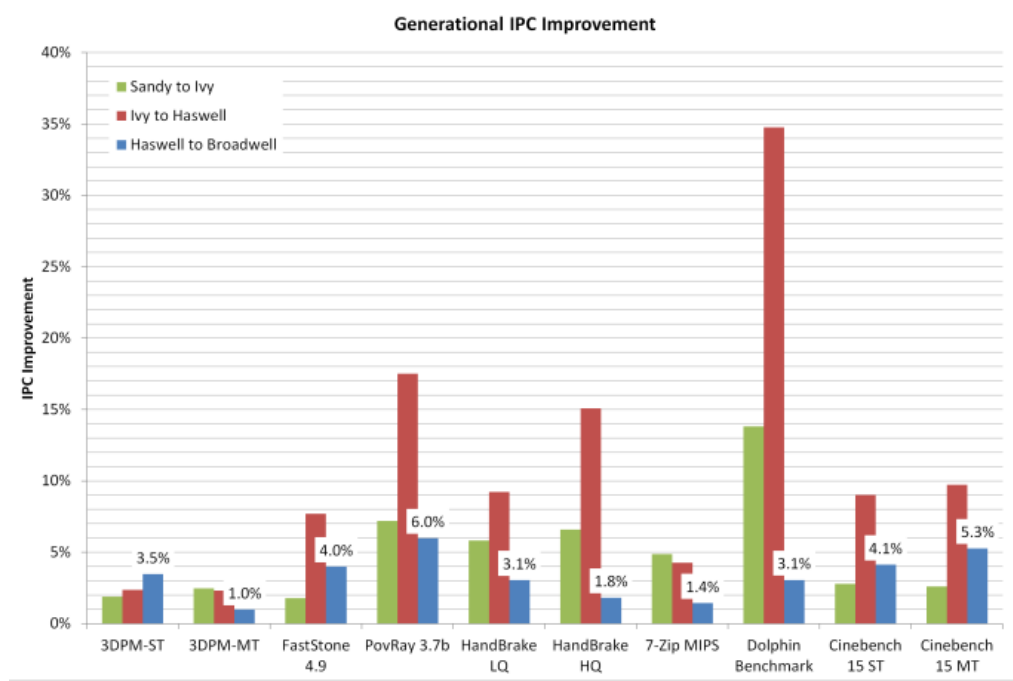
This graph shows something a little bit different. From these numbers:

Sandy Bridge to Ivy Bridge: Average ~5.0% Up
Ivy Bridge to Haswell: Average ~11.2% Up
Haswell to Broadwell: Average ~3.3% Up

Thus in a like for like environment, when eDRAM is not explicitly a driver for performance, Broadwell gives a 3.3% gain over Haswell. That's a take home message worth considering, but it also affords the difference in performance between an architecture update and a node change.

Cycling back to our WinRAR test, things look a little different. Ivy Bridge to Haswell gives only a 3.2% difference, but the eDRAM in Broadwell slaps on another 23.8% performance increase, dropping the benchmark from 76.65 seconds to 63.91 seconds. When eDRAM counts, it counts a lot.

OVERCLOCKING BROADWELL   COMPARING IPC: DISCRETE GAMING

COMPARING IPC: MEMORY LATENCY AND CPU BENCHMARKS   ⌄

Comments Locked

121 Comments

View All Comments

TheinsanegamerN - Monday, August 3, 2015 - link

Quite nice comparison.

Unfortunately, it seems that, while broadwell does have the best IPC of the bunch, the overclock is pathetic. 1.325v to hit 4.2 GHz? my ivy bridge 3570k does the same clock with 1.075v. now, I've been told I have a exceptionally good chip, but it strikes me as odd that broadwell, being on a smaller 14nm process, cant match what ivy bridge could do two years ago. and since sandy bridge can be OC'ed to 4.7GHz+ with ease,and ive can hit 4.5, it seems there is still no reason to upgrade to broadwell, as any IPC gains are cancelled out by the lower clock rate. unless you need to do lots of dolphin emulation and refuse to overclock at all, the ancient sandy bridge still seems to do the best.

K_Space - Monday, August 3, 2015 - link

TheinsanegamerN agreed. Those who held into their Sandy made a very wise investment, just like those good ol' 920s back in the X58 era.

Dupl3xxx - Monday, August 3, 2015 - link

Ah, yes, the 920 was a lovely beast. Started overclocking at 3.6. It booted, tried 3.8, booted, tried 4.0, failed. 3.8 was literally done in less than an hour as my second ever attempt at overclocking, with my first being the intel e6600. And when a dying PSU wounded it, I got a 3930k. It does 4.0 ghz, and I've yet to find any situation where it's a bottleneck, besides things like rendering and benchmarks. I considered upgrading to the 59xx series, but when I learned that only the 5960x would be a 8-core, that was quickly decided against.

It'll be interesting to watch Skylake and Zen fight it out in a year or so.

Impulses - Monday, August 3, 2015 - link

I'm surprised Intel isn't banking on nostalgic memories of the Q6600 to hype the 6600K & 6700K...
Surely marketing had a hand in the simplified naming reminiscent of the old C2Q.

augiem - Monday, August 3, 2015 - link

I'm still on a i7-920 from mid 2009. Been running 3.6GHz the entire time, still rock solid as the day I bought it. I still can't believe I've been using a PC for this long. Before the i7, I would upgrade every 1.5 - 2 years tops. This thing is nuts.

mkozakewich - Tuesday, August 4, 2015 - link

We've reached the end of that exponential advancement, so you can expect things to advance at roughly this rate for a while, at least until we also reach "small enough".

close - Tuesday, August 4, 2015 - link

That's logarithmic advancement :). It keeps slowing down year after year.

Cryio - Tuesday, August 4, 2015 - link

Technically with Sandy Bridge they reached the end. SB was quite a jump over Nehalem.

Harry Lloyd - Tuesday, August 4, 2015 - link

There is no end. Intel just do not care, as they have no competition. Why would they waste money on increasing performance, when they can focus on efficiency for mobile? They can get away with selling basically the same CPUs every year on desktop, as they are still the fastest.

Badelhas - Tuesday, August 4, 2015 - link

I also blame AMD. If they had good high end CPUs Intel would be forced to improve the ones they´ve been selling for the last 5 years or so.

1   2   3   4   5   6   13   ▶

LINKS

Home
About
Forums
RSS
Pipeline News
Bench
Terms of Use
Contact Us
Accessibility Statement

TOPICS

CPUs
Motherboards
SSD/HDD
GPUs
Mobile
Enterprise & IT
Smartphones
Memory
Cases/Cooling/PSU(s)

Displays
Mac
Systems
Cloud
Trade Shows
Guides

FOLLOW

Facebook

Twitter

RSS

The Most Trusted in Tech Since 1997

About   Advertising   Privacy Policy