AMD THREADRIPPER PRO

White Paper | # AMD RYZEN™ THREADRIPPER™ PRO PROCESSORS: RIDING THE THIRD WAVE OF WORKSTATION COMPUTING

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This white paper is a technical explanation of what the discussed technology has been designed to accomplish. The actual technology or feature(s) in the resultant products may differ or may not meet these aspirations. Each description of the technology must be interpreted as a goal that AMD strived to achieve and not interpreted to mean that any such performance is guaranteed to be fully achieved. Any computer system has risks of security vulnerabilities that cannot be completely prevented or mitigated.

INTRODUCTION

With its introduction of the AMD Ryzen™ Threadripper™ PRO processors, AMD helped to usher in the third wave of high-performance workstation computing, marrying the best of superscalar and multi-core CPU design with AMD Infinity Fabric architecture. Now in its second generation, the Threadripper PRO processor family provides access to dramatic performance scaling for the rapidly expanding range of modern professional workloads.

The first generation AMD Ryzen™ Threadripper™ PRO processor family not only achieved breakthrough performance scaling with single-chip options of up to 64 cores, levels previously attainable only through the costly addition of a second socket, and it did so with industry-leading base clock frequencies to help sustain the best possible overall throughput. Building on that initial synergy, and deploying AMD "Zen 3" microarchitecture, the second generation Ryzen™ Threadripper™ PRO 5000 WX-Series processors drive aggregate performance even further. Threadripper™ PRO offers unique balance of technologies opens up the opportunity to not only speed today's typical professional workflows in CAD, M&E and oil/gas, it can enable the jump to a range of high-demand, heavily-threaded emerging uses, like 8K video production, next-generation intelligent manufacturing (i.e., Industry 4.0), machine learning, and data science.

The AMD Ryzen™ Threadripper™ PRO 5000 WX-Series processors are now available in premium workstation models from leading workstation vendors, including Lenovo and Dell.

AMD RYZEN™ THREADRIPPER™ PRO 5000 WX-SERIES: RIDING THE THIRD WAVE OF WORKSTATION PROCESSORS

AMD Ryzen™ Threadripper™ PRO processors manage to create this inflection point on the back of three key technologies, marking a new era – a third wave – in workstation CPUs: the "Zen" microarchitecture gains in superscalar throughput, a consistent progression in manufacturing to enable higher-density on-chip cores, and AMD Infinity Fabric architecture, a novel approach that allows ease of performance scaling while mitigating challenges in thermal dissipation and product costs.

HIGH-PERFORMANCE CPUs – THE THIRD WAVE

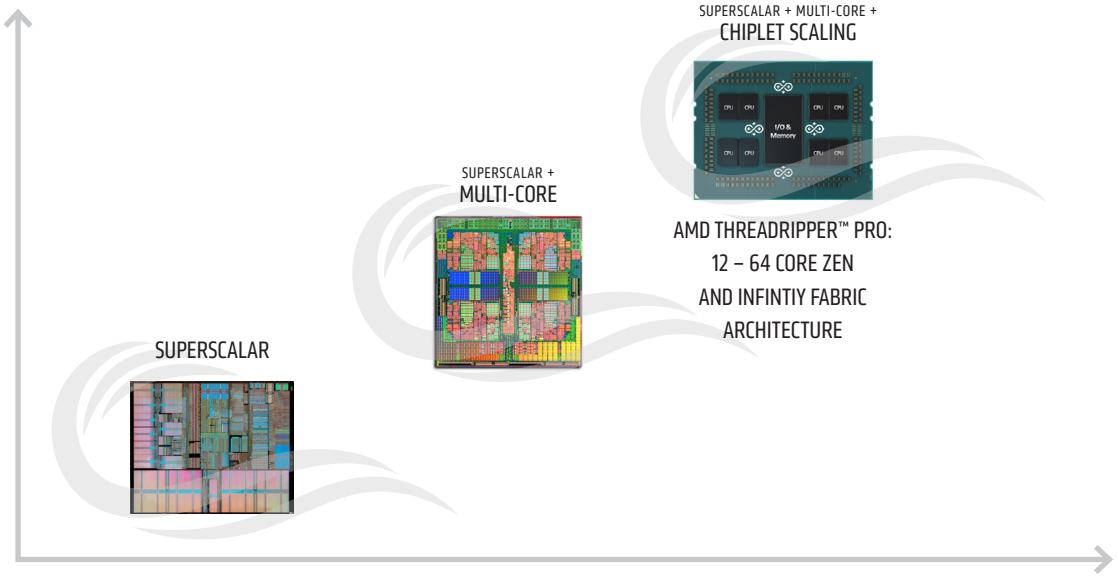

FIGURE 1: THREADRIPPER™ PRO PROCESSORS ARE PIONEERING A THIRD WAVE IN HIGH-PERFORMANCE WORKSTATION COMPUTING

Along with 3rd generation "Zen 3" and its 7nm process, AMD chiplet technology, enabled by the AMD Infinity Fabric™ architecture interconnect, forms a linchpin to Threadripper™ PRO processors' outstanding combination of core count and sustained clock rates. Rather than simply forcing geometrically higher core counts onto the same monolithic die, AMD Ryzen™ Threadripper™ PRO processors integrate multiple 8-core "Zen 3" CCX (Core Complex) chiplets, each tied to memory, I/O and each other via AMD Infinity Fabric™ architecture interconnect.

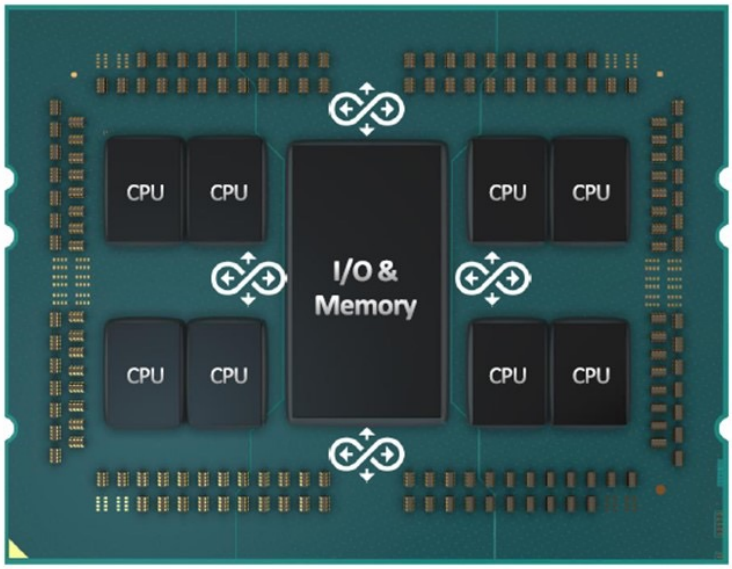

FIGURE 2: AMD INFINITY FABRIC™ ENABLES THREADRIPPER™ PRO PROCESSORS' CHIPLET IMPLEMENTATION, PROVIDING AN OUTSTANDING COMBINATION OF CORES RUNNING AT HIGH CLOCK RATES (SEE FIGURE 5).

AMD Ryzen™ Threadripper™ PRO 5000 WX-Series Processors: Supporting the Full Range of Professional Workloads and Budgets

The Infinity Fabric architecture approach eases the electrical and thermal constraints of monolithic design, helping engineers keep clock frequencies up while driving core counts to sizes unattainable with a single chip of silicon. In combination with the "Zen 3" architecture core and CCX enhancements, the Infinity Fabric architecture forms a trio of technology advancements allowing the Threadripper™ PRO 5000 WX-series processors to offer both the highest core count available[1], as well as higher base frequencies at the same core count, as compared to the comparable competitive processor series[1]. For example, a 12 core Threadripper™ PRO 5945WX processor can sustain an operating base frequency of up to 4.1 GHz, while the top-end Threadripper™ PRO 5995WX processor scales up to a massive 64 cores, 26 more cores than the competing single-processor workstation CPU today[1].

PROCESSOR	CORES / THREADS	BASE / TURBO FREQUENCY[2] (GHZ)	L2+L3 CACHE (MB)	GEN 4 PCIE® LANES	MEMORY CHANNELS
Ryzen™ Threadripper™ PRO 5995WX	64 / 128	2.7 / up to 4.5	288	128	8
Ryzen™ Threadripper™ PRO 5975WX	32 / 64	3.6 / up to 4.5	144	128	8
Ryzen™ Threadripper™ PRO 5965WX	24 / 48	3.8 / up to 4.5	140	128	8
Ryzen™ Threadripper™ PRO 5955WX	16 / 32	4.0 / up to 4.5	72	128	8
Ryzen™ Threadripper™ PRO 5945WX	12 / 24	4.1 / up to 4.5	70	128	8

FIGURE 3: THE AMD RYZEN™ THREADRIPPER™ PRO 5900 WX-SERIES WORKSTATION PROCESSORS (SOURCE: AMD)

Highest Core Counts at Highest Sustained Base Clock Rates[1]: The Recipe for Maximum Performance Scaling

A CPU's overdriven turbo or boost clock rates are a clever and rewarding tool to temporarily crank up throughput exploiting short-term available thermal power, particularly for single-to-few threaded workloads. But when it comes to running the long-term, heavy-duty computation common in professional workstation applications, boost rates are no longer practical. Eventually, electrical and thermal constraints tighten, boost rates must drop, ultimately leaving the base rate to count on for high levels of throughput.

The Infinity™ Fabric architecture approach helps reduce thermal density and minimize hot spots, allowing Threadripper™ PRO processors to run all cores indefinitely at the industry's highest base frequencies (core counts being equal)[1]. The Threadripper PRO 5000 WX-Series Series' combination of core count and base clock rates stand out in the context of popular currently available workstation CPU alternatives. The figure below charts core count versus base frequency for four AMD Ryzen™ Threadripper™ PRO processor SKUs, relative to the Intel Xeon W-2200 family as well as the 12th Generation Intel Core i9 (for both, SKUs selected for offering the highest base frequency at the given core count[3]).

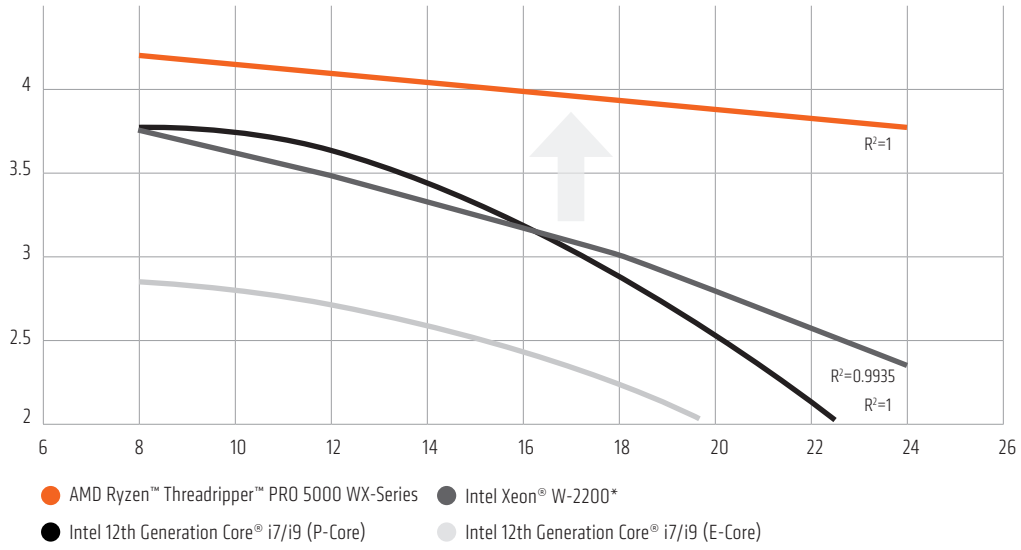

FIGURE 4: THE END RESULT: AMD RYZEN™ THREADRIPPER™ PRO PROCESSORS, AN INFLECTION POINT IN CORE COUNT VS. BASE FREQUENCY (SOURCE: AMD AND INTEL[3])

* Xeon W-2200 series SKUs selected for hightest base frequency at given core count (8 cores and higher) available in workstation models from OEMs Dell, HP, and Lenovo (models Dell Precision 5820, Lenovo Thinkstation P520, and HP Z4 G4). 12th Gen Core i7 and i9P-Core and E-Core "-K" suffix SKUs selected for highest P-Core base frequency at given core count (10-16 total) and available in fixed workstation models from Dell, HP and Lenovo (models Dell Precision 3660, Lenovo ThinkStation P360, and HP. Trendlines selected to provide optimal R^2 correlation closest to 1.

More Than an Afterthought, Cost Always Matters

Then there's optimizing for cost. Too often, white papers and analyses like this focus exclusively on performance, as if all the benefits of compelling technology and cutting-edge engineering come free. Performance justifiably sits high on a professional user's criteria, but such metrics are rarely viewed in a vacuum. With scant few exceptions, assessing the value of products derived from that technology and engineering is moot without the context of price.

The AMD Infinity Fabric architecture approach enables more effective performance scaling versus a non-chiplet design. All else equal, a more modest die size will yield more functional chips, and more functional chips produced per wafer can lower the cost to manufacture the chip. By manufacturing chips from die with sizes closer to that functionality versus die-size sweet spot, then scaling up via AMD Infinity Fabric architecture, AMD Threadripper™ PRO 5000 WX-Series processors can extend from mainstream core counts of 12 and 16 at compelling price points, all the way up to the maximum available 64 core AMD Threadripper PRO.

CHIPLET VS. MONOLITHIC DESIGN YIELD

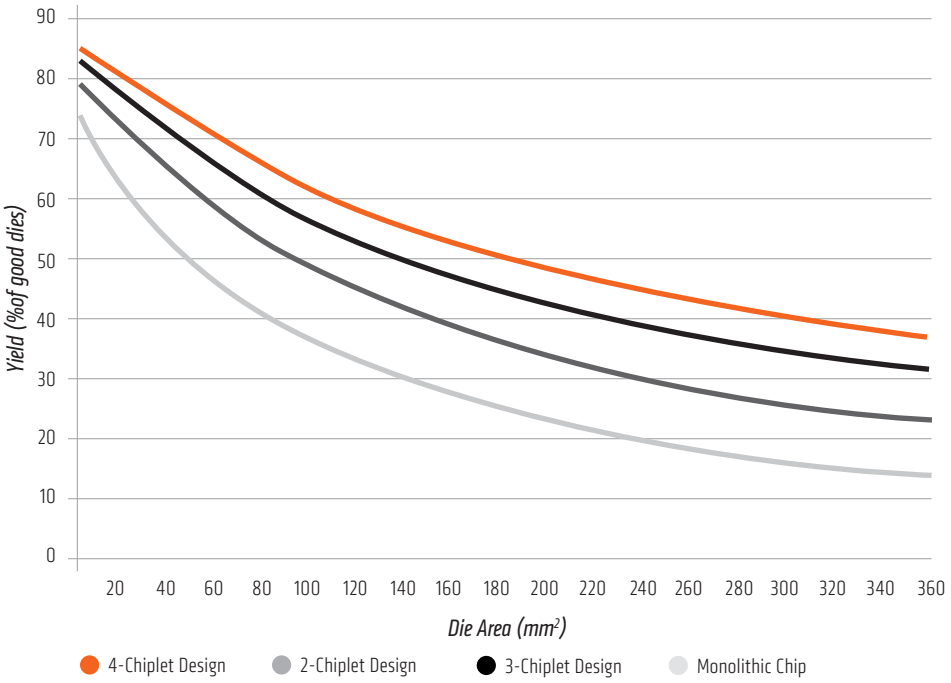

FIGURE 5: CHIPLET APPROACHES LIKE AMD INFINITY ARCHITECTURE PROVIDE FOR SUPERIOR SCALING (SOURCE: WIKICHIP)

"Zen 3" Microarchitecture

Representing a comprehensive design overhaul of the "Zen 2" core, AMD "Zen 3" core architecture extends on "Zen" architecture with ample, judicious improvements over its predecessor. "Zen 3" incorporates a range of improvements across its front end, execution and load/store units, most notably:

- Enhanced 8-core complex (CCX), allowing each core access to twice as much L3 cache
- Wider, faster arithmetic units
- Higher base and boost clock rates2
- More effective instruction prediction and faster decode to minimize execution "bubbles"
- Dedicated load and store units for increased fine-grain parallelism

In aggregate, "Zen 3" enhancements contribute to a fast, balanced microarchitecture eliminating conspicuous bottlenecks and enabling streamlined processing across the widest range of professional computing types. Additionally "Zen 3" drives up instructions per cycle (IPC) substantially.

Learn more about the "Zen 3" core architecture here.

AMD THREADRIPPER™ PRO 5000 WX-SERIES PROCESSORS: A HOLISTIC ARCHITECTURAL APPROACH DELIVERS COMPELLING GENERATIONAL PERFORMANCE GAINS

"Zen 3" Microarchitecture Cranks up1T Performance[4]

The combination of the Infinity Fabric architecture powering Threadripper™ PRO 5000 WX-Series processors, backed by a high-density, 7nm silicon process forms the cornerstone of its ability to scale to breakthrough core counts, driving modern, high-demand professional workflows to new levels of throughput. Yet some fundamental workflow tasks like parametric modeling, 3D graphics drawing operations, and legacy encryption algorithms still rely largely on serial, single-thread execution.

With the combination of "Zen 3" higher base and boost frequencies versus the prior generation – the latter up to 4.5 GHz[2] and often the barometer of 1T throughput – Threadripper™ PRO processors are up to the task. Threadripper PRO 5945WX processor achieves an average of 20% higher single-thread performance over its predecessor, running PassMark PerformanceTest 10 single-thread test and Cinebench R20 in single-thread mode.

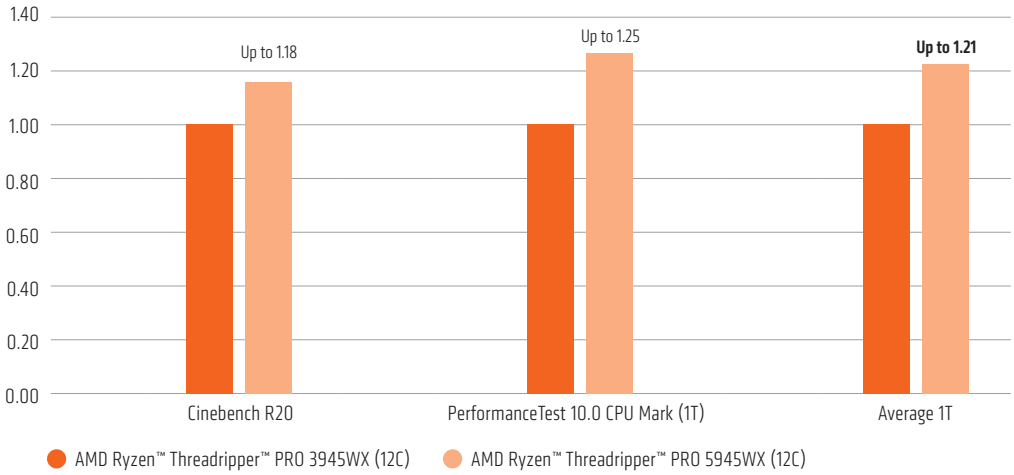

FIGURE 6: IT TEST RESULTS FOR 2ND GENERATION 12C AMD THREADRIPPER™ PRO 5945WX, NORMALIZED TO 1ST GENERATION 12C 3945WX, ON SIMILARLY CONFIGURED SYSTEM.[5,6]

Furthermore, professionals requiring a full range of today's workloads –both superior multi-thread and single-thread processing – need not second-guess a move to higher core counts, worried the legacy 1T performance will suffer. AMD Infinity Fabric architecture enables boost clock rates to be maintained up and down the Threadripper™ PRO 5000 WX-Series processor stack, supporting consistent 1T processing rates.

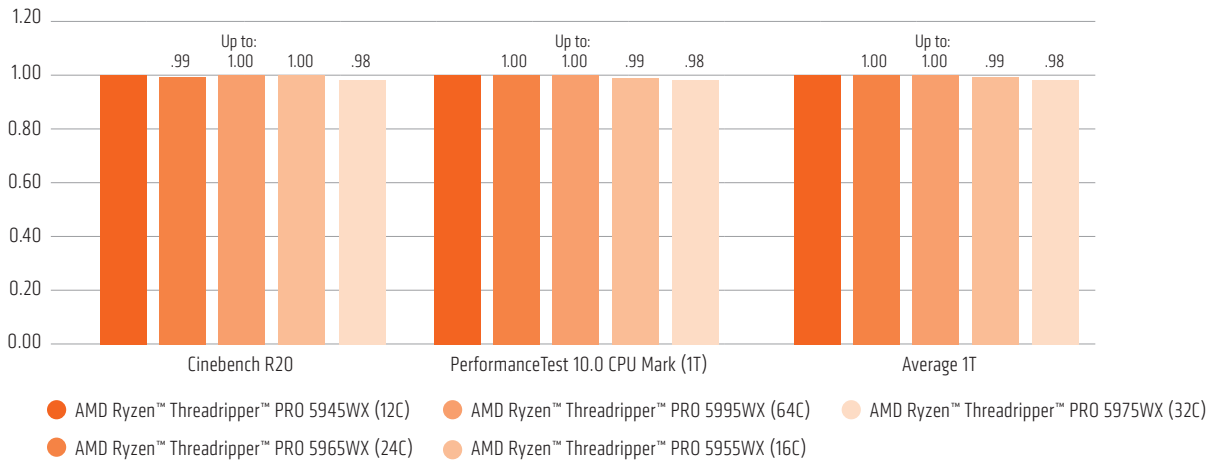

FIGURE 7: AMD THREADRIPPER™ PRO 5000 WX-SERIES 1T TEST RESULTS FOR IDENTICALLY CONFIGURED SYSTEMS[5,6]

Comprehensive, Supporting Architectural Infrastructure the Key to Sustaining Consistent, Graceful Performance Scaling

One Threadripper™ PRO processor integrates up to eight CCX chiplets, each with eight 'Zen 3' cores, connected to I/O, memory and each other via the established hyper-speed AMD Infinity Fabric architecture. But Threadripper™ PRO bar-raising core counts would count for naught were they supported by insufficient memory, with respect to not just bandwidth, but capacity and latency as well. AMD ensured Threadripper™ PRO processors' memory subsystem would be up to the task, as the Threadripper PRO 5000 WX-Series processors are backed up with incredible on-chip cache and high performing memory in a single x86 CPU socket: eight 3200 MHz DDR4 memory channels with ECC, supporting up to 2 TB capacity, and delivering up to 204 GB/s of aggregate bandwidth, more than double that of Intel Xeon® W-2200 Series, and in excess of the Intel Core i9-12900K processor, a more recent Intel CPU relevant in entry-class workstations. *See Figure 6.*

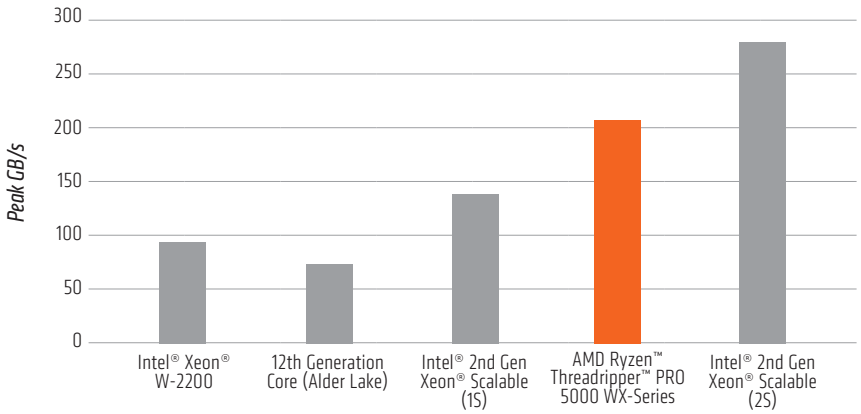

FIGURE 6: AMD RYZEN™ THREADRIPPER™ PRO 5000 WX-SERIES PROCESSORS WITH 8 CHANNELS OF DDR4-3200 ECC MEMORY OFFER MORE MAXIMUM MEMORY BANDWIDTH THAN ANY WORKSTATION CPU IN A SINGLE SOCKET AVAILABLE TODAY (SOURCE: AMD AND INTEL)

AMD Threadripper™ PRO 5000 WX-Series Processor Performance Gains: Over its Predecessor and Workstation Market Alternatives

The enhancements to both the core "Zen 3" microarchitecture and supporting cache and memory infrastructure pay off, as AMD Threadripper™ PRO 5000 WX-Series processors provide dramatic performance gains over the previous generation AMD Threadripper™ PRO 3900WX Series processors. In the process, the AMD Threadripper PRO 5000 WX-Series processor pushes further beyond the current workstation market default alternative Intel® Xeon® W-2200 Series, while revealing the drawbacks of emerging hybrid architectures in mission-critical, workstation-caliber computing.

Benchmarking the bookends of the AMD Threadripper™ PRO Series, the 12C and 64C models, yields results showing a compelling average of 23% gain in performance[7] across multi-threaded benchmark tests, generation to generation, and remarkably consistent at both core counts[5].

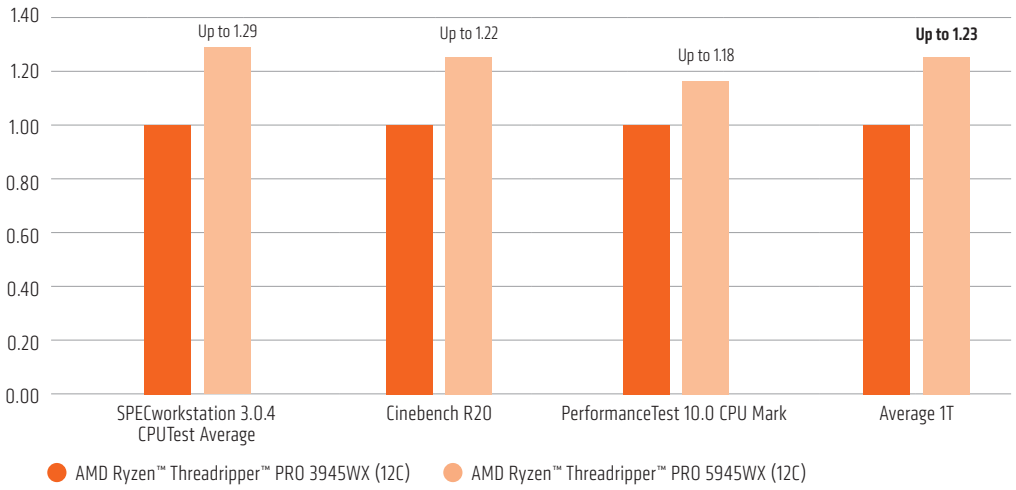

FIGURE 7: MULTI-THREAD (MT) GENERATION-TO-GENERATION 12C TEST RESULTS FOR SIMILARLY CONFIGURED SYSTEMS[5,6], NORMALIZED TO AMD THREADRIPPER PRO 3945WX

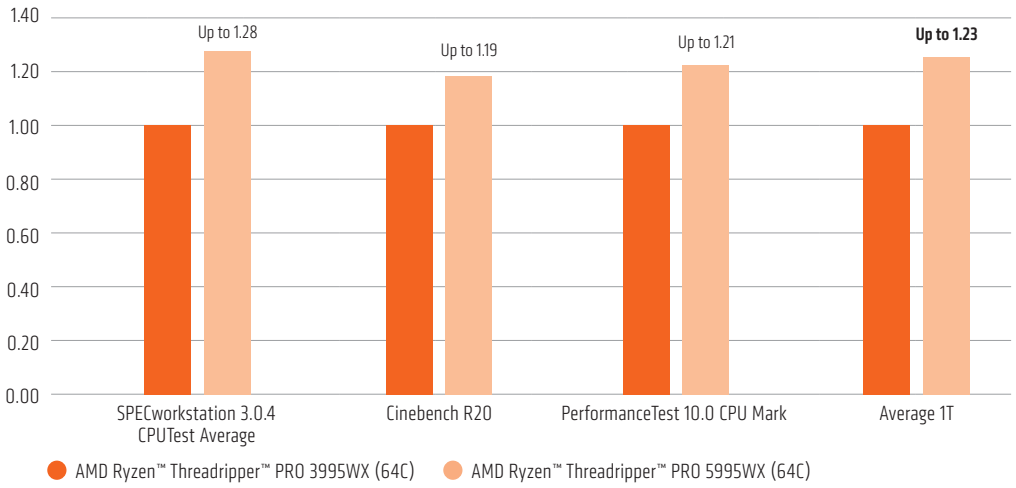

FIGURE 8: MULTI-THREAD (MT) GENERATION-TO-GENERATION 64C TEST RESULTS FOR SIMILARLY CONFIGURED SYSTEMS[5,6], NORMALIZED TO AMD THREADRIPPER PRO 3995WX

Furthermore, the Threadripper PRO 5000 WX-Series Series improves upon the ability to scale performance for professional-caliber workloads as more threads are allocated across more incremental cores. The graphs below show the relative scaling of the 12C and 64C 5000 WX-Series processors running PassMark PerformanceTest 10 Compression test, compared to prior generation. Each graph charts each CPU's performance scaling multiple at the given thread count relative to its own 1T test score.

The effective and improved ability of Threadripper™ PRO processors to scale up performance by core count is evident at both ends of the family. In both cases, the AMD Threadripper PRO 5995WX processor shows both a higher and more consistent, sustained performance improvement as more threads are deployed to more cores. The results underscore the merits of the enhanced "Zen 3" core microarchitecture and the ability of more ample supporting cache and memory resources results to support higher aggregate levels of throughput.

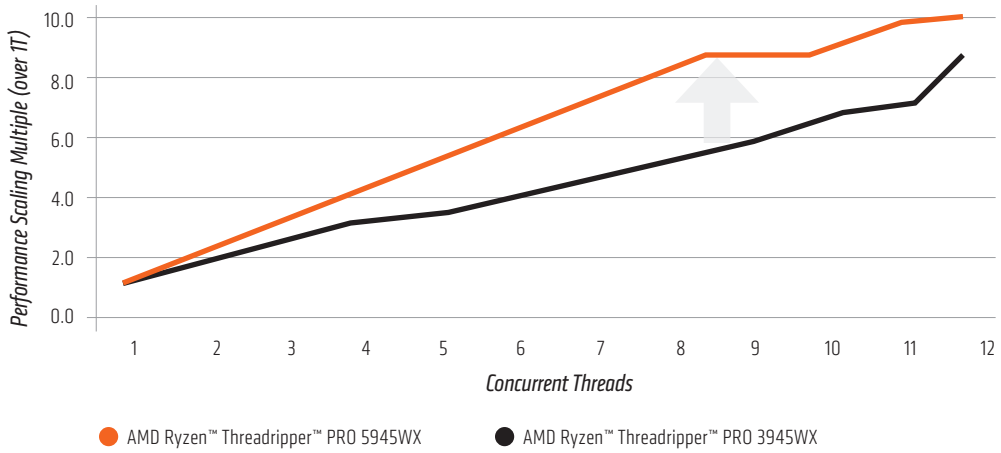

FIGURE 9: MULTI-THREAD (MT) TEST RESULTS SHOWING EACH GENERATION'S 12C CPU PERFORMANCE SCALING MULTIPLE (OVER ITS OWN 1T SCORE) RUNNING PASSMARK PERFORMANCETEST 10'S COMPRESSION TEST ON SIMILARLY CONFIGURED SYSTEMS[5,6]

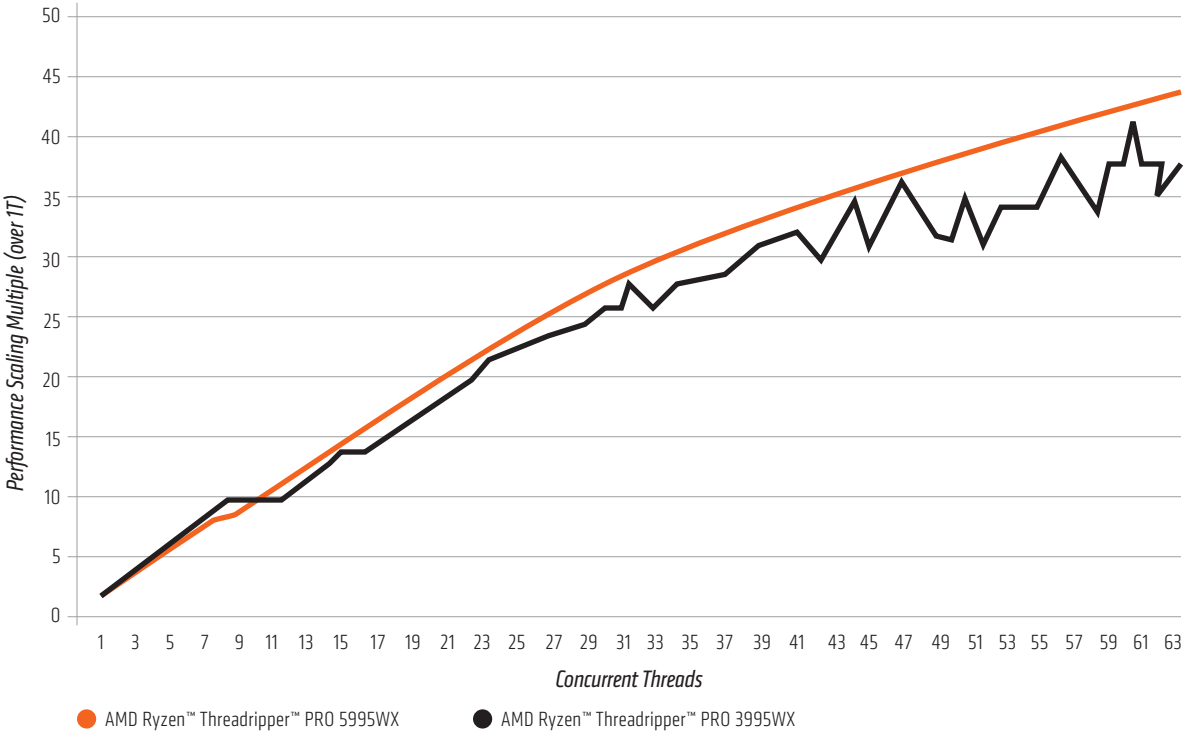

FIGURE 10: MULTI-THREAD (MT) TEST RESULTS SHOWING EACH GENERATION'S 64C CPU'S PERFORMANCE SCALING MULTIPLE (OVER ITS OWN 1T SCORE) RUNNING PASSMARK PERFORMANCETEST 10'S COMPRESSION TEST ON SIMILARLY CONFIGURED SYSTEMS[ii,iii]

Compared to the 12C Intel Xeon® W-2265, complemented with nearly equivalent memory, storage and graphics hardware, the 12C AMD Threadripper PRO 5995WX processor managed to yield 45% higher throughput, on average, for tests particularly relevant to the types of workloads seen in common workstation applications , . Specifically, running the battery of CPU specific tests from SPECworkstation 3.0.4, the AMD Threadripper™ PRO 5945WX processor scored up to 37% higher; on Cinebench R20, up to 46% higher; and on PassMark PerformanceTest 10 CPU Mark, up to 52% higher[5,6.]

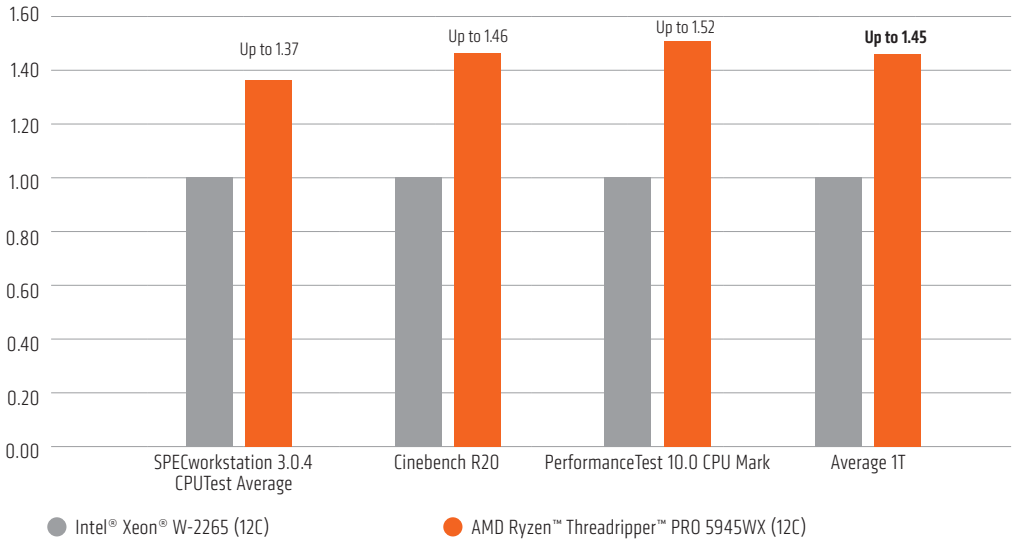

FIGURE 11:MULTI-THREAD (MT) TEST RESULTS FOR SIMILARLY CONFIGURED SYSTEMS[5,6,] NORMALIZED TO INTEL® XEON® W-2265 (12C)

PERFORMANCE AND POWER BALANCE, YES … AT A LOSS OF PRODUCTIVITY, NO

A fundamental tenet of AMD Ryzen™ Threadripper™ PRO 5000 WX-Series design philosophy is to minimize power consumption whenever and wherever possible. While effective power conservation is of value for virtually any product, it's crucial for a CPU serving high-demand workstation application, where doing so not only helps out on the electric bill but, more critically, directly contributes to the overarching goal of maximum performance. The more power a silicon chip consumes, the more heat it produces. Exceed thermal limits, and regardless of how fast that chip's transistors and internal wires can theoretically switch, frequency (often hand in hand with voltage) must be reined in to mitigate temperatures, dragging down throughput with it. The bottom line: paying attention to power reaps dividends in improved performance, regardless of whether the machine is plugged into the wall or not.

However, virtually all power optimization design techniques have their trade offs, and appropriate deployment of those tools depends on the ends the specific machine intends to serve. For mobile platforms, where battery life is critical, most any approach that saves watts and battery minutes can help, even if sacrificing performance. But for professional, line-powered desk bound workstations, performance is paramount, and some power-saving techniques can excessively penalize throughput, at a time the user needs every ounce of performance possible.

Consider the emerging approach of hybrid multi-core architectures, in which a single processor can be comprised of a mix of heterogeneous cores, one focused on performance and another on power efficiency. By judiciously apportioning the number of performance-focused cores versus efficiency-focused cores, a processor can be shaped to lean more toward performance, more toward efficiency, or somewhere in between. Such is the basic philosophy behind Intel's recent introduction of "Alder Lake," a CPU family blending P-Cores and E-Cores to fit a variety of applications and market. Go a bit heavier on E-cores for those sockets that want to constrain watts, and choose more P-cores when throughput is the overwhelming priority.

The approach has its advantages, such as being able to leverage a shared foundation of core technology for a wider range of products. But it doesn't come without an obvious trade off, one that's more consequential in workstation computing: compromising on performance when performance is critical. While it can provide an effective performance per watt balance for mobile and mainstream computing uses, the workstation is a different animal. Where it might be rare in mainstream computing applications to consistently demand maximum performance executing every thread running on every core, it's commonplace in professional computing. Consider applications from rendering, simulation, physics and scientific modeling, where algorithms can yield steady, compute-intensive loads on every core the hardware can make available. And once all performance-oriented cores are already busy running high-demand threads, any additional threads queued for execution must get handled by a slower, efficiency-focused core, resulting in reduced incremental performance.

That behavior is clearly seen when benchmarking the 12C Xeon® W-2265 alongside the 12th Generation Core® i9-12900K processor on PassMark PerformanceTest 10 Floating Point benchmark. In the same manner as described previously for Threadripper PRO processors running the Compression test, the benchmark repeats a compute intensive compression algorithm, starting with one thread and repeating 16 times, each iteration with one more thread spawned, up to the maximum of 16. The graph charts each CPU's performance at each thread count as a multiple over its own single-thread performance. As the graph illustrates, the Intel Core® i9-12900K scales performance effectively and consistently up to around 8 threads, after which the incremental performance gain per additional thread diminishes substantially. The knee in the curve aligns with the point that P-Cores have been exhausted and incremental threads must be deployed to lower-performance E-Cores.

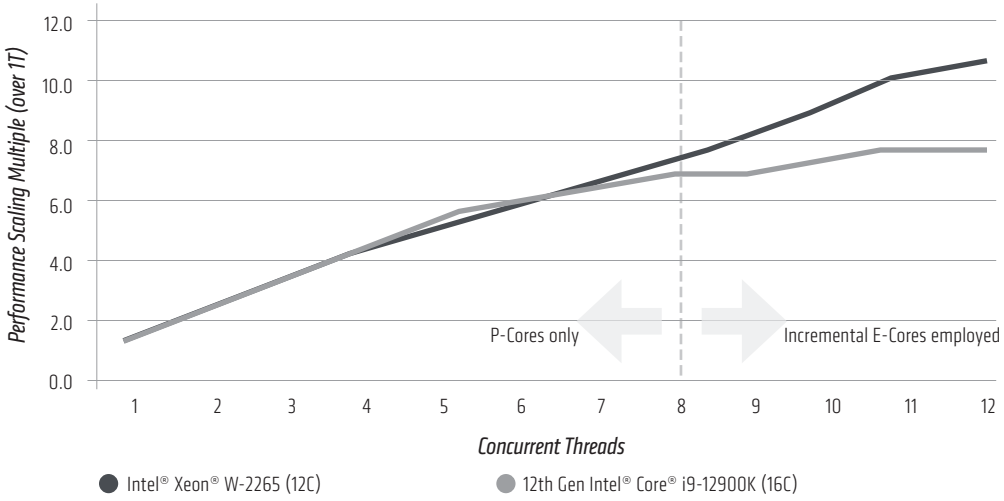

FIGURE 12: MULTI-THREAD (MT) TEST RESULTS SHOWING EACH GENERATION'S 12C CPU PERFORMANCE SCALING MULTIPLE (OVER ITS OWN 1T SCORE) RUNNING PASSMARK PERFORMANCETEST 10'S COMPRESSION TEST ON SIMILARLY CONFIGURED SYSTEMS[5,6]

The results below compare the performance for the 16C Threadripper™ PRO 5955WX processor on the same workstation-relevant multi-threaded workloads as outlined above, normalized to those of the 16C 12th Generation Intel Core i9-12900K, the most recent and fastest available comparable CPU available from Intel as of this writing. Given only half of the Core i9-12900K 16 cores are focused on maximum performance, the 5955WX processor's edge of 23% (on average) is both significant and logical.

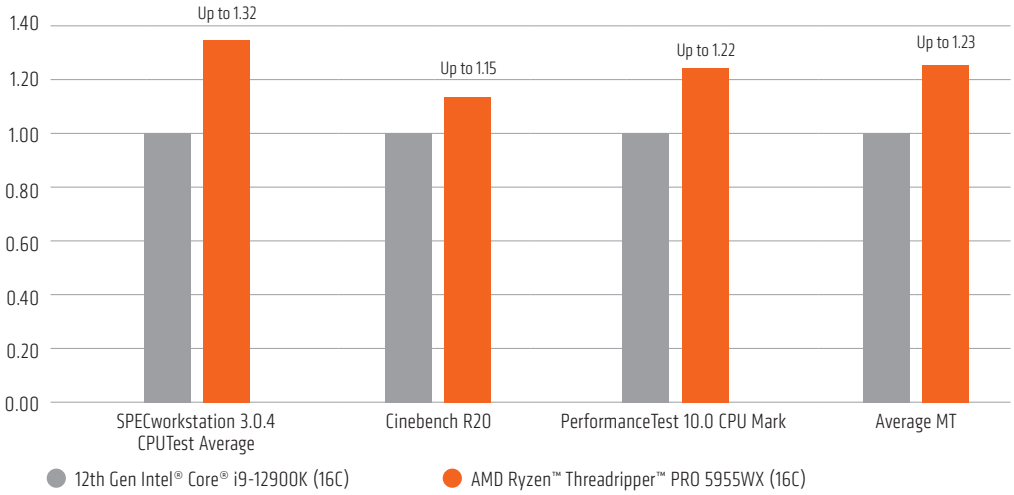

FIGURE 13: MULTI-THREADED CPU-SPECIFIC TEST RESULTS FOR THE 16C THREADRIPPER™ PRO 5955WX, NORMALIZED TO THE 16C INTEL CORE I9-12900K, WITH SIMILARLY CONFIGURED SYSTEMS[6], NORMALIZED TO 12TH GEN INTEL® CORE® I9-12900K (16C)

Dual-socket Performance, Without the Second Socket

With its wide range of available core counts, AMD Ryzen™ Threadripper™ PRO 5000 WX-Series processors offer an opportunity to rethink the proposition of a dual-socket (2S) workstation. With up to 64 cores now available in 1S platform, how imperative is a move to a dual-socket workstation? Price matters, and all else equal, 2S workstation models will cost more.

Granted, there is certainly more than one reason a buyer looks to make that jump up to a 2S platform: for example, to get the absolute maximum memory and storage that may come from the more ample capacity of a typical 2S chassis. But that aside, if the goal is to secure as many CPU cores as possible, and your application doesn't demand the 99th percentile in memory or drive capacity – a Threadripper™ PRO processor-based workstation will have you questioning the default decision to upgrade to a dual-socket workstation. Supporting 2 TB of memory served by up to 204 GB/s peak across 8 channels, completed by both more and faster PCI®Express Gen 4 lanes than two 2nd Generation Intel Xeon® Scalable processors can manage with Gen 3, a 32 or 64 core Threadripper™ PRO processor today can serve the bulk of demands that used to require a dual socket machine.

While integrating 32 and 64 cores in a single CPU socket is no small engineering achievement, there would be no point if performance couldn't scale to that level effectively. Threadripper™ PRO processors' comprehensive design approach, dedicated to the goal of efficient scaling, proves that ability in spades, even compared with today's leading dual-socket workstation platform. Compared to a workstation built not on one but two Intel Xeon® Scalable Platinum 8280 CPUs, complemented with nearly equivalent memory, storage and graphics hardware8, a Ryzen™ Threadripper™ PRO 5995WX processor scored on average 45% higher throughput in testing relevant to the types of workloads seen in common workstation applications6. Specifically, running the CPU specific tests from SPECworkstation 3.0.4, the Threadripper™ PRO 5995WX processor scored 45% higher (averaged across CPU tests), up to 38% higher on Cinebench R20, and up to 53% higher on PassMark PerformanceTest 10 CPU Mark.6,. Perhaps even more noteworthy, the 32-core Threadripper™ PRO 5975WX processor eclipsed the 2x28C Xeon® Scalable Platinum workstation by 8%, on average, across the same benchmarks.

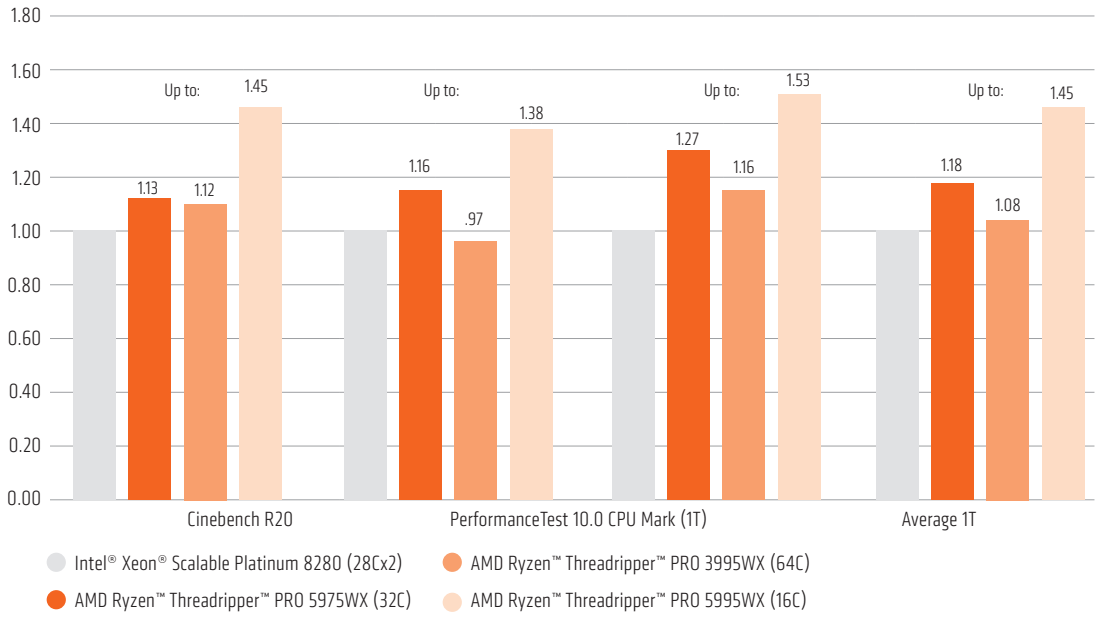

FIGURE 14: MULTI-THREAD TEST RESULTS FOR SIMILARLY CONFIGURED SYSTEMS[8], NORMALIZED TO INTEL® XEON® SCALABLE PLATINUM 8280 (28CX2)

WORKSTATION PERFORMANCE WRAPPED UP IN A PROFESSIONAL PACKAGE: AMD PRO TECHNOLOGIES

Regardless of performance, no workstation platform will get far without as much attention given to reliability and availability as to throughput. Built with AMD PRO technologies, Threadripper™ PRO processors check those boxes and then some. The cornerstone of AMD PRO technologies is the AMD Security Processor (ASP), a dedicated security co-processor integrated directly on CPU silicon to implement security protocols.

Consider AMD Memory Guard[9], a feature providing memory-level encryption to help reduce the chance of data theft should a machine be stolen or compromised. For professionals entrusted with clients' golden IP, AMD Memory Guard offers valuable peace of mind, particularly appealing for a workstation out in the field or on location, or any situation where security features are paramount. Secure Boot prevents malware from accessing critical and otherwise vulnerable code prior to and during the load of the system operating system. In addition, AMD PRO technologies provide support for Microsoft Endpoint Manager and Windows Defender Application Guard malware prevention.

THE BEST OF BOTH WORLDS: THREADRIPPER™ PRO PROCESSORS USHER IN THE THIRD WAVE OF HIGH-PERFORMANCE WORKSTATION COMPUTING

It's been suggested tongue-in-cheek that computing professionals would be best served with two different machines to handle their disparate workloads: one housing as many processing cores as possible to accelerate the rapidly expanding pool of highly parallel, multi-threaded workloads. And a second that ditches all those extra cores, instead optimized to maximize performance for single-thread workloads. Two machines are of course an impractical solution, but the point is well taken, as the hyperbole highlights the paradox all too familiar to workstation computing professionals.

Tailored for modern workstation workloads, Threadripper™ PRO achieves the highest core counts at highest sustained base clock rates in the industry[2]. That combination serves as the cornerstone enabling efficient performance scaling for the type of modern, compute-intensive, multi-threaded workloads more common in professional computing applications from manufacturing, design, and software development to digital media, and architecture, construction and engineering.

Combined with Zen 3 and the Infinity™ Fabric benefits in IPC, scaling and power mitigation, a Threadripper™ PRO 5000 WX-Series processor offers excellent performance in lightly threaded applications. It institutes appropriate and effective power optimizations to reduce carbon footprint and help keep clock rates high, but not overboard to the point of sabotaging productivity. And it all is delivered in a package that doesn't take shortcuts in reliability and security features, because a machine that's down due to mechanical failure or malware produces no throughput at all.

Built upon the triad foundation of 7 nm manufacturing, "Zen 3" microarchitecture and chiplet technology supported by AMD Infinity™ Fabric, AMD Ryzen™ Threadripper™ PRO processors represent a tipping point in workstation-caliber computing. With AMD Ryzen™ Threadripper™ PRO processors offering far more cores at higher frequencies to crank through both heavily threaded and minimally threaded code – supported by the fastest and most advanced memory and storage subsystems available[3] – workstation professionals can now come closer than ever to having the best of both worlds.

DISCLOSURES / NOTES:

BENCHMARK PROCEDURES AND PARAMETERS:

All benchmarks were run at least twice on each system (and any obvious outlier results eliminated and rerun). When comparing systems, identical procedures and parameters were employed for apples-to-apples consistency. Each system was configured as deliberately as possible to ensure the CPU is the focus (and score-limiter) of each test. However, based on limitations of product and component availability, not every system could be outfitted with identical GPU, storage or memory peripherals.

SPECworkstation 3.0.4 CPU tests: Blender, handbrake, LuxRender, CalculiX, WPCcfd, RodiniaCFD, lammps, namd, rodiniaLifeSci, FSI, Convolution, FFTW, Kirchhoff, poisson, srmp, 7zip, octave, and python36. Each result was normalized to the comparison system's result and then averaged to the aggregate value.

PassMark PerformanceTest 10: All Performance Test CPU tests run to produce the CPU Mark. Individual components, namely the Floating Point, Physics and Compression tests were also individually run with repetitive, ascending thread counts at the Very Long setting, from one thread to N threads, where N = the number of physical cores (i.e. does not count logical cores available via HyperThreading).

LEGAL:

[1] Based on AMD internal analysis, September 2022. The Intel Xeon W-3300 Series, offers up to 38 cores, while the Threadripper™ PRO 5000 WX Series offers up to 64 cores. Comparing the individual SKUs of the same core count in the respective processor series, the Threadripper™ PRO 5000 WX Series processors' base frequencies are higher. CGP-32

[2] Max boost for AMD Ryzen™ Threadripper™ processors is the maximum frequency achievable by a single core on the processor running a bursty single-threaded workload. Max boost will vary based on several factors, including, but not limited to: thermal paste; system cooling; motherboard design and BIOS; the latest AMD chipset driver; and the latest OS updates. GD-150

[3] Intel® Xeon® W-2200 series and [1] Intel® 12th Generation Core® i9 SKUs selected for highest base frequency at given core count (8 cores and higher) from among SKUs offered by workstation OEMs Dell, HP, and Lenovo as of 6/10/2022, in models Dell Precision 5820, Lenovo ThinkStation P520, and HP Z4 G4.

INTEL® XEON® W-2200 SERIES SKU	# CORES	BASE FREQUENCY (GHZ)
Xeon® W-2245	8	3.9
Xeon® W-2255	10	3.7
Xeon® W-2265	12	3.5
Xeon® W-2255	10	3.8
Xeon® W-2265	12	3.5
Xeon® W-2275	14	3.3
Xeon® W-2295	18	3.0

[4] Based on AMD performance lab testing on January 31, 2022, using the Revit RFO benchmark, the V-Ray benchmark and the Unreal Engine compile benchmark to compare performance of (5) AMD Ryzen™ Threadripper™ PRO 5000WX-Series reference systems, each configured with 8x32GB DDR4, NVIDIA Quadro RTX A5000, 1TB SSD, Win 11 vs. (5) similarly configured BOXX APEXX4 workstations with Intel® Xeon® W-3300 series processors. Results may vary. CGP-21 5.

[5] Threadripper PRO 5000 WX-Series processor system configurations (all SKUs):

MEMORY SIZE (GB)	64 (8 x 8 GB)
MEMORY CHANNELS	8
DDR MEMORY SPEED ECC RDIMM)	3200
PRIMARY STORAGE	PCIe® Gen 4 M.2 NVMe SSD
GPU	NVIDIA® Quadro® RTX A5000
OS	Windows 10 Pro We refer to the Pluton security processor, which requires Win 11???

[6] 12C-16C test system configurations

	INTEL® XEON® W-2265 (12C)	INTEL® 12TH GENERATION CORE® I9-12900K (16C)	AMD RYZEN™ THREADRIPPER™ PRO 3945WX (12C)	AMD RYZEN™ THREADRIPPER™ PRO 5945WX (12C)	AMD RYZEN™ THREADRIPPER™ PRO 5955WX (16C)
CPU CORES (PHYSICAL)	12	16 (8P/8E)	12	12	16
CPU BASE FREQUENCY (GHZ)	3.5	3.2	4.0	4.1	4.1
MEMORY SIZE (GB)	64 (4 x 2R x 8 GB)	64 (2 x 32 GB)	64 (8 x 8 GB)	64 (8 x 8 GB)	64 (8 x 8 GB)
MEMORY CHANNELS	4	2	8	8	8
DDR MEMORY SPEED	2933	4800	3200	3200	3200
PRIMARY STORAGE	PCIe® Gen 3 M.2 NVMe SSD	PCIe® Gen 4 M.2 NVMe SSD	PCIe® Gen 3 M.2 NVMe SSD	PCIe® Gen 4 M.2 NVMe SSD	PCIe® Gen 4 M.2 NVMe SSD
GPU	NVIDIA® Quadro® RTX 6000	NVIDIA® RTX A2000	NVIDIA® RTX 6000	NVIDIA® RTX A5000	NVIDIA® RTX A5000
OS	Windows 10 Pro	Windows 11 Pro	Windows 10 Pro	Windows 10 Pro	Windows 10 Pro

[7] Refer to figure 9 Multi-thread (MT) generation-to-generation 12C test results for similarly configured systems[5,6]

[8] 64C test system configurations

	INTEL® XEON® SCALABLE PLATINUM 8280 (28CX2)	AMD RYZEN™ THREADRIPPER™ PRO 3995WX (64C)	AMD RYZEN™ THREADRIPPER™ PRO 5995WX (64C)
CPU CORES (PHYSICAL)	56 (2 x 28)	64	64
CPU BASE FREQUENCY (GHZ)	2.7	2.7	2.7
MEMORY SIZE (GB)	384 GB (2 x 6 x 32 GB)	256 (8 x 32 GB)	256 (8 x 32 GB)
MEMORY CHANNELS	12 (2 x 6)	8	8
DDR MEMORY SPEED	2933	3200	3200
PRIMARY STORAGE	PCIe® Gen 3 M.2 NVMe SSD	PCIe® Gen 4 M.2 NVMe SSD	PCIe® Gen 3 M.2 NVMe SSD
GPU	NVIDIA® Quadro® RTX 6000	NVIDIA® RTX A2000	NVIDIA® RTX 6000
OS	Windows 10 Pro	Windows 11 Pro	Windows 10 Pro

[9] Full system memory encryption with AMD Memory Guard is included in AMD Ryzen PRO, AMD Ryzen Threadripper PRO, and AMD Athlon PRO processors. Requires OEM enablement. Check with the system manufacturer prior to purchase. GD-206

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