



SUPERMICRO SYSTEMS WITH INTEL® XEON® 6 SERIES WITH E-CORES AND P-CORES: WHAT IS THE DIFFERENCE, AND WHY DOES IT MATTER?

New Supermicro Servers Tuned for Workloads Using the Intel Xeon 6 Processors with E-Cores and P-Cores



Supermicro X14 System Lineup

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Executive Summary

Supermicro servers with the Intel Xeon 6 processors are initially available in two (later four) configurations, each with multiple SKUs (cores, power, etc.) The two processor families differ in their target workloads, which differs from previous generations of Intel Xeon processors when all cores were equal on a given CPU family. These new processors are referred to as those designed for Energy efficiency (E-Cores) and those designed for maximum performance (P-Cores). Intel Xeon 6 family processors are not cross-compatible in the same system, i.e., E-cores and P-Cores cannot coexist in the same CPU or a combination in a dual or quad socket systems. Intel has designated the CPU lines as the Intel Xeon 6700E series and Intel Xeon 6900P series.

Rationale

From the edge to data center computing, workloads are increasingly matched to the most optimized underlying hardware, which includes performance and energy use per unit of work. Intel has recognized that different workloads require different instruction sets. Besides the absolute performance, the energy used (Watts) per unit of work is gaining importance as electricity prices increase worldwide, and the availability of power delivered to a data center may limit the overall capacity of the data center. By creating CPUs and, thus, their cores to excel at specific workloads, data center operators can reduce costs and improve the performance of applications as desired. A lower TCO can be realized by matching the application workload to the chosen server type and the CPU family choice. For example, moving towards systems with specific CPUs optimized for the workloads, density can be increased, and the application's performance can be increased as well.

Supermicro Product Matching

Supermicro's wide range of servers and storage systems are expertly matched to accommodate the Intel Xeon 6 series processors with E-Cores and P-Cores. The workload-optimized systems are now further tuned with the inclusion of the new Intel Xeon 6 series processors. Learn more at https://www.supermicro.com/white_paper/white_paper_X14_Servers.pdf

Overview of Intel Xeon 6 CPUs

Intel has developed and continues to create a new generation of CPUs, the Intel Xeon 6 product family. Currently, there are two types of processors: in the Intel Xeon 6 families, one with Efficient optimized cores (E-cores), and the second with Performance optimized cores, or P-cores. These current CPUs and follow-ons will be interchangeable by the system manufacturer at the socket level but are designed for different workloads. Acquiring the CPU type within a system leads to more flexibility and broader availability of server types. A server can only contain a single CPU family type and socket type. While the Intel platform design is that any binary will work on either E-core or P-core based systems, there will be benefits to running the application on the system and the CPU type where intended. Below is an image of the different CPUs to scale.



E-Cores and P-Cores

Intel Xeon 6 processors with E-Cores (Intel Xeon 6700E Series)

E-cores are designed to be energy efficient. More work can be completed for a given amount of power compared to previous generations of cores. This capability can be thought of in two ways.

- Compared to a previous generation of cores, a similar amount of work can be performed using less electricity.
- More work can be performed using the same TDP specification, especially at the data center level.

Intel Xeon 6700-series with E-cores will excel in application environments where single threading is sufficient and the application is not heavily dependent on floating point and matrix operations. Commonly referred to as "cloud-native," the applications that will run best on CPUs with E-cores deliver a service as part of a larger application framework, i.e., a microservice. Database applications, analytics, network microservices, content delivery networks, and application development will benefit from CPUs with E-Cores, when high performance computing using vector and matrix FP64 data types is not required.

Intel Xeon 6 processors with P-Cores (Intel Xeon 6900P/6700P/6500P Series)

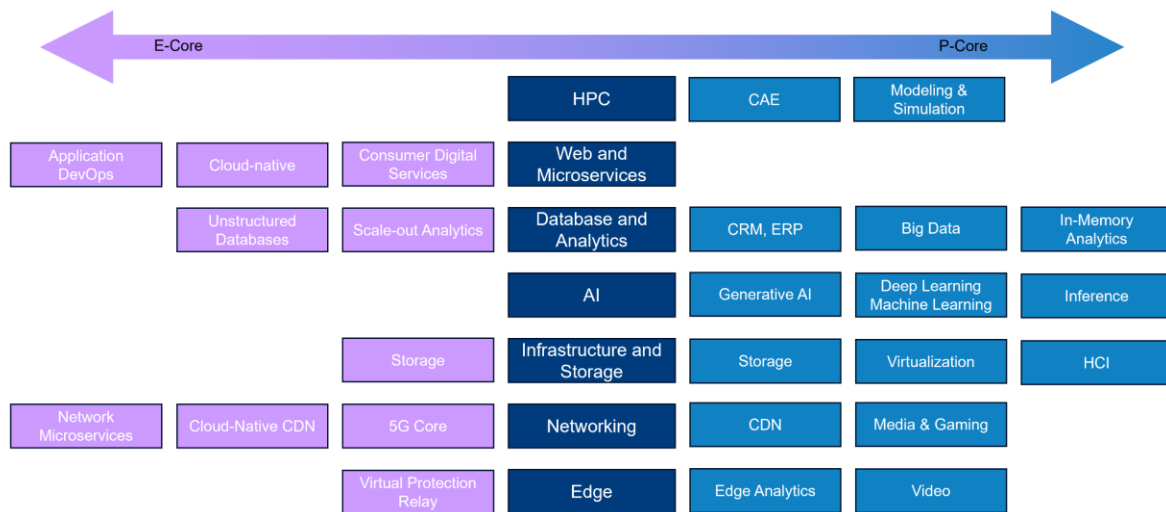
P-Cores are designed to deliver the maximum performance for specific workloads. The Intel Xeon 6900/6700/6500 series with P-cores has an instruction set that many high performance applications require. With Intel AMX and AVX-512 instructions, CPUs with P-Cores are ideally suited for AI and HPC workloads, which are at the heart of these application algorithms. Intel Xeon 6 CPUs with P-Cores have two threads per core, increasing performance compared to single thread per core architectures. In addition, the Intel Xeon 6 CPUs with P-cores can use MRDIMMs at up to 8800MT/s, which is 37% higher performance than DDR5-6400 DIMMs. In addition, there are new FP16 instructions on the CPU within the AMX accelerator.

Intel® Xeon® 6900/6700/6500 series with P-cores have built-in accelerators to speed up AI, HPC, encryption, compression, data movement, network packet handling, and in-memory analytics. By offloading tasks from the CPU core, built-in accelerators deliver even greater performance and efficiency.

Intel Xeon 6900-series processors with P-Cores have a larger instruction cache than systems built with Intel Xeon 6700E-series with E-Cores, speeding up application execution by keeping future instructions close to the CPU. In contrast, systems based on the E-Cores, at this time, will have more cores available.

Workload Matching to E-Cores and P-Cores

Data centers run a wide variety of applications, which operators can now match to specific CPU architectures. While some applications are apparent matches for systems and CPUs using E-cores or P-cores, other applications will see a gradual performance improvement, moving from one type of CPU with either E-cores or P-cores to the other type. Looking at the diagram below, different workloads will show better performance and performance per watt on the different CPUs.



Cloud-Native Applications – Ideal for Intel Xeon 6 processors with E-Cores

- **Microservices architecture:** Cloud-native applications are built as microservices, which are small, independent services that work together. This modular approach makes cloud-native applications more flexible and easier to maintain.
- **Containers:** Containers are a way of packaging an application with all its dependencies to run on any cloud platform. This makes cloud-native applications more portable.
- **DevOps:** DevOps is a culture and set of practices that brings together development, operations, and security teams. DevOps is essential for cloud-native development because it allows for rapid development and deployment cycles.

Networking Applications – Great Match for Intel Xeon 6 processors with E-Cores

- **Networking packet delivery:** High-speed packet processing is needed as the amount of data generated rises and the ubiquity of cloud-native applications rises.
- **Media and Gaming:** As the amount of media delivered over IP networks grows, efficient delivery of video and other content requires a large number of efficient cores. Content Delivery Networks show high performance and performance per watt compared to previous generations of Intel Xeon processors.

Edge Computing – Low Power Systems with Intel Xeon 6 with E-Cores

- **Edge computing:** Placing a right-sized server near where the data is generated is critical for efficient edge-to-data center IT workflows. The Supermicro edge systems with Intel Xeon 6 processors with E-cores require significantly less power than previous generations of Intel Xeon CPUs.

AI and HPC – Fast Processing results in High Performance with Intel Xeon 6 with P-Cores

- **Generative AI:** The massive amounts of data that must be processed require P-cores' performance.
- **HPC:** Handling FP64 (floating point with 64-bit) calculations requires the fast performance of P-Cores with high-performance connections (UPI links) between the cores.

Database, Analytics, and In-Memory Workloads – Boost Computational Power with Intel Xeon 6 with P-Cores

- Applications needing several TBs of memory and fast response times will require Intel Xeon 6900-series with P-cores.
- In-Memory Workloads: Data must be kept in memory with fast access using MRDIMMs and 12 memory channels.

Performance (Estimates from Intel - August 2024)

Intel Xeon 6700-series with E-Cores:

- Up to 2.7x higher server-side performance per watt for Java throughput.*
- Up to 3.5x higher performance per watt for the next gen firewall.*
- Up to 2.6x higher performance per watt for media transcode.*
- Up to 2.7x higher performance per watt for MySQL OLTP workloads.*

* (7W4, 7N2, 7T2, 7D1) <https://edc.intel.com/content/www/us/en/products/performance/benchmarks/intel-xeon-6/>

Intel Xeon 6900-series with P-Cores:

- Up to 8x higher OpenFOAM performance vs. 2nd Gen Intel Xeon processors *
- Up to 11x Higher BERT-Large performance vs. 2nd Gen Intel Xeon processor *
- Up to 6.4x higher general compute performance vs. 5-year servers *
- Up to 6.1x higher performance for compute-intensive workloads such as HPC, AI, and data vs. 2nd Gen Intel Xeon CPUs*

* (9G10,9H10,9A210) <https://edc.intel.com/content/www/us/en/products/performance/benchmarks/intel-xeon-6/>

Intel Xeon 6 processors with P-Cores and E-Cores Comparisons and Details

Specifications	Intel Xeon 6900/6700/6500 Series with P-Cores (6900P)	Intel Xeon 6700 Series with E-Cores (6700E)	Notes
Maximum Cores Per CPU	128	144	
Maximum Threads Per CPU	256	144	
Max TDP Per CPU	500 Watts (6980P)	330 Watts (6780E)	
Watts Per Core	3.9	2.3	
Watts Per Thread	1.95	2.3	P-cores have lower watts per thread
Number of Sockets/Server	1 or 2	1 or 2	
Number of Memory Channels	12	8	More addressable memory with 6900P
Maximum Memory Speed (DDR5)	6400 MT/s	6400 MT/s	

MRDIMM Support	8800 MT/s	N/A	6900P can handle faster memory, a 37% increase in raw performance
PCIe 5.0 Lanes Per CPU	96	88	
UPI Links	6	4	
CXL	CXL 2.0	CXL 2.0	
Integrated Accelerators	Intel QuickAssist Technology, Intel Dynamic Load Balancer, Intel Data Streaming Accelerator, Intel In-memory Analytics Accelerator		
AI Acceleration	Intel Advanced Matrix Extensions (INT8, BF16, FP16) Intel Advanced Vector Extensions		

Below is a summary of the Intel Xeon 6900P series processors:

SKU	Cores	Base	All Core Turbo (GHz)	Max Turbo	TDP (Watts)	Cache	Maximum Scalability	DDR5 Memory Speed	MRDIMM Memory Speed	UPI Links Enabled	Default DSA Devices	Default IAA Devices	Default QAT Devices	Default DLB Devices	Intel On Demand Capable	Intel Speed Select Technology (SST) Capable
2S Performance Per Core Optimized																
6980P	128	2.0	3.2	3.9	500	504	2S	6400	8800	6	4	4	4	4	N	N
6979P	120	2.1	3.2	3.9	500	504	2S	6400	8800	6	4	4	4	4	N	N
6972P	96	2.4	3.5	3.9	500	480	2S	6400	8800	6	4	4	4	4	N	Y
6952P	96	2.1	3.2	3.9	400	480	2S	6400	8800	6	4	4	4	4	N	Y
6960P	72	2.7	3.8	3.9	500	432	2S	6400	8800	6	4	4	4	4	N	Y

Below is a summary of the Intel Xeon 6700P series processors

SKU	Cores	Base (GHz)	All Core Turbo (GHz)	Max Core Turbo (GHz)	TDP (Watts)	Cache	Maximum Scalability	DDR5 Memory Speed	MRDIMM Memory Speed	UPI Links Enabled	Default DSA Devices	Default IAA Devices	Default QAT Devices	Default DLB Devices	Intel SGX Capacity (Per CPU)
6700P 2S Performance Per Watt Optimized															
6787P	86	2.0	3.2	3.8	350	336	2S	6400	8000	6	4	4	4	4	512GB
6767P	64	2.4	3.6	3.9	350	336	2S	6400	8000	6	4	4	4	4	512GB
6747P	48	2.7	3.8	3.9	330	288	2S	6400	8000	6	4	4	4	4	512GB
6760P	64	2.2	3.4	3.8	330	320	2S	6400	N	6	2	2	2	2	128GB
6740P	48	2.1	3.3	3.8	270	288	2S	6400	N	6	2	2	2	2	128GB
6730P	32	2.5	3.6	3.8	250	288	2S	6400	N	6	2	2	2	2	512GB
6736P	36	2.0	3.4	4.1	205	144	2S	6400	N	6	4	4	4	4	512GB
6737P	32	2.9	4.0	4.0	270	144	2S	6400	N	6	4	4	4	4	512GB
6700P 1S Performance Per Watt Optimized															
6781P	80	2.0	3.2	3.8	350	336	1S	6400	8000	6	3	3	3	3	125GB
6761P	64	2.5	3.6	3.9	350	336	1S	6400	8000	6	3	3	3	3	125GB
6741P	48	2.5	3.7	3.8	300	288	1S	6400	N	6	3	3	3	3	128GB
6731P	32	2.5	3.9	4.1	245	144	1S	6400	N	6	3	3	3	3	128GB
6700P 8S, xNC Performance Per Watt Optimized															
6788P	86	2.0	3.2	3.8	350	336	8S, xNC	6400	N	6	4	4	4	4	512GB
6768P	64	2.4	3.6	3.9	330	336	8S, xNC	6400	N	6	4	4	4	4	512GB
6700P 4S/8S Performance Per Watt Optimized															
6748P	48	2.5	3.8	4.1	300	192	4s_8S	6400	N	6	4	4	4	4	512GB
6738P	32	2.9	4.1	4.2	270	144	4s_8S	6400	N	6	4	4	4	4	512GB
6728P	24	2.7	3.9	4.1	210	144	4s_8S	6400	N	6	4	4	4	4	512GB
6700P 8S Performance Per Watt Optimized															
6724P	16	3.6	4.2	4.3	210	72	8S	6400	N	6	2	2	2	2	512GB
6714P	8	4.0	4.3	4.3	165	48	8S	6400	N	6	2	2	2	2	512GB

Below is a summary of the Intel Xeon 6500P series processors

6500P 2S Performance Per Watt Optimized															
6530P	32	2.3	3.7	4.1	225	144	2S	6400	N	6	2	2	2	2	128GB
6520P	24	2.4	3.4	4.0	210	144	2S	6400	N	6	2	2	2	2	128GB
6527P	24	3.0	4.2	4.2	255	144	2S	6400	N	6	4	4	4	4	512GB
6517P	16	3.2	4.0	4.2	190	72	2S	6400	N	6	2	2	2	2	512GB
6507P	8	3.5	4.3	4.3	150	48	2S	6400	N	6	2	2	2	2	512GB
6515P	16	2.4	3.8	3.8	150	72	2S	6400	N	6	2	2	2	2	128GB
6505P	12	2.2	3.9	4.1	150	48	2S	6400	N	6	2	2	2	2	128GB
6500P 1S Performance Per Watt Optimized															
6521P	24	2.6	4.1	4.1	225	144	1S	6400	N	6	3	3	3	3	128GB
6511P	16	2.5	4.2	4.3	150	72	1S	6400	N	6	2	2	2	2	128GB

Below is a summary of the Intel Xeon 6500 E series processors

SKU	Cores	Base	All Core Turbo (GHz)	TDP (Watts)	Cache(MB)	Maximum Scalability	DDR5 Memory Speed	UPI Links Enabled	Default DSA Devices	Default IAA Devices	Default QAT Devices	Default DLB Devices	Intel® On Demand Capable
2S Performance Per Watt Optimized													
6780E	144	2.2	3.0	330	108	2S	6400	4	2	2	2	2	N
6766E	144	1.9	2.7	250	108	2S	6400	4	2	2	2	2	N
6756E	128	1.8	2.6	225	96	2S	6400	4	2	2	2	2	N
6746E	112	2.0	2.7	250	96	2S	5600	4	2	2	2	2	N
6740E	96	2.4	3.2	250	96	2S	6400	4	2	2	4	4	N
6710E	64	2.4	3.2	205	96	2S	5600	4	2	2	4	4	N
1S Performance Per Watt Optimized*													
6731E	96	2.2	3.1	250	96	1S	5600	0	2	2	2	2	N

Conclusion

Supermicro X14 servers are designed to incorporate the latest Intel Xeon 6 processors. Intel has optimized these processors for specific workloads, which can generally be categorized as those requiring a high number of Efficient cores or workloads requiring the highest performance per core or Performance cores. Supermicro X14 servers, designed for different application requirements, will now be even more tuned to the workloads that customers use daily.

For more information:

Supermicro X14 web site: <https://www.supermicro.com/en/products/x14>

[Supermicro X14 Whitepaper](#)

[Supermicro Benchmarks with Intel Xeon 6 Series processors with E-Cores for CDN](#)

[Supermicro Benchmarks with Intel Xeon 6 Series processors with E-Cores for SPEC.org](#)

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