AMD vs Intel 2020: Who Makes the Best CPUs?

By Paul Alcorn april 2020

We put AMD vs Intel in a battle of processor prowess.

If you're looking for the best gaming CPU or the best CPU for desktop applications, there are only two choices to pick from: AMD and Intel. That fact has spawned an almost religious following for both camps, and the resulting flamewars, that make it tricky to get unbiased advice about the best choice for your next processor. But in many cases, the answer is actually very clear. In fact, for most users, it's a blowout win in AMD's favor.
This article covers the never-ending argument of AMD vs Intel desktop CPUs (we're not covering laptop or server chips) based on what you plan to do with your PC, pricing, performance, driver support, power consumption and security. There's a clear winner overall, but which brand of CPU you should buy depends most on what kind of features, price and performance are important to you.

AMD vs Intel CPU Pricing and Value

Pricing is the most important consideration for almost everyone, and AMD is hard to beat in the value department. The company offers a plethora of advantages, like bundled coolers and full overclockability on all models, not to mention complimentary software that includes the innovative Precision Boost Overdrive auto-overclocking feature.

You also benefit from the broad compatibility of Socket AM4 motherboards that support both forward and backward compatibility, ensuring that not only do you get the most bang for your processor buck, but also your motherboard investment. AMD also allows overclocking on all but its A-Series motherboards (see our article on how to overclock AMD Ryzen), which is another boon for users.

Processor Pricing by Family	AMD	Intel
Threadripper - Cascade Lake-X	$900- $3,750	$800 - $1,000 ($2,999)
AMD Ryzen 9 - Intel Core i9	$434 - $739	$459 - $505
AMD Ryzen 7 - Intel Core i7	$294 -$339	$300 - $370
AMD Ryzen 5 - Intel Core i5	$149 - $249	$125 - $200
AMD Ryzen 3 - Intel Core i3	$95 - $120	$78 - $173

And, in this battle of AMD vs Intel CPUs, we haven't even discussed the actual silicon yet. AMD's modern processors tend to offer either more cores or threads and faster PCIe 4.0 connectivity at every single price point, which we'll cover below.

Even though we have seen some price easing on Intel's high end-desktop (HEDT) models, the company continues to charge a premium for its silicon. Intel includes bundled coolers with its non-overclocking SKUs (you have to pay more to overclock), but they are flimsy and 'good enough,' at best. We've even seen cases where Intel's stock coolers don't provide full performance at stock settings. They certainly aren't comparable to AMD's standard fare, which even spans up to RGB coolers with some processors.
Intel also doesn't throw in a cooler at all for its pricey overclockable K-series SKUs (see our article on how to overclock an Intel CPU). Be sure to budget in a cooler (and a beefy one at that) if you plan on overclocking an Intel processor.

Meanwhile, most of AMD's bundled coolers are suitable for at least moderate overclocking. If you're looking for a budget Intel chip, though, the Core i5-9400F is certainly worthy of consideration. It lacks integrated graphics and overclocking, but $125 is actually a decent price for an Intel Core i5.
Intel not only charges a premium for its overclockable K-Series chips, but you'll also need to shell out for a pricey Z-Series motherboard for the privilege of tuning your processor—Intel doesn't allow overclocking on B- or H-series motherboards. Intel also has a long history of rapid socket transitions, meaning the odds of dropping a new chip into your existing motherboard, or taking the older processor over to a newer board, aren't as high. Plan for limited forward and backward compatibility on the Intel side. You'll also miss out on PCIe 4.0 connectivity—Intel remains mired on the PCIe 3.0 bus that offers half the transfer speed of AMD's PCIe 4.0 connection.

While AMD offers the most bang for your hard-earned dollar, as with any type of product, you can expect to pay a premium for the utmost performance—in particular the Ryzen 9 3950X. Intel has long enjoyed a commanding performance lead over AMD processors in many metrics. Still, even though the company continues to charge a premium, its days of a clear-cut performance leadership have largely come to an end.

Win: AMD. When you're comparing AMD vs Intel CPUs, Team Red has a compelling value story across the full breadth of its product stack, especially when we take performance-per-dollar into account. However, if you're looking for integrated graphics paired with a processor with more than four cores, Intel is currently your only choice. Not that we'd recommend integrated graphics for most users, particularly if you're interested in gaming—check out our GPU hierarchy for details on how the various graphics solutions fare.

AMD vs Intel CPU Gaming Performance

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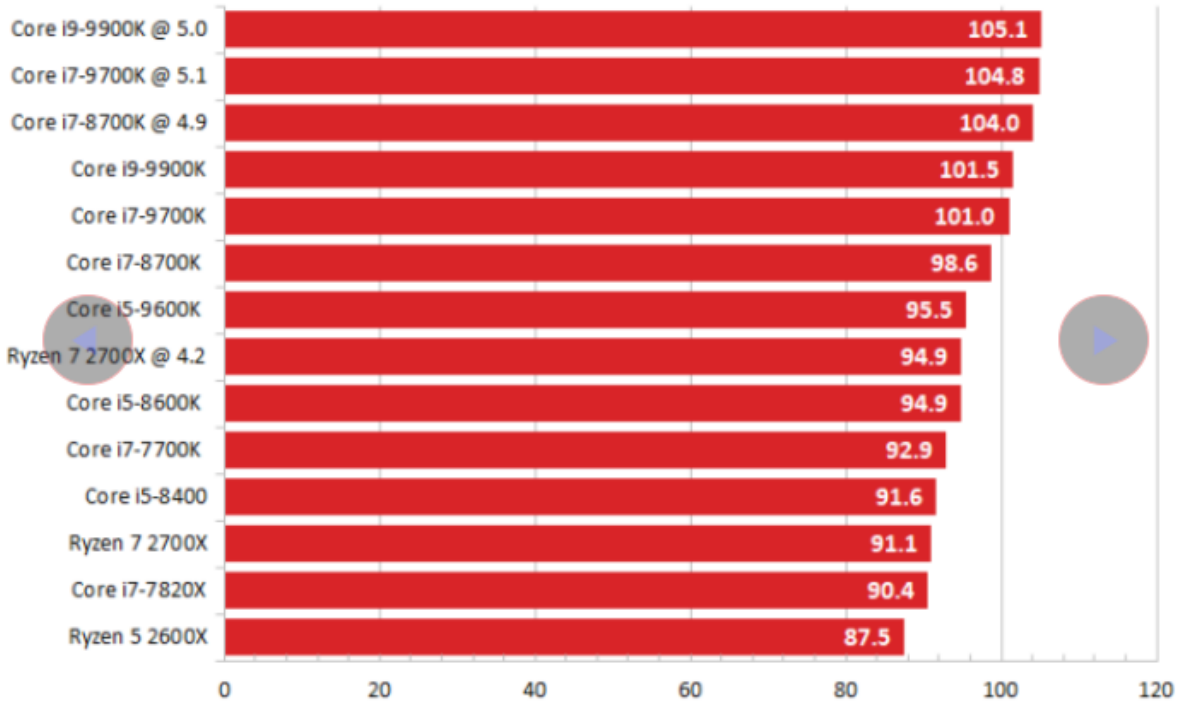


(Image credit: Tom's Hardware)

In the AMD vs Intel CPU battle, Intel still barely holds the edge in per-core performance, meaning it offers really snappy performance in lightly-threaded scenarios and applications that don't scale well with core and thread counts. That includes the majority of games. However, AMD holds the lead in a few critical price bands, particularly right in the middle of its stack, and our benchmarks show the company's gaming performance is no slouch, either.

Above we have a wide selection of collective gaming performance measurements in the different price bands.
Intel definitely holds the ultimate in gaming performance with its most expensive desktop processor, the Core i9-9900K, and it's mid-range Core i9-9700K isn't far behind. However, the performance delta between Intel and AMD's comparably-priced chips often isn't worth the premium, at least for the vast majority of enthusiasts.
You'd be hard-pressed to notice the small differences in gaming performance at the top of the AMD vs Intel stack, but things are more complicated in the mid-range. Referring back to our previous category, pricing is the ultimate measuring stick, and AMD pulls off a few key wins in the mid-range where most of us shop, while Intel's victories aren't as clearly defined.

You'll need a fire-breathing high-end GPU and high-refresh rate monitor to get the most out of Intel's performance advantage, and you'll need to game at the mundane 1080p resolution, too. Kicking your resolution up to 1440p and beyond typically pushes the bottleneck back to the GPU, so you won't gain as much from your CPU's gaming prowess. However, a bit of extra CPU gaming performance could pay off if you plan on updating your graphics card with a newer generation while keeping the rest of your system intact—AMD's Big Navi and Nvidia's GTX 3080 / Ampere are slated to launch this year.
We expect most builds in the mid-range to come with lesser GPUs, which generally serves as an equalizer in terms of CPU performance. It's also noteworthy that AMD often provides more cores and threads at any given price point, so there's less of a chance of utterly erratic performance if you're running chat clients, web browsers, and other tasks in the background while gaming. If you're into game streaming, AMD is almost always the best choice due to its healthy ratio of cores and threads.

You should always buy the best GPU you can afford, provided your CPU can push it along at full speed because it's often the bottleneck. That's why you should pay close attention to our library of best gaming CPUs and best graphics cards articles, along with our CPU hierarchy and GPU hierarchy, to ensure you have the best pairing of those two critical components.
Winner: Intel wins this round of the AMD vs Intel CPU showdown, but only because we measure strictly by the absolute top performance possible. If you're a gaming fanatic that prizes every single last frame you can squeeze out, particularly if you're into overclocking, Intel is your answer on the high-end. That leading-edge performance will also pay off if you plan to upgrade your GPU soon. Just plan to pay for the privilege.
You'll find that AMD is often the best option in the mid-range, and unless you're running a tricked-out rig with the fastest GPUs paired with low-resolution high-refresh monitors, you won't miss the slim gaming performance deltas to be had with Intel CPUs.

AMD vs Intel Productivity and Content Creation Performance

In the non-gaming performance battle of AMD vs Intel CPUs, the picture is a lot clearer. AMD's chips take the outright win, period, in terms of the ultimate in performance in productivity and content creation applications. AMD's copious slathering of cores, threads, and cache on its processors also equates to a big win in the performance-per-dollar category.

Intel's trouble moving forward to denser process nodes has left it behind in the core count race, and now AMD has offerings on both the HEDT and mainstream desktop that Intel simply can't match. Consider this: AMD has a 16-core Ryzen 9 3950X for the mainstream desktop that offers twice the cores and threads of Intel's most powerful Core i9-9900K. Meanwhile, AMD's Ryzen Threadripper 3990X comes with an insane 64 cores and 128 threads for HEDT. That's a 3.5X advantage in core counts over Intel's halo HEDT models.

AMD's chips offer far more performance on both the mainstream desktop and HEDT platforms, so they are also more expensive than Intel's respective flagships. You don't need to drop major dollars to see the advantages of AMD's chips, though. In terms of cores and threads, AMD offers more for less at every single price range. Those extra cores equate to big performance-per-dollar wins in almost every type of threaded workload, like rendering and video processing.

Winner: AMD. For professionals on the hunt for performance in content creation and productivity applications, the winner of AMD vs Intel CPUs is a pretty one-sided affair. AMD's lack of integrated graphics on its 6-core and above CPUs (for now) means you'll have to stick with Intel if you want to build a rig without dedicated graphics, but most professionals will want a dedicated graphics card regardless.

AMD vs Intel Processor Specifications and Features

AMD has its Ryzen 3, Ryzen 5, Ryzen 7, Ryzen 9, and Threadripper lines, while Intel breaks its offerings up into the Core i3, Core i5, Core i7, Core i9, and Cascade Lake-X families. To compare AMD vs Intel CPUs based on specs and features, we could chart the entire product stacks, but for the sake of brevity we'll focus on the top chips in the respective product lines. Be aware that both companies have value options within each tier, but we can get a general sense of the current competitive landscape with these (relatively) short lists. We're using both vendor recommended pricing and street pricing to give you a sense of the current state of the market.

AMD vs Intel CPUs HEDT Specs and Pricing

High End Desktop (HEDT)	**MSRP / Retail**	**Cores / Threads**	**Base / Boost GHz**	**L3 Cache**	**TDP**	**PCIe**	**Memory**
Threadripper 3990X	**$3,990 / $3,750**	**64 / 128**	**2.9 / 4.3**	**256**	**280 W**	**72 Usable Gen4**	**Quad DDR4-3200**
Intel W-3175X	$2,999 / N/A	28 / 56	3.1 / 4.8	38.5	255W	48 Gen3	Six-Channel DDR4-2666
Threadripper 3970X	**$1,999 / $1,899**	**32 / 64**	**3.7 / 4.5**	***128**	**280 W**	**72 Usable Gen4**	Quad DDR4-3200
Threadripper 3960X	**$1,399 / $1,399**	**24 / 48**	**3.8 / 4.5**	***128**	**280 W**	**72 Usable Gen4**	Quad DDR4-3200
Xeon W-3265	$3,349	24 / 48	2.7 /	33	205W	64	Six-

	/ N/A		4.6			Gen3	Channel DDR4-2933
Core i9-10980XE	$979 / $1,099	18 / 36	3.0 / 4.8	24.75	165W	48 Gen3	Quad DDR4-2933

The high end desktop (HEDT) is the land of creative prosumers with fire-breathing multi-core monsters for just about every need. Intel has long enjoyed the uncontested lead in this segment, but while AMD's first-gen Threadripper lineup disrupted the status quo, the Threadripper 3000 lineup destroyed it.

Here we can see that when it comes to AMD vs Intel HEDT CPUs, AMD holds the uncontested lead with 64 cores and 128 threads in its flagship Threadripper 3990X, and the 32- and 24-core Threadripper 3970X and 3960X models cement the overwhelming lead over Intel's chips.
Intel splits its highest-end lineup into two classes, with the Xeon W-3175X and W-3265 dropping into exotic LGA3647 motherboards that carry eye-watering price tags to match the chips' insane pricing. These aren't really enthusiast-class systems though; think of these as more for the professional workstation market.
Intel's HEDT lineup truly begins with its 18-core Cascade Lake-X Core i9-10980XE that drops into existing LGA2066 motherboards. The chip is powerful given its price point, but Threadripper's 3.5X advantage in core counts is impossible to beat, so Intel has basically ceded the top of the HEDT stack to AMD.
You'll get more cores, cache, and faster PCIe 4.0 connectivity with AMD's Threadripper lineup, but they do come with higher price tags befitting such monstrous processors. However, when we boil it down to per-core pricing, or how much you pay for each CPU core, AMD does offer a compelling value story.

AMD vs Intel CPUs High End Specs and Pricing

High End Mainstream	**MSRP / Retail**	**Cores / Threads**	**Base / Boost GHz**	**L3 Cache**	**TDP**	**PCIe**	**Memory**
Ryzen 9 3950X	**$749 / $739**	**16 / 32**	**3.5 / 4.7**	**64**	**105W**	**24 Gen4**	**Dual DDR4-3200**
Ryzen 9 3900X	$499 / $434	12 / 24	3.8 / 4.6	64	105W	24 Gen4	Dual DDR4-3200
Core i9-9900K	$488 / $524	8 / 16	3.6 / 5.0	16	95W	16 Gen3	Dual DDR4-2666
Core i7-9700K	$374 / $370	8 / 8	3.6 / 4.9	12	95W	16 Gen3	Dual DDR4-2666

Ryzen 7 3800X	$399 / $339	8 / 16	3.9 / 4.5	32	105W	24 Gen4	Dual DDR4-3200
Ryzen 7 3700X	$329 / $294	8 / 16	3.6 / 4.4	32	65W	24 Gen4	Dual DDR4-3200

In the battle of high-end AMD vs Intel CPUs, AMD's Ryzen 9 and Ryzen 7 families square off against Intel's Core i9 and Core i7 lineup. Again, AMD holds the absolute lead with the 16-core 32-thread Ryzen 9 3950X that sets the new high watermark for the mainstream desktop both in terms of core counts and performance—and price, not including a cooler. Intel's 8-core 16-thread Core i9-9900K pales in comparison, but based on pricing, it actually battles AMD's Ryzen 9 3900X. Here we see that AMD has both the core count and price-per-core advantage in this price bracket, which it complements with more cache, PCIe 4.0 and faster base memory support. The 9900K does hold the absolute gaming performance leadership position, but that's about it. And the 3900X is close enough that Intel's performance delta won't be noticeable to most gamers, though it might be useful if you upgrade your GPU.

The same story plays out in the decidedly more mainstream Ryzen 7 and Core i7 markets. Honestly, these are the chips the majority of gamers should buy. Here AMD's Ryzen 7 3700X easily outweighs Intel's Core i7-9700K with eight extra threads, which is helpful in any number of workloads. Again, the 9700K holds the gaming crown, but the Ryzen 7 family owns the rest of the benchmarks—and wins big on pricing.

ntel CPUs Mid-Range and Budget Specs and Pricing

Mainstream/Budget	**MSRP / Retail**	**Cores / Threads**	**Base / Boost GHz**	**L3 Cache**	TDP	**PCIe**	Memory
Core i5-9600K	$262 / $200	6 / 6	3.7 / 4.6	9MB	95W	16 Gen3	Dual DDR4-2666
Ryzen 5 3600X	$249 / $205	6 / 12	3.8 / 4.4	32 MB	95W	16 +4 Gen4	Dual DDR4-3200
Ryzen 5 3600	$199 / $175	6 / 12	3.6 / 4.2	32 MB	65W	16 +4 Gen4	Dual DDR4-3200

Core i5-9400 / F	$182 / $125	6 / 6	2.9 / 4.1	8MB	65W	16 Gen3	Dual DDR4-2400
Core i3-9350K / F	$184 / $174	4 / 4	4.0 / 4.6	8MB	91W	16 Gen3	Dual DDR4-2666
Ryzen 3 3300X	$120	4 / 8	3.8 / 4.3	16 MB	65W	16 +4 Gen4	Dual DDR4-3200
Ryzen 3 3100	$99	4 / 8	3.8 / 3.9	16 MB	65W	16 +4 Gen4	Dual DDR4-3200
Ryzen 5 3400G	$150 / $207	4 / 8	3.7 / 4.2	4MB	65W	16 Gen3	Dual DDR4-2933
Core i3-9100 / F	$122 / $78	4 / 4	3.6 / 4.2	6MB	65W	16 Gen3	Dual DDR4-2400
Ryzen 3 3200G	$99 / $95	4 /4	3.6 / 4.0	4MB	65W	8 Gen3	Dual DDR4-2933

When it comes to AMD vs Intel mid-range and budget CPUs, the Core i5 and i3 families do battle with AMD's Ryzen 5 and Ryzen 3 processors. This market segment comprises the most substantial portion of both AMD and Intel's sales, so pricing and value here are paramount.

AMD's Ryzen 5 3600X matches Intel core-for-core, but throws in extra threads to offset the Core i5-9600K's clock speed and overclocking advantage, making the 3600X the uncontested best mix of performance and price for the mid-range. You can even step down to the Ryzen 5 3600 and get nearly the same performance as the 3600X by using AMD's one-click Precision Boost Overdrive overclocking. Pro tip: Always search out AMD's non-X models for the best value.

AMD is shoring up its defenses with a new line of graphics-less $120 Ryzen 3 3300X and $99 Ryzen 3 3100 models, too. Three years ago Intel's flagship chips cost roughly $350 and came with four cores and eight threads, but now AMD's Ryzen 3 lineup offers the same number of cores and threads for as low as $99. That opens up a tremendous amount of threaded performance at every point in AMD's stack, and obviously deals the resale value on older Intel chips yet another blow. AMD also announced that B550 motherboards will arrive soon, bringing a more value-conscious ecosystem of PCIe 4.0 products down to the low end of the market.

AMD also leans on its Ryzen 5 3400G and Ryzen 3 3200G APUs to fend off Intel's Core i5-9400F, Core i3-9350K/F, and Core i3-9100F models. AMD's models come with potent Vega graphics units that enable low-end gaming across a broad spate of titles. Intel's chips can't hold a candle there—you'll need a discrete GPU if you plan to do any meaningful gaming. Which is why the i5-9400F and i3-9100F are so attractive, as they shave $50 off the price for users that intend to buy a dedicated graphics card anyway. The new Ryzen 3 3300X and 3100 aren't on the market yet, but it will be interesting to see how they impact this portion of the market.
Neither vendor offers integrated graphics units (iGPU) with their HEDT chips. Still, even though Intel sells its graphics-less F-Series chips for a discount, it holds the advantage of having a graphics option across the full breadth of its mainstream product stack.

In contrast, AMD only offers integrated graphics on its APU models, which means you'll need a discrete graphics card (GPU) for any chip that has more than four cores (or costs more than ~$150). That's a significant disadvantage for most mainstream users that aren't interested in gaming, and also eliminates a big chunk of the professional/OEM markets. Intel's iGPUs are mostly useless for gaming but are useful for display and QuickSync purposes, while AMD's iGPUs offer the best gaming experience, hands down. However, AMD's limited selection cuts it out a significant portion of the market.

Winner: AMD. When you compare AMD vs Intel CPU specifications, you can see that AMD offers more cores and/or threads at every price point, more cache, support for faster memory, and PCIe 4.0 for the mid-range and high end. From the top of the HEDT market to the high-end, mid-range and low-end sectors, AMD has a capable Ryzen processor that offers more value than comparable Intel models.

AMD vs Intel CPU Overclocking

There's no debate when you compare AMD vs Intel CPU overclocking. Intel offers the most overclocking headroom, meaning you can gain more performance over the baseline speed with Intel chips than you can with AMD's Ryzen processors.

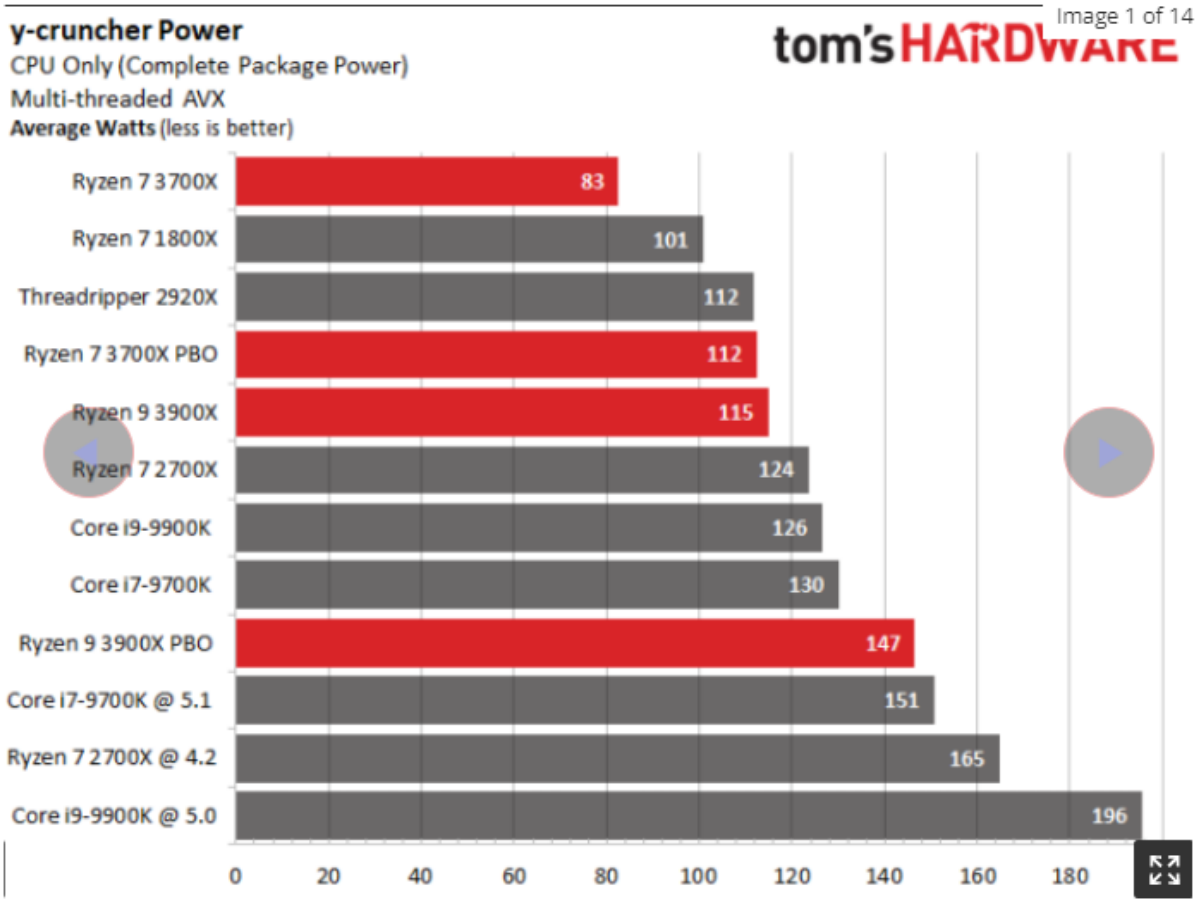
As mentioned, you'll have to pay a premium for Intel's K-Series chips and purchase a pricey Z-Series motherboard, not to mention splurge on a capable aftermarket cooler (preferably liquid), to unlock the best of Intel's overclocking prowess. However, once you have the necessary parts, Intel's chips are relatively easy to push to their max, which often tops out at over 5 GHz on all cores with the 9th-Gen Coffee Lake Refresh processors.

AMD doesn't have as much room for manual tuning. In fact, the maximum achievable all-core overclocks often fall a few hundred MHz beneath the chips' maximum single-core boost. That means all-core overclocking can actually result in *losing* performance in lightly-threaded applications, albeit a minor amount.
Part of this disparity stems from AMD's tactic of binning its chips to allow some cores to boost much higher than others. In tandem with AMD's Precision Boost and innovative thread-targeting technique that pegs lightly-threaded workloads to the fastest cores, AMD exposes near-overlocked performance right out of the box. That results in less overclocking headroom.

However, AMD offers its Precision Boost Overdrive, a one-click auto-overclocking feature that will wring some extra performance out of your chip based on its capabilities, your motherboard's power delivery subsystem and your CPU cooling. AMD's approach provides the best performance possible with your choice of components and is generally hassle-free. In either case, you still won't achieve the high frequencies you'll see with Intel processors (5.0 GHz is still unheard of with an AMD chip without liquid nitrogen cooling), but you do get a free performance boost.

Winner: Intel. When it comes to AMD vs Intel CPU overclocking, Team Blue has far more headroom and much higher attainable frequencies. Just be prepared to pay for the privilege. AMD's approach is friendlier to entry-level users, rewarding them with hassle-free overclocking based on the capabilities of their system, but you don't gain as much performance.

AMD vs Intel CPU Power Consumption and Heat



When comparing AMD vs Intel CPU power and heat, the former's 7nm process node makes a huge difference. Power consumption comes as a byproduct of design choices, like lithography and architecture which we'll discuss below. However, higher power consumption often correlates to more heat generation, so you'll need beefier coolers to offset the heat output of greedier chips.

Intel has improved its 14nm processes to strengthen its power-to-performance ratio by more than 70% in the five long years its been on the market, but it's no coincidence that Intel's latest chips are known for high power consumption and heat. That's because Intel has had to turn the power dial up further with each generation of chips to provide more performance as it fends off the resurgent AMD. That leads to problems with some stock coolers and also requires robust power delivery on your motherboard. Those factors combine to make Intel a notorious power guzzler.

In contrast, AMD has the benefit of TSMC's 7nm node, which is more efficient than Intel's 14nm. AMD does lose some of that advantage in its Ryzen 3000 series processors due to a large central 14nm I/O die that comes as part of the package. Still, in aggregate, AMD's 7nm chips either consume less power or provide much better power-to-performance efficiency. As a result, you'll get more work done per watt of energy consumed, which is a win-win, and AMD's cooling requirements aren't nearly as overbearing.

Winner: AMD. In judging AMD vs Intel CPU performance per watt, It's impossible to overstate the importance of having the densest process node paired with an efficient microarchitecture, and TSMC's 7nm and AMD's Zen 2 are the winning combination. The latest Ryzen processors consume less power on a performance-vs-power basis, which in turn equates to less heat generation. That eases cooling requirements.

AMD vs Intel CPU Drivers and Software

When we look at AMD vs Intel CPU software support, Team Blue has a stronger reputation. AMD has been beset by issues with its CPU chipset drivers and graphics drivers of late, which is a natural byproduct of its limited resources compared to its much-larger rivals. Intel isn't without its missteps on the driver front, but the company's reputation for stability did help earn it the top spot in the processor market, particularly with OEMs.

In terms of its established products, Intel's graphics drivers have become much better lately as the company ramps up to bring its dedicated Xe Graphics cards to market. Day-zero game drivers have become the norm for the chip producer, which by virtue of its integrated graphics on its chips, is the world's largest graphics vendor with an install base of over a billion screens—that's a billion *slow* screens, but who's counting? (Answer: Every PC gamer out there.)

You might be a little more cautious when approaching Intel's more exotic solutions, though. In the past, the company has developed innovative new products that have been relegated to the dustbin of history due to pricing and market forces, and long-term support for those products might not always be clear cut.

AMD still has its work cut out for it. The company has had several issues with BIOS releases that failed to expose the full performance of its chips, though AMD has mostly solved those issues after a long string of updates. As a side effect of being the smaller challenger, AMD also faces a daunting challenge in offsetting the industry's incessant optimization for Intel's architectures above all others.

Upsetting the semiconductor industry is hard, particularly when you're fighting an entrenched and much-larger rival, and sometimes things get broken when you're redefining an industry. In AMD's case, those broken things consist of operating systems and applications that weren't tuned to extract the full performance of its fledgling first-gen Zen architecture, let alone the core-heavy designs of Zen 2.

Winner: Intel wins the battle of AMD vs Intel CPU drivers and software**.** Over the last year, Intel has addressed its laggardly driver updates for its integrated graphics, and the company has an army of software developers at its disposal that help ensure its products get relatively timely support with the latest software. A decade of dominance also finds most software developers optimizing almost exclusively for Intel architectures. AMD has made amazing progress convincing the developer ecosystem to optimize for its radical new Zen architectures, but there's still plenty of work to be done as the company moves forward.

AMD vs Intel CPU Lithography

There are a few major underlying technologies that dictate the potency of any chip. The most fundamental rule of processors still holds true: The densest process nodes, provided they have decent power, performance, and area (PPA) characteristics, will often win the battle if paired with a solid microarchitecture. When you judge AMD vs Intel CPUs based on these criteria, AMD has the lead in both lithography and architecture.

But whether or not AMD actually *owns* the process lead is a topic of debate: Unlike Intel, AMD doesn't produce its processors. Instead, the company designs its processors and then contracts with outside fabs that actually produce the chips. In the case of AMD's current-gen Ryzen processors, the company uses a combination of GlobalFoundries 12nm process and TSMC's 7nm node for its chips, with the latter being the most important.

TSMC's 7nm node is used by the likes of Apple and Huawei, among many others, so it benefits from industry-wide funding and collaborative engineering. The result is what Intel itself calls a superior 7nm process compared to Intel's 10nm and 14nm chips. Intel says its process tech won't achieve parity with the industry again until 2021, and it won't retake leadership until it releases 5nm at an undefined time.
The benefits of TSMC's 7nm node means AMD can build cheaper, faster, and denser chips with more cores, and all within a relatively low power consumption envelope. That lends the designs a comfortable lead, provided they're combined with a decent design.

We don't have to focus on Intel's 10nm for this article: Intel has been stuck for five long years on the 14nm process for its desktop chips, which isn't changing any time soon, and its 10nm chips that have debuted in laptops are generally unimpressive. (Intel hasn't had a single 10nm model with more than four cores.)

Regardless of whether or not AMD can lay claim to developing the 7nm node to wrest the lead from Intel, the company had the foresight to contract with TSMC to gain access to a superior process node technology. That bedrock advantage gives AMD a wonderful silicon canvas to paint its microarchitectures on, a combination that Intel is finding impossible to beat with its 14nm chips.

The only concern for AMD is production capacity: While AMD has access to 7nm production, the company can't source enough silicon from TSMC, at least in the near term, to match the power of Intel's captive fabs. That leaves AMD exposed to shortages and potentially restricts market penetration. That might not matter much, though, because Intel has been in its own perpetual shortage for more than a year. That's partly due to AMD's new designs forcing the company to boost its core counts, which in turn reduces the number of chips Intel can produce, combined with 10nm delays that created issues with forecasting and logistics.

Winner: AMD (TSMC). Intel has been stuck on 14nm for desktop processors for five years. The company has wrung an amazing amount of performance out of its aging design through a series of "+" optimizations. Still, those enhancements aren't enough to help Team Blue win the battle of AMD vs Intel CPU process nodes. Intel needs a good 10nm or 7nm desktop chip, the sooner the better.

AMD vs Intel CPU Architecture

When comparing AMD vs Intel CPUs, we must consider that two design decisions have a big impact on performance, scalability, and performance-per-dollar: Interconnects and microarchitecture.

AMD's Infinity Fabric allows the company to tie together multiple dies into one cohesive processor. Think of this as numerous pieces of a puzzle that come together to form one larger picture. The approach allows the company to use many small dies instead of one large die, which improves yields and reduces cost. It also grants a level of scalability that Intel might not be able to match with its new mesh interconnect inside its HEDT chips, and it undoubtedly takes the lead over Intel's aging ring bus in its desktop processors.

AMD first paired that advantage with its Zen microarchitecture, which is designed from the ground up for scalability, yielding an explosive 52% increase in instructions per clock (IPC) throughput over AMD's previous-gen 'Bulldozer' chips. The current-gen Ryzen processors come with the Zen 2 microarchitecture that added another 15% improvement to IPC. Paired with the 7nm process, AMD lunged forward another (up to) 31% in per-core performance (a mixture of frequency and IPC).

In terms of per-core performance, the move to the Zen 2 architecture brought AMD's processors to near-parity with Intel's finest. That's largely because Intel is stuck on 14nm, and its architectures are designed specifically for the nodes they are built on. That means promising new Intel microarchitectures can only ride on smaller processes, like 10nm, leaving the company woefully unprepared for its prolonged issues productizing 10nm products.

Intel plans to fix this in the future with microarchitectures that are portable between nodes. Until then, the company is stuck on the same Skylake microarchitecture that's most significant changes have come as hardware-based silicon fixes for its plethora of security vulnerabilities, plus adding more cores.

Winner: AMD. In judging AMD vs Intel CPU architecture, it's clear that one brand is moving faster. Intel has been riding its Skylake microarchitecture since 2015, and it shows. AMD, fueled by rapid advances in its designs while Intel continues to lean on a five-year-old microarchitecture, has taken the lead in many of the most important aspects of chip design.

AMD vs Intel CPU Security

The last few years have found security researchers poking and prodding at the speculative execution engine that's one of the key performance-boosting features behind all modern chips. The resulting research has spawned an almost never-ending onslaught of new vulnerabilities that threaten the safety of your system and private data. Unfortunately, these types of vulnerabilities are incredibly dangerous because they are undetectable—these tactics steal data by using the processor exactly as it was designed; thus, they are undetectable by any known anti-virus program.

The rash of fixes required to plug these holes also continues to grow, and many of them result in reduced performance. That's particularly painful for Intel because the company suffers from far more of these vulnerabilities than other vendors.

Intel currently has 242 publicly disclosed vulnerabilities, while AMD has only 16. That's a 15:1 difference in AMD's favor. It's hard to ascertain if these limited discoveries in AMD processors are due to a security-first approach to hardened processor design, or if researchers and attackers merely focus on Intel's processors due to their commanding market share: Attackers almost always focus on the broadest cross-section possible. We see a similar trend with malware being designed for Windows systems, by far the predominant desktop OS, much more frequently than MacOS, though that does appear to be changing.
Regardless, right now AMD has had far fewer security holes to plug. We've seen some of the fixes drop performance more than two or three architecture updates on Intel, which is particularly painful, and there's no end to these exploits in sight.

Winner: AMD. The gap in AMD vs Intel CPU security is just too large to ignore. As things stand, Intel is susceptible to far more vulnerabilities than AMD. That could change as AMD gains market share, and security researchers increasingly turn their microscopes on its architecture. For now, Intel processors require far more mitigations to improve their security standing. These mitigations often come with a performance penalty, and Intel tends to suffer larger performance losses than the few fixes we've seen from AMD, granting Team Red the win.

Which Processor is Best: AMD or Intel?

AMD's relentless onslaught with its Zen-based processors has redefined our expectations for both the mainstream desktop and the HEDT markets, catching Intel flatfooted as it remains mired on the 14nm process and Skylake architectures. The past several years have seen AMD CPUs go from value-focused and power hungry solutions to leading-end designs that deliver more cores, more performance, and lower power requirements.

Intel has fought back by slowly adding features and cores across its product stack, but that has also resulted in negative side effects, like more power consumption and heat generation. These only serve to highlight the company's struggles on the design and fabrication side of its operation.

The AMD vs. Intel CPU conversation would change dramatically if Intel would lower pricing on its mainstream lineup and ease its draconian segmentation policies that limit features, like overclockability, to pricey chips and motherboards. Intel's tactic of squeezing every penny out of every feature has allowed AMD to offer a more compelling value story across the full breadth of the consumer desktop CPU market.

And AMD has the top-notch performance to match its value story. Intel holds the leadership position in per-core performance, which also grants it a leading position in the gaming market, but that edge only applies to the absolute top of its product stack. AMD does the most damage down in the high-volume mid-range where it is far more competitive.

That's an amazing reversal of fortunes for a company that teetered on the brink of bankruptcy a mere three years ago. AMD still has some work to do as it expands its ecosystem of OEM partners and works with the community to broaden software optimizations for its chips. Still, given the great mix of price, performance, and value, AMD is already in a good spot.

Intel still holds sway with the innumerable customers that don't use a discrete GPU, especially in the high-volume OEM market, so it has some time to try to wrest back the crown. The company's Comet Lake processors are also on the cusp of release, but barring significant price reductions, we don't expect yet another 14nm refresh to change the pecking order much. And as we've seen, AMD isn't sitting still.

AMD wins the CPU war overall right now, but depending on your needs, an Intel processor could still be the better choice. If you want the best in overclocking, gaming or software support, or if you want productivity performance without buying a discrete GPU, Team Blue has the advantage. But if you want the best balance of price and performance, Team Red deserves your money.

AMD vs Intel CPUs

	Intel	AMD
CPU Pricing and Value		X
Gaming Performance	X	
Content Creation/Productivity		X
Specifications		X
Overclocking	X	
Power Consumption		X
Drivers and Software	X	
Process Node		X
Architecture		X
Security		X
Winner: AMD - Total	3	7

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