

Nehalem (microarchitecture)

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Nehalem (pronounced^[a]) is the codename for an Intel processor microarchitecture, successor to the Core microarchitecture.^[2] Nehalem processors use the 45 nm process. A preview system with two Nehalem processors was shown at Intel Developer Forum in 2007. The first processor released with the Nehalem architecture was the desktop Core i7,^[3] which was released in November 2008.

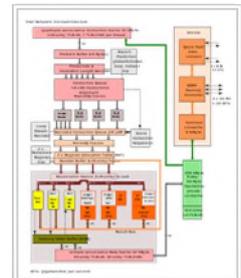
Nehalem, a recycled codename, refers to a completely different architecture from Netburst, although Nehalem still has some things in common with NetBurst. Nehalem-based microprocessors utilize higher clock speeds and are more energy-efficient than Penryn microprocessors. Hyper-threading is reintroduced along with an L3 Cache missing from most Core-based microprocessors. Nehalem was replaced with the Sandy Bridge microarchitecture, released in January 2011.

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Technology

- Hyper-threading reintroduced.
- 4–12 MB L3 cache
- Second-level branch predictor and translation lookaside buffer
- Native (all processor cores on a single die) quad- and octo-core processors
- Intel QuickPath Interconnect in high-end models replacing the legacy front side bus
- 64 KB L1 cache/core (32 KB L1 Data + 32 KB L1 Instruction) and 256 KB L2 cache/core.
- Integration of PCI Express and DMI into the processor in mid-range models, replacing the northbridge
- Integrated memory controller supporting two or three memory channels of DDR3 SDRAM or four FB-DIMM2 channels
- 2nd generation Intel Virtualization Technology which introduced Extended Page Table support, virtual processor identifiers (VPIDs), and non-maskable interrupt-window exiting^[4]



Microarchitecture of the quad-core implementation

Performance and power improvements

It has been reported that Nehalem has a focus on performance, thus the increased core size.^[5] Compared to Penryn, Nehalem has:

- 10-25% more single-threaded performance / 20-100% more multithreaded performance at the same power level
- 30% lower power usage for the same performance
- Nehalem provides a 15–20% clock-for-clock increase in performance per core(average)

Overclocking is possible with Bloomfield processors and the X58 chipset. Lynnfield processors use a PCH removing the need for a northbridge chipset.^[6]

Nehalem processors incorporate SSE 4.2 SIMD instructions, adding 7 new instructions to the SSE 4.1 set in the Core 2 series. The Nehalem architecture reduces atomic operation latency by 50% in an attempt to eliminate atomic overhead.^[7]

Westmere

Westmere (formerly **Nehalem-C**) is the name given to the 32 nm die shrink of *Nehalem*. The first *Westmere*-based processors were launched on January 7, 2010.

Westmere's feature improvements from Nehalem as reported:

- Native six-core (Gulftown) and ten-core (Westmere-EX) processors.^[8]
- A new set of instructions that gives over 3x the encryption and decryption rate of Advanced Encryption Standard (AES) processes compared to before.^[9]
 - Delivers seven new instructions (AES instruction set or AES-NI) that will be used by the AES algorithm. Also an instruction called PCLMULQDQ (see CLMUL instruction set) that will perform carry-less multiplication for use in cryptography.^[10]

These instructions will allow the processor to perform hardware-accelerated encryption, not only resulting in faster execution but also protecting against software targeted attacks.

- Integrated graphics, added into the processor package (dual core Arrandale and Clarkdale only).
- Improved virtualization latency.^[11]
- New virtualization capability: "VMX Unrestricted mode support," which allows 16-bit guests to run (real mode and big real mode).
- Support for "Huge Pages" of 1 GB in size.

Variants Overview

Processing Cores (interface)	Process	Die Size	CPUID	Model	Stepping	Mobile	Desktop, UP Server	DP Server	MP Server
Eight-Core (Quad-Channel)	45 nm	684 mm ²	206E6	46	D0				Beckton (80604)
Quad-Core (Triple-Channel)	45 nm	263 mm ²	106A4 106A5	26	C0 D0		Bloomfield (80601)	Gainestown (80602)	
Quad-Core (Dual-Channel, PCIe)	45 nm	296 mm ²	106E4 106E5	30	B0 B1	Clarksfield (80607)	Lynnfield (80605)	Jasper Forest (80612)	
Dual-Core (Dual-Channel, PCIe, Graphics Core)	45 nm					Auburndale (<i> canceled </i>)	Havendale (<i> canceled </i>)		
Ten-Core (Quad-channel) ^[12]	32 nm	513 mm ²	206F2	47	A2				Westmere-EX (80615)
Six-Core (Triple-Channel)	32 nm	248 mm ²	206C2	44	B1		Gulftown (80613)	Westmere-EP (80614)	
Dual-Core (Dual-Channel, PCIe, Graphics Core)	32 nm 45 nm	81+114 mm ²	20652 20655	37	C2 K0	Arrandale (80617)	Clarkdale (80616)		

Nehalem

- Lynnfield processors feature integrated PCIe 1 x16 or 2 x8.
- ¹ 6500 series scalable up to 2 sockets, 7500 series scalable up to 4/8 sockets.^[13]