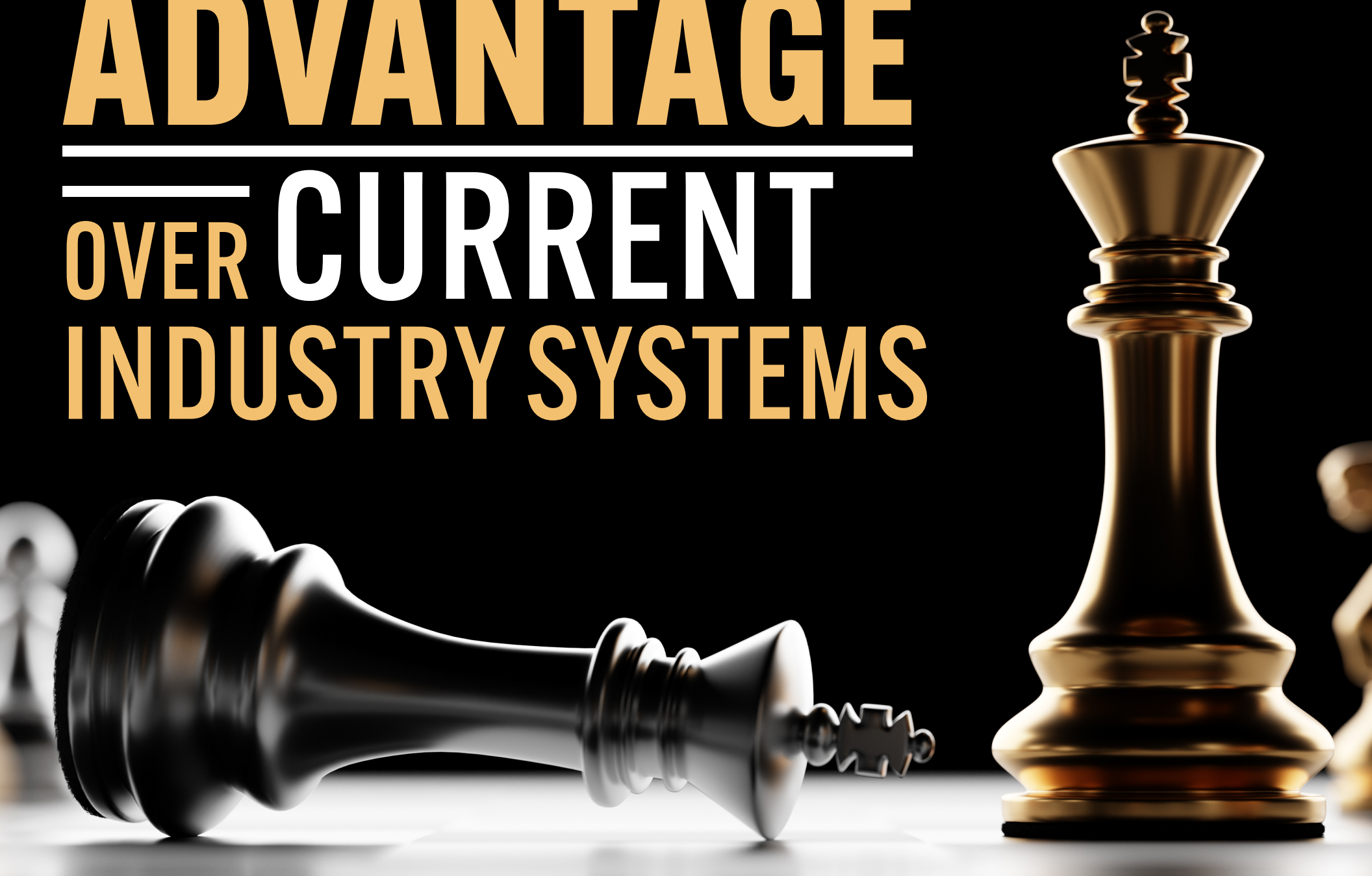
BIMBOX'S COMPETITIVE ADVANTAGE OVER CURRENT INDUSTRY SYSTEMS



introduction

In November 2022, Intel released their latest I-Series processors, the 13th Generation Raptor Lake chipsets. With the release of these new processors, several other significant upgrades to the hardware industry followed, including DDR5 memory and PCIe 5.0. The release of these technologies in such a short time frame not only places high expectations on the performance of this year's desktop PCs but the stability of that performance.

This whitepaper is intended to highlight the performance capabilities of desktops released this year while also bringing to light some of the challenges posed by this year's upgrades and how BIMBOX has overcome them to produce the fastest AEC PCs ever built.

Intel 13th Generation Processors: Performance Capabilities

The Intel Core i9-13900K is a desktop processor with 24 cores and 32 threads. 13th Gen Intel Core CPUs integrate two types of cores into the processor: performance cores (P-cores) and efficiency cores (E-cores). The P-Core's base frequency comes in at 3 Ghz with the ability to clock up to 5.8 GHz. The base frequency of the E-cores starts at 2.2Ghz with the max turbo frequency limited to 4.3 GHz. There are 36 MB of L3 cache, 32MB of L2 cache, 16 PCIe 5.0 lanes from the CPU and four PCIe 4.0 lanes. Intel is building the Core i9-13900K on a 10 nm production process called Intel 7.

The latest 13th Gen Core processors also include the new Intel Thread Director, which is a hardware-based task scheduler that works with the operating system to assign computational tasks to the proper cores or threads to achieve optimal performance and efficiency. For example, Intel Thread Director helps maximize 13th Gen performance by shifting background tasks to the E-cores while prioritizing the P-cores for critical tasks or applications with heavier workloads.

With a TDP of 253 W, the Core i9-13900K consumes a lot of power and generates a significant amount of heat, which we will discuss below. Intel's processor supports both DDR4 and DDR5 memory with a dual-channel interface. For communication with other components in the computer, the i9-13900K uses a PCI-Express Gen 5 connection.

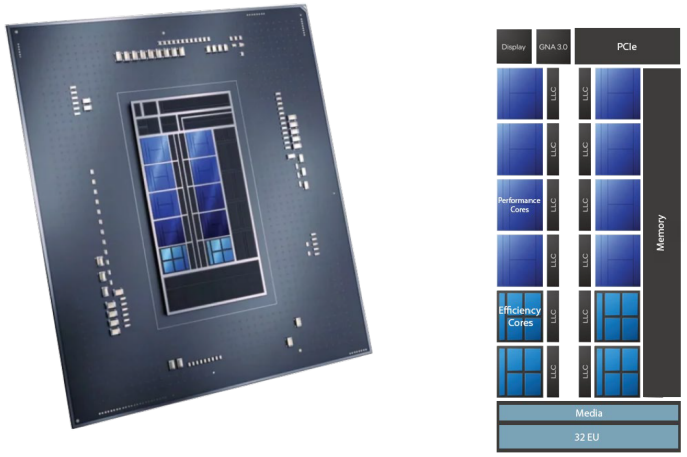


Fig. 1: Intel Alder Lake Architecture

Challenges

Intel 13th Gen processors have shown significant performance gains across many benchmark tests compared to Intel's 12th Gen lineup. However, this increase in performance has also been paired with an exceptionally high increase in CPU temperatures. Most system builders have chosen to accept the thermal limitations of the new processors since a majority of them choose to not maximize their performance potential.

Other system builders are even going as far as reducing the maximum boost clock speed as a means of preventing the processor from being thermally throttled. Rather than addressing the cooling challenges of the 13th Gen processors, we have seen systems from other big-brand manufacturers limited to a maximum speed of 4.7Ghz, compared to Intel's advertised 5.8Ghz. Intel does note that this practice is acceptable for system builders. While limiting the performance of a processor is acceptable for the manufacturer, it can be misleading for the consumer as the system builder is not required to advertise the reduced performance.

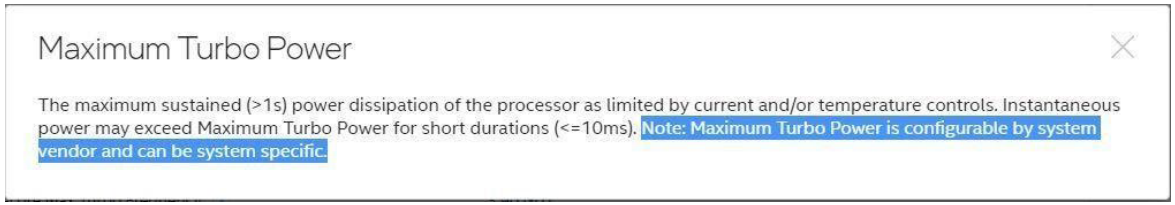


Fig. 2: System Vendors Dictate Maximum CPU speed

When asked questions related to IHS deflection on the 13th generation chipsets, Intel responded with the following:

Are there any planned changes to the ILM design? This condition might only exist with certain versions of the ILM. Can you confirm that these ILM are to spec?

"Based on current data, we can't attribute the IHS deflection variation to any specific vendor or socket mechanism. However, we are investigating any potential issues alongside our partners and customers, and we will provide further guidance on relevant solutions as appropriate." —Intel Spokesperson to Tom's Hardware.

Some users report reduced thermal transfer from the deflection issue, which makes sense as it clearly impacts the ability of the IHS to mate with the cooler. Would Intel RMA the chip if the mating was poor enough to lead to thermal throttling?

Challenges

"Minor IHS deflection is expected and does not cause the processor to run outside of specifications or prevent the processor from meeting published frequencies under the proper operating conditions. We recommend users who observe any functional issues with their processors to contact Intel Customer Service." —Intel Spokesperson to Tom's Hardware.

The chip deflection issue also impacts motherboards. As a result of the deflection on the chip, the rear of the socket ends up bending, and thus the motherboard. This raises the possibility of damage to the traces running through the motherboard PCB, etc. Is this condition also within spec?

"When there's backplate bending occurring on the motherboard, the warping is being caused by the mechanical load being placed on the motherboard to make electrical contact between the CPU and the socket. There's no direct correlation between IHS deflection and backplate bending, other than they can both be caused by the mechanical socket loading." —Intel Spokesperson to Tom's Hardware.

*Intel questions thread from Tom's Hardware

Intel claims it continues to monitor the situation but currently there are no changes queued for the socket design. Intel insists the deflection of the Alder Lake processors isn't a problem, but system builders looking to maximize performance and stability in their systems disagree. The warped IHS provides sub-optimal contact for a cooling solution to effectively dissipate heat, resulting in higher CPU temperatures.

Fig. 3: System Vendors Dictate Maximum CPU speed

Addressing Thermal Challenges

BIMBOX's performance specialists attempted to reign in the elevated temperatures of Intel's new chipsets by testing some of the industry's top CPU performance solutions. The standards for evaluating the cooling performance of each solution included six-hour cycles of AIDA 64 and Cinebench R23. The initial line of testing included the following solutions:

- Three 360mm AIO CPU coolers
- One 420mm AIO CPU cooler
- One custom open-loop liquid cooling solution

The goal of the testing was to achieve a stable overclock of 5.5 - 5.8Ghz without producing excessive temperatures during testing. All solutions were tested twice, each time being repasted and reseated to ensure optimal contact with the IHS was achieved. The results shown below begin to highlight the overclocking challenges of Intel's 12th and 13th gen chipsets. While each solution was capable of achieving a "stable" overclock of 5.5 - 5.8Ghz, all five solutions failed to complete the stress tests without hitting the 100°C thermal limit of the CPU.

The ability of the IHS to effectively dissipate heat is insufficient for the processor's performance. As a solution, BIMBOX has removed the IHS from the i9-13900K processors in their Stryker IV systems. By eliminating the concave IHS from the cooling equation, BIMBOX is able to reduce the temperature of the processor by 20°C while under load. With cooling under control, BIMBOX is able to overclock the processors to run at a sustained speed of 5.8Ghz across all P-Cores, with single-core speeds reaching 6.2Ghz while maintaining safe operating temperatures.

This Year's Performance Gains

The performance of the new 13900K processor paired with DDR5 memory has shown promising results for the industry. Even with the thermal challenges mentioned above, this new generation clearly outperforms its predecessors. To quantify these performance improvements for the AEC industry, BIMBOX put systems to the test with the Revit RFO 2022 Benchmark tool. This tool offers results that are much more relatable to AEC industry workflows compared to synthetic benchmarks, which often heavily weigh hardware performance in tasks not performed in our industry.

The Revit RFO tool evaluates the performance of a computer by timing the duration of a series of tasks in Revit. These tasks stress hardware in a variety of ways that are applicable to many other AEC software. A majority of 3D and 2D modeling tasks fall in the category of single-threaded processes, meaning only a single core of the processor is used to complete each task. Other tasks are categorized as multi-threaded processes where multiple processor cores are used simultaneously. The Revit RFO tool includes tasks from both categories to assess overall computer performance.

The systems reviewed in this paper include BIMBOX's previous generation desktop, the Stryker III, a new desktop from another system builder, and the new BIMBOX Stryker IV. The Stryker III uses an Intel i9-11900K processor, which is delidded and overclocked to 5.3Ghz. This system was the fastest AEC system on the market prior to Intel's release of their 13th Gen processors. The desktop from another system builder utilizes an Intel i9-12900K running at stock speeds and incorporates an air cooling solution for the processor. This setup is very typical for desktop systems offered by large system builders. The Stryker IV includes a delidded (IHS removed) Intel i9-13900K cooled by a 360mm AIO cooling system and overclocked to 5.8Ghz. All tested systems included 64GB of memory, an RTX 3060ti graphics card, and a 1TB solid-state drive.

This Year's Performance Gains (continued)

BIMBOX ROI Calculator		
Computer Comparison		
Configuration	**BIMBOX Stryker IV**	**Current System**
Processor	Intel i9-13900K	Intel i9-11900K
Core Count	16 Cores 24 Threads	8 Cores 16 Threads
Clock Frequency	5.7Ghz All Core 6.1GHZ 1 Core	5.3Ghz
Video Card	RTX 3060Ti 8GB	RTX 3060Ti 8GB
Memory	64GB DDR5 4800Mhz	64GB DDR4 3600Mhz
Revit Benchmark Results (Lower is Better)	**BIMBOX Stryker IV**	**Client Provided**
Opening and loading custom template	3.45	3.93
Creating the floors levels and grids	6.94	9.01
Creating a group of walls and doors	8.88	12.76
Modifying the group by adding a curtain wall	13.89	21.37
Creating the exterior curtain wall	5.14	7.46
Creating the sections	4.26	6.22
Changing the curtain wall panel type	1.81	2.64
Creating area plans	6.35	9.02
Creating and applying view template	0.84	1.22
Total (s)	51.56	73.63
Increase In Production Efficiency with BIMBOX (%)	**30%**	

Fig. 4: BIMBOX Stryker IV vs Stryker III

This Year's Performance Gains (continued)

BIMBOX ROI Calculator		
Computer Comparison		
Configuration	**BIMBOX Stryker IV**	**Current System**
Processor	Intel i9-13900K	Intel i9-12900K
Core Count	16 Cores 24 Threads	16 Cores 24 Threads
Clock Frequency	5.8Ghz All Core 6.2GHZ 1 Core	3.2-5.2Ghz
Video Card	RTX 3060Ti 8GB	RTX 3060Ti 8GB
Memory	64GB DDR5 4800Mhz	64GB DDR5 4000Mhz
Revit Benchmark Results (Lower is Better)	**BIMBOX Stryker IV**	**Client Provided**
Opening and loading custom template	3.45	3.82
Creating the floors levels and grids	6.94	8.77
Creating a group of walls and doors	8.88	12.53
Modifying the group by adding a curtain wall	13.89	28.85
Creating the exterior curtain wall	5.14	9.60
Creating the sections	4.26	5.90
Changing the curtain wall panel type	1.81	3.74
Creating area plans	6.35	8.45
Creating and applying view template	0.84	1.15
Total (s)	51.56	82.81
Increase In Production Efficiency with BIMBOX (%)	**38%**	

Fig. 5: BIMBOX Stryker IV vs Competitor

This Year's Performance Gains (continued)

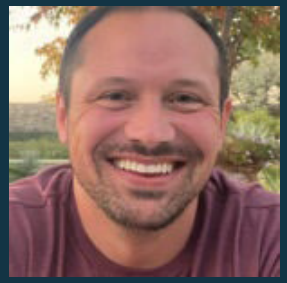
Comparing the Revit RFO tool results of the Stryker IV and Stryker III systems (Fig. 4) shows a performance increase of 25%. Even with a lower clock speed, the Stryker IV 13th Gen processor has significant gains in performance over the Stryker III. While performance gains are expected from new generations of processors, the speed and efficiency of the new i9-12900K when properly cooled far exceeds expectations for a single generation jump.

However, comparing the test results between the BIMBOX Stryker IV and a competitor's desktop (Fig. 5) highlights the disparity in performance when the i9-12900K is not properly cooled. A 33% difference in performance using a similar processor model shows just how much the 12th and 13th Gen processors are being thermally throttled, even under the lighter load of the Revit RFO tool.

conclusion:

Intel's latest processor technology exhibits impressive performance potential for desktops moving forward. Until Intel is able to resolve the concave IHS issue, the 12th and 13th Gen Intel processors will continue to produce limited performance with traditional cooling methods.

Currently, BIMBOX is the only system builder offering Intel 13th Gen desktops that take full advantage of the i9-13900K performance capabilities. The new Stryker IV desktop has been delidded and paired with a 360mm all-in-one cooling solution to maximize cooling efficiency and performance of the processor to achieve an all P-core overclock of 5.8GHz and 6.2Ghz for single-core. Other system builders in the industry are currently hindering the performance of these processors with traditional cooling methods or producing desktops with limitations on the maximum speed to prevent thermal issues.



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Brad was born and raised in Southern Idaho and attended the University of Idaho to pursue all three of his degrees – B.S. in Virtual Technology & Design, master's in architecture and Ph.D. in Education. Following his time at the U of I, he served as Washington State University's Emerging Academic Technology Specialist where he was the lead researcher for educational technologies.

In 2017, he changed careers and moved to the construction industry, joining Clark Construction's VDC team. During his time at Clark, Brad led BIM coordination on billion-dollar projects, managed all VDC efforts in the Pacific Northwest Region and established the company's VDC hardware standards. He joined the ATG team to fuel his passion for hardware and to make an impact in the AEC industry by helping people find the right tools.

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