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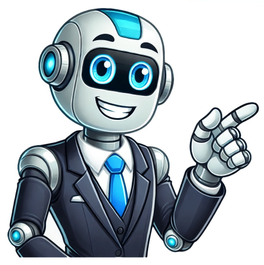

AMD vs Intel: which CPUs are better? One of the first questions many of you will have when you get into PCs or laptops. On the one hand, you have Team Blue (Intel)- traditionally known for charging a premium for its quality silicon. In the other corner, is Team Red (AMD), a brand that has successfully shaken its ‘performance on a budget’ image and now stands toe-to-toe with Intel in the CPU market. The decision between Intel and AMD processors rests on user needs. If you’re looking for a CPU dedicated to heavy multitasking loads then purchasing an Intel processor is a great option. However, if you’re looking for an energy effcient CPU that’s on the slightly cheaper side then AMD might be the right choice. If you’re still unsure which way to swing after reading this comparison guide, you can head to our CPU buyers guide hub to crack down on the market’s favorite CPUs out there and what they could bring to your desktop. AMD is now seen as a genuine contender by the PC community, and under charismatic CEO Dr. Lisa Su, the company has soared to record highs and dramatically improved its CPU performance. But in the real world, how do they stack up? This article is all about dissecting the two company’s current offerings to see which CPUs come out on top in 2025. As a reader, you’re likely seeking clarity on which brand will serve your computing needs best, whether it’s for multitasking, gaming, or efficient PC power usage—and we’re here to provide just that. After all, we have plenty of hands-on experience with both AMD and Intel products. We’ll explore the latest specs and features, evaluate the pricing and value, and delve into how Intel processors and AMD processors handle multitasking and productivity tasks. For the gamers, we'll examine which CPUs could give you the edge in the latest titles. And because performance isn’t the only consideration, we'll also discuss power consumption and heat output—critical factors for many builds so you’ll know if you’ll need to replace anything. Without further ado, let’s dig into some of the best CPUs offered by Team Blue and Team Red. This is Intel vs AMD. When evaluating the latest CPU offerings, Intel and AMD present their unique takes on power and performance. Previously its top-of-the-line CPU, Intel’s Core i9-13900K commands attention with its 24 cores and 32 threads, and its high boost clock of 5.8 GHz is impressive. It maintains a TDP of 125W but can push to 253W for peak performance. However, Intel's Raptor Lake refresh that was released in October 2023 saw the i9 14900K, built upon the Raptor Lake architecture, reach speeds of up to 6 GHz. On the other hand, AMD's Ryzen 9 7950X3D stakes its claim with a 144MB cache and an efficient energy profile, topping at 162W under full load. It can also almost match Intel’s capabilities, with a boosted clock speed of 5.7 GHz, without draining that much power. Intel’s strengths lie in its architectural design, which delivers a balanced performance that’s tough to beat. The Core i9-13900K stands out for its ability to handle intensive multi-threaded tasks without breaking a sweat, making it ideal for both gaming and productivity. The downside? These chips can be power-hungry under load, which might lead to higher energy bills and the need for better desktop cooling solutions. Annoyingly, it seems that the refreshed 14th Gen chips are no exception, and although delivering better performance, they haven’t been blessed with lower power consumption. What this means is you’re going to need a pretty hefty cooling solution, especially when you start looking at the i9s. Even as far back as the i9990k, top-end Intel chips are known to run very hot. CPUMSRPCores / Threads (P+E)P-Core Base/Boost (GHz)Cache (L2/L3)TDP-PBP / MTPCore i9-14900KS$68924 / 32 (8+16)3.2 / 6.268MB (32+36)150W / 253WCore i9-14900K$58924 / 32 (8+16)3.2 / 5.868MB (32+36)150W / 253WCore i9-13900K$58924 / 32 (8+16)3.0 / 5.868MB (32+36)125W / 253WRyzen 9 7950X$69916 / 324.5 / 5.780MB (16+64)170W / 230WRyzen 9 7950X3D$69916 / 324.2 / 5.7144MB (16+128)120W / 162WRyzen 9 7900X$54912 / 244.7 / 5.676MB (12+64)170W / 230WRyzen 9 7900X3D$59912 / 244.4 / 5.6140MB (12+128)120W / 162WRyzen 7 5800X3D$4498 / 163.4 / 4.596MB105WCore i7-14700K$4098 / 123.4 / 5.561MB (33/28)125W / 253WCore i7-13700K$40916 / 24 (8+8)3.4 / 5.454MB (24+30)125W / 253WRyzen 7 7700X$3998 / 164.5 / 5.440MB (8+32)105W / 142WRyzen 7 8700G$3298 / 164.2 / 5.124 (8+16)45-65WRyzen 5 7600X$2996 / 124.7 / 5.338MB (6+32)105W / 142WCore i5-14600K$31914 / 20 (6+8)3.5 / 5.344MB (20+24)125W / 181WCore i5-13600K$31914 / 20 (6+8)3.5 / 5.144MB (20+24)125W / 181WRyzen 5 7600X$2996 / 124.7 / 5.338MB (6+32)105W / 142WRyzen 5 8600G$2296 / 124.3 / 5.022MB (6+16)45-65WRyzen 5 8500G$2296 / 123.5 / 5.022MB (6+16)45-65WRyzen 3 8300G$1764 / 83.4 / 4.912MB (4+8)45-65WTable showing the Intel and AMD chips, including their pricing and cache size in descending order AMD’s Ryzen 9 7950X3D excels in gaming thanks to its massive cache, giving it an edge in high-frame-rate scenarios. However, the focus on gaming performance means that it can lag in general productivity tasks when compared to Intel’s more balanced offerings. Additionally, Ryzen’s reliance on the newer DDR5 memory means users will face higher upgrade costs if they’re coming from older systems. One thing AMD does have over Intel is what they’ve called a 3D V-Cache (You can tell if you have one because it’ll have 3D in the name, such as the Ryzen 75800X3D). This vertical cache was so effective, combining efficiency and more than 200 times the interconnect density of a 2D chipset, that it’s among the fastest desktop processors in the world. We’ve broken down the Intel Core i9 14900KS vs Ryzen 7 5800X3D, should you want a closer look at how the 3D V-Cache compares with Intel’s top-of-the-range chip. After considering the pros and cons, Intel comes out on top in the specs and features category. Its CPUs offer a blend of performance and versatility that’s hard to overlook, providing a better overall experience for a wider range of activities. Intel also maintains compatibility with DDR4, allowing for a more budget-friendly upgrade path. Thus, for users looking for an all-encompassing CPU that delivers across the board, Intel is still the way to go in the AMD vs Intel showdown. AMD is more than fine if you’re looking to build a gaming rig, but if you’re wanting to build an all-rounder, an i7 or if the budget stretches, an i9, is still the way to go in 2025. In the AMD vs Intel battle of CPU pricing and value, Team Blue has rolled up its sleeves to reclaim its position in the market. The launch of Raptor Lake is a clear indicator of Intel’s aggressive strategy, marking a significant drop in the cost per core and thread across its Core i5, i7, and i9 ranges. This strategic pricing allows Intel to overshadow AMD in value, particularly in the mid to high-end segments. AMD has long been the go-to for budget-conscious buyers, thanks to perks like included coolers and the freedom to overclock across most of its product line. The company’s forward-thinking features like Precision Boost Overdrive further cemented its place as a value leader. But times have unfortunately changed. AMD’s price hikes and the removal of bundled coolers, coupled with increased cooling demands for its CPUs, have dampened its competitive edge. This shift has made AMD’s offerings less appealing to those seeking maximum value for their investment. Intel stands out in the multitasking and productivity arena, particularly with its Core i9-13900K processor. Boasting 24 cores capable of juggling 32 threads, it’s an impressive powerhouse that excels in keeping numerous tasks moving fluidly. The chip’s performance shines in benchmarks, notching a towering Passmark score of 60,009, and it leads the pack with a single-thread rating of 4,679. The 14 Gen takes things even further, with i7 models now more than capable of serious multi-tasking and putting up a fight against older i9 models. AMD, while offering solid CPUs, can’t match Intel’s core and thread count, which translates to a slightly more constrained multitasking experience. Especially for those engaged in content creation or heavy multitasking, this core count discrepancy can be the deciding factor. Intel’s chips are adept at seamlessly transitioning between tasks, ensuring productivity doesn’t falter even under heavy loads. With a blend of robust single-threaded performance and a multitude of cores for parallel processing, Intel delivers a smooth and efficient computing experience. This balance makes Intel the preferred choice for users who demand peak performance across a breadth of applications. When it comes to AMD vs Intel in the gaming realm, AMD steals the spotlight with its X3D line of CPU chipsets, which includes the Ryzen 7 7800X3D, Ryzen 9 7950X3D, and Ryzen 9 7900X3D. These processors are tailored for gamers seeking the pinnacle of performance, and they deliver by topping the charts in gaming benchmarks. Notably, the Ryzen 7000 series features high-performance integrated graphics – the Radeon Graphics integrated graphics solution. However, we’ve still made sure to delve into the best GPU for the Ryzen 7 7800X3D to find you a graphics card that this AMD CPU superpower won’t bottleneck. The Ryzen 7 7800X3D, in particular, has made waves as an outstanding gaming processor, marking its territory as the best option available for pure gaming prowess. It’s a formidable choice for those who prioritize gaming above all else and is recognized as such among the community of gamers. However, this gaming superiority comes with certain caveats in productivity workloads, where AMD’s X3D chips may not perform as well as some users require. If your computing needs are multifaceted, encompassing both gaming and productivity, Intel’s offerings might serve you better. They provide a more balanced package, ensuring that users don’t have to compromise on performance outside of their gaming escapades. The top-end Intel cards are incredibly powerful but need the right cooling solutions. Make sure you check your coolers to ensure they’re powerful enough to deal with a significant amount of heat. We woud always recommend liquid over air coolers fo i9 CPUs. When it comes to power consumption and heat, AMD leads with its advanced 5nm process technology. AMD chips are more power-efficient and cooler, translating to energy savings and less strain on cooling systems. Intel, despite improvements with its Raptor Lake series, still tends to consume more power. However, the performance delivered by Intel CPUs often justifies their higher energy use for many users. Nevertheless, the overall efficiency crown goes to AMD. Its CPUs offer more processing power for each watt consumed and come with more manageable thermal demands. This makes AMD the better choice for those who prioritize energy efficiency and lower operating temperatures in their computing tasks. A great way to see how the two brands compare is by looking at both of their flagship CPUs and seeing how they differ. Both the Core i9-14900K from Intel and Ryzen 9 7950X from AMD offer extremely high processing capabilities and paired with the right GPU can create quite the powerful PC setup. But how are they different? There is quite a lot to be said about the differences between these processors – the only thing they seem to have in common is that they’re both X86 CPUs. The i9-14900K supports Raptor Lake architecture and is a Hybrid monolithic CPU, meaning that it is a single piece of silicon made up of both 8 P-cores and 16 E-cores. Whereas, the Ryzen 9 7950X is based on Zen 4 architecture; using two chips that contain eight cores each. The hybrid design in the i9-14900K is beneficial because only a few P-cores are necessary for good single-threaded performance, meaning the E-cores can provide for multi-threaded tasks. Therefore, in terms of raw performance, the difference in architecture here means that the Core i9-14900K takes the slight upper hand. Another major difference between these two processors is their process nodes. Process nodes refer to the way the chip is manufactured, which plays a large role in the capabilities of the CPU. The Ryzen 9 7950X is made of TSMC’s 5nm node and the Core i9-14900K is made on the Intel 7 node (formerly 10nm). In this area, the Ryzen 9 7950X is slightly in front, because its node is nearly a full generation ahead of the i9-14900K, improving its efficiency. Both CPUs are highly powerful, but due to their architecture, they do pose different advantages for use. If you’re looking for raw performance then the i9-14900K might be the right option for you. However, if efficiency plays a major role in your decision making then perhaps the Ryzen 9 7950X is the right choice. Shop on Amazon CHECK PRICE There are some apparent differences in the way that Intel and AMD manufacture their processors, which subsequently play a role in their performance capabilities. Since AMD’s partnership with TSMC, it has been able to produce smaller, more efficient chips that are able to compete with the prowess of processors manufactured by Intel. AMD outsources its chips from the Taiwanese company with the latest range of processors featuring TSMC’s 5nm node. Intel has always been at the top of the game when it comes to producing high-quality processors, however, they take a different approach to AMD during the manufacturing process. Unlike AMD, Intel uses its own manufacturing process, with the latest being called ‘Intel 7’. This process uses 7nm technology in Intel’s latest generation of commercial chips. Which allows the processors to be faster and more energy-efficient due to their smaller transistors and size. Gamers looking for the top frame rates in games often gravitate toward AMD’s high-end offerings. AMD has made significant strides with its Ryzen series, especially the X3D chips that offer the best gaming performance currently available, and for this reason, they tend to score highly when it comes to the best CPUs for gaming. That being said, Intel still very much represents the highest-end when it comes to CPUs. While not every generation is created equal – the 14th Gen for example received a lukewarm response from the community after the decent 13th gen chips, Intel CPUs typically are better all-rounders when facing off against the more gaming-focused AMD offerings. Intel and AMD use different socket designs for their processors. For example, Intel’s 12th, 13th, and 14th Generation CPUs use the LGA 1700 socket, while AMD’s Ryzen 5000 series CPUs use the AM4 socket, and its latest Ryzen 7000 series CPUs use the new AM5 socket. It’s essential to match the CPU to a motherboard with the correct socket type, so it’s good to have this knowledge under your belt. When you’re investing in a CPU upgrade, you’ll no doubt be weighing up between AMD and Intel, as they sit neck and neck at the top of the processor market. While Intel might take the edge in terms of speed on heavy multitasking loads, AMD’s speeds aren’t far behind and often perform more energy efficiently. With such close competition on our hands, the CPU that’s going to be better for you depends on your current system setup, what you need it for, and how much you have available to spend on it. If you’re just going to focus on building a gaming rig, then opting for an i9 is overkill and you can absolutely consider a cheaper, AMD CPU. However, if you’re looking to multi-task or you do a lot of video editing, Intel chips – especially newer i7 and i9 models, will be absolutely perfect for you. Opt for the 13th Gen if you’re looking to get a balance of value and performance, which we think will go down even more in price once Intel reveals their rumored 15th Gen chips. Sat, August 3, 2024 at 12:37 PM UTCWhen you buy through links on our articles, Future and its syndication partners may earn a commission.If you're looking for the best CPUs for gaming or the best workstation CPU, or just one of the best budget CPUs, there are only two choices: AMD and Intel. That fact has spawned an almost religious following for both camps, and the resulting AMD vs Intel flamewars 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: AMD's chips win for most users looking for the best balance of performance in both gaming and productivity at a more accessible price point. Additionally, AMD's lineup of specialized X3D CPUs is the hands-down winner for PCs focused on gaming.This article covers the never-ending argument of AMD vs Intel desktop CPUs (we're not covering laptop or server chips). We judge the chips on five criteria based on what you plan to do with your PC: pricing, performance, driver support, power consumption, and security, giving us a clear view of the state of the competition. We'll also discuss the process nodes and architectures influencing the moving goalposts. However, each brand has its strengths and weaknesses, so which CPU brand you should buy depends mostly on what blend of features, price, and performance is important to you.The 'Arrow Lake Core Ultra 200S series builds on Intel's hybrid architecture formula but leverages a new design philosophy that constrains gaming performance. However, the chips do provide strong performance in single- and multi-thread productivity workloads, along with improved energy efficiency.AMD's answer is its Zen 5 Ryzen 9000 series. These chips debuted with a fizzle on the gaming front, but subsequent firmware and operating system updates have improved the overall performance significantly, making these chips the bang-for-the-buck leader for most users looking for a balanced system.AMD's powerful gaming-optimized Ryzen 9000 "X3D" models utilize a breakthrough 3D chip-stacking tech to take the lead in gaming performance, as you can see in our Ryzen 9 9800X3D review that finds the 9800X3D to be the fastest gaming CPU on the planet, bar none. AMD has also leveraged this X3D tech with its older architectures to make incredibly value-centric gaming chips, like the Ryzen 5 5600X3D. The gains in gaming performance are phenomenal, so much so that the competition against Intel chips isn't even close, giving AMD a walk-in touchdown for gaming PCs.AMD vs Intel: Which CPU is Best?IntelAMDPricing and ValueXGaming PerformanceXProductivity and Content Creation PerformanceXXSpecifications and FeaturesXCPU Power Consumption and HeatXCPU Drivers and SoftwareXSecurityXTotal35AMD wins our 2025 CPU face-off with a win in five categories compared to Intel's three. AMD's relentless onslaught with its Zen-based processors has redefined our expectations for both the mainstream desktop and the HEDT markets, originally catching Intel flatfooted as it remained mired on the 14nm process and Skylake architectures due to execution challenges. The past several years have seen AMD CPUs go from value-focused and power hungry chips to designs that deliver more cores, more performance, and lower power requirements than Intel's competing chips, especially in gaming. Intel fought back by slowly adding features and cores across its product stack, resulting in negative side effects, like more power consumption and heat. That only highlighted the company's struggles on the design and fabrication side of its operation. AMD isn't taking the challenge lying down, as its new lineup of 4nm Ryzen 9000 X3D chips use the company's new second-gen 3D V-Cache tech to impart tremendous gains in gaming performance, giving AMD the lead in sheer gaming performance. Intel's chips also hold the crown on overclockability for both core and memory frequencies, and not by a small margin. If you spend the cash on a Z-series motherboard, you'll attain far more overclocking headroom than you'll get with the Ryzen 9000 chips. You can see an example in our How to Overclock a CPU feature. An AMD processor is the better choice depending on your needs, like if you prize stability, the lowest power consumption, or forward compatibility with your motherboard for a few more chip generations. AMD also has amazing gaming performance on tap with its X3D chips, and they don't suffer from lower performance in productivity applications like they used to. They do cost a premium, but they are the no-compromise solution for leading performance in both disciplines.For now, if you want the best blend of gaming and application performance, all within a reasonable power consumption envelope, not to mention forward compatibility with your existing motherboard, Team Red deserves your hard-earned dollars.AMD vs Intel CPU Pricing and Value 2025Pricing is the most important consideration for almost everyone, and AMD has generally been hard to beat in the value department. The company's standard Ryzen 9000 series models often sell below MSRP, with the flagship Ryzen 9 9950X often selling for $100 less than its suggested etail price. The company's gaming-optimized X3D processors do come at a premium, but those models provide more than enough gaming performance to justify the price tag.In contrast, Intel's Core Ultra 200S series processors tend to stubbornly hover around their MSRP. While they hold advantages in productivity performance, it isn't enough to justify the markup. Additionally, their severely lagging gaming performance makes them a tough sell against AMD's X3D gaming lineup; it's simply a no-contest.FamilyAMDIntelThreadripper - Xeon W$2,399- $10,000$949 - $5,889AMD Ryzen 9 - Intel Core i9$469 - $699$549 - $599AMD Ryzen 7 - Intel Core i7$359 -$480$384 - $404AMD Ryzen 5 - Intel Core i5$250 - $279$270 - $319AMD Ryzen 3 - Intel Core i3$95 - $120$97 - $154AMD still freely allows overclocking on all chip models and all but its A-Series motherboards (see our article on CPU overclocking), which is a boon for enthusiasts. Meanwhile, Intel still 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 overclocking your processor — Intel doesn't allow full overclocking on B- or H-series motherboards, but has enabled memory overclocking on its B and H chipsets, though.AMD generally has better coolers than Intel — most of AMD's bundled coolers are suitable for at least moderate overclocking — but the company no longer includes them with any of the 'X' models. Intel also doesn't throw in a cooler for its pricey overclockable K-series SKUs. So be sure to budget for a cooler (and a beefy one, at that) if you plan on overclocking an Intel processor.Both Intel and AMD include a bundled cooler with their downstream SKUs (non-K for Intel, non-X for AMD), but Intel's coolers 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. AMD, in contrast, has solid coolers that often even provide a bit of headroom for overclocking. Intel did slightly bulk up its coolers, but the aesthetic and slight thermal improvements aren't enough to match AMD's competent coolers, and they aren't available on all models.Pricing isn't entirely dictated by what you pay for the chip, though — we also have to factor in platform pricing. Intel's Arrow Lake chips drop into the same LGA 1851 interface that isn't backward-compatible with prior-gen Intel chips. And there is no guarantee it will support the next-gen options, either, which means you'll probably have to buy a new board if you want to upgrade in the future. AMD supported its AM4 socket for five generations of chips, and while that platform will live on for some time with the Ryzen 5000 chips slotting in as value alternatives, the company's new AM5 socket houses its newest Ryzen 7000 chips. AMD says it will support this socket until 2025+, so it is possible that it could enjoy similar longevity to AM4, thus giving enthusiasts a long upgrade path.AMD followed Intel in exiting the high end desktop (HEDT) segment entirely, marking the end of an era. Now you'll have to step up to workstation-class processors from both companies to attain more cores and connectivity, as seen in our Threadripper Pro 5995WX and 5975WX reviews. In either case, AMD owns the performance tier for the best CPUs for workstations, so it can charge eye-watering premiums as a result — and it does. The company even excluded its lowest-priced Threadripper models from retail, creating a $2,399 bar for entry. That puts workstation chips far out of the reach of the majority of enthusiasts. Winner: AMD. When comparing Intel vs AMD CPUs, Team Red currently offers the best overall performance and value across the full spectrum of price ranges. AMD owns the gaming category in a landslide win with its X3D processors, and it also has strong performance in productivity applications. Intel's Arrow Lake does have the lead in some facets of performance, such as in single-threaded applications, but that isn't enough to outweigh the higher pricing and lower performance in multi-threaded applications and gaming.Additionally, AMD has a strong lead in the platform department, too. The AM5 platform supports both Ryzen 7000 and 9000 processors and will play host to at least one more generation of processors. If tradition holds, we could see it soldier on for several more generations, though AMD has remained coy about the details. In contrast, Intel's LGA 1851 platforms support just one generation of chips — Arrow Lake — and they aren't officially said to support Intel's next-gen chips, either. However, Intel might release an Arrow Lake Refresh generation, but the inherent limitations of the chip design mean it will almost certainly not be a contender against AMD, especially in gaming. That makes a new Intel motherboard a bad investment.AMD vs Intel Gaming Performance 2025In the AMD vs Intel CPU gaming performance battle, AMD's X3D processors hold the lead in all critical price bands. Below, we have a wide selection of collective gaming performance measurements for the existing chips in the different price bands. You can see a much more holistic view in our CPU Benchmarks Hierarchy.Image 1 of 5Image 2 of 5Image 3 of 5Image 4 of 5Image 5 of 5As you can see, AMD's standard 'Granite Ridge' Ryzen 9000 models take the lead over Intel's current-gen Core Ultra 200S 'Arrow Lake' processors, and the gaming optimized Ryzen 9000X3D chips, which cost more than the standard models, take an overwhelming lead, often by 30% or more.Intel's current-gen Core Ultra 7 285K is the new flagship, but its unique tile-based (chiplet) design has a negative impact on gaming performance, so it isn't as fast as the prior-gen models in gaming. That leaves the Core i9-14900K as the fastest Intel gaming chip, and it often sells at a steep discount. However, it isn't as fast in productivity applications as AMD's latest products, making it a tough sell to drop back to the previous-gen model. Additionally, the 14900K isn't as fast in gaming as the AMD X3D models.AMD's standard Ryzen 9000 models, like the flagship Ryzen 9 9950X, are faster in gaming than Intel's Core Ultra 200S series, but Intel's previous-gen 14900K holds the edge. However, AMD's X3D models, like the Ryzen 7 9800X3D and the Ryzen 9 9950X3D, are the fastest gaming chips on the planet, beating Intel's current-gen chips by 30+%. These chips also deliver the full performance of the standard models in productivity workloads, eliminating the tradeoffs associated with the X3D models that we've seen in the past. The X3D models do come at a premium, but they justify their price tag with the fastest gaming performance money can buy.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 (see our best graphics cards) with a newer generation while keeping the rest of your system intact. We expect most builds in the mid-range to come with lesser GPUs, which generally serve as an equalizer in terms of CPU performance. In terms of integrated graphics performance, there's no beating AMD. The company's current-gen Cezanne APUs offer the best performance available from integrated graphics with the Ryzen 7 5700G and Ryzen 5 5600G. Hit those reviews for a dedicated breakdown, or head to our CPU Benchmark hierarchy for even more detail. Winner: AMD. AMD's standard Ryzen 9000 models deliver solid performance in gaming, beating Intel's current-gen models, but they trail the previous-gen Intel chips. However, the Ryzen 9000X3D models take the unequivocal lead in gaming by massive margins, giving AMD an easy win in the gaming department. The previous-gen Raptor Lake Refresh models are a distant second in gaming performance, and they aren't as performant as the Ryzen 9000 models in productivity applications, making them a tough choice as an alternative.AMD vs Intel Productivity and Content Creation Performance 2025Image 1 of 7Image 2 of 7Image 3 of 7Image 4 of 7Image 5 of 7Image 6 of 7Image 7 of 7In the non-gaming performance battle of AMD vs Intel CPUs, Intel's Arrow Lake chips have made great strides against AMD's finest, but they fail to deliver a tangible enough lead over AMD's core-heavy models to make productivity performance a make-or-break buying decision. AMD leads in overall multi-threaded performance with its Ryzen 9 9950X3D and 9950X by a slim margin, but Intel keeps a solid grip on the lead in single-threaded applications.Arrow Lake marks Intel's continuation of using a mixture of two types of cores for the mainstream desktop PC. The big performance cores (P-cores) are best for latency-sensitive work, giving Intel the uncontested lead in single-threaded applications. The efficiency cores (E-cores) step in to add some additional heft in threaded and background applications, which pays big dividends in heavily-threaded content creation and productivity applications.In contrast, AMD continues to leverage its tried-and-true P-core only design, which also supports AVX-512, a big consideration for those who leverage powerful productivity applications that employ the high-performance instructions. Solid performance in single-threaded work equates to faster performance in all manner of workloads, particularly day-to-day applications that rely on snappy responsiveness from the processor. The Core 7 285K has taken the uncontested lead in single-threaded performance across the full suite of our benchmarks, but that's Intel's most expensive mainstream CPU. If you're searching for snappy single-threaded performance, the other Arrow Lake processors also take the lead over competing AMD processors. Overall, Intel's Arrow Lake family holds the single-threaded performance crown.Winner: Tie. For professionals on the hunt for the highest performance in content creation and productivity applications, the winner of AMD vs Intel CPUs is a tie overall. The chips are closely matched in multi-threaded work, with the lead going to AMD, but Intel enjoys a lead in single-threaded applications. Overall, the decision will come down to the types of workloads you tend to use the most.AMD vs Intel Processor Specifications and Features 2025AMD has its Ryzen 3, 5, 7, and 9 lines, while Intel breaks up its offerings into Core Ultra 3, 5, 7, and 9. For the sake of brevity, we'll focus on the top chips in the respective families to compare Intel vs AMD CPUs based on specs and features. Be aware that both companies have value options within each tier, but we can get a general sense of the landscape with these (relatively) smaller lists. We're using both vendors' recommended pricing and street pricing.CPUStreet (MSRP)ArchCores / Threads (P+E)P-Core Base / Boost Clock (GHz)E-Core Base / Boost Clock (GHz)Cache (L2/L3)TDP / PBP or MTPMemoryRyzen 9 9950X3D$699Zen 5 X3D16 / 324.3 / 5.7—144 MB (16+128)170W / 230WDDR5-5600Ryzen 9 7950X3D$740 ($699)Zen 4 X3D16 / 324.2 / 5.7—144MB (16+128)120W / 162WDDR5-5200Ryzen 9 9950X$545 ($599)Zen 516 / 324.3 / 5.7—80MB (16+64)170W / 230WDDR5-5600Core Ultra 9 285K$620 ($589)Arrow Lake24 / 24 (8+16)3.7 / 5.73.2 / 4.676MB (40+36)125W / 250WCUDIMM DDR5-6400 / DDR5-5600Ryzen 9 9900X3D$599Zen 5 X3D12 / 244.4 / 5.5—140MB (12+128)120W / 162WDDR5-5600Ryzen 9 7900X3D$740 ($599)Zen 4 X3D12 / 244.4 / 5.6—140MB (12+128)120W / 162WDDR5-5200Ryzen 7 9800X3D$480Zen 5 X3D8 / 164.7 / 5.2—104MB (8+96)120W / 162WDDR5-5600Ryzen 7 7800X3D$450 ($449)Zen 4 X3D8 / 164.2 / 5.0—104MB (8+96)120W / 162WDDR5-5200Ryzen 9 9900X$380 ($469)Zen 512 / 244.4 / 5.6—76MB (12+64)120W / 162WDDR5-5600Core Ultra 7 265K / KF$365 ($394) / $339 ($379)Arrow Lake20 / 20 (8+123.9 / 5.53.3 / 4.666MB (36+30)125W / 250WCUDIMM DDR5-6400 / DDR5-5600Ryzen 7 9700X$289 ($329)Zen 58 / 163.8 / 5.5—40MB (8+32)65W / 88W / 105WDDR5-5600AMD Ryzen 5 9600X$210 ($269)Zen 56 / 123.9 / 5.4—38MB (6+32)65W / 88WDDR5-5600Core Ultra 5 245K / KF$309 / $294Arrow Lake14 / 14 (6+8)4.2 / 5.23.6 / 4.650MB (26+24)125W / 250WCUDIMM DDR5-6400 / DDR5-5600In the battle of AMD vs Intel CPUs, AMD's Ryzen 9, Ryzen 7, and Ryzen 5 families square off against Intel's Core Ultra 9, Core Ultra 7, and Core Ultra 5.The Ryzen 9 9950X3D is one of the fastest gaming chips on the market, essentially tying its sibling, the Ryzen 7 9800X3D. As mentioned, these chips do carry a premium, though. The 9950X3D holds the throne as the best all-around processor for gaming, single- and multi-threaded work, while the Core Ultra 9 285K takes a few leads in some types of multi-threaded work. However, that comes at a big tradeoff in performance in the other categories. A similar story plays out in the decidedly more mainstream Ryzen 7 and Core Ultra 7 markets. Honestly, these are the chips the majority of gamers should buy if they have enough cash. Here, Intel's Core 7 285K offers nearly the same gaming performance as the Core Ultra 9 285K, albeit at the expense of some threaded horsepower in productivity applications, but at a far lower price point. The Ryzen 7 9800X3D easily leads this category, though, with the fastest gaming performance on the market and strong performance in threaded applications.Winner: Intel. When you compare AMD vs Intel CPU specifications, you can see that Intel offers options with lower pricing and more performance. Intel's chips also provide support for DDR4, an important consideration in these early days of DDR5 adoption.AMD vs Intel CPU Power Consumption and Heat 2025When comparing AMD vs Intel CPU power and heat, the former's 4nm TSMC process node makes a big difference. Power consumption comes as a byproduct of design choices, like lithography and architecture. However, higher power consumption often correlates to more heat generation, so you'll need beefier coolers to offset the heat output of greedier chips.Image 1 of 13Image 2 of 13Image 3 of 13Image 4 of 13Image 5 of 13Image 6 of 13Image 7 of 13Image 8 of 13Image 9 of 13Image 10 of 13Image 11 of 13Image 12 of 13Image 13 of 13Overall, Intel has reduced its power consumption from meme-worthy to an acceptable level, but it still consumes more power than Ryzen. Still, in aggregate, AMD's 4nm chips either consume less power or provide much better power-to-performance efficiency.Image 1 of 7Image 2 of 7Image 3 of 7Image 4 of 7Image 5 of 7Image 6 of 7Image 7 of 7As you can see above, 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 4nm and AMD's Zen 5 are the winning combination. The latest Ryzen processors consume less power than Intel on a power-vs-performance basis.Intel vs AMD CPU Overclocking 2025There's no debate when you compare Intel vs AMD 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. To learn more about overclocking, head to our How to Overclock a CPU guide.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, Intel's chips are relatively easy to push to their max, though gains can be slim in some applications.Intel doesn't allow full overclocking on B- or H-series motherboards, but it has infused memory overclocking into its B560 and H570 chipsets, and that works with any chip that is compatible with the platform. 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. This one-click auto-overclocking feature 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, but you do get a free performance boost. AMD has also vastly improved its memory overclocking capabilities.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 – you'll have to buy a K-series processor. Intel has added memory overclocking to the newest B- and H-series motherboards, which is an improvement. AMD's approach is friendlier to entry-level users, rewarding them with hassle-free overclocking based on their system's capabilities, but you don't gain as much performance.AMD vs Intel CPU Drivers and Software 2025When we look at AMD vs Intel CPU software support, Team Blue has a stronger reputation. AMD has suffered plenty of issues with its CPU and chipset drivers, a natural byproduct of its limited resources compared to its much-larger rivals. Intel isn't without its missteps on the driver front, but its reputation for stability helped earn it the top spot in the processor market, particularly with OEMs.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 its chips' full performance, 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.Intel also continues to face challenges, though. The company's Core Ultra 200S architecture uses large performance cores (P-cores) and small efficiency cores (E-cores) for different types of tasks, and other elements, like I/O and the GPU, are placed on separate tiles/dies, which complicates matters. Placing the correct workloads on the correct cores requires a new Intel Thread Director technology, but that means some programs might need extra handholding to extract the best performance in Windows 10.Winner: Intel wins the battle of AMD vs Intel CPU drivers and software. Over the last few years, 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. AMD has made amazing progress convincing the developer ecosystem to optimize for its new Zen architectures. However, there's still plenty of work to be done as the company moves forward.AMD vs Intel CPU Security 2025The 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 it suffers from more of these vulnerabilities than other vendors. The company has developed in-silicon mitigations with newer processors that can reduce or eliminate the performance overhead, but some older processors are subject to drastic reductions in performance.AMD isn't immune to vulnerabilities, though. It's hard to ascertain if the initially limited speculative execution vulnerability discoveries in AMD processors were due to a security-first approach to hardened processor design, or if researchers and attackers merely focused on Intel's processors due to their commanding market share: Attackers lmost 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.However, AMD has also had several other new vulnerability disclosures in the recent past, including a Meltdown-esque variant that requires software re-coding. Like Intel, AMD has made a few targeted in-silicon fixes for its newer Ryzen processors, thus lowering its exposure to vulnerabilities.However, newer vulnerabilities and hacks continue to present issues for chipmakers. For instance, computer motherboard maker MSI was recently hacked, leading to its OEM private keys, used for verifying firmware to a computer's secure boot mechanisms, being released to the public. This puts an untold number of PCs at risk from fake drivers and firmwares.Winner: AMD. The AMD vs Intel CPU security debate continues to evolve as researchers and nefarious actors alike turn more of an eye towards AMD's newer architectures. As things stand, Intel still suffers from more known vulnerabilities than AMD, and the impact of the Spectre mitigations on previous-gen Intel processors leads to larger performance losses (at times equivalent to a few generational gains worth of improvement) than the fixes we've seen from AMD, granting Team Red the win. AMD brand for microprocessors Not to be confused with Ryzom. RyzenGeneral informationLaunchedMarch 2, 2017; 8 years ago (2017-03-02)[1]Marketed byAMDDesigned byAMDCommon manufacturersGlobalFoundries (14 nm and 12 nm only)TSMC (7 nm and beyond)PerformanceMax. CPU clock rate3.0 GHz to 5.7 GHzHyperTransport speeds800 MT/s to 2 GT/sArchitecture and classificationTechnology node14 nm to 5 nmMicroarchitectureZen microarchitecture:ZenZen+Zen 2Zen 3Zen 3+Zen 4Zen 5Instruction setMain processor: x86-64 Platform Security Processor: ARM Cortex-A5ExtensionsMMX(+), SSE1, SSE2, SSE3, SSSE3, SSE4a, SSE4.1, SSE4.2, AVX, AVX2, AVX-512 with Zen 4, FMA3, CVT16/F16C, ABM, BMI1, BMI2AES, CLMUL, RDRAND, SHA, SMEAMD-V, AMD-ViPhysical specificationsCoresMainstream: 4–16 coresHEDT: 8–64 coresWorkstation: 12–96 coresGPURadeon Graphics on APUsSocketsMainstream desktop AM4AM5High-end desktop and workstation TR4sTRX4sWRX8sTR5VariantsThreadripper (high-end desktop and workstation)Athlon (low-end desktop and mobile)Epyc (server and embedded)HistoryPredecessorsA-SeriesFX Ryzen 3 PRO 2100GE[2] found in some OEM markets in limited quantities Ryzen (/ˈraɪzən/ RY-zən)[3] is a brand[4] of multi-core x86-64 microprocessors, designed and marketed by AMD for desktop, mobile, server, and embedded platforms, based on the Zen microarchitecture. It consists of central processing units (CPUs) marketed for mainstream, enthusiast, server, and workstation segments, and accelerated processing units (APUs), marketed for mainstream and entry-level segments, and embedded systems applications. A majority of AMD's consumer Ryzen products use the AM4 and AM5 platforms. In August 2017, AMD launched their Ryzen Threadripper line aimed at the enthusiast and workstation markets. Ryzen Threadripper uses different, larger sockets such as TR4, sTRX4, sWRX8, and sTR5, which support additional memory channels and PCI Express lanes. AMD has moved to the new AM5 platform for consumer desktop Ryzen with the release of Zen 4 products in late 2022. AMD Ryzen 7 3700X top and pins Ryzen uses the "Zen" CPU microarchitecture, a redesign that returned AMD to the high-end CPU market after a decade of near-total absence since 2006.[5] AMD's primary competitor, Intel, had largely dominated this market segment starting from the 2006 release of their Core microarchitecture and the Core 2 Duo.[6] Similarly, Intel had abandoned their prior Pentium 4 lineup, as its NetBurst microarchitecture was uncompetitive with AMD's Athlon XP in terms of price and efficiency, and with their Athlon 64 & 64 X2, they were outmatched in terms of raw performance as well.[7] Until Ryzen's initial launch in early 2017, Intel's market dominance over AMD continued to grow with the launch of the now famous "Intel Core" CPU lineup and branding, as well as the successful rollout of their now well-known "tick-tock" CPU release strategy. The strategy was most famous for alternating between a new CPU microarchitecture and a new fabrication node each year. Intel followed that release cadence for almost a decade, starting with Intel's initial Q3 2006 launch of 65 nm Conroe, and continuing until the release of the 14 nm Broadwell desktop CPUs, which were delayed a year from a planned 2014 launch to Q3 2015. The delay necessitated a refresh of their pre-existing 22 nm Haswell CPU lineup in the form of "Devil's Canyon", and thus officially ended "tick-tock" as a practice.[8][9] The events proved to be incredibly important for AMD, as Intel's inability to further sustain "tick-tock" was critically important in providing both the initial and continually growing market openings for AMD's Ryzen CPUs, and indeed the Zen CPU microarchitecture as a whole to succeed. Also of note is the release of AMD's Bulldozer microarchitecture in 2011, which, despite being a ground up CPU design like Zen, had been designed and optimized for parallel computing above all else, leading to starkly inferior real-world performance in any workload that was not highly multi-threaded, which was still the case for the vast majority at that time. This caused it to be woefully uncompetitive in essentially every area outside of raw multi-thread performance and its use in low power APUs with integrated Radeon graphics.[10] Despite a die shrink and several revisions of the Bulldozer architecture, performance and power efficiency failed to catch up with Intel's competing products.[11] Consequently, all of this forced AMD to completely abandon the entire high-end CPU market (including desktop, laptops, and server/enterprise) until Ryzen's release in 2017. Ryzen is the consumer-level implementation of the newer Zen microarchitecture, a complete redesign that marked the return of AMD to the high-end central processing unit (CPU) market, offering a product range capable of competing with Intel.[12][13] Having more processing cores, Ryzen processors offer greater multi-threaded performance at the same price point relative to Intel's Core processors.[14] The Zen architecture delivers more than +52 percent improvement in instructions per cycle (clock) over the prior-generation Bulldozer AMD core, without raising electrical power use.[15] The changes to the instruction set architecture also adds binary-code compatibility to AMD's CPU.[16] Since the release of Ryzen, AMD's CPU market share has increased while Intel's appears to have stagnated and/or regressed.[17] AMD announced a new series of processors on December 13, 2016, named "Ryzen", and delivered them in Q1 2017,[4] the first of several generations. The 1000 series featured up to eight cores and sixteen threads, with a +52 percent instructions per cycle (IPC) increase over their prior CPU products, namely AMD's previous Excavator microarchitecture.[15] The second generation of Ryzen processors, the Ryzen 2000 series, released in April 2018, featured the Zen+ microarchitecture. The aggregate performance increased +10 percent (of which approximately +3 percent was IPC and +6 percent was clock frequency).[18] Most importantly, Zen+ fixed the cache and memory latencies that had been major weak points.[19] The third generation of Ryzen processors launched on July 7, 2019, based on AMD's Zen 2 architecture, featuring significant design improvements with a +15 percent average IPC boost, a doubling of floating point capability to a full 256-bit-wide execution data path much like Intel's Haswell released in 2014,[20] a shift to an multi-chip module (MCM) style "chiplet" package design, and a further shrink to Taiwan Semiconductor Manufacturing Company (TSMC)'s 7 nm fabrication process. On June 16, 2020 AMD announced new Ryzen 3000XT series processors with increased boost clocks and other small performance enhancements compared to 3000X processors.[21] On October 8, 2020 AMD announced the Zen 3 architecture for their Ryzen 5000 series processors, featuring a +19 percent IPC improvement over Zen 2, while being built on the same 7 nm TSMC node with out-of-the-box operating boost frequencies exceeding 5 GHz for the first time since AMD's Piledriver.[22] This was followed by an unusually short stop-gap release of Ryzen 6000 mobile-only series processors on January 4, 2022, using the modestly changed Zen 3+ core on a 6 nm process by TSMC, with claims up to +15 percent performance uplift gains from frequency rather than IPC.[23] The Ryzen 7000 series was released September 27, 2022 for desktops, featuring the new Zen 4 core with a +13 percent uplift in IPC and +15 percent increase in frequency for a claimed nearly +30 percent in single thread performance.[24] The Ryzen 7000 series also features a brand new AM5 socket and uses DDR5 memory. In mid 2024, AMD confirms to announce a new grounds-up redesign of Ryzen named "Zen 5" stemming from a leaked slide by Zen father and legendary chip architect Jim Keller who worked with AMD to release the first Ryzen chips in 2017. Jim Keller, leading the new RISC-V team at Tenstorrent, claims absolute dominance in integer performance in a specific INTSPEC benchmark slide which was taken down.[citation needed] Main article: Threadripper Threadripper, which is geared for high-end desktops (HEDT) and professional workstations, was not developed as part of a business plan or a specific roadmap. Instead, a small team inside AMD saw an opportunity to develop the benefits of Ryzen and EPYC CPU roadmaps, so as to give AMD the lead in desktop CPU performance. After some progress was made in their spare time, the project was greenlit and put in an official roadmap by 2016.[25] Ryzen AI is the brand name for AMD's AI technology, based on intellectual property from AMD's acquisition of Xilinx.[26] AMD Ryzen AI can work across a Neural Processing Unit (NPU) powered by XDNA architecture, a Radeon graphics engine, and Ryzen processor cores.[27] Introduced on the Ryzen 7040 mobile series in mid 2023, it can be used to run neural network applications such as camera background effects, voice recognition, photo artifact removal and skin smoothing.[28] Neural network tasks can be computationally intensive to run on a general-purpose CPU, resulting in significant energy usage and a larger thermal footprint. An AI accelerator is a coprocessor specifically designed to process neural networks efficiently, similar in concept to other work-offloading specialized processing units such as video decoders[26] or FPGAs. Software support for Microsoft Windows was made widely available in December 2023,[29] while software support for Linux was introduced in January 2024.[30] Main article: List of AMD Ryzen processors Socket AM4 for Ryzen and Socket TR4 for Ryzen Threadripper.[31][32] Based on first generation Zen. Ryzen CPUs based on Summit Ridge architecture. Threadripper based on Whitehaven architecture. 4.8 billion transistors per 192 mm2[33] 8-core "Zeppelin" die[1] with one die being used for Ryzen and two for Ryzen Threadripper. Stepping: B1[34] Memory support: Ryzen dual-channel: DDR4–2666 ×2 single rank, DDR4–2400 ×2 dual rank, DDR4–2133 ×4 single rank, or DDR4–1866 ×4 dual rank.[31][35] Ryzen Threadripper quad-channel: DDR4–2666 ×4 single rank, DDR4–2400 ×4 dual rank, DDR4–2133 ×8 single rank, or DDR4–1866 ×8 dual rank. Instructions sets: x87, MMX, SSE, SSE2, SSE3, SSSE3, SSE4.1, SSE4.2, AES, CLMUL, AVX, AVX2, FMA3, CVT16/F16C, ABM, BMI1, BMI2, SHA.[16] All Ryzen-branded CPUs (except PRO variants) feature unlocked multipliers. AMD's SenseMI Technology monitors the processor continuously and uses Infinity Control Fabric to offer the following features:[31][36][37] Pure Power reduces the entire ramp of processor voltage and clock speed, for light loads. Precision Boost increases the processor voltage and clock speed by 100–200 MHz if three or more cores are active (five or more, in the case of Threadripper, and by 300 MHz); and significantly further when less than three are active (less than five, in the case of Threadripper).[38] XFR (eXtended Frequency Range) aims to maintain the average clock speed closer to the maximum Precision Boost, when sufficient cooling is available.[39] Neural Net Prediction and Smart Prefetch use perceptron based neural branch prediction inside the processor to optimize instruction workflow and cache management. Ryzen launched in conjunction with a line of stock coolers for Socket AM4: the Wraith Stealth, Wraith Spire and Wraith Max. This line succeeds the original AMD Wraith cooler, which was released in mid-2016.[40] The Wraith Stealth is a bundled low-profile unit meant for the lower-end CPUs with a rating for a TDP of 65 W, whereas the Wraith Spire is the bundled mainstream cooler with a TDP rating of 95 W, along with optional RGB lighting on certain models. The Wraith Max is a larger cooler incorporating heatpipes, rated at 140 W TDP. In December 2019, AMD started producing first generation Ryzen products built using the second generation Zen+ architecture.[41] An example is the Ryzen 5 1600, with new batches having an "AF" identifier instead of its usual "AE", essentially being an underbinned Ryzen 5 2600 with the same specifications as the original Ryzen 5 1600. Overview of desktop Ryzen 1000 series models Model line Codename Architecture Core count Integrated graphics Ryzen Threadripper 1000 Whitehaven Zen (1st gen) 8–16 none Ryzen 1000 / 1000X Summit Ridge 4–8 Ryzen 1000 (AF) Pinnacle Ridge Zen+ 4–6 The first Ryzen 2000 CPUs, based on the 12 nm Zen+ microarchitecture, were announced for preorder on April 13, 2018[42] and launched six days later. Zen+ based Ryzen CPUs are based on Pinnacle Ridge architecture,[43] while Threadripper CPUs are based on the Colfax architecture. The first of the 2000 series of Ryzen Threadripper products, introducing Precision Boost Overdrive technology,[39] followed in August. The Ryzen 7 2700X was bundled with the new Wraith Prism cooler. In January 2018, AMD announced the first two Ryzen desktop APUs with integrated Radeon Vega graphics under the Raven Ridge codename. These are based on first generation Zen architecture. The Ryzen 3 2200G and the Ryzen 5 2400G were released in February.[44] Overview of desktop Ryzen 2000 series models Model line Codename Architecture Core count Integrated graphics Ryzen Threadripper 2000 Colfax Zen+ 12–32 none Ryzen 2000 / 2000X Pinnacle Ridge 4–8 Ryzen 2000G Raven Ridge Zen (1st gen) 4 Radeon Vega (GCN 5), up to 11 CU In May 2017, AMD demonstrated a Ryzen mobile APU with four Zen CPU cores and Radeon Vega GPU.[45] The first Ryzen mobile APUs, codenamed Raven Ridge, were officially released in October 2017.[46] 4.95 billion[47] transistors on a 210 mm2 die,[47] based on a modified 14 nm Zeppelin die where four of the cores are replaced by an integrated fifth-generation GCN-based GPU. Precision Boost 2[43] 16 external PCIe 3.0 lanes (four each to chipset and M.2 socket; eight to a PCIe slot). 16 internal PCIe 3.0 lanes for the integrated GPU and on-board input/output (I/O).[citation needed] In 2019, AMD released some new dual core Zen mobile parts branded as 300 or 3000, codenamed Dali. Overview of laptop Ryzen 2000 series models Model line Codename Architecture Core count Integrated graphics Ryzen 2000 Raven Ridge Zen (1st gen) 2–4 Radeon Vega (GCN 5), up to 11 CU See also: List of AMD Ryzen processors § Great Horned Owl (V1000 series, Zen based) In February 2018 AMD announced the V1000 series of embedded Zen+ Vega APUs, based on the Great Horned Owl architecture, with four SKUs.[48] See also: List of AMD Ryzen processors § Banded Kestrel (R1000 series, Zen based) In April 2019 AMD announced another line of embedded Zen+ Vega APUs, namely the Ryzen Embedded R1000 series with two SKUs.[49] On May 27, 2019 at Computex in Taipei, AMD launched its third generation Ryzen processors which use AMD's Zen 2 architecture. For this generation's microarchitectures, Ryzen uses Matisse, while Threadripper uses Castle Peak. The chiplet design separates the CPU cores, fabricated on TSMC's 7FF process, and the I/O, fabricated on GlobalFoundries' 12LP process, and connects them via Infinity Fabric.[50] The Ryzen 3000 series uses the AM4 socket similar to earlier models and is the first CPU to offer PCI Express 4.0 (PCIe)

connectivity.[51] The new architecture offers a 15% instruction-per-clock (IPC) uplift and a reduction in energy usage. Other improvements include a doubling of the L3 cache size, a re-optimized L1 instruction cache, a larger micro-operations cache, double the AVX/AVX2 bandwidth, improved branch prediction, and better instruction pre-fetching.[50] The 6, 8 and 12 core CPUs became generally available on July 7, 2019, and 24 core processors were launched in November.[52] The competing Intel Core i9-10980XE processor has only 18 cores and 36 threads. Another competitor, the workstation-oriented Intel Xeon W-3275 and W-3275M, has 28 cores, 56 threads, and cost more when launched.[citation needed] The 4, 6 and 8 core processors have one core chiplet. The 12 and 16 core processors have two core chiplets. In all cases the I/O die is the same.[50] The Threadripper 24 and 32 core processors have four core chiplets. The 64 core processor has eight core chiplets. All Threadripper processors use the same I/O die. Desktop and mobile APUs are based on the Picasso microarchitecture, a 12 nm refresh of Raven Ridge, offering a modest (6 percent) increase in clock speeds (up to an additional 300 MHz maximum boost), Precision Boost 2, an up-to-3-percent increase in IPC from the move to the Zen+ core with its reduced cache and memory latencies, and newly added solder thermal interface material for the desktop parts.[53] Fabricated at GlobalFoundries, this gives Picasso an aggregate 10 percent performance uplift from the "original" 14 nm Zen-based Raven Ridge series initially released in 2017. Overview of desktop Ryzen 3000 series models Model line Codename Architecture Core count Integrated graphics Ryzen Threadripper PRO 3000 Castle Peak Zen 2 12–64 none Ryzen Threadripper 3000 24–64 Ryzen 3000 / 3000X Matisse 4–16 Ryzen 3000G Picasso Zen+ 4 Radeon Vega (GCN 5), up to 11 CU In 2019, AMD first released the Ryzen 3000 APUs, consisting only of quad core parts. Then in January 2020, they announced value dual-core mobile parts, codenamed Dalí, including the Ryzen 3 3250U and lower-end Athlon-branded parts. Overview of laptop Ryzen 3000 series models Model line Codename Architecture Core count Integrated graphics Ryzen 3000 Picasso Zen+ 2–4 Radeon Vega (GCN 5), up to 11 CU Ryzen 3 3250U,Ryzen 3 3200U Dali Zen (1st gen) 2 Radeon Vega (GCN 5), 3 CU The Ryzen 4000 APUs are based on Renoir, a refresh of the Zen 2 Matisse CPU cores, coupled with Radeon Vega GPU cores. They were released only to OEM manufacturers in mid-2020. Unlike Matisse, Renoir does not support PCIe 4.0.[54] Ryzen PRO 4x50G APUs are the same as 4x00G APUs, except they are bundled a Wraith Stealth cooler and are not OEM-only.[55] It is possible this is a listing mistake, since 4x50G CPUs are unavailable on retail (as of Oct 2020) and PRO SKUs are usually the OEM only parts. In April 2022, AMD released the Ryzen 5 4600G to retail, and launched the Ryzen 4000 series of CPUs without integrated graphics, for budget-oriented users.[56] Unlike the Ryzen 3000 series CPUs which are based on "Matisse" cores, these new Ryzen 4000 series desktop CPUs are based on "Renoir" cores and are essentially APUs with the integrated graphics disabled. Overview of desktop Ryzen 4000 series models Model line Codename Architecture Core count Integrated graphics Ryzen 4000 Renoir Zen 2 4–6 none Ryzen 4000G 4–8 Radeon Vega (GCN 5), up to 8 CU Zen 2 APUs, based on the 7 nm Renoir microarchitecture, commercialized as Ryzen 4000.[57][58][59] Overview of laptop Ryzen 4000 series models Model line Codename Architecture Core count Integrated graphics Ryzen 4000 Renoir Zen 2 4–8 Radeon Vega (GCN 5), up to 8 CU See also: List of AMD Ryzen processors § Grey Hawk (V2000 series, Zen 2 based) In November 2020, AMD announced the V2000 series of embedded Zen 2 Vega APUs. The desktop Ryzen 5000 series, based on the Zen 3 microarchitecture, was announced on October 8, 2020.[60][61] They use the same 7 nm manufacturing process, which has matured slightly.[62] Mainstream Ryzen 5000 CPUs are codenamed Vermeer. Enthusiast/workstation Threadripper 5000 CPUs are codenamed Chagall,[63] initially named Ryzen Threadripper 4000 under the codename Genesis.[64] In contrast to their CPU counterparts, the APUs consist of single dies with integrated graphics and smaller caches. The APUs, codenamed Cezanne, forgo PCIe 4.0 support to keep power consumption low.[65] Overview of desktop Ryzen 5000 series models Model line Codename Architecture Core count Integrated graphics Ryzen Threadripper PRO 5000 Chagall Zen 3 12–64 none Ryzen 5000 / 5000X / 5000X3D Vermeer 6–16 Ryzen 7 5700G Cezanne 8 Radeon Vega (GCN 5), up to 8 CU Ryzen 7 5700 none Ryzen 5 5600G 6 Radeon Vega (GCN 5), up to 8 CU Ryzen 5 5500 none Ryzen 3 5100 4 The 5000 series includes models based on the Zen 2 microarchitecture (codename Lucienne) and Zen 3 microarchitecture. The codenames of the Zen 3-based mobile APUs are Cezanne for the 2021 models and Barceló for the 2022 models. HX models are unlocked, allowing them to be overclocked if the host device manufacturer has exposed that functionality. Simultaneous multithreading (SMT) is now standard across the lineup unlike the 4000-series Ryzen Mobile. Overview of laptop Ryzen 5000 series models Model line Codename Architecture Core count Integrated graphics Ryzen 7 5700U,Ryzen 5 5500U,Ryzen 3 5300U Lucienne Zen 2 4–8 Radeon Vega (GCN 5), up to 8 CU Ryzen 5000 Cezanne Zen 3 4–8 Barcelo 2–8 At CES 2022, AMD announced the Ryzen 6000 mobile series. It is based on the Zen 3+ architecture, which is Zen 3 on 6 nm with efficiency improvements, and is codenamed Rembrandt. Other noteworthy upgrades are RDNA2 based graphics, PCIe 4.0 and DDR5/LPDDR5 support. Ryzen PRO versions of these processors were announced on April 19, 2022[66] and use a 6x50 naming scheme. Overview of laptop Ryzen 6000 series models Model line Codename Architecture Core count Integrated graphics Ryzen 6000 Rembrandt Zen 3+ 6–8 Radeon 6x0M (RDNA 2), up to 12 CU AMD Ryzen 9 7900X processor In May 2022 AMD revealed its roadmap showing the Ryzen 7000 series of processors for release later that year, to be based on the Zen 4 architecture in 5 nm (codenamed Raphael).[67][68] Included are DDR5 and PCIe 5.0 support as well as the change to the new AM5 socket. On May 23, 2022 at AMD's Computex keynote, AMD officially announced the Ryzen 7000 to be released in Fall 2022, showing a 16-core CPU reaching boost speeds of 5.5 GHz and claiming a 15 percent increase in single-thread performance.[69] The initial four models of the Ryzen 7000 series, ranging from Ryzen 5 7600X to Ryzen 9 7950X, were launched on September 27, 2022.[70] The L2 cache per core is doubled to 1 MB from Zen 3. The I/O die has moved from a 12 nm process to 6 nm and incorporates an integrated RDNA 2 GPU with two CUs on all Ryzen 7000 models (except the Ryzen 5 7500F), as well as DDR5 and PCIe 5.0 support.[71][72] DDR4 memory is not supported on Ryzen 7000. According to Gamers Nexus, AMD said that the RDNA GPU was intended for diagnostic and office purposes without using a discrete GPU and not for gaming.[73] The operating power of AM5 is increased to 170 W from AM4's 105 W, with the absolute maximum power draw or "Power Package Tracking" (PPT) being 230 W.[74] The Ryzen Threadripper and Threadripper PRO 7000 series were released on November 21, 2023. Threadripper features up to 64 cores, while Threadripper PRO 7000 features up to 96 cores. These new HEDT and workstation processor lineups both utilize a new socket, sTR5, as well as DDR5 and PCIe 5.0. Two new chipsets have been introduced for the sTR5 socket: TRX50 and WRX90.[75][76] In conversations with Gamers Nexus regarding the later Ryzen 7 9800X3D, AMD engineers revealed that in 7000X3D series processors, the 1st-generation V-Cache and accompanying structural silicon above the cores effectively act as a thermal insulator, thus inhibiting cooling of the cores.[77] The cores running hotter thus limited the clock frequencies of 7000X3D series processors, compared to their non-X3D counterparts.[77] The engineers refuted earlier speculation that the temperature of the V-Cache had instead been the limiting factor.[77] Overview of desktop Ryzen 7000 series models Model line Codename Architecture Core count Integrated graphics Ryzen Threadripper PRO 7000 Storm Peak Zen 4 12–96 none Ryzen Threadripper 7000 24–64 Ryzen 7000 / 7000X / 7000X3D Raphael 6–16 Radeon (RDNA 2), 2 CU The Ryzen 7000 mobile series initially launched in September 2022 with the Ryzen 7020 Mendocino line of low-end Zen 2 ultra mobile processors.[78] In early 2023, the rest of the Ryzen 7000 mobile lineup was released, starting with Ryzen 7030, Ryzen 7035, and later Ryzen 7045 and Ryzen 7040 series processors. The Ryzen 7020 series targets the "everyday computing" segment.[79] It is a new Zen 2 design based on 6 nm process and RDNA 2 integrated graphics. The Ryzen 7030 series is a refresh of Ryzen 5000 series processors codenamed "Barcelo-R",[80] targeting the "mainstream thin-and-light" segment.[79] The Ryzen 7035 series is a refresh of Ryzen 6000 series processors codenamed "Rembrandt-R",[80] targeting "premium thin-and-light" laptops.[79] The Ryzen 7040 series is a new design based on Zen 4, targeting "elite ultrathin" segment.[79] It integrates a built-in AI accelerator (branded as "Ryzen AI") for the first time in an x86 processor,[81] and features RDNA 3 integrated graphics with up to 12 compute units. The Ryzen 7045 series is the top of the range, based on Zen 4. It targets "extreme gaming and creator" laptops, i.e. desktop replacement class laptops,[79] with models providing up to 16 cores. It uses a chiplet package built using a separate CCD (Core Complex Die, containing processor cores) and I/OD (Input/Output Die), the same as those used in Raphael desktop processors.[82] Altogether, there are four different CPU architectures, and three different GPU architectures used across the various models in the 7000 series lineup.[83] With the launch of the mobile Ryzen 7000 series, a new CPU model naming system was also introduced, which is used with Ryzen and Athlon mobile processors launching from this point onwards, as follows:[84] Ryzen/Athlon xabc: x – timeline of creation (7 for 2022, 8 for 2023, etc) a – performance segment (1 for low end, 7 for high-end, 9 for enthusiast, etc) b – Microarchitecture the processor is based on (1 for Zen / Zen+, 3 for Zen 3 / 3+, 4 for Zen 4, 5 for Zen 5, etc) c – feature / minor performance segment (0 for lower segment, 5 for higher segment) The new naming system has drawn criticism for being overly complex and confusing to consumers.[85][86] Desktop processors continue to use the old naming system.[87] Overview of laptop Ryzen 7000 series models Model line Codename Architecture Core count Integrated graphics Ryzen 7045 Dragon Range Zen 4 6–16 Radeon 610M (RDNA 2), 2 CU Ryzen 7040 Phoenix 4–8 Radeon 7x0M (RDNA 3), up to 12 CU Ryzen 7035 Rembrandt-R Zen 3+ Radeon 6x0M (RDNA 2), up to 12 CU Ryzen 7030 Barcelo-R Zen 3 Radeon Vega (GCN 5), up to 8 CU Ryzen 7020 Mendocino Zen 2 2–4 Radeon 610M (RDNA 2), 2 CU On April 25, 2023, AMD announced the Ryzen Z1 series of APUs for "handheld PC gaming consoles", and announced that the Asus ROG Ally would use the Ryzen Z1 Extreme processor.[88] AMD promised compatibility with Windows 11, among other operating systems.[88] Overview of handheld Ryzen Z1 series models Model line Architecture Core count Integrated graphics Ryzen Z1 Zen 4 6-8 RDNA 3, 4–12 CU On January 8, 2024, AMD announced the Ryzen 8000G series of desktop APUs for the AM5 socket at the 2024 Consumer Electronics Show. These APUs are based on Zen 4 and feature up to 12 CUs of RDNA3 integrated graphics. Furthermore, the upper-end models such as Ryzen 5 8600G and Ryzen 7 8700G feature "Ryzen AI", which is a neural processing unit (NPU) for artificial intelligence PC applications.[89] AMD claims that the integrated graphics in Ryzen 8000G APUs is capable of playing AAA games such as Cyberpunk 2077 and Far Cry 6 at 1080p low settings.[90] On April 1, 2024, AMD quietly released Ryzen 8000 series processors without integrated graphics, which also use the Zen 4 architecture. These processors are essentially based on the Ryzen 8000G series but with the integrated graphics and NPU disabled. The Ryzen 7 8700F however can provide AI acceleration when paired with a Radeon discrete GPU that supports it.[91] Overview of desktop Ryzen 8000 series models Model line Codename Architecture Core count Integrated graphics Ryzen 8000 Phoenix Zen 4 6–8 none Ryzen 8000G 4–8 Radeon 7x0M (RDNA 3), up to 12 CU A refresh of Ryzen 7040 mobile processors named the Ryzen 8040 and 8045 series were announced on December 6, 2023.[92] These processors feature small firmware and software optimizations for performance and have up to 1.6x faster NPU performance (6 TOPS higher) compared to Ryzen 7040.[93] A refresh of the Dragon Range series was added on April 10, 2025, primarly featuring minor clock speed adjustments. [94] Overview of mobile Ryzen 8000 series models Model line Codename Architecture Core count Integrated graphics Ryzen 8045HSRyzen 8040HS Hawk Point Zen 4 4–8 Radeon 7x0M (RDNA 3), up to 12 CU Ryzen 8045HX Dragon Range Refresh Zen 4 8–16 Radeon 610M (RDNA 2), 2 CU The Ryzen 9000 series of desktop processors, codenamed "Granite Ridge", were announced on June 3, 2024 at a Computex presentation. Utilizing the Zen 5 microarchitecture and built on a TSMC 4 nm process, Granite Ridge features up to 16 cores, uses the AM5 socket and has the same up-to-two-CCDs and one I/O die chiplet layout as the direct predecessor line of CPUs, Raphael. The initial lineup consists of four models with no 3D V-Cache variants, like with the Ryzen 7000 series at launch.[95] Ryzen 9000 processors were originally scheduled to launch at the end of July 2024, but had been delayed to early August for quality control reasons.[96] On October 21, AMD teased that it would launch X3D model(s) (featuring 3D V-Cache) in the series on November 7.[97] On October 31, AMD announced it would release a Ryzen 7 9800X3D processor.[98] The 9800X3D will feature 2nd-generation 3D V-Cache, wherein the V-Cache has been moved from above the CCD to below the CCD.[98] This change is claimed to lower the CCD temperature, thus allowing for higher clock frequencies.[98] Originally, 9000 series X3D models had been expected to arrive in January 2025.[99] On January 6, 2025, AMD announced that it would release 9900X3D and 9950X3D desktop processors in Q1 2025.[100] The models will have 2 CCDs, only one of which will feature 2nd-generation 3D V-Cache.[101] In January 2025, AMD stated that there were no technical barriers to adding 2nd-generation 3D V-Cache to both CCDs of a CPU.[102][103] However, internal testing led them to conclude that games wouldn't benefit enough from such configurations, making them economically infeasible; and thus AMD declined to launch dual 3D V-Cache variants of their CPUs.[102][103] Overview of desktop Ryzen 9000 series models Model line Codename Architecture Core count Integrated graphics Ryzen 9000 / 9000X / 9000X3D Granite Ridge Zen 5 6–16 Radeon (RDNA 2), 2 CU The Ryzen 9000 series of mobile processors, codenamed "Fire Range", were announced on January 6, 2025 at CES 2025.[104] Overview of mobile Ryzen 9000 series models Model line Codename Architecture Core count Integrated graphics Ryzen 9000HX / 9000HX3D Fire Range Zen 5 12–16 Radeon (RDNA 2), 2 CU Alongside the Ryzen 9000 desktop series, AMD also introduced the Ryzen AI 300 series of elite ultrathin mobile processors codenamed "Strix Point" on June 3, 2024 at Computex. It features up to 12 cores, a third-generation Ryzen AI NPU based on XDNA 2 and up to 16 compute units (CUs) of RDNA 3.5 integrated graphics. The NPU provides up to 50 TOPS for AI inference processing. These new processors also deviate from the naming scheme used with Ryzen 7000 and 8000 series mobile processors, instead using a three-digit model numbering system similar to Intel's Core and Core Ultra 3/5/7/9 series.[105] AMD has allegedly decided not to introduce a whole range of SKUs that previously existed, namely U (ultra-low power) and H(S) (high performance) models and instead OEMs are now allowed to configure the APU thermals as they see fit ranging from 15 to 54 W.[citation needed] The codename "Krackan Point" and high-end codename "Strix Halo" additions to the 300 series were announced on January 6, 2025 at CES 2025.[106][107][108] Overview of mobile Ryzen AI 300 series models Model line Codename Architecture Core count Integrated graphics Ryzen AI 300 Strix Point Zen 5Zen 5c 10–12 Radeon 8x0M (RDNA 3.5), up to 16 CU Ryzen AI 7 350,Ryzen AI 5 340 Krackan Point 6–8 Radeon 8x0M (RDNA 3.5), up to 8 CU Ryzen AI MAX+ 395,Ryzen AI MAX 390,Ryzen AI MAX 385,Ryzen AI MAX 380 Strix Halo Zen 5 6–16 Radeon 80x0S (RDNA 3.5), up to 40 CU The Ryzen 200 series of mobile processors, codenamed "Hawk Point Refresh", were announced on January 6, 2025 at CES 2025.[106][107] Overview of mobile Ryzen 200 series models Model line Codename Architecture Ryzen 200 Hawk Point Refresh Zen 4Zen 4c On January 6, 2025, AMD announced the Ryzen Z2 series of APUs at CES, as a sequel to its previous Ryzen Z1 series.[100] The Z2 Go model is exclusive to the Lenovo Legion Go S handheld device.[109][110] Overview of handheld Ryzen Z2 series models Model line Architecture Core count Integrated graphics Ryzen Z2 Zen 5 4–8 RDNA 3.5, 12-16 CU The first Ryzen 7 (1700, 1700X, and 1800X) processors debuted in early March 2017 and were generally well received by hardware reviewers.[111][112][113] Ryzen was the first brand new architecture from AMD in five years, and without very much initial fine-tuning or optimization, it ran generally well for reviewers.[114] Initial Ryzen chips ran well with software and games already on the market, performing exceptionally well in workstation scenarios, and well in most gaming scenarios. Compared to Piledriver-powered FX chips, Zen-powered Ryzen chips ran cooler, much faster, and used less power. IPC uplift was eventually gauged to be 52 percent higher than Excavator, which was two full generations ahead of the architecture still being used in AMD's FX-series desktop predecessors like the FX-8350 and FX-8370.[1] Though Zen fell short of Intel's Kaby Lake in terms of IPC, and therefore single-threaded throughput, it compensated by offering more cores to applications that can use them. Power consumption and heat emission were found to be competitive with Intel, and the included Wraith coolers were generally competitive with higher-priced aftermarket units. Ryzen 7 1800X's multi-threaded performance, in some cases while using Blender or other open-source software, was around four times the performance of the FX-8370, or nearly double that of the Core i7-7700K.[115] One reviewer found that Ryzen chips would usually outperform competing Intel's Core i7 processors for a fraction of the price when all eight cores are used.[115] However, one complaint among a subset of reviewers was that Ryzen processors lagged behind their Intel counterparts when running older games, or some newer games at mainstream resolutions such as 720p or 1080p.[116] AMD acknowledged the gaming performance deficit at low resolutions during a Reddit "Ask Me Anything" thread, where it explained that updates and patches were being developed.[117] Subsequent updates to Ashes of the Singularity: Escalation and Rise of the Tomb Raider increased frame rates by 17-31 percent on Ryzen systems.[118][119] In April 2017, developer id Software announced that, in the future, its games would exploit the greater parallelism available on Ryzen CPUs.[120] It has been suggested that low threaded applications often result in Ryzen processors being underused, yielding lower than expected benchmark scores, because Zen relies on its core count to make up for its lower IPC rating than that of Kaby Lake.[121][122][123] However, AMD and others have argued thread scheduling is not the fundamental issue to Windows 10 performance.[124][125] Early AM4 motherboards were also hindered by BIOS bugs and poor DDR4 memory support.[citation needed] AMD verified that computers with Ryzen CPUs can boot Windows 7 and Windows 8 both 64- and 32-bit. However, newer hardware including AMD Ryzen and Intel Kaby Lake and later is only officially supported by Microsoft with the use of Windows 10. Windows Update blocks updates from being installed on newer systems running older versions of Windows, though that restriction can be circumvented with an unofficial patch.[126] Windows 11 is only officially supported on Ryzen APUs and CPUs using Zen+ architecture or newer; systems running Zen architecture-based CPUs or APUs are not entitled to receive updates.[127][128][129] Although AMD initially announced that Ryzen chipset drivers would not be provided for Windows 7,[130] its chipset driver packages do in fact list and include them.[131] Full support for Ryzen processors' performance features in Linux requires kernel version 4.10 or newer.[132] Like nearly all modern high performance microprocessors, Ryzen was susceptible to the "Spectre" vulnerabilities. The vulnerabilities can be mitigated without hardware changes via microcode updates and operating system workarounds, but the mitigations incur a performance penalty.[133] Ryzen and Epyc suffer up to 20 percent penalty from the mitigations,[134] depending on workload, comparing favorably with a penalty of in some benchmarks up to 30 percent for Intel Core and Xeon processors,[135][136] in part as a result of the AMD processors not requiring mitigation against the related Meltdown vulnerability.[137] Launched in 2019, Zen 2 includes hardware mitigations against the Spectre V4 speculative store bypass vulnerability.[50][138] Some early shipments of Ryzen 1000 series processors produced segmentation faults on some workloads on Linux, especially while compiling code with GNU Compiler Collection (GCC).[139] AMD offered to replace the affected processors with newer ones that are unaffected by the problem.[140] In early 2018, Israeli computer security consultancy firm CTS Labs stated that they had discovered several major flaws in the Ryzen components ecosystem,[141] publicly disclosing them after giving AMD 24 hours to respond and raising concerns and questions regarding their legitimacy,[142][143] though they were later confirmed by two separate security firms.[144] AMD has since stated that while the flaws are real and will be fixed via microcode updates, their severity was overstated as physical access to the hardware is required to exploit the flaws.[145] Athlon AMD Accelerated Processing Unit List of AMD processors List of AMD Athlon processors List of AMD Epyc processors List of AMD FX processors List of AMD Opteron processors List of AMD Phenom processors List of AMD Ryzen processors ^ a b c Cutress, Ian (February 22, 2017). "AMD Launches Ryzen: 52% More IPC, Eight Cores for Under $330, Pre-order Today, On Sale March 2nd". AnandTech. Retrieved November 18, 2022. ^ "AMD Ryzen 3 PRO @ 3138.55 MHz - CPU-Z VALIDATOR". valid.x86.fr. Retrieved December 14, 2022. ^ Cutress, Ian (December 13, 2016). "AMD Gives More Zen Details: Ryzen, 3.4 GHz+, NVMe, Neural Net Prediction, & 25 MHz Boost Steps". AnandTech. Retrieved November 18, 2022. ^ a b "AMD Takes Computing to a New Horizon with Ryzen Processors". AMD (Press release). Austin, TX. December 13, 2016. Archived from the original on December 14, 2016. Retrieved July 20, 2018. ^ Cutress, Ian (March 2, 2017). "The AMD Zen and Ryzen 7 Review: A Deep Dive on 1800X, 1700X and 1700". AnandTech. Retrieved November 28, 2022. ^ Shimpi, Anand Lal (July 14, 2006). "Intel's Core 2 Extreme & Core 2 Duo: The Empire Strikes Back". AnandTech. Retrieved November 28, 2022. ^ Yawar (May 6, 2023). "Full Details about intel processor". Retrieved May 10, 2023. ^ Cutress, Ian (July 11, 2014). "Devil's Canyon Review: Intel Core i7-4790K and i5-4690K". AnandTech. Retrieved November 28, 2022. ^ Cutress, Ian (June 2, 2015). "The Intel Broadwell Desktop Review: Core i7-5775C and Core i5-5675C Tested (Part 1)". AnandTech. Retrieved November 28, 2022. ^ Shimpi, Anand Lal (October 12, 2011). "The Bulldozer Review: AMD FX-8150 Tested". Anandtech. Retrieved November 28, 2022. ^ Cutress, Ian (February 4, 2016). "Who Controls the User Experience? AMD's Carrizo Thoroughly Tested". AnandTech. Retrieved November 28, 2022. ^ Anthony, Sebastian; Walton, Mark (December 13, 2016). "AMD's Zen CPU is now called Ryzen, and it might actually challenge Intel". Ars Technica. Retrieved June 26, 2018. ^ Murray, Matthew (January 8, 2018). "AMD's New Desktop Processors for 2018: What You Need to Know". Tom's Guide. Retrieved June 26, 2018. ^ Cuttress, Ian (March 2, 2017). "The AMD Zen and Ryzen 7 Review: A Deep Dive on 1800X, 1700X and 1700". AnandTech. p. 23. Retrieved September 4, 2017. ^ a b Cutress, Ian (February 22, 2017). "AMD Launches Ryzen: 52% More IPC, Eight Cores for Under $330, Pre-order Today, On Sale March 2nd". AnandTech. Retrieved August 5, 2022. ^ a b "[PATCH] add znver1 processor". ^ "PassMark CPU Benchmarks - AMD vs Intel Market Share". CPU Benchmark. Retrieved August 1, 2017. ^ Cutress, Ian (April 19, 2018). "The AMD 2nd Gen Ryzen Deep Dive: The 2700X, 2700, 2600X, and 2600 Tested". AnandTech. Retrieved December 11, 2019. ^ Cutress, Ian (April 13, 2018). "AMD Ryzen 2nd Gen Details: Four CPUs, Pre-Order Today, Reviews on the 19th". AnandTech. Retrieved April 13, 2018. ^ Walton, Steven (November 16, 2020). "AMD Ryzen 5000 IPC Performance Tested". TechSpot. Retrieved August 18, 2021. ^ Loeffler, John (June 16, 2020). "New AMD Ryzen 3000 XT processors are coming one year after the originals". TechRadar. Retrieved February 6, 2021. ^ Alcorn, Paul (November 26, 2020). "AMD Ryzen 9 5950X and 5900X Review: Zen 3 Breaks the 5 GHz Barrier". Tom's Hardware. Retrieved August 18, 2021. ^ Sandhu, Tarinder (February 17, 2022). "Deep dive into AMD Ryzen 6000 Series mobile technology". Club386. Retrieved November 9, 2022. ^ Ganti, Anil (August 30, 2022). "AMD Ryzen 7000 series of processors unleashed with new Zen 4 architecture, 13 percent IPC uplift, up to 170 W TDP, and an attractive price tag". NotebookCheck. Retrieved November 9, 2022. ^ Leather, Antony. "AMD Ryzen Threadripper: The Fascinating Story Behind The Processor That Beat Intel". Forbes. Retrieved January 6, 2020. ^ a b Hachman, Mark (May 15, 2023). "Why AMD thinks Ryzen AI will be just as vital as CPUs and GPUs". PCWorld. Retrieved March 26, 2024. ^ The Future of AI PCs Gets Even Better with AMD and AMD XDNA Architecture. ^ Tucker, Laura (December 7, 2023). "AI Is Hitting Your Computer Hardware: AMD Ryzen AI". Make Tech Easier. Retrieved March 26, 2024. ^ Bonshor, Gavin (December 6, 2023). "AMD Widens Availability of Ryzen AI Software For Developers, XDNA 2 Coming With Strix Point in 2024". www.anandtech.com. Retrieved March 26, 2024. ^ Larabel, Michael (January 25, 2024). "AMD Publishes XDNA Linux Driver: Support For Ryzen AI On Linux". www.phoronix.com. Retrieved March 26, 2024. ^ a b c Cutress, Ian (March 2, 2017). "The AMD Zen and Ryzen 7 Review: A Deep Dive on 1800X, 1700X and 17000". AnandTech. Retrieved March 16, 2017. ^ Johnson, Renee (March 2, 2017). "AMD's Ryzen 7 1800X, Ryzen 7 1700X, and Ryzen 7 1700 CPUs reviewed". Tech Report. Retrieved March 3, 2017. ^ "AMD Ryzen 7 1800X och 7 1700X- Sweclockers". Sweclockers.com. ^ Hagedoom, Hilbert (March 2, 2017). "AMD Ryzen 7 1800X Review - CPU-Z Screenshots & System". The Guru of 3D. Retrieved November 28, 2022. ^ "Gaming: Tips for Building a Better AMD Ryzen System". AMD Community. March 15, 2017. Retrieved March 15, 2017. ^ Walton, Mark (March 2, 2017). "AMD Ryzen 7 1800X still behind Intel, but it's great for the price". Ars Technica. Retrieved March 3, 2017. ^ Alcorn, Paul (March 2, 2017). "AMD Ryzen 7 1800X CPU Review". Tom's Hardware. Retrieved March 3, 2017. ^ Verry, Tim (March 4, 2017). "PSA: AMD XFR Enabled On All Ryzen CPUs, X SKUs Have Wider Range". PC Perspective. Retrieved February 3, 2018. ^ a b Hallock, Robert (April 1, 2019). "AMD Ryzen Processor Features Defined". Reddit. Retrieved November 28, 2022. ^ Singh, Karandeep (February 21, 2017). "AMD Ryzen 7 Getting More Interesting, New Wraith RGB Coolers and Box Design Revealed". Racing Junky. Retrieved November 28, 2022. ^ Federowicz, Evan (December 21, 2019). "First-Gen AMD Ryzen CPUs are Appearing with 12nm Zen+ Architecture". Wccftech. Retrieved November 28, 2022. ^ Alcorn, Paul (April 13, 2018). "AMD Announces 2nd Generation Ryzen 7 & 5 CPUs: Pricing, Pre-Orders". Tom's Hardware. Retrieved April 13, 2018. ^ a b Hallock, Robert (November 27, 2017). "Understanding Precision Boost 2 in AMD SenseMI technology". AMD. Retrieved November 28, 2022. ^ "AMD's 2018 roadmap: Desktop APUs in February, second-generation Ryzen in April". Ars Technica. January 8, 2018. Retrieved January 16, 2018. ^ Shrout, Ryan (May 30, 2017). "Computex 2017: AMD Demos Ryzen Mobile SoC with Vega Graphics". PC Perspective. Retrieved June 2, 2017. ^ Cutress, Ian (October 26, 2017). "Ryzen Mobile is Launched". AnandTech. Retrieved October 26, 2017. ^ a b "The Mobile CPU Comparison Guide Rev. 13.0 Page 5 : AMD Mobile CPU Full List". TechARP. Retrieved December 13, 2017. ^ Alcorn, Paul (February 21, 2018). "AMD Launches Ryzen Embedded V1000, EPYC Embedded 3000 Processors". Tom's Hardware. Retrieved April 5, 2018. ^ "AMD Expands Embedded Product Family, Adds Design Wins and Customers, with New Ryzen Embedded R1000". AMD. April 16, 2019. Retrieved August 8, 2019. ^ a b c d Cutress, Ian (June 10, 2019). "AMD Zen 2 microarchitecture analysis: Ryzen 3000 and EPYC Rome". AnandTech. Retrieved November 18, 2022. ^ Cutress, Ian (January 9, 2019). "AMD Ryzen 3rd Gen 'Matisse' Coming Mid 2019: Eight Core Zen 2 with PCIe 4.0 on Desktop". AnandTech. Retrieved November 28, 2022. ^ Cutress, Ian (September 20, 2019). "AMD: Next Gen Threadripper and Ryzen 9 3950X, Coming November". AnandTech. Retrieved November 28, 2022. ^ Cutress, Ian (June 10, 2019). "AMD Ryzen 3000 APUs: Up to Vega 11, More MHz, Under $150, Coming July 7th". AnandTech. Retrieved November 18, 2022. ^ Cutress, Ian (July 21, 2020). "AMD Launches 12 Desktop Renoir Ryzen 4000G Series APUs: But You Can't Buy Them". AnandTech. Retrieved April 26, 2021. ^ "Ryzen 3 PRO 4350G". AMD. Retrieved November 28, 2022. ^ Mann, Parm (March 15, 2022). "AMD launches seven new Ryzen CPUs as part of extensive desktop overhaul". Club386. Retrieved July 7, 2023. ^ Cutress, Ian (January 6, 2020). "AMD Ryzen 4000 Mobile APUs: 7nm, 8-core on both 15W and 45W, Coming Q1". AnandTech. Retrieved January 7, 2020. ^ Alcorn, Paul (January 7, 2020). "AMD Launches Threadripper 3990X and Ryzen 4000 'Renoir' APUs". Tom's Hardware. Retrieved January 7, 2020. ^ Gartenberg, Chaim (January 6, 2020). "AMD's 7nm Ryzen 4000 CPUs are here to take on Intel's 10nm Ice Lake laptop chips". The Verge. Retrieved January 7, 2020. ^ Abazovic, Fuad (May 20, 2020). "Ryzen 4000 desktop was planned for Computex 2020". Fudzilla. Retrieved November 28, 2022. ^ Hruska, Joel (January 10, 2020). "AMD's Lisa Su Confirms Zen 3 Coming in 2020, Talks Challenges in Notebooks". ExtremeTech. Retrieved November 28, 2022. ^ Cutress, Ian (October 16, 2020). "AMD Zen 3: An AnandTech Interview with CTO Mark Papermaster". AnandTech. Retrieved November 28, 2022. ^ Subramaniam, Vaidyanathan (March 8, 2022). "AMD launches Ryzen Threadripper Pro 5000 WX series led by the 5995WX that trounces two Intel Xeon Platinum 8280s". Notebookcheck. Retrieved March 6, 2023. ^ Hagedoorn, Hilbert (July 24, 2019). "Ryzen Threadripper 4000 Codename - AMD Genesis (and Vermeer): spotted in AIDA64". Guru3D.com. Retrieved March 6, 2023. ^ Cutress, Ian (April 13, 2021). "AMD Ryzen 5000G APUs: OEM Only For Now, Full Release Later This Year". AnandTech. Retrieved April 26, 2021. ^ "AMD Ryzen Processors with PRO Technologies". AMD. Retrieved November 28, 2022. ^ "AMD confirms Zen4 & Ryzen 7000 series lineup: Raphael in 2022, Dragon Range and Phoenix in 2023". VideoCardz. May 3, 2022. Retrieved May 3, 2022. ^ Liu, Zhiye (May 3, 2022). "AMD Confirms Zen 4 Dragon Range, Phoenix APUs for 2023". Tom's Hardware. Retrieved July 3, 2022. ^ "AMD Ryzen 5 7500F im Test/Review" (in German). PCMasters. August 18, 2023. Retrieved September 19, 2023. ^ "AMD Ryzen 7000 "Zen4" desktop series launch September 27th, Ryzen 9 7950X for 699 USD". VideoCardz. August 29, 2022. Retrieved August 30, 2022. ^ Bonshor, Gavin (May 23, 2022). "AMD Ryzen 7000 Announced: 16 Cores of Zen 4, Plus PCIe 5 and DDR5 for Socket AM5, Coming This Fall". AnandTech. Retrieved November 18, 2022. ^ Alcorn, Paul (September 30, 2022). "AMD Zen 4 Ryzen 7000 Specs, Release Date, Benchmarks, Price Listings". Tom's Hardware. Retrieved November 18, 2022. ^ Gamers Nexus (May 23, 2022). AMD's 5+GHz 16-Core Zen 4 CPUs, X670 & B650, Ryzen 7000 & 6000, & AM5. YouTube. Retrieved May 23, 2022. ^ Bonshor, Gavin (May 26, 2022). "AMD Corrects Socket AM5 Power Specifications: 170 W TDP and 230 W PPT". AnandTech. Retrieved July 3, 2022. ^ Hachman, Mark (October 19, 2023). "AMD's monstrous Threadripper 7000 CPUs aim for desktop PC dominance". PCWorld. Retrieved January 10, 2024. ^ Roach, Jacob (November 20, 2023). "AMD isn't competing with Intel anymore -- Threadripper wins". Digital Trends. Retrieved January 10, 2024. ^ a b c "AMD Responds to Intel: Ryzen 7 9800X3D Price, Specs, & Major Changes". YouTube. Gamers Nexus. October 31, 2024. Retrieved October 31, 2024. ^ Hachman, Mark (September 20, 2022). "AMD Ryzen 7020 'Mendocino' CPUs want low-cost laptops to last all day long". PCWorld. Retrieved April 24, 2023. ^ a b c d e Prasad (January 5, 2023). "AMD announces new Ryzen 7000 desktop and mobile CPUs". GSMArena.com. Retrieved April 26, 2023. ^ a b Connatser, Matthew (January 5, 2023). "AMD unveils Ryzen 7000 mobile APUs, V-Cache chips, and RX 7000 laptop GPUs". XDA Developers. Retrieved April 26, 2023. ^ Hardawar, Devindra (January 4, 2023). "AMD's Ryzen 7000 mobile CPUs feature up to 16 cores and 5.4GHz speeds". Engadget. Retrieved April 26, 2023. ^ Bonshor, Gavin. "AMD Announces Ryzen Mobile 7045 HX-Series CPUs, Up to 16-Cores and 5.4 GHz for Laptops". www.anandtech.com. Retrieved January 9, 2023. ^ "AMD Ryzen 7000 Mobile: RDNA 3 in der Zen-4-APU und 16 Kerne per Chiplet-Ansatz". computerbase.de (in German). ComputerBase. January 5, 2023. Retrieved April 8, 2023. ^ Woods, Rich (September 7, 2022). "Only some of AMD's Ryzen 7000 mobile processors will be Zen 4". XDA Developers. Retrieved April 24, 2023. ^ Hachman, Mark (April 5, 2023). "AMD's ridiculously complex Ryzen names make buying a laptop hard". PCWorld. Retrieved April 17, 2023. ^ White, Monica (April 4, 2023). "AMD's Ryzen 7000 lineup is confusing, but at least we get a sticker". Digital Trends. Retrieved April 17, 2023. ^ "AMD's New Ryzen Mobile CPU Naming Scheme Explained". Beebom. September 12, 2022. Retrieved April 24, 2023. ^ a b "AMD Introduces Ryzen™ Z1 Series Processors, Expanding the "Zen 4" Lineup into Handheld Game Consoles" (Press release). Santa Clara, California: AMD. Globe Newswire. April 25, 2023. Retrieved January 8, 2025. ^ Cunningham, Andrew (January 8, 2024). "AMD launches Ryzen 8000G desktop CPUs, with updated iGPUs and AI acceleration". Ars Technica. Retrieved January 10, 2024. ^ Bonshor, Gavin (January 8, 2024). "AMD Unveils Ryzen 8000G Series Processors: Zen 4 APUs For Desktop with Ryzen AI". www.anandtech.com. Retrieved January 10, 2024. ^ Klotz, Aaron (April 11, 2024). "AMD quietly confirms worldwide launch for Ryzen 7 8700F, Ryzen 5 8400F — official specs revealed". Tom's Hardware. Retrieved April 12, 2024. ^ Cunningham, Andrew (December 6, 2023). "AMD's new Ryzen 8040 laptop chips look a lot like the Ryzen 7040 CPUs". Ars Technica. Retrieved January 10, 2024. ^ Bonshor, Gavin (December 6, 2023). "AMD Unveils Ryzen 8040 Mobile Series APUs: Hawk Point with Zen 4 and Ryzen AI". www.anandtech.com. Retrieved January 10, 2024. ^ "AMD Ryzen 8000HX "Dragon Range Refresh" Mobile Processors Official". TechPowerUp. April 10, 2025. Retrieved April 17, 2025. ^ Bonshor, Gavin (June 2, 2024). "AMD Unveils Ryzen 9000 CPUs For Desktop, Zen 5 Takes Center Stage at Computex 2024". www.anandtech.com. Retrieved June 3, 2024. ^ Cunningham, Andrew (July 24, 2024). "AMD delays Ryzen 9000 launch to August "out of an abundance of caution"". Ars Technica. Retrieved July 24, 2024. ^ Warren, Tom (October 21, 2024). "AMD's highly anticipated 9000-series X3D desktop CPUs arrive on November 7th". The Verge. Retrieved October 26, 2024. ^ a b c "The Gaming Legend Continues — AMD Introduces Next-Generation AMD Ryzen 7 9800X3D Processor" (Press release). Santa Clara, California: AMD. Globe Newswire. October 31, 2024. Retrieved October 31, 2024. ^ AleksandrK (August 23, 2024). "AMD Ryzen 9000X3D Processors with 3D V-Cache Arrive in January at CES 2025". TechPowerUp. Retrieved August 29, 2024. ^ a b "AMD Announces New Gaming Products for Ultimate Gameplay Experience at CES" (Press release). Las Vegas: AMD. Globe Newswire. January 6, 2025. Retrieved January 6, 2025. ^ Alcorn, Paul (January 6, 2025). "AMD launches Ryzen 9 9950X3D and 9900X3D, claims 20% faster gaming performance than Intel's flagship Arrow Lake processors". Tom's Hardware. Retrieved January 6, 2025. ^ a b Schilling, Andreas (January 8, 2025). "3D V-Cache auf nur einem CCD: AMD führt rein wirtschaftliche Gründe an" [3D V-Cache on only one CCD: AMD cites purely economic reasons]. HardwareLuxx (in German). Retrieved March 13, 2025. ^ a b Fox, Jacob (January 8, 2025). "AMD says there are no technical reasons for not having an X3D processor with 3D V-Cache on both CCDs, but we probably won't see such a dual-stacked chip anyway". PC Gamer. Retrieved March 13, 2025. ^ Alcorn, Paul (January 6, 2025). "AMD Launches 'Fire Range' HX3D mobile processor with game-boosting 3D V-Cache, other HX Series SKUs built on Zen 5 desktop CPU silicon". Tom's Hardware. Retrieved January 7, 2025. ^ Hachman, Mark (June 2, 2024). "AMD's Ryzen AI 300 is built to dominate thin, light Copilot+ laptops". PCWorld. Retrieved June 3, 2024. ^ a b "AMD Announces Expanded Consumer and Commercial AI PC Portfolio at CES" (Press release). Las Vegas: AMD. Globe Newswire. January 6, 2025. Retrieved January 7, 2025. ^ a b Nasir, Hassam (January 6, 2025). "AMD launches Ryzen AI 300 and 200 series chips for laptops". Tom's Hardware. Retrieved January 8, 2025. ^ Alcorn, Paul (January 6, 2025). "AMD's beastly 'Strix Halo' Ryzen AI Max+ debuts with radical new memory tech to feed RDNA 3.5 graphics and Zen 5 CPU cores". Tom's Hardware. Retrieved January 8, 2025. ^ "Lenovo Legion Go S". Lenovo US. n.d. Retrieved March 13, 2025. exclusive AMD Ryzen™ Z2 Go ^ Barr, Kyle (February 10, 2025). "Lenovo Legion Go S Review: Comfortable, but Compromised". Gizmodo. Retrieved March 13, 2025. ^ Cutress, Ian (March 2, 2017). "The AMD Zen and Ryzen 7 Review". AnandTech. Retrieved June 23, 2017. ^ Kampman, Jeff (March 2, 2017). "AMD's Ryzen 7 1800X, Ryzen 7 1700X, and Ryzen 7 1700 CPUs reviewed". Tech Report. Retrieved June 23, 2017. ^ Shrout, Ryan (March 2, 2017). "The AMD Ryzen 7 1800X Review: Now and Zen". PC Perspective. Retrieved June 23, 2017. ^ Lillah, Sarmad (September 28, 2020). "In Order For AMD Ryzen To Deliver In Performance AMD Needs Game Developers To Optimize Game Accordingly". Segment Next. Retrieved November 28, 2022. ^ a b Ung, Gordon (March 2, 2017). "Ryzen review: AMD is back". PCWorld. Retrieved March 2, 2017. ^ Hruska, Joel (March 2, 2017). "AMD Ryzen 7 1800X reviewed: Zen is an amazing workstation chip with a 1080p gaming Achilles heel". ExtremeTech. Retrieved November 18, 2022. ^ "Didn't Attend AMD's Ryzen Reddit AMA? Here's What You Missed!". Custom PC Review. March 3, 2017. Archived from the original on March 12, 2017. Retrieved March 9, 2017. ^ Shrout, Ryan (March 29, 2017). "Ashes of the Singularity Gets Ryzen Performance Update". PC Perspective. Retrieved March 30, 2017. ^ Shrout, Ryan (May 30, 2017). "Rise of the Tomb Raider Gets a Ryzen Performance Update". PC Perspective. Retrieved May 31, 2017. ^ Killian, Zak (April 26, 2017). "id software talks about Ryzen". Tech Report. Retrieved April 26, 2017. ^ "AMD's Ryzen CPU Series will Need Modern Linux Kernel for Proper Support". TechPowerUp. February 28, 2017. Retrieved November 18, 2022. ^ "AMD: Ryzen CPU gaming performance inhibited by lack of optimization". Yahoo!. Archived from the original on March 12, 2017. Retrieved November 18, 2022. ^ Moammer, Khalid (March 8, 2017). "AMD Ryzen Performance Negatively Affected by Windows 10 Scheduler Bug". Wccftech. Retrieved November 18, 2022. ^ "AMD Ryzen Community Update". AMD. Retrieved March 13, 2017. ^ Malventano, Allyn (March 10, 2017). "AMD Ryzen and the Windows 10 Scheduler - No Silver Bullet". PC Perspective. Retrieved March 13, 2017. ^ Whitwam, Ryan (April 20, 2017). "Unofficial Patch Unblocks Windows 7 and 8.1 Updates for Kaby Lake, Ryzen". ExtremeTech. Retrieved September 3, 2017. ^ Hollister, Sean (September 21, 2021). "Windows 11 won't stop older PCs, but it might make you sign this waiver". The Verge. Archived from the original on September 21, 2021. Retrieved September 22, 2021. ^ Hollister, Sean (August 28, 2021). "Microsoft is threatening to withhold Windows 11 updates if your CPU is old". The Verge. Archived from the original on September 22, 2021. Retrieved September 22, 2021. ^ "Windows 11 Supported AMD Processors". Microsoft. Retrieved June 28, 2021. ^ Hachman, Mark (February 8, 2017). "AMD: Sorry, there will be no official Ryzen drivers for Windows 7". PCWorld. Retrieved April 23, 2017. ^ "Chipset". support.amd.com. Retrieved November 5, 2018. ^ Chacos, Brad (March 13, 2017). "Kernel 4.10 gives Linux support for AMD Ryzen multithreading". PCWorld. Retrieved June 28, 2017. ^ "Security Vulnerability: "Meltdown" and "Spectre" side channel attacks against CPUs with speculative execution". www.suse.com. ^ Larabel, Michael (December 2, 2020). "The Spectre Mitigation Performance Impact On AMD Ryzen 5000 "Zen 3" Processors". Phoronix. Retrieved November 28, 2022. ^ Larabel, Michael (August 30, 2018). "The Spectre Mitigation Performance Impact On AMD Ryzen 5000 "Zen 3" Processors". Phoronix. Retrieved November 18, 2022. ^ Larabel, Michael (November 16, 2018). "Bisected: The Unfortunate Reason Linux 4.20 Is Running Slower". Phoronix. Retrieved November 28, 2022. ^ "AMD Processor Security". AMD. Retrieved November 28, 2022. ^ btarunr (June 12, 2019). "AMD Zen 2 has Hardware Mitigation for Spectre V4". TechPowerUp. Retrieved October 18, 2019. ^ Larabel, Michael (August 7, 2017). "AMD Confirms Linux Performance Marginality Problem Affecting Some, Doesn't Affect Epyc". Phoronix. Retrieved November 28, 2022. ^ Hruska, Joel (August 29, 2017). "AMD Replaces Ryzen CPUs for Users Affected By Rare Linux Bug". ExtremeTech. Retrieved November 18, 2022. ^ Cimpanu, Catalin (March 13, 2018). "AMD Investigating RyzenFall, MasterKey, Fallout, and Chimera CPU Vulnerabilities". Bleeping Computer. Retrieved June 12, 2018. ^ Mott, Nathaniel (March 14, 2018). "CTS Labs Speaks: Why It Blindsided AMD With Ryzenfall And Other Vulnerabilities". Tom's Hardware. Retrieved November 18, 2022. ^ Cutress, Ian (March 13, 2018). "Security Researchers Publish Ryzen Flaws, Gave AMD 24 hours Prior Notice". AnandTech. Retrieved November 28, 2022. ^ Hachman, Mark (March 19, 2018). "AMD's Ryzen, Epyc security co-processor and chipset have major flaws, researchers claim". PCWorld. Retrieved November 18, 2022. ^ Wagner, Jayce (March 20, 2018). "AMD is working on fixes for the reported Ryzenfall, MasterKey vulnerabilities". Digital Trends. Retrieved June 26, 2018. Retrieved from " 2Extension to the x86 instruction set by AMD3DNow!Design firmAdvanced Micro DevicesIntroduced1998Typeinstruction set architecture 3DNow! is a deprecated extension to the x86 instruction set developed by Advanced Micro Devices (AMD). It adds single instruction multiple data (SIMD) instructions to the base x86 instruction set, enabling it to perform vector processing of floating-point vector operations using vector registers. This improvement enhances the performance of many graphics-intensive applications. The first microprocessor to implement 3DNow! was the AMD K6-2, introduced in 1998. In appropriate applications, this enhancement raised the speed by about 2–4 times.[1] However, the instruction set never gained much popularity, and AMD announced in August 2010 that support for 3DNow! would be dropped in future AMD processors, except for two instructions, PREFETCH and PREFETCHW.[2] These two instructions are also available in Bay-Trail Intel processors.[3] 3DNow! was developed at a time when 3D graphics were becoming mainstream in PC multimedia and games. Realtime display of 3D graphics depended heavily on the host CPU's floating-point unit (FPU) to perform floating-point calculations, a task in which AMD's K6 processor was easily outperformed by its competitor, the Intel Pentium II. As an enhancement to the MMX instruction set, the 3DNow! instruction-set augmented the MMX SIMD registers to support common arithmetic operations (add/subtract/multiply) on single-precision (32-bit) floating-point data. Software written to use AMD's 3DNow! instead of the slower x87 FPU could execute up to four times faster, depending on the instruction mix. The first implementation of 3DNow! technology contains 21 new instructions that support SIMD floating-point operations. The 3DNow! data format is packed, single-precision, floating-point. The 3DNow! instruction set also includes operations for SIMD integer operations, data prefetch, and faster MMX-to-floating-point switching. Later, Intel would add similar (but incompatible) instructions to the Pentium III, known as SSE (Streaming SIMD Extensions). 3DNow! floating-point instructions are the following: PI2FD – Packed 32-bit integer to floating-point conversion PF2ID – Packed floating-point to 32-bit integer conversion PFCMPGE – Packed floating-point comparison, greater or equal PFCMPGT – Packed floating-point comparison, greater PFCMPEQ – Packed floating-point comparison, equal PFACC – Packed floating-point accumulate PFADD – Packed floating-point addition PFSUB – Packed floating-point subtraction PFSUBR – Packed floating-point reverse subtraction PFMIN – Packed floating-point minimum PFMAX – Packed floating-point maximum PFMUL – Packed floating-point multiplication PFRCP – Packed floating-point reciprocal approximation PFRSQRT – Packed floating-point reciprocal square root approximation PFRCPIT1 – Packed floating-point reciprocal, first iteration step PFRSQIT1 – Packed floating-point reciprocal square root, first iteration step PFRCPIT2 – Packed floating-point reciprocal/reciprocal square root, second iteration step 3DNow! integer instructions are the following: PAVGUSB – Packed 8-bit unsigned integer averaging PMULHRW – Packed 16-bit integer multiply with rounding 3DNow! performance-enhancement instructions are the following: FEMMS – Faster entry/exit of the MMX or floating-point state PREFETCH/PREFETCHW – Prefetch at least a 32-byte line into L1 data cache (this is the only non-deprecated instruction) There is little or no evidence that the second version of 3DNow! was ever officially given its own trade name. This has led to some confusion in documentation that refers to this new instruction set. The most common terms are Extended 3DNow!, Enhanced 3DNow! and 3DNow!+. The phrase "Enhanced 3DNow!" can be found in a few locations on the AMD website but the capitalization of "Enhanced" appears to be either purely grammatical or used for emphasis on processors that may or may not have these extensions (the most notable of which references a benchmark page for the K6-III-P that does not have these extensions).[4][5] This extension to the 3DNow! instruction set was introduced with the first-generation Athlon processors. The Athlon added five new 3DNow! instructions and 19 new MMX instructions. Later, the K6-2+ and K6-III+ (both targeted at the mobile market) included the five new 3DNow! instructions, leaving out the 19 new MMX instructions. The new 3DNow! instructions were added to boost DSP. The new MMX instructions were added to boost streaming media. The 19 new MMX instructions are a subset of Intel's SSE instruction set. In AMD technical manuals, AMD segregates these instructions apart from the 3DNow! extensions.[4] In AMD customer product literature, however, this segregation is less clear where the benefits of all 24 new instructions are credited to enhanced 3DNow! technology.[6] This has led programmers to come up with their own name for the 19 new MMX instructions. The most common appears to be Integer SSE (ISSE).[7] SSEMMX and MMX2 are also found in video filter documentation from the public domain sector. ISSE could also refer to Internet SSE, an early name for SSE. 3DNow! extension DSP instructions are the following: PF2IW – Packed floating-point to integer word conversion with sign extend PI2FW – Packed integer word to floating-point conversion PFNACC – Packed floating-point negative accumulate PFPNACC – Packed floating-point mixed positive-negative accumulate PSWAPD – Packed swap doubleword MMX extension instructions (Integer SSE) are the following: MASKMOVQ – Streaming (cache bypass) store using byte mask MOVNTQ – Streaming (cache bypass) store PAVGB – Packed average of unsigned byte PAVGW – Packed average of unsigned word PMAXSW – Packed maximum signed word PMAXUB – Packed maximum unsigned byte PMINSW – Packed minimum signed word PMINUB – Packed minimum unsigned byte PMULHUW – Packed multiply high unsigned word PSADBW – Packed sum of absolute byte differences PSHUFW – Packed shuffle word PEXTRW – Extract word into integer register PINSRW – Insert word from integer register PMOVMSKB – Move byte mask to integer register PREFETCHNTA – Prefetch using the NTA reference PREFETCHT0 – Prefetch using the T0 reference PREFETCHT1 – Prefetch using the T1 reference PREFETCHT2 – Prefetch using the T2 reference SFENCE – Store fence 3DNow! Professional is a trade name used to indicate processors that combine 3DNow! technology with a complete SSE instructions set (such as SSE, SSE2 or SSE3).[8] The Athlon XP was the first processor to carry the 3DNow! Professional trade name, and was the first product in the Athlon family to support the complete SSE instruction set (for the total of: 21 original 3DNow! instructions; five 3DNow! extension DSP instructions; 19 MMX extension instructions; and 52 additional SSE instructions for complete SSE compatibility).[9] The Geode GX and Geode LX added two new 3DNow! instructions which is absent in all other processors. 3DNow! "professional" instructions unique to the Geode GX/LX are the following: PFRSQRTV – Reciprocal square root approximation for a pair of 32-bit floats PFRCPV – Reciprocal approximation for a pair of 32-bit floats One advantage of 3DNow! is that it is possible to add or multiply the two numbers that are stored in the same register. With SSE, each number can only be combined with a number in the same position in another register. This capability, known as horizontal in Intel terminology, was the major addition to the SSE3 instruction set. A disadvantage with 3DNow! is that 3DNow! instructions and MMX instructions share the same register-file, whereas SSE adds 8 new independent registers (XMM0–XMM7). Because MMX/3DNow! registers are shared by the standard x87 FPU, 3DNow! instructions and x87 instructions cannot be executed simultaneously. However, because it is aliased to the x87 FPU, the 3DNow! and MMX register states can be saved and restored by the traditional x87 F(N)SAVE and F(N)RSTOR instructions. This arrangement allowed operating systems to support 3DNow! with no explicit modifications, whereas SSE registers required explicit operating system support to properly save and restore the new XMM registers (via the added FXSAVE and FXRSTOR instructions.) The FX* instructions from SSE provide a functional superset of the older x87 save and restore instructions. They can save not only SSE register states but also the x87 register states (hence are applicable also for MMX and 3DNow! operations where supported). On AMD Athlon XP and K8-based cores (i.e. Athlon 64), assembly programmers have noted that it is possible to combine 3DNow! and SSE instructions to reduce register pressure, but in practice it is difficult to improve performance due to the instructions executing on shared functional units.[10] All AMD processors after K6-2 (based on K6), Athlon, Athlon 64 and Phenom architecture families. Not supported in Bulldozer, Bobcat and Zen architecture processors and their derivates. The last AMD APU processor supporting 3DNow! is the A8-3870K, which is based on the Llano architecture. It is also the only APU with 3DNow! instructions, as the Bobcat and up exclude support for it. National Semiconductor Geode GX2, later AMD Geode. VIA C3 (also known as Cyrix III) "Samuel", "Samuel 2", "Ezra", and "Eden ESP" cores. IDT WinChip 2, 3 ^ "Effectively Utilizing 3DNow in Linux". Linux Journal. December 1, 1999. Archived from the original on 2011-06-07. Retrieved 2010-10-03. ^ "3DNow Instructions are Being Deprecated | AMD Developer Central". Blogs.amd.com. 2010-08-18. Archived from the original on 2010-10-24. Retrieved 2010-10-03. ^ "IntelE38xx - MinnowBoard Wiki". Archived from the original on 11 February 2017. Retrieved 13 February 2017. ^ a b "AMD Extensions to the 3DNow and MMX Instruction Sets Manual" (PDF). Advanced Micro Devices, Inc. March 2000. Archived (PDF) from the original on 2008-05-17. Retrieved 2008-06-07. ^ "Mobile AMD-K6-III-P Processor-Based Notebook: Ziff-Davis CPUmark 99". Archived from the original on 2008-07-24. Retrieved 2008-06-07. Incorrect title on page: Mobile AMD-K6-III+ and Mobile AMD-K6-2+ Processors with Enchanced [sic] 3DNow! Technology ^ "AMD Athlon Processor Product Brief". Advanced Micro Devices, Inc. Archived from the original on 2008-02-25. Retrieved 2008-06-08. ^ "ISSE". AviSynth. Archived from the original on 2017-07-02. Retrieved 2017-07-19. ^ "Explaining the new 3DNow! Professional Technology". Advanced Micro Devices, Inc. Archived from the original on 2009-01-21. Retrieved 2008-06-08. ^ "AMD Athlon XP Architectural Features". Advanced Micro Devices, Inc. Archived from the original on 2008-02-25. Retrieved 2008-06-08. ^ Larry Lewis (9 July 2003). "3DNow+ vs SSE on Athlon XP". Newsgroup: comp.sys.ibm.pc.hardware.chips. Usenet: ad82cd69.0307090931.25391323@posting.google.com. Archived from the original on 2012-10-03. Retrieved 4 January 2023 – via Google Groups. Case, Brian (1 June 1998). "3DNow Boosts Non-Intel 3D Performance". Microprocessor Report. Oberman, S.; Favor, G.; Weber, F. (March 1999). "AMD 3DNow technology: architecture and implementations". IEEE Micro. 3DNow Technology Partners, archived from the original (removed from AMD's website in early 2001) AMD 3DNow Instruction Porting Guide (PDF), archived from the original (removed from AMD's website in 2014) 3DNow Technology Manual AMD Extensions to the 3DNow and MMX Instruction Sets Manual AMD Geode LX Processors Data Book Retrieved from " 3 The following pages link to 3DNow! External tools (link count transclusion count sorted list) · See help page for transcluding these entries Showing 50 items. View (previous 50 | next 50) (20 | 50 | 100 | 250 | 500)AMD (links | edit) Athlon (links | edit) DEC Alpha (links | edit) AMD K6 (links | edit) Pascal (programming language) (links | edit) Quake II (links | edit) Windows 2000 (links | edit) X86 (links | edit) Instruction set architecture (links | edit) Single instruction, multiple data (links | edit) AltiVec (links | edit) MMX (instruction set) (links | edit) Streaming SIMD Extensions (links | edit) Vector processor (links | edit) Visual Instruction Set (links | edit) Windows 98 (links | edit) Duron (links | edit) Direct3D (links | edit) SuperH (links | edit) Opteron (links | edit) ATI Technologies (links | edit) Athlon 64 (links | edit) X86 assembly language (links | edit) X86-64 (links | edit) VIA C3 (links | edit) AMD K6-2 (links | edit) AMD K6-III (links | edit) SSE2 (links | edit) List of AMD Athlon XP processors (links | edit) List of AMD Opteron processors (links | edit) Processor register (links | edit) SSE3 (links | edit) WinChip (links | edit) 3dnow! (redirect page) (links | edit) X86 instruction listings (links | edit) List of AMD Duron processors (links | edit) List of AMD Athlon 64 processors (links | edit) List of AMD Athlon processors (links | edit) Windows NT 4.0 (links | edit) Xilinx (links | edit) Sempron (links | edit) PowerNow! (links | edit) Array programming (links | edit) List of AMD Sempron processors (links | edit) 3DNow (redirect page) (links | edit) Table of AMD processors (links | edit) 3dnow (redirect page) (links | edit) User:Dcljr/CPU (links | edit) Socket 939 (links | edit) Geode (processor) (links | edit) Einstein@Home (links | edit) List of AMD Turion processors (links | edit) View (previous 50 | next 50) (20 | 50 | 100 | 250 | 500) Retrieved from " WhatLinksHere/3DNow!" AMD has been unafraid to push back against the long-standing dominance of Intel in the CPU arena by talking up both the value-per-dollar and high-end performance delivered by their latest Ryzen hardware.In 2020, AMD debuted the Ryzen 5000 desktop CPUs including the high-end Ryzen 9 processor. AMD's latest line of processors are primed to compete against Intel's current Core i3, i5, i7 and i9 offering.Let's take stock and see how the two silicon heavyweights compare.In our opinion, many non-enthusiast PC builders will be better off buying a processor like the Intel Core i7-12700KF even if it costs a little bit more than its closest Ryzen counterpart. However, if you're looking for more grunt or want to crank the settings menu in Cyberpunk 2077 all the way to ultra without breaking the bank, AMD's higher-end Ryzen processors are the way to go. The first wave of AMD's mainstream Ryzen chips was split across three families: Ryzen 7, Ryzen 5 and Ryzen 3. The higher the numeral, the higher the spec of the processor. Simple enough, right? This initial three-tiered approach also made it pretty easy to compare AMD's Ryzen chips against the competition. The Ryzen 3 was an entry-level alternative to the Intel i3, the Ryzen 5 was a mainstream counterpart to the Intel i5, and the Ryzen 7 was pitched in opposition to the performance offered by an Intel i7.Then, in 2018, AMD introduced their second wave of Ryzen CPUs. Relying on a new 12nm manufacturing process and Zen+ architecture, this second series of Ryzen CPUs was broken out into four families. The Ryzen 3, Ryzen 5 and Ryzen 7 all returned. This reincarnated Ryzen family offered higher boosted clock speeds, reduced power consumptionAMD also topped out the range with a set of ultra-high-end CPUs called the Threadripper.Where the mainline Ryzen range offers an impressive 8 cores and 16 threads, the Threadripper series starts at 12 cores and 24 threads and goes all the way up to 64 cores and 128 threads. It's wild.The extra processor cores offered by Ryzen compared to Intel's Kaby and Coffee Lake CPUs meant that certain tasks ran MUCH faster. If you did a lot of 3D rendering/video encoding or any of your favourite games ran better on multiple cores (few do, but some popular titles like Battlefield 1 and Civ are included in the short-but-growing list) then the extra money was well worth paying. The extra cores could also help with video game streaming on services like Twitch.In late 2019, AMD updated their Ryzen portfolio. However, they didn't just upgrade the Ryzen 3, 5 and 7. They also introduced a new option to the range: the Ryzen 9.If you've been noticing more fanfare around AMD in the last six months or so, the Ryzen 9 series is probably the reason why. In his review, Gordon Mah Ung called the chipset 'historic' for AMD and said that "With the 16-core Ryzen 9 3950X, AMD is essentially running down the field, spiking the ball, and doing what the NFL would probably fine for excessive end-zone celebrations these days." Since then we've been introduced to the AMD Ryzen 9 5900X, which is much faster and offers even greater performance for gamers looking for an edge.If you're looking for a short and easy way to navigate AMD's Ryzen family: here's the most important thing you need to understand. Right now, every current AMD Ryzen CPU you can build a desktop PC around falls into one of the following five families:Ryzen 3 (Starts at $263 on Amazon)Ryzen 5 (Starts at $164 on Amazon)Ryzen 7 (Starts at $321 on Amazon)Ryzen 9 (Starts at $779 on Amazon)Ryzen Threadripper (Currently unavailable on Amazon)Generally speaking, Intel Core i7 CPUs perform better than Intel Core i5 CPUs, which are in turn better than Core i3 CPUs. A Core i7 does not have seven cores nor does Core i3 have three cores. The numbers are more of an arbitrary way to distinguish between their relative processing powers than a specific designation based on core count or clock speed or anything technical like that.There's also the Intel Core i9 to consider. Introduced in 2017, the Core i9 series is a super high-end range of processors that boasts incredibly high thread and core-counts. The top-end Core i9-12900Ks (Amazon) touts 16 cores (8 Performance cores and 8 Efficiency cores clocked at 5.20 Ghz) and can handle 24 threads at once while the cheapest option on Amazon – the i9-10850K boasts 10 cores (capable of serving 20 threads) and a base clock speed of 3.6GHz.Unfortunately, as fearsome (and appealing) as those numbers might sound, most modern software isn't really ready to make use of these capabilities – especially in the gaming space. They're also quite expensive compared to the rest of the lineup. In many respects, they're more analogous to AMD's Ryzen Threadripper CPUs than they are Ryzen 9 CPUs.As put by PCWorld's Gordan Mah Ung, "If you're buying a 16-core CPU solely to play games, you might want to consider an 8-core chip, or even a 6-core chip instead, because few games can use all of the cores. That's the conventional wisdom, anyway. The problem is modern gaming isn't about playing a game, winning, and going to sleep warm and happy. It's about streaming it live, or recording it while adding LOL memes, sound effects, and all kinds of "gaming"-related tasks that didn't exist a few years ago."So while i7s and i9s do offer higher performance than i3s or i5s, whether or not they'll be better for you really does ultimately depend on what you're using your PC for and how much you can afford to spend.If you're looking to build your next desktop PC around Intel's latest (12th Generation) Core processors, here's what to expect:Intel Core i3 (Starts at $169 on Amazon)Intel Core i5 (Starts at $269 on Amazon)Intel Core i7 (Starts at $519 on Amazon)Intel Core i9 (Starts at $779 on Amazon)Next Page: How does AMD's Ryzen CPU compare to Intel's Core CPU for performance?AMD Ryzen and Intel Core CPU Specs ComparedHere's a quick table allowing you to quickly and easily see how each AMD Ryzen CPU compares to their Intel counterparts when it comes to hardware specs.Intel Core i3 (12th Gen) vs Ryzen 3DesktopMobileWhen it comes to desktop CPUs, Intel has something of an edge against AMD's CPUs with the top-line Intel i3-12300 capable of higher maximum clock speeds than anything else on the table here. However, it's worth noting that AMD's Ryzen 3 CPUs have higher base clock rates overall.We see the same trend on the mobile front – Intel's Core i3 CPUs emerge as winners if you're looking at maximum clock rates. However, AMD's mobile CPUs once again have higher base clock rates.Intel Core i5 (12th Gen) vs Ryzen 5DesktopMobileThe Ryzen 5 Desktop CPUs aren't quite as power efficient as their mobile counterparts and they lack the integrated graphics found in Intel's Core i5 chips. However, they do offer higher thread counts, larger cache sizes and – in some cases – faster clock speeds.One area where they can fall short, however, is in memory expansion. Ryzen 5 CPUs support faster memory modules but they sometimes only support up to 64GB where Intel's i5 chips are able to go up to 128GB.On the mobile front, again, Ryzen excelled when it came to power efficiency and graphics rendering. However, it clearly lagged behind Intel when it came to both base and boosted clock speeds and cache size.Intel Core i7 (10th Gen) vs Ryzen 7DesktopMobileThough a few caveats apply, we found that the scales really begin to tip in favor of AMD here. Though they might not reach the same highs as Intel's i7 10700 and i7 10700K, the Ryzen 7 3700X, 3800X and 3800XT all boast significantly higher base performance.As opposed to previous generations of Ryzen chipsets, the third generation hardware here also surpasses previous limits to match Intel for 128GB of supported memory. Factor in the cache advantages inherent to AMD's architecture and the case for choosing a Ryzen 7 CPU over an Intel Core i7 isn't hard to hear.Things were a little closer when it came to Ryzen Mobile. The latest in Ryzen 7 mobile processors can't match the thread and core count allowed for by Intel's own Core i7 processors, nor can they keep up when it comes to clock speeds.That being said, the Vega graphics processing grunt that comes integrated with Ryzen 7 easily eclipses what you're going to get out of Intel's own in-house GPU. If the laptop you're looking at also features a dedicated graphics card, that's not necessarily going to be a big deal but, if it doesn't and you're keen to squeeze in some gaming, then it's going to probably be worth siding with AMD here.Intel Core i9 (10th Gen) vs Ryzen ThreadripperDesktopIf you're the kind of high performance power user that AMD and Intel are looking to woo with the Threadripper and Core i9 respectively, your preference is ultimately going to come down to whether you think the higher clock speeds available with Intel are worth the higher the thread count, cache size and memory support you'll get AMD.Of course, it should also be noted that even the cheapest ThreadRipper consumes twice as much power as its i9 counterpart and that while the latter does include integrated graphics, they aren't any better than what you'll get out of the closest Intel Core i7 processor.Which CPU price is best: Intel or AMD?As always, it should be noted that component pricing can sometimes be quite elastic. The below comparisons have been put together using PCPartsPicker.com.Intel Core i3 (10th Gen) vs Ryzen 3Depending on where you're buying them from, Intel's current crop of i3 CPUs currently range from approximately $206 on the low-end to $406 for the i3-10300. In comparison, AMD's Ryzen 3 3200G can be had for about around half that at $175 (we've seen it as low as AU$138). And when you compare the two, it's easy to see the value.Even if it does fall short on clock speed and cache size, Ryzen offers significantly better on-board graphics plus reduced power consumption.You can find it on Amazon here.Intel Core i5 (10th Gen) vs Ryzen 5Depending on where you're buying them from, Intel's current crop of i5 CPUs currently range from around $356 for the i5-10500 to $455 for the i5-10600. In contrast, you can grab a Ryzen 5 2600X for $339 or Ryzen 5 3400G for $240 respectively.Again, the Ryzen counterparts to Intel's i5 chips are almost half the price – so, even if they do fall short on certain fronts, there's a lot of value here. You can find it on Amazon here.Intel Core i7 (10th Gen) vs Ryzen 7Depending on where you're buying them from, AMD's Ryzen 7 CPUs float between $350 and $520. As usual, Intel's CPUs tend to be slightly more expensive. We've seen the i7-10700 go as low as $586. We've seen the i7-10900 go as high as $895.As noted in our theoretical comparison, the latest in Ryzen 7 mobile processors simply can't match the thread and core count allowed for by Intel's own Core i7 processors, nor can they keep up when it comes to clock speeds. Depending on what you're looking do with your PC, that might just be enough reasons to pay the premium here.Intel Core i9 (10th Gen) vs Ryzen ThreadripperThis is the one front where AMD doesn't have the edge on price. Depending on where you buy from, you'll probably be able to pull one of Intel's high-end i9 CPUS for as low as $895 and as high as $949.In contrast, AMD's mighty Threadripper CPUs start at around $2399 and we've seen them go as high as $6262. They offer a level of performance that Intel's i9 hardware can't match, to be sure. However, no matter how you swing it, that's higher pricing is a pretty bitter pill to swallow. You can find it on Amazon here.Next Page: How do AMD Ryzen and Intel compare in practice?AMD Ryzen and Intel ComparedPerformance: How we testFor the Intel tests we used our regular Test Rig components and an Intel Core i7 7700K CPU.The AMD AM4 Test Rig used the same Samsung 960 Pro NvME hard drive, Nvidia 1070 graphics card but opted for a Gigabyte Aorus GA-AX370-Gaming 5 motherboard (BIOS rev: 5b) and Corsair Vengeance 3000MHz LPX DDR4 RAM.We ran the tests at default BIOS settings with only the memory timings being adjusted to run at the advertised speeds.AMD told us that these still need to be done manually but we found on our Gigabyte motherboard that we could still set the timings and voltage automatically using Intel's proprietary XMP settings. It only took a couple of clicks and we were good to go.OverclockingWe then ran the same tests with a system's automatic overclocking features. We don't tweak settings as high as an enthusiastic overclocker might, since (relatively) few people will be bothered to do the same. However, where it made sense (like if our motherboard settings or an app made it easy to stably boost performance), we were happy to do so.For example, Intel's processors played nicely with the Gigabyte Z170X Designare motherboard's built-in (and automatic) overclocking settings to allow us to easily increase the clock speed on our CPU. This feature isn't available on Gigabyte's AX370 mobo but same sort of overclocking can be achieved by launching the RyzenMaster Windows app and sliding the sliders to select the speed you want.We only had access to a modest Noctua NH-U12S SE-AM4 air cooler which meant we couldn't push the Ryzen 1800X CPU too hard. Ryzen's built in heat management means it manages its own speed at high temperatures. This has the side effect of running faster when cooler. We found the 3.6GHz CPU crashed at 4.1GHz but would run stably at 4GHz.The exception here was in the Cinebench 3D rendering test which pushes all cores to 100% usage. It quickly crashed at 4GHz and only worked sporadically at 3.8GHz. We strongly suspect that a better cooler will improve this performance but, unfortunately, we didn't have access to one at the time of writing.Why AMD Ryzen requires Windows Power Settings to be set to High Performance?We usually leave our test rig at default settings with Balanced Performance but AMD insists that it requires Windows to be set to High Performance in order to get the best from Ryzen because of the platform's innovative heat-influenced performance features which can be detrimentally affected by Windows core parking and power management.We found that switching from Balanced to High Performance yielded immediate results. Doing so raised Ryzen's PC Mark score from 4171 to 4317 (this compares a Core i7 7700K's Balanced Performance score of 4411).Which processor was faster: Intel or AMD?Generally speaking, Intel's 7th Generation Kaby and Coffee Lake processors are faster than AMD's Ryzen processors but there are exceptions. In general usage Intel wins but if and when an application or game that takes full advantage of all the available cores is used, Ryzen can be significantly faster.Our AMD Ryzen test rig arrived with some unusual tweaks (AMD is adamant it shouldn't have but it did) and when we reset the (rev. 3f) BIOS (and

set up the RAM with XMP timings) it scored 3,944 in PC Mark.Gigabyte provided us with the latest rev. 5b version and the score increased to 4,010. That's still behind the Kaby Lake 7700K's 4,448 and also behind Intel's older 6th generation 4GHz Skylake Core i7 6600K score of 4,040.When overclocked the Ryzen score only increased to 4,147 but the Intel 6700K pushed on to 4,355 and the 7700K pushed on to 4,477.So in the general usage PC Mark test, Intel wins – which will be enough for most people.We also ran the Creative 3.0 PC Mark test which focuses more on photo manipulation and video editing. In this case Intel scored 5,853 while Ryzen scored 5,861. That's a slight win for Ryzen which, as we see below, will translate to potentially-dramatic time saving if you do extensive media encoding.3D Mark Ryzen resultsIn 3D Mark the 1800X Ryzen processor scored consistently higher than Intel's 7700K. However, this score is made up of three parts: two graphics tests and a CPU test.Both graphics tests were actually very similar: 37fps and 32.5fps which isn't surprising due to both systems relying on the same Nvidia GTX 1070 graphics card. Still, 3D Mark appears to make good use of the extra cores on offer with Ryzen and it scored 26fps versus Intel's 18.5fps.While these are all airy fairy numbers it does tell us that when used as a general gaming system both platforms are comparable in performance. It also reflects the fact – regardless of what really goes into creating these scores – that if a game (or game benchmark) is optimised to use more than four cores, it will perform better with AMD Ryzen.For that reason, it's worth checking how your favourite game supports more-than-four cores. As far as we understand, the following games do: Battlefield 1, Battlefield V, Civilization 6, Ghost Recon: Wildlands, Rise of the Tomb Raider, DOOM, Lords of the Fallen, Wolfenstein: The New Colossus and Forza Horizon 3.Cinebench R15Cinebench renders a 3D scene and is useful in that it maximises all cores and threads when it runs. It's in tasks like this (and movie encoding) where you'd expect an eight-core processor like Ryzen should destroy a four-core processor like the Kaby Lake 7700K – and it did.At stock speed it scored 1,604 compared to the 7700K's 995. When overclocked to 3.8GHz the Ryzen managed 1637. This is almost double what Intel's 7700K was able to offer.This test which really shows how AMD's platform excels. Usually, you'd use an Intel Core i7 6900K (which scored 1,560) to perform extensive rendering and encoding tasks but those cost $1500.That AMD Ryzen can beat that performance when it costs less than half the price is truly outstanding.Next Page: Which CPU should you buy right now?AMD deserves a great deal of credit for coming back from nowhere to match Intel and produce some interesting technology but its claims of matching Intel for dramatically less money are somewhat misguided. If we're talking general day-to-day usage, Intel's platform is often still faster and cheaper.Most buyers will be better off buying a processor like the Intel Core i7-10700 (Amazon) even if it costs a little bit more than its closest Ryzen counterpart (Amazon) and, as far as most general-usage tasks go, it performs better. It also doesn't require having your PC set up for Maximum Performance – which is not healthy for power bills.However, the math here changes dramatically if you regularly need your PC to perform any of the following tasks:3D Rendering or video encodingPlaying a game where performance is boosted by multiple coresEnthusiast-grade overclockingStreaming your games online without using a separate computerIn these instances, Ryzen will be worth paying the premium for as it won't just enhance your enjoyment but save you a lot of time – and potentially money as well. You can find the full Ryzen range on Amazon here.