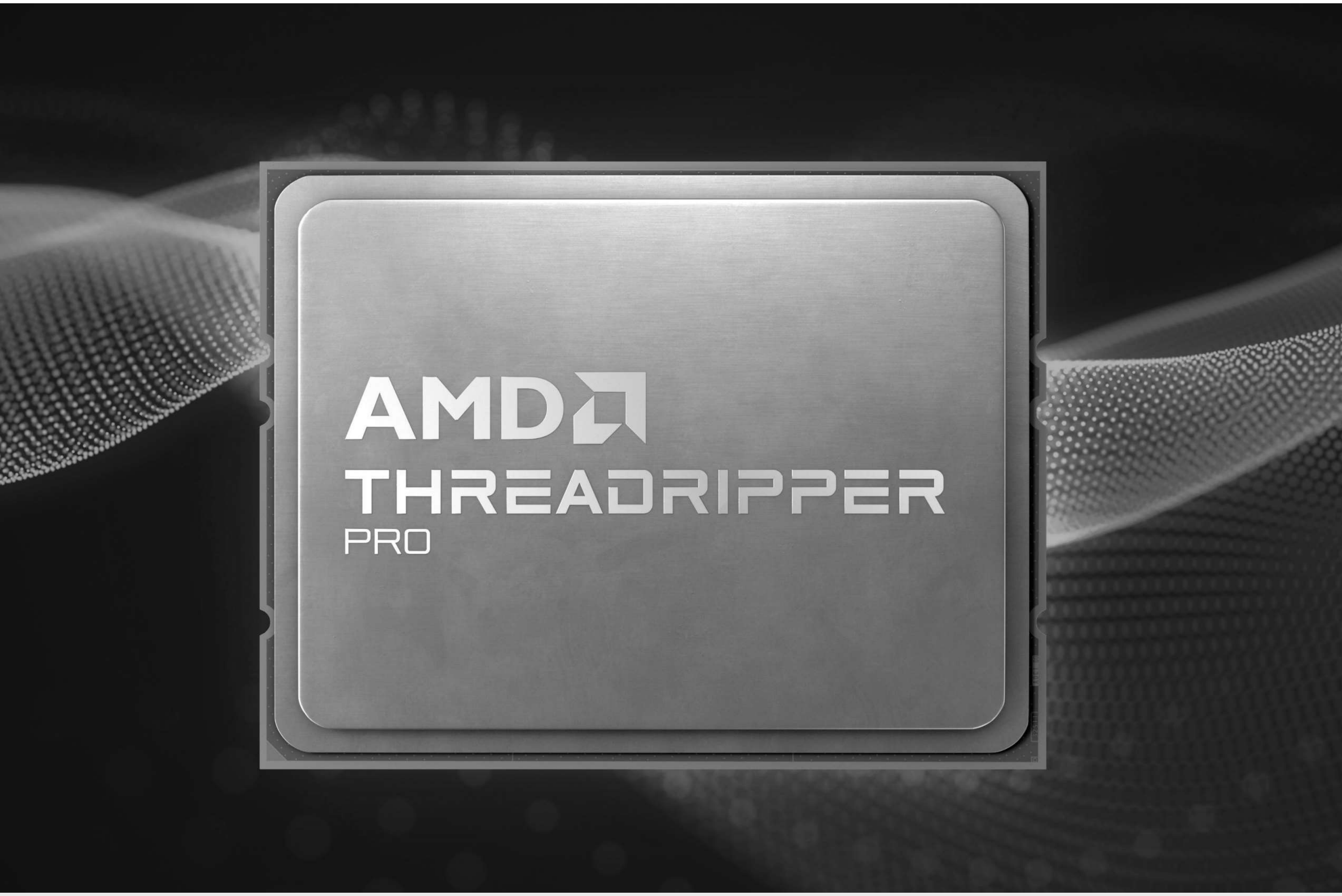
AMD
THREADRIPPER
PRO



WHITE PAPER | # AMD RYZEN™ PRO 7000 WX-SERIES PROCESSORS: RAISING THE BAR ON WORKSTATION PERFORMANCE

THREADRIPPER PRO 7000 WX-SERIES PROCESSORS EXTEND WORKSTATION-FOCUSED PROCESSING ON ALL FRONTS: SILICON, MICROARCHITECTURE AND INFINITY ARCHITECTURE IMPLEMENTATION

REVISION 1.0 / 11.13.23
FIRST DRAFT. NOT 100% POLISHED. FOR AMD PRODUCT/
MARKETING REVIEW FOR CONTENT, FLOW, GRAPHICS.

TABLE OF CONTENTS

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

Exploiting a synergistic trio of advanced technologies — the "Zen 4" microarchitecture, the leading-edge 5 nm silicon process, and 3rd generation AMD Infinity Architecture — the AMD Ryzen™ Threadripper™ PRO 7000 WX-Series processors drive workstation-caliber performance one big step further. Threadripper™ PRO offers a unique balance of technologies, enabling a leap forward to address emerging computing demands across the range of professional computing applications in design/manufacturing (D&M), architecture/engineering/construction (AEC), digital media and entertainment (DME), finance, and scientific applications in geology, medicine, research and artificial intelligence. It can enable the jump to a range of high-demand, heavily-threaded emerging uses, like 8K video production, generative design and intelligent manufacturing.

AMD RYZEN™ THREADRIPPER™ PRO 7000 WX-SERIES

AMD Ryzen™ Threadripper™ PRO processors manage to create this inflection point on the back of three key technologies, marking a new era in workstation CPUs: the "Zen" microarchitecture advancements in superscalar processing and instructions per cycle (IPC); a consistent progression in leading-edge manufacturing to enable higher-density on-chip cores; and the AMD Infinity Fabric architecture, a novel and proven approach to multi-die-processor implementation that opens the door to massive performance scaling and a broad range of core counts, while mitigating thermal issues and optimizing product costs.

The third generation of Threadripper PRO product line, the 7000 WX-Series retains the breadth of available CPU core counts of the preceding 5000 WX-Series line to serve the full range of workstation-caliber workloads and computing professionals' budgets: from the 12-core 7945WX to the 64-core 7985WX. But the 7000 WX-Series pushes the performance scaling envelope a significant step further, raising the industry bar to 96 cores with the 7995WX.

Processor	Cores / Threads	Base / Boost Frequency (GHz)	Total cache	TDP
Ryzen Threadripper PRO 7995WX	96 / 192	5.1 / 2.5	480 MB	350 W
Ryzen Threadripper PRO 7985WX	64 / 128	5.1 / 3.2	320 MB	350 W
RYZEN THREADRIPPER PRO 7975WX	32 / 64	5.3 / 4.0	160 MB	350 W
	24 / 48	5.3 / 4.2	152 MB	350 W
Ryzen Threadripper PRO 7955WX	16 / 32	5.3 / 4.5	80 MB	350 W
Ryzen Threadripper PRO 7945WX	12 / 24	5.3 / 4.7	76 MB	350 W

Table 1: The second generation of AMD Ryzen Threadripper Pro 7000 WX-Series workstation CPUs (Source: AMD)

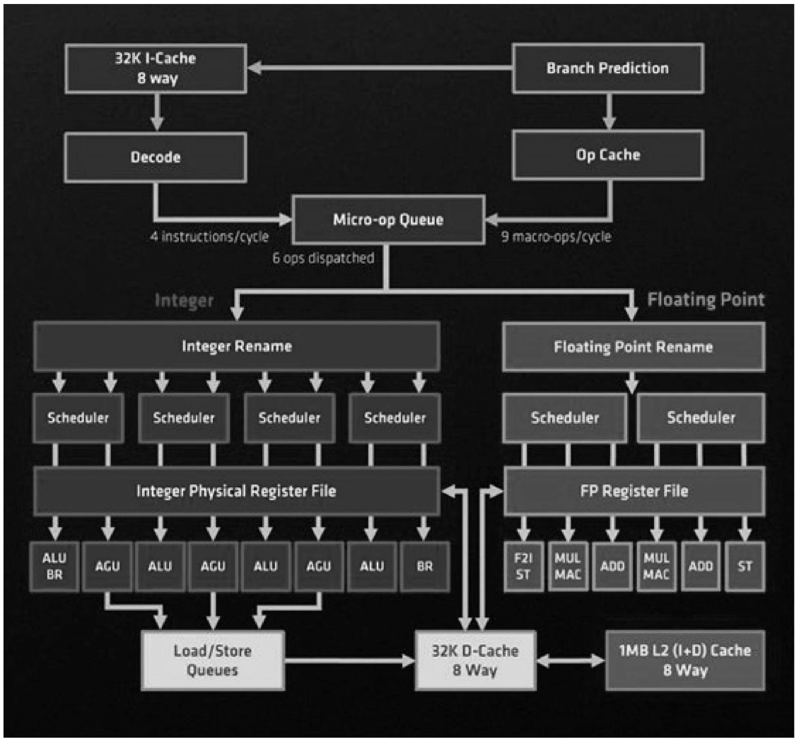
ZEN 4 IPC AND LEADING-EDGE SILICON PROCESS: THE SYNERGY YIELDS A LEAP FORWARD IN CORE THROUGHPUT

The primary axis of progress in computing performance has been clear for nearly two decades: multi-core architectures, a path that has spawned a related thread – chiplet architectures allowing for multiple die in a single CPU socket, thereby contributing to the same goal: more available processing cores per socket. Reducing the emphasis on driving clock frequencies alone — or as the primary dial to produce generation-to-generation gains — became not a possibility but an imperative, simply because of thermodynamic roadblocks that CPUs were facing. Power consumed translates to heat produced, and power directly proportional to frequency meant pushing GHz was unsustainable — more incremental heat would be produced than could be effectively dissipated. Hence the rationale behind the shift to multi-core processing: instead of doubling the clock of one bigger core, instantiate two cores of (more or less) the same clock rate, and achieve the same aggregate gain in maximum possible performance.

Superscalar evolution, however, is no afterthought. To round out a workstation computing platform capable of speeding all elements of a modern workflow, it can't be. Squeezing more aggregate throughput — instructions per cycle (IPC) — out of an individual processing core remains a critical axis of performance progression. The rationale is two-fold, as first, many of the most useful computing algorithms offer opportunities for large-grain parallelism — suitable for multi-thread implementations, some still don't. And moreover, some never will, as they are simply too serial in nature to reap much in the way of speed up from spawning additional threads of executions. Both key processing components of the most common professional workflow sequence — refine the model, visualize and repeat — are examples. Parametric modeling by definition mandates sequential processing, as does 3D graphics (from the perspective of the CPU, not the GPU) which requires (or at least prefers for simplicity) that drawing order be enforced. Second, while architects sensibly pursue multiple core instances to drive up aggregate throughput, a faster core multiplied by that increasing core count will only help further the ultimate goal of maximum performance per processor/socket.

While the low-hanging fruit of superscalar techniques has long been picked over decades of CPU evolution, opportunities remain for clever and judicious enhancements to existing techniques. The “Zen 4” core’s pipelines benefit substantially by a higher density leading-edge 5 nm process, allowing for notably larger instruction and data caches, deeper buffers and queues. Of course, with deeper buffers often come more severe penalties when failing to correctly predict an instruction branch. Accordingly, “Zen 4” ups its prediction game, introducing a second speculative branch per cycle to reduce the frequency of a miss. All combine to raise the utilization rates of enhanced arithmetic units — for example, a new AVX-512 unit capable of twice the peak SIMD floating point throughput with AI-optimal formats —by minimizing idle “bubbles” in instruction and execution datapaths. All told, the Zen 4 core’s advancements deliver an estimated 45% more integer and 75% more floating point performance than the prior generation[iv,i].

Figure 2: The Zen 4 microarchitecture: retaining proven Zen DNA with impactful enhancements in superscalar throughput



There is little point speeding up internal core structures only to introduce or ignore a bottleneck getting instructions and data in and out of the core. Ample resources are allocated across the "Zen 4" core’s load and store units, as well as internal memory cached and interface to external memory. For example, the "Zen 4" core manages substantially fewer port conflicts and a larger TLB to reduce any cycles lost (and latency gained) for virtual address translation.

Perhaps most critically, access to memory — be it core-dedicated L1 and L2 cache, core-shared L3 or external memory — needs to keep up with core datapaths and processing units, lest they be starved for data and inevitably cut utilization rates. The Threadripper PRO 7000 WX-Series integrates 95% more aggregate L3 cache on average than the most comparable CPU family in the industry, the Intel Xeon W-3400. And with its 8 channels of DDR5-5200 memory support, the Threadripper PRO 7000 WX-Series, in conjunction with a next-generation socket WRX90, can manage a peak of 332.8 GB/s of ECC-capable external memory bandwidth (based on DDR5 5200MHz), up to 8.3% more than the Intel Xeon W-3400.[iii]

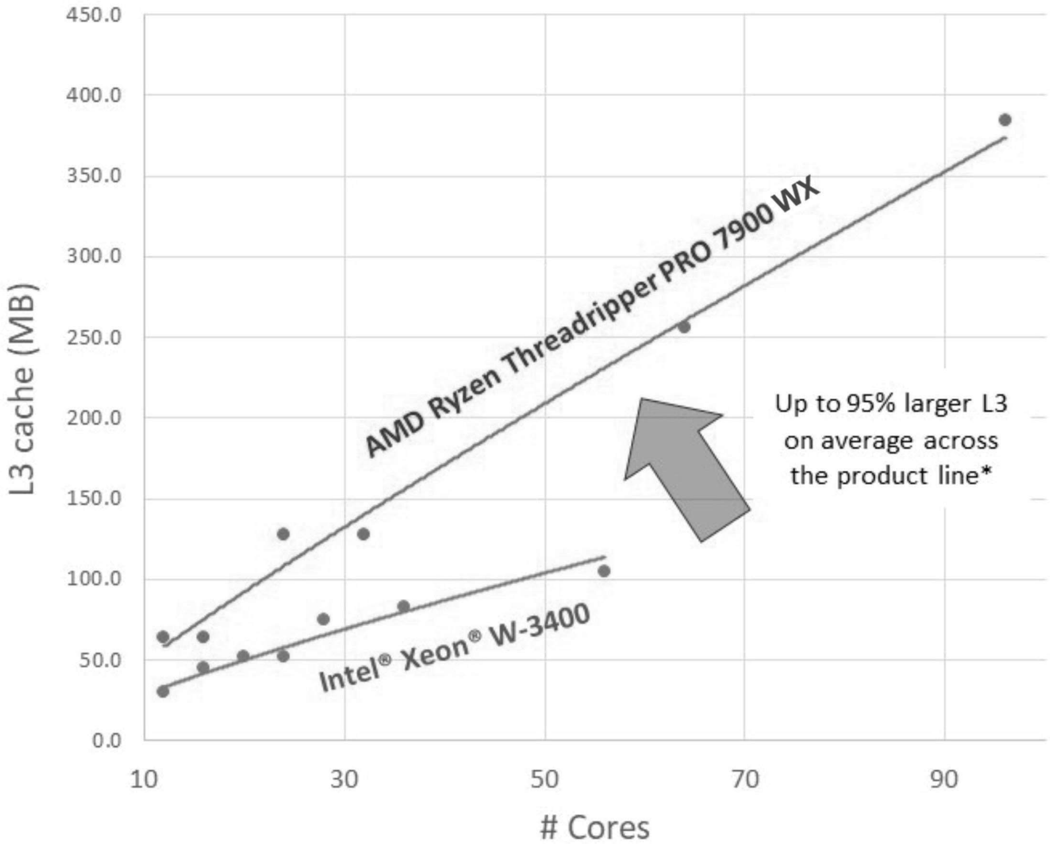


Figure 3: L3 cache sizes across the AMD Ryzen Threadripper PRO 7000 WX-Series and Intel Xeon W-3400 series[ii].

Threadripper PRO's I/O capabilities have climbed as well, with the 7000 WX-Series making the transition to PCIe 5.0, giving its 128 lanes up to 504.3 GB/s (in both directions), nearly double that of its 5000 WX predecessor and providing up to 14.3% higher peak transfer rate than the comparable Intel Xeon W-3400 processor family.

Aggregating the holistic breadth of "Zen 4" advancements leads to a substantial generational jump in IPC, up to 14% higher[v] than previous generation "Zen 3" on the same workloads.

ZEN 4 IPC IMPROVEMENTS COMPOUNDED BY LEADERSHIP SILICON PROCESS AND HIGHEST-IN-CLASS BOOST CLOCK FREQUENCIES YIELD BEST-IN-CLASS CORE PERFORMANCE

A critical avenue that "Zen 4" successfully exploits, IPC isn't the only dial architects have at their disposal to advance per-core performance to benefit the range of workstation-class computing, from single-thread to large-grain massively parallel workloads. While clock frequencies are no longer a singular focus of CPU architects, their effectiveness to simply and directly drive up performance hasn't changed. An increase in clock rate can still yield a linearly proportional higher peak potential throughput, making clock rate a compelling and ongoing focus of CPU design, albeit one requiring careful attention to commensurate power consumption.

Judicious circuit engineering, dovetailing with the cutting edge 5 nm manufacturing process opened the way to higher core frequencies, both with respect to boost clocks, often correlating to best single or few thread processing, and base clocks, typically indicative of rates during heavy, sustained multi-core execution). For example, the Threadripper PRO 7000 WX-Series manages boost clock rates on average 16.9% faster than previous-generation Threadripper PRO 5000WX and up to 10% faster than the most comparable CPU family in the industry, the Intel Xeon-3400[ix].

Moreover, consider the compounding effect of "Zen 4" IPC gain and boost clock frequency improvements, presenting the opportunity to dramatically increase per-core throughput, precisely the avenue "Zen 4" and Threadripper PRO 7000 WX-Series exploits. The higher boost frequency in combination with "Zen 4" lift in IPC yields on average 28% faster workstation-caliber single-thread performance over previous generation 5000WX and up to 13% over the Intel™ Xeon™ W-3400[viii].

Threadripper PRO 7900WX CPU scores, normalized to the Intel Xeon W-3400 SKU

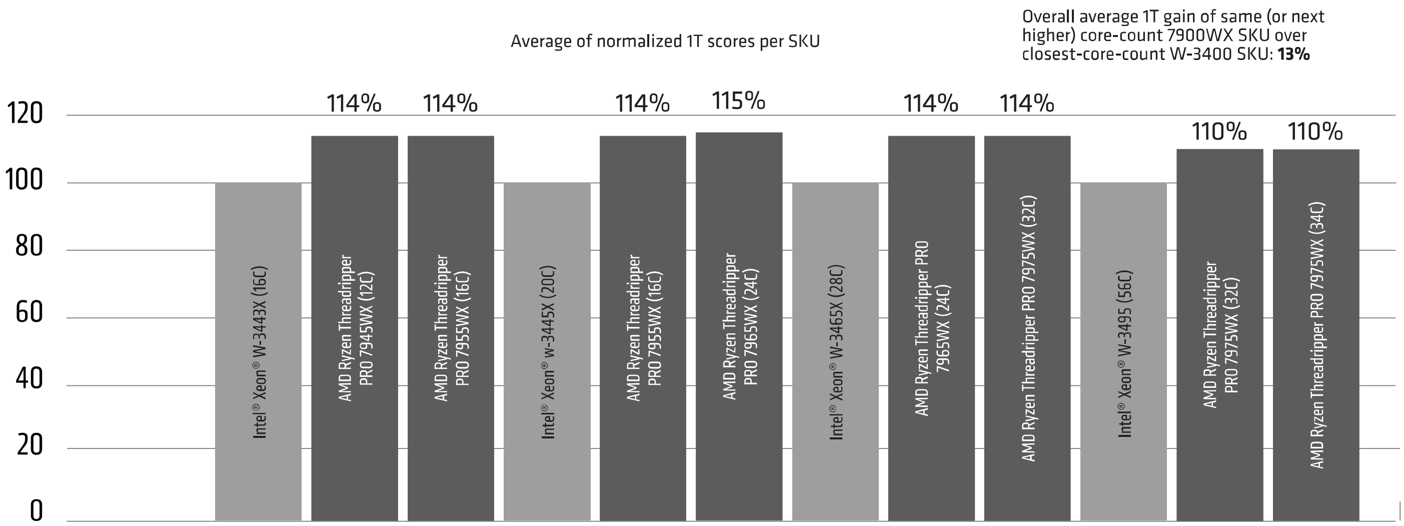


Figure 4: AMD Ryzen Threadripper PRO 7000 WX-Series offers best-in-class single-thread workstation-caliber performance[ix]

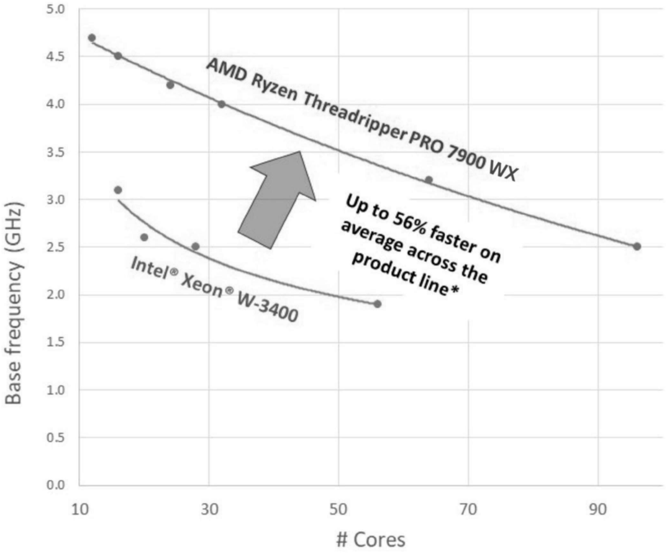
SUPERIOR POWER EFFICIENCY DELIVERS BEST-IN-CLASS BASE FREQUENCIES, THE CRITICAL ANTE TO MASSIVE MULTI-THREADED PERFORMANCE SCALING

A CPU's transient over-driven turbo or boost clock rates have long proven a clever and rewarding tool to temporarily crank up throughput by exploiting short-term available thermal power headroom, particularly for single-to-few threaded workloads.

But unfortunately, when it comes to running the types of long-term, heavy-duty multi-thread computation ubiquitous in professional workstation applications — computational fluid dynamics, finite element analysis, lighting simulations, machine learning and inference, complex modeling in finance, geology, science and medical applications — boost rates are no longer relevant. Eventually, thermal output climbs as a function of utilized cores, electrical and thermal constraints tighten, and boost rates must drop, ultimately leaving the base rate to count on for high levels of throughput. But while thermodynamic laws don't bend, their impact to a CPU's performance can be mitigated by thoughtful, innovative engineering.

Perhaps ironic on the surface, the criterion most often considered in the context of battery-powered handheld and laptop computing, power efficiency, pays off as dramatically on the other end of computing spectrum: high-performance workstation and server computing. Consider both directions engineers can turn the power efficiency dial. Particularly in mobile applications, design might lean toward delivering the same performance at reduced power, thereby improving battery life. But turn the dial the other way, and at similar levels of power consumption, superior efficiency can translate directly into higher achievable performance.

That's precisely how "Zen 4" — in conjunction with an improved silicon process — has allowed Threadripper PRO 7000 WX-Series to run at significantly higher base clock rates than both its predecessor, the 5000WX family, and the most comparable alternative processors available in the industry. On average, the AMD Ryzen Threadripper PRO 7000 WX-Series models achieve 13% faster base frequencies than the 5000WX generation and up to 56% faster than the comparable Intel Xeon W-3400 models[x].



THE CORE — AND PERFORMANCE — SCALING LINCHPIN: THE 3RD GEN INFINITY ARCHITECTURE

Driving up both IPC and base clock rates presents a highly effective path to maximizing multi-thread performance for the wealth of highly parallel workloads pervasive in workstation computing. Of course, that combination is moot without the means to effectively populate a multitude of cores in a single processor socket. Threadripper PRO has that means, and it's one that has again allowed for the highest core count available in the industry: the AMD Infinity Architecture. Rather than incurring the additional cost and complexity of building many incarnations of a unique monolithic die per processor SKU, the Infinity Architecture instantiates multiple simpler die to scale the 7000 WX-Series from the 12-core 7495WX all the way up to the 96-core 7995WX.

In Zen microarchitecture parlance, Threadripper PRO employs the base functional unit of the Core Complex (CCX), integrating eight "Zen 4" cores, along with 32 MB of shared L3 cache. Two such CCXes comprise a single Core Complex Die (CCD), of which anywhere from one to six CCD are integrated into a single CPU, stitched together with high-performance Infinity Fabric.

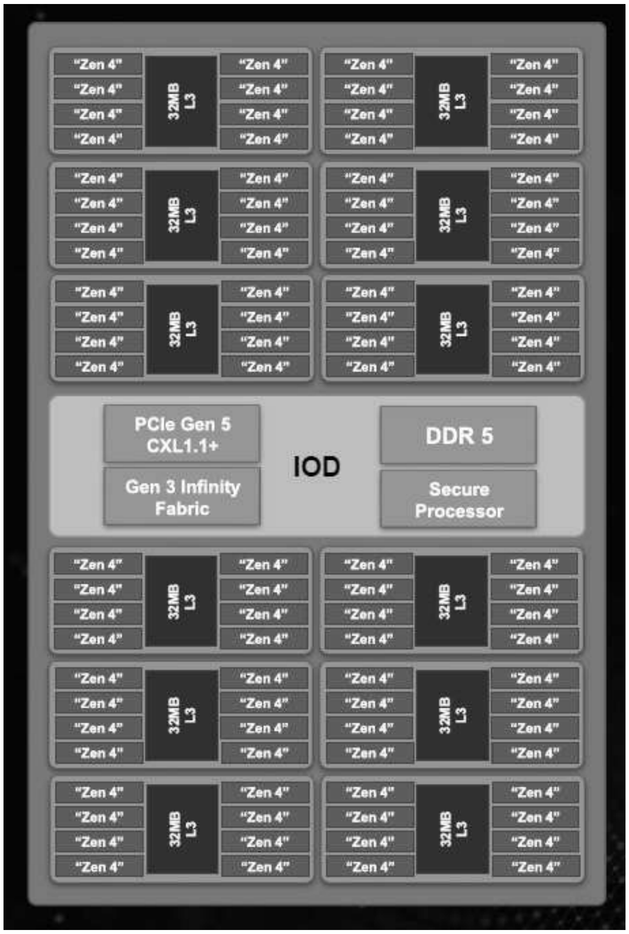


Figure 5: The ultimate incarnation of Infinity Architecture-enabled Threadripper PRO: the 7995WX, comprising 12 CCXes, six CCDs, and 96 total cores in a single CPU socket

THE DEVIL IN THE DETAILS: 3RD GENERATION INFINITY ARCHITECTURE PUSHES FORWARD

On paper, what the industry now generally refers to as a “chiplet architecture” fits the bill for the type of hefty core scaling that computing markets like workstations and servers favor. Given thermal, electrical and manufacturing constraints developing high-performance silicon — and proven implementations of several generations of AMD EPYC, Ryzen, and Threadripper PRO processors — there’s little debate that a chiplet approach yields an effective means to achieve top-end multi-core scaling.

But all chiplet architectures are not created equal. An alternative methodology might be capable of physically fitting multiple processor die into a package that can offer more cores than a monolithic chip would have, but if those cores are starved for memory or I/O, it won’t lead to the ultimate objective: performance. Boasting high core counts is a nice feather on the cap, but the end game is delivering sustained, multi-threaded throughput. What might sound simple on the surface — slap together a few die, hook up some communication interface between them, and deliver it all in a single package — in reality demands a robust high-performance, holistically designed interconnection fabric with capabilities that allow for high-bandwidth, low-latency access both between die and off-processor, particularly to attached system memory. Now in its third generation, the AMD Infinity Architecture has been both proven and enhanced since its introduction in 2017, progressively minimizing latency and maximizing bandwidth.

Consider again Threadripper PRO 7000 WX-Series' ample L3 cache, this time in the context of an important synergy with the Infinity Architecture multi-die implementation. The larger the L3, the less frequent are external memory loads and stores, the former being particularly onerous as latency rises. While L3 cache has become a critical resource in the age of multi-core designs, its utility has only been magnified in the age of multi-die implementations, where the latency penalty to access “distant” memory (with physical interface on a neighboring die) is higher.

Furthermore, in conjunction with leveraging its third generation of Infinity Architecture Threadripper PRO 7000 WX-Series introduces support for “thread pinning”, allowing for deployment of threads with optimal access to its working set in memory. One algorithm may spawn more closely-coupled threads which benefit from a shared working set capable of residing in the same L3 cache. With another, threads might execute more independently, benefit from having unilateral access to its “own” L3. Judicious pinning of threads to specific CCXes and CCDs makes optimal use of the architectures copious L3, minimizing the impact of the potentially longer latency to memory that any chiplet architectures must contend with.

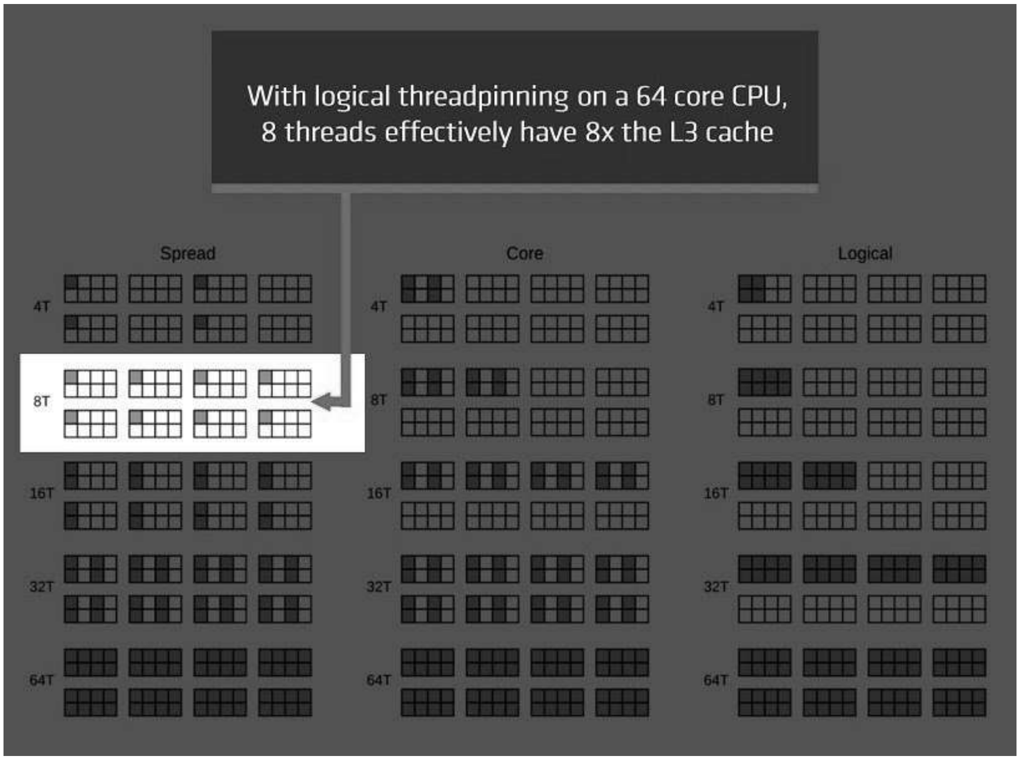


Figure 6: The combination of Threadripper PRO's larger physical L3 caches, in combination with more ample "effective" L3 sizes minimizes costly memory access and drives performance possible with AMD Infinity Architecture

COMPREHENSIVE, HOLISTIC AND AMPLY-OUTFITTED ARCHITECTURE YIELDS THREADRIPPER PRO 7000 WX-SERIES INDUSTRY-LEADING MULTI-THREAD PERFORMANCE SCALING

Finally, consider the compounded effect of the full breadth of Threadripper PRO 7000 WX-Series holistically-designed enhancements: the improved IPC of Zen 4; the superior power and density characteristics of 5 nm; microarchitectural power efficiency; the highest clock rates in class for both boost and base; and the ability to scale to massive core counts at high performance with 3rd Gen Infinity Architecture technology. The end result? The 7000 WX-Series has been able to dramatically improve on the performance scaling of its predecessor, the 5000WX, while setting itself apart from any other workstation-caliber processor in its class.

Tracking a workstation-relevant composite score of Pass Mark Performance Test 11 tests, performance rises steeply and smoothly with thread count. At the extreme top end, the Threadripper PRO 7995WX achieves a strong performance return as incremental threads are deployed up to 96, its physical core count, while even reaping further gains beyond. Both the 7995WX and the 64C 7985WX CPUs manage substantially higher throughput at all thread counts than the most comparable 56C Intel Xeon w9-3495Xx. These test results show both Threadripper PRO SKUs delivering performance levels at 32 threads that the Intel Xeon w9-3495X achieves with 56 threads.

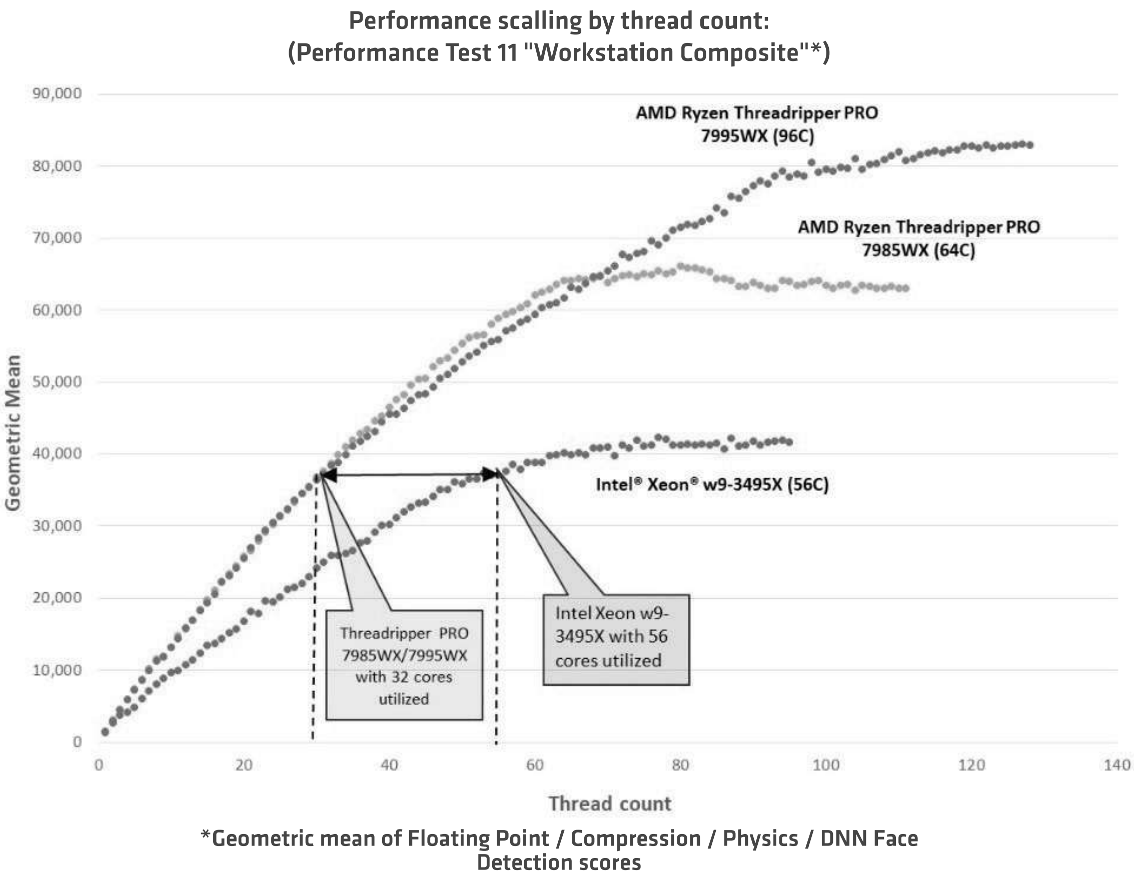


Figure 7: AMD Ryzen Threadripper PRO 7995WX and 7985WX performance scaling by thread count[xi,xiii]

The entire Threadripper PRO 7000 WX-Series exhibits this highly effective performance return on incremental thread count. On average, comparing each 7000 WX-Series SKU with the same – or next lower – core-count SKU of the Intel® Xeon® W-3400 family, the 7000 WX-Series manages up to 43% higher performancexii. Even when comparing each 7000 WX -Series model with the same or next higher core count Intel® Xeon® W-3400 SKU, Threadripper PRO still manages up to 18% higher throughputxii, supporting the proposition the former delivers better performance with fewer cores.

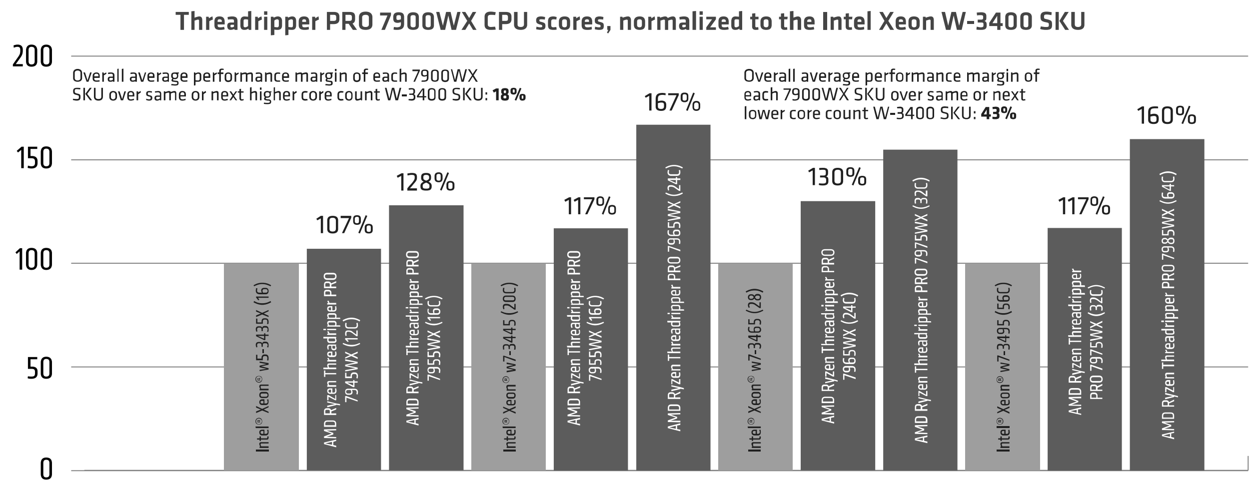


Figure 8: Aggregate performance advantage of AMD Ryzen Threadripper PRO 7000 WX-Series CPUs, normalized to four comparable Intel Xeon W-3400 SKUs[xiii]

RAISING THE BAR ON THE TOP END: THE 96-CORE THREADRIPPER PRO 7995WX STANDS ALONE

Performance data for the current Intel® Xeon® W-3400 and closest comparable Threadripper PRO 7000 WX-Series models presented in the chart above leaves out one 7000 WX-Series SKU, and for good reason. There is simply no other single-socket workstation-class processor available in the industry with a core count in the neighborhood of the 96-core 7995WX, leaving it in a class of its own. In the context the of top-end members of the two competing product lines, the superior multi-threaded performance of the 7995WX is both clear and dramatic, achieving up to 76% higher performancexii than the highest core count Intel® Xeon® W-3400 SKU, the w9-3495X.

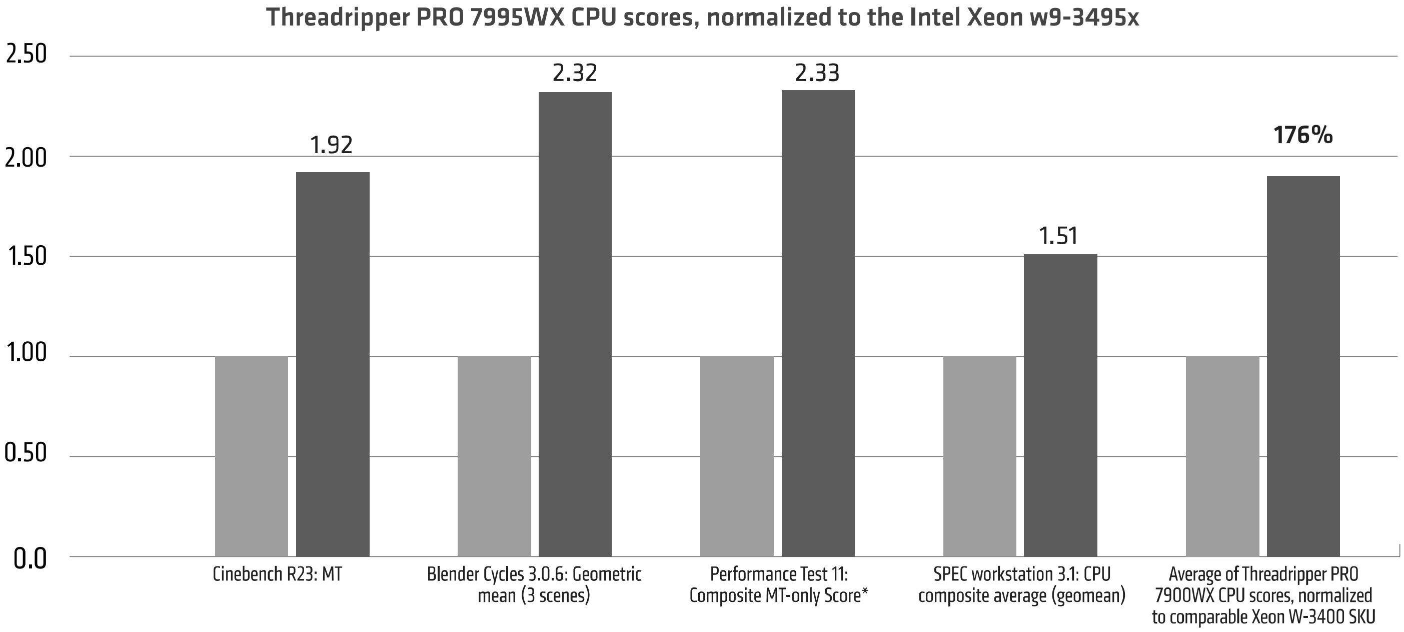


Figure 9: Aggregate performance advantage of AMD Ryzen Threadripper PRO 7995WX relative to the Intel Xeon W9-3495X

SUMMARY

Leveraging a range of technology advancements — most notably the Zen 4 microarchitecture, 5 nm silicon process, and 3rd Gen Infinity Architecture — the AMD Ryzen Threadripper PRO 7000 WX-Series raises the bar on workstation performance running both modern multi-threaded (MT) workloads as well as legacy and serially constrained single-thread (1T) tasks.

The Threadripper PRO 7000 WX-Series outperforms its predecessor 5000 WX line on average by up to 34% running common workstation-caliber multi-threaded workloads and up to 27% on 1T, with speedups consistent across the range of core count SKUs.

The 7000 WX-Series outperforms the most comparable alternative line of workstation-focused CPUs in the industry, the Intel™ Xeon™ W-3400 series, on average by up to 43% on MT processing and up to 13% on 1T (comparing W-3400 SKUs with same or next higher core count 7000 WX-Series. Even comparing each 7000 WX SKU with the same or next lower available core count Xeon W-3400 SKU, the former outperforms the latter by up to 17% on average.

The AMD Ryzen™ Threadripper™ PRO 7000 WX-Series processors are now available in premium workstation models from leading OEM partners, including Dell, Lenovo and HP.

The ultimate beneficiaries of the 7000 WX-Series family, workstation professionals demanding substantial generation-to-generation gains in productivity for mission-critical applications, can now upgrade their computing throughput as they see fit: choosing from more performance with fewer cores at the lower end of the spectrum, to absolute best-in-class, no-compromise throughput at the top.

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[i] SPECrate®2017_fp_base comparison based on published scores from www.spec.org as of 03/31/2023. Comparison of published 2P AMD EPYC 9534 (1160 SPECrate®2017_fp_base, 560 Total TDP W, 128 Total Cores, $17606 Total CPU $, 2.071 Perf/W, http://spec.org/cpu2017/results/res2023q1/cpu2017-20230116-33521.html) is 1.75x the performance of published 2P AMD EPYC 7763 (663 SPECrate®2017_fp_base, 560 Total TDP W, 128 Total Cores, $15780 Total CPU $, 1.184 Perf/W, http://spec.org/cpu2017/results/res2021q4/cpu2017-20211121-30146.html) [at 1.75x the performance/W] [at 1.57x the performance/CPU$].AMD 1Ku pricing and Intel ARK.intel.com specifications and pricing as of 3/31/23.SPEC®, SPEC CPU®, and SPECrate® are registered trademarks of the Standard Performance Evaluation Corporation. See www.spec.org for more information.

[ii] Average relative L3 cache size across product families is calculated as follows, given that the AMD Ryzen Threadripper PRO 7900WX and Intel Xeon W-3400 product families do not completely match in CPU core count: for each Intel W-3400 SKU (from 12C to 56C), the L3 cache size of the matching core count 7900WX SKU – or next lower core count SKU if no exact match available – is calculated then all averaged (with arithmetic mean). Comparing the next lower core count 7900WX SKU should not work in Threadripper PRO's favor, as L3 cache sizes virtually always decline with lower core counts, independent of vendor and implementation.

Intel® Xeon® W-3400	# Cores	L3 cache (MB)	AMD Ryzen Threadripper PRO 7900WX	# cores	L3 cache (MB)	L3 cache size advantage (matching or next lower core count)
w5-3425 (12C)	12	30.0	7945WX (12C)	12	64	113%
w5-3435X (16C)	16	45.0	7955WX (16C)	16	64	42%
W7-3445 (20C)	20	52.5	7955WX (16C)	16	64	22%
	24	52.5	7955WX (24C)	24	128	144%
w7-3465X (28C)	28	75.0	7955WX (24C)	24	128	71%
w9-3475X (36C)	36	82.5	7965WX (32C)	32	128	55%
w9-3495X (56C)	56	105.0	7965WX (32C)	32	256	144%
Average L3 cache size advantage						95%

[iii]Peak memory bandwidth for each product family calculations based on the following published specifications for each:

	DDR speed	Channels	Peak memory bandwidth (GB/s)
Intel® Xeon® W-3400	4800	8	307.2
AMD Ryzen Threadripper PRO 7900WX	5200	8	332.8

[vi]Both processor families support PCIe 5.0 transfer rates, with the 7000WX series supporting 128 lanes versus Intel Xeon W-3400's 112 lanes.

[v]Based on AMD internal testing as of 09/19/2022, geomean performance improvement at the same fixed-frequency on a 4th Gen AMD EPYC™ 9554 CPU compared to a 3rd Gen AMD EPYC™ 7763 CPU using a select set of workloads (33) including est.SPECrate®2017_int_base, est.SPECrate®2017_fp_base, and representative server workloads.

[vi]Average boost clock gain for each of the 12C, 16C, 24C, 32C and 64C SKUs in the Threadripper PRO 7000 WX-Series line relative to the boost clock of the matching core-count SKU in the Threadripper PRO 5000 WX family.

[vii]Comparing average of Cinebench R23 (single thread mode) and PerformanceTest 11 CPU Single Threaded for each of the 12C, 16C, 24C, 32C and 64C SKUs in the Threadripper PRO 7000 WX-Series line normalized to the same scores of matching core-count SKU in the Threadripper PRO 5000 WX family.

[ix]Compares each of the four tested CPU SKU in the Intel Xeon W-3400 family with the comparable AMD Ryzen Threadripper PRO 7900WX SKUs. Where the 7900WX family has a core count that exactly matches one of the W-3400 SKUs, the comparison 7900WX SKUs include both the matching core count model as well as the SKU with the next fewer core count. Where the 7900WX family does not have a core count that exactly matches one of the W-3400 SKUs, the comparison 7900WX SKUs include the next higher, In each of the four comparisons, each comparable W-3400 and 7900WX SKUs scores are calculated from an average of scores for Cinebench R23 (single thread mode) and PerformanceTest 11 CPU Single Threaded, then normalized to the W-3400 SKU's scores. Run with respective system specificationsxi.

[ix]Comparing each Threadripper PRO 5000WX SKU with the same core count successor in the 7000 WX family, then averaging across the family. The same calculation applies in referencing average advantages for both base and boost clocks.

AMD Ryzen Threadripper PRO 5909WX	# Cores	Base GHz	Turbo GHz	AMD Ryzen Threadripper PRO 7900WX	# cores	Base GHz	Turbo GHz	Base clock advantage (at the same core count)	Boost clock (at the same core count)
5945WX (12C)	12	4.1	4.5	7945WX (12)	12	4.7	5.3	47%	18%
5955WX (16C)	16	4	4.5	7955WX (16)	16	4.5	5.3	45%	18%
5955WX (24C)	24	3.8	4.5	7955WX (24C)	24	4.2	5.3	62%	18%
5965WX (32C)	32	2.5	4.5	7965WX (32C)	32	4	5.3	68%	18%
5975WX (64C)	64	2.7	4.5	7975WX (64C)	64	3.2	5.1	60%	13%
					Average across 7000 WX family			13%	17%

[x]Average calculated as follows, given that the AMD Ryzen Threadripper PRO 7900WX and Intel Xeon W-3400 product families do not completely match in CPU core count: for each Intel W-3400 SKU (from 12C to 56C), the clock advantage of the matching core count 7900WX SKU – or next higher core count SKU if no exact match available — is calculated then all averaged (with arithmetic mean). Comparing the next higher core count 7900WX SKU should not work in Threadripper PRO's favor, as clock specifications tend to all fall with higher core counts, independent of vendor and implementation. The same calculation applies in referencing average advantages for both base and boost (Intel's Turbo Max 3.0) clocks. Specifications for Intel Xeon W-3400 SKUs source: Intel.com.

Intel® Xeon® W-3400 SKU	# Cores	Base frequency (GHz)	Turbo GHz	AMD Ryzen Threadripper PRO 7900WX SKU	# cores	Base GHz	Turbo GHz	Base clock advantage	Boost clock
w5-3425	12	3.2	4.6	7945WX	12	4.7	5.3	47%	15%
w5-3435X	16	3.1	4.7	7955WX	16	4.5	5.3	45%	13%
W7-3445	20	2.6	4.8	7955WX (24C)	24	4.2	5.3	62%	10%
w7-3455	24	2.5	4.8	7955WX (24C)	24	4.2	5.3	68%	10%
w7-3456X	28	2.5	4.8	7965WX (32C)	32	4	5.3	60%	10%
w9-3475X	36	2.2	4.8	7965WX (32C)	32	4	5.3	45%	6%
W9-3495X	56	1.9	4.8	7975WX (64C)	64	3.2	5.1	68%	6%
Mean of all 7900WX models' clock advantage over comparison Xeon W-3400 SKU								56%	10%

[xi]Values produced by calculating the geometric mean of four individual tests in PassMark PerformanceTest 11 –Floating Point, Compression, Physics, and DNN Face Detection – using the Advanced CPU option to run repetitive iterations with ascending thread counts from one to a maximum of two times the SKU's physical core count. Run on respective system specifications[xi].

[xii]Test system specifications for AMD Ryzen Threadripper PRO 7900WX and Intel Xeon W-3400:

	Intel® Xeon® W-3400	**AMD Ryzen Threadripper PRO 7900WX**
SKUs tested	W9-3495X / W7-3465X	3.2
W7-3445X / W5-3435X	7945WX / 7955WX /7965WX	3.1
7975WX / 7985WX / 7995WX	20	52.5
Memory DIMMs	DDR5-4800 with ECC	DDR5-5600 with ECC
Operating system	Microsoft Windows 10 Professional	
Chassis volume (liters)	30.8	65.0
Cooling	Conventional air-cooling	

[xiii]Compares each of the four tested CPU SKU in the Intel Xeon W-3400 family with the comparable AMD Ryzen Threadripper PRO 7900WX SKUs. Where the 7900WX family has a core count that exactly matches one of the W-3400 SKUs, the comparison 7900WX SKUs include both the matching core count model as well as the SKU with the next fewer core count. Where the 7900WX family does not have a core count that exactly matches one of the W-3400 SKUs, the comparison 7900WX SKUs include both the next higher core count model as well as the model with the next fewer core count. In each of the four comparisons, scores for the W-3400 SKU and the comparable 7900WX SKU's scores are calculated from an average of the following tests, then normalized to the W-3400 SKU's scores:

SPECworkstation 3.1: Media and Entertainment
SPECworkstation 3.1: Product Development
SPECworkstation 3.1: Life Sciences
SPECWORKSTATION 3.1: FINANCIAL SERVICES
SPECworkstation 3.1: Energy
SPECworkstation 3.1: General Operations
Cinebench R23 (in standard execution with all cores available)
Blender Cycles 3.0.6: Geometric mean (3 scenes)
Performance Test 11: "Composite MT-only Score" (the geomean of all individual tests with exception of CPU Single Threaded to better focus on multi-threading performance)

Run with respective system specifications[xi].

[xiv]The scores for both CPUs are calculated from an average of the same battery of tests[xii], then normalized to the w9-3495X's resulting average score. Run with respective system specifications[xi].