Intel 7th-gen ‘Kaby Lake’ Core i7 processor review

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Intel’s Tuesday rollout of 7th-generation Kaby Lake CPU for desktops has met a dubious fanfare of leaked reviews that dismiss the new chip as one huge Core i Yawn. Kaby Lake seems to offer barely any movement forward and when overclocked, apparently gets to nuclear-fusion levels of heat output.

But it’s too early to write off Kaby Lake. There’s a lot more to it that you still need to know.

What Kaby Lake brings to the desktop

Kaby Lake launched in August with dual-core versions for laptops that offered reasonable performance upticks. The highlight is its video engine, which can handle 10-bit content without breaking a sweat. Play a 10-bit color depth file on a Skylake laptop with integrated graphics, and you drop frames and destroy battery life. The same video on Kaby Lake hums along with far less impact. You can see this demonstrated right here. The updated graphics core with the latest content protection can now stream 4K from services such as Netflix.com.

On the desktop side, however, power users don’t care about integrated graphics, focusing more on the lackluster x86 performance.To be fair, Intel set the expectation in August that Kaby Lake was basically Skylake on an improved process that squeezes out more megahertz.

For example, the top-end Core i7-7700K has a base clock of 4.2GHz and a Turbo Boost clock speed of 4.5GHz, vs. a Skylake Core i7-6700K’s base clock of 4GHz and Turbo Boost of 4.2GHz.

The cache size, the core count, the memory controller and even the same LGA1151 socket are unchanged from the previous chip.



This is the real launch

Intel fleshes out the Kaby Lake lineup with a total of 42 CPUs: 17 ultra low power chips for laptops, two quad-core Xeons, seven quad-core laptop CPUs, and 16 desktop CPUs.

Of particular interest in that desktop lineup to DIYers are the three unlocked “K” chips. The first two were expected: a quad-core with 4.2GHz Core i7-7700K with Hyper-Threading and a quad-core 3.8GHz Core i5-7600K without Hyper-Threading. The third is a surprise: the dual-core 4.2GHz Core i3-7350K. The CPU has Hyper-Threading but since it is a Core i3, does not have Turbo Boost enabled.

(This isn’t the first time for Intel. When the company released the budget Pentium G3258 Anniversary Edition in 2014 and in 2010, it offered a dual-core Core i5-655K.)

The new Z270 is “Optane Ready”

With Kaby Lake for desktops, Intel is introducing new 200-series chipsets to replace the 100-series chipsets that was introduced with Skylake. Like Kaby Lake, it is an incremental

update that disappoints a bit.

We expected the 200-series chipsets to feature native support for USB 3.1 10Gbps or maybe even Thunderbolt 3, but no. Instead, motherboard makers will have to add additional chips for those functions.

From what I can tell, there are three key changes to Z270. The first is an upgrade from the 20 lanes of PCIe Gen 3 in the Z170 to 24 lanes in the new performance Z270 chipset. The move will let motherboard makers integrate high-bandwidth connections such as M.2 or U.2 without having to share bandwidth between devices. Intel says it has also improved overclocking capability.

The last upgrade is official “Optane ready” support. What that means isn’t exactly clear, but we do know Intel’s Optane (a non-volatile memory that promises much higher performance than SSDs) will go into an M.2 slot on the board, where it can be used as a traditional storage device or as a way to accelerate system performance, much like what’s done today with Intel’s Smart Response Technology, which uses an SSD to cache performance from a traditional hard drive.

That doesn’t mean Optane won’t work in other systems using older chipsets, but Intel is likely to support it only for “system acceleration” on Z270 initially.

If none of these sound like much of an upgrade over your existing Z170 motherboard, the good news is you don’t have to buy a Z270 motherboard. Kaby Lake drops into most LGA1151 Z170 motherboards and works just fine, as long as you’re using an updated BIOS that supports the new CPU.





From left to right: An 8-core Core i7-5960X, the new Core i7-7700K, the ancient Core i7-2600K and a Core i7-4790K.

How we tested

For our performance testing, I focused on how Kaby Lake does against the CPU it replaces: I dropped the Core i7-7700K into the same Asus Z170 Deluxe motherboard that the Skylake chip was first tested with. The CPU was cooled with a Corsair H80i closed liquid cooler and outfitted with 16GB of Corsair DDR4/2133 RAM, a reference GeForce GTX 980 card and a 256GB HyperX SSD. The OS was Windows 10 running the TH2 build.

Cinebench R15 multi-core performance



Our first test is Maxon's Cinebench R15. It's a benchmark based on Cinema 4D's rendering engine and is a pure CPU test. We recorded scores from many of Intel's high-end quad-core mainstream chips, as well as chips with more cores for context.

Among the quad-cores, the Core i7-7700K the winner by the expected amount. The Kaby Lake CPU is roughly 4 to 5 percent higher in clock speed and roughly 4 to 5 percent faster in Cinebench. When you look back to the Core i7-2600K though, it's a huge 42-percent difference in performance. Stock clock performance between the Kaby Lake, Skylake and Devil's Canyon, though, isn't exactly going to set the world on fire.

Cinebench R15 single-core performance



One error with focusing exclusively on multi-core performance is reality sometimes doesn't match that. Some applications are

lucky to exploit more than a single thread, instead favoring higher clock speeds and more efficient CPU cores. Once we set Cinebench R15 to run in single-threaded mode, the quad-cores with their higher clock speeds jump to the front of the line, with the Core i7-7700K now leading the pack. For most people, who don’t do 3D rendering or other heavily multi-threaded tasks, a quad-core with higher clock speeds is the right choice.

Other highlights from the results: There isn’t a lot daylight between the Core i7-7700K and the Core i7-6700K. Note, too, that our 10-core Broadwell-E Core i7-6950X was performed without Turbo Boost Max. Turbo Boost Max lets the CPU greatly increase the clock speed on a single core, bringing performance a lot closer to the quad-cores.

POV Ray performance

Another CPU-heavy test we use is POV Ray. It’s a ray-tracing program that traces its roots back to the Amiga. Our benchmark set is a little smaller but no surprise, the Kaby Lake, with its 4- to 5-percent clock speed advantage, finishes the test about 4 to 5 percent faster, putting the Core i7-7700K just barely behind a six-core Ivy Bridge-E Core i7-4960X.

As with Cinebench R15, we also run the test using a single-threaded workload. With lighter loads the CPUs can run at higher clock speeds and no surprise, the pair of quad-cores take the lead. Again, we saw maybe a 5 percent advantage for the Core i7-7700K over the Core i7-6700K.

Blender performance



Our final rendering test uses Blender 2.77a and Mike Pan’s BMW workfile to measure how fast the various CPUs can render a single frame using the free and popular Blender app. The Core i7-7700K again pulls ahead of the Core i7-6700K by a small percentage,well within what we expected for its clock speed advantage. And yes, that six-core Ivy Bridge-E Core i7-4960X is really starting to look moldy here. One thing I’d like to point out about Blender is it doesn’t show the scaling with thread count as much as Cinebench R15. While the 10-core Core i7-6950X is the winner here, it’s not as impressive as I would have expected for a $1,723 CPU.

HandBrake 10.2 performance



Turning to video encoding, we used the popular and free HandBrake 10.2 encode to convert a 30GB MKV file using the Android tablet preset. The Core i7-7700K again comes in slightly ahead of the Core i7-6700K. There’s also a pretty healthy distance between the Kaby Lake chip and the still-excellent Devil’s Canyon chip. The older Ivy Bridge-E Core i7-4960X disappoints yet again, especially consider that it has six cores yet is basically tied with the quad-core Kaby Lake chip.

The IPCs have it

CPU nerds like to talk about IPC, or instructions per cycle of a CPU. It’s one way to gauge efficiency at a given clock speed. I took the performance of each CPU running the CineBench R15 test in single-threaded mode with Turbo Boost switched off on all of the CPUs. As I said with the Skylake

Core i7-6700K review, it’s a pretty sobering wakeup call to see just how slowly IPC is inching along in modern CPUs.

The good news for modern processors is IPC isn’t the only place you can pick up performance. Clock speed, core count and ability to hold Turbo Boost speeds longer (thanks to improved manufacturing) have all added up to better performance. Here’s that reminder seen in the first chart we ran from Cinebench R15, when each CPU is allowed to run unfettered rather than locked down to a fixed frequency.

Conclusion

So let’s sum it up. In laptops, the performance bump is very decent, with perhaps 20 percent or more going from just Broadwell to Kaby Lake.

Desktops aren’t constrained by thermals and battery life the way laptops are, so the performance difference between the generations is far less. The one really big difference between previous chips is the greatly improved video engine. To performance-oriented desktop users, though, integrated graphics—outside of NUC-style mini-PC’s—is unimportant.

The price, though equal to Skylake, is a little disappointing for those who expected it to be cheaper, but it’s not like you’re paying more for less performance. Instead, you’re paying the same price to get a little better performance.

Kaby Lake is better and faster, but despite the greater overclocking potential, you can see why, for most DIYers, it’s a little bit of a yawn. Still, some builders should consider it, and I break down the decision tree CPU by CPU below.

If I had a Core i7-6700K system: I wouldn't upgrade to Kaby Lake, and I don't think Intel expects you to unless you want to help prop up the company's bottom line. There's just absolutely nothing compelling that would warrant it on a discrete graphics system right now. If Intel's Optane emerges as a game changer, then you'd consider a move.

If I were going to build a new Core i7-6700K system: I wouldn't. Instead, I'd build one using the new Core 7-7700K. Even if you don't intend to overclock it at first, the stock clock is already higher, and prices will be the same once initially demand settles down. The simple math is Kaby Lake is better, so there's no reason to buy Skylake today.

If I had a Core i7-4770K or Core i7-4790K system: I probably wouldn't upgrade. The Core i7-4770K is still quite a powerful and useful CPU. The only reason would be the need for more M.2 or U.2 storage options, or if you want to be ready for Optane

If I had a Core i7-4960X or Core i7-3960X system: The results are pretty clear for these elderly CPUs: Even a once mighty six-core CPU can now be matched by Intel's new Core i7-7700K chip in some workloads. However, if you were the kind of person who bought a six-core Sandy Bridge-E or Ivy Bridge-E, you care about core count for a reason. It makes far more sense to buy into Intel's Broadwell-E platform to run a six-core or eight-core CPU. Or just wait to see if AMD's Ryzen can give you the core counts and performance you need.

If I had a Core i7-3770K or Core i7-2600K: Look, there's nothing wrong with the classic Core i7-3770K or Core i7-2600K in actual CPU performance. The problem is your chipset. The Z77 chipset only has two SATA 6Gbps ports, and good luck trying to run a modern M.2 NVMe drive in them. These platforms are about as creaky as a Pontiac Grand Am with 275,000 miles on the odometer and a leaky transmission. It's basically time to upgrade, and Kaby Lake would be fine for both.

If I had a Core i5: You can get by with a quad-core without Hyper-Threading but anecdotal reports from many say the days of a quad-core only CPU are drawing to a close. And if you have to upgrade your Sandy Bridge or Ivy Bridge Core i5 chip (or even Haswell or Skylake) it probably makes sense to upgrade all the way to a new Kaby Lake CPU.