

What is in Your Workstation?

Why choose Intel® Xeon® processor E3-based workstations versus Intel® Core™ i3, Intel® Core™ i5 and Intel® Core™ i7 processor-based desktops

Intel® Xeon® processor-based workstations represent the premier platform used by industry innovators to create, test and modify their ideas. If a user can accelerate an evaluation of an idea by as little 20% per day (1.6 hours), they can potentially reduce the design cycle time by almost one business quarter.

This paper explores key elements and differences that exist between an entry-level workstation based on the Intel® Xeon® processor E3-1200 family and desktop systems based on Intel® Core™ i3, Intel® Core™ i5, and Intel® Core™ i7 processors. We will contrast each platform on four key workstation pillars; processor performance, cache size, memory type/speed and graphics.

Where They Are Similar

Entry-level workstation solutions based on the Intel Xeon processor E3-1200 family and business clients based on Intel Core i3/i5/i7 processors have a foundation based on 32nm Intel® microarchitecture code named Sandy Bridge. They both support a variety of computational core counts and varying sizes in Last Level Cache (LLC), Intel® Advanced Vector extensions, and SATA 3.0.

Where They Are Different

It is important to understand that delivered performance is not just about frequency or the number of cores, it is also about the entire infrastructure that helps get data to where it is needed, when is it is needed, so that it can be transformed into actionable information in the shortest amount of time.

Computational Cores

- **Intel Core i3 processor** supports a high clock frequency (up to 3.3 GHz) and Intel® Hyper-Threading Technology¹ (Intel® HT Technology). However, it is limited to only 2 physical computational cores and does not support Intel® Turbo Boost Technology.²

A 3.3 GHz Intel Xeon processor E3-1245^A with an 8M LLC supports Intel Turbo Boost Technology and delivers up to 2X better performance¹ than an Intel Core i3 processor-based business client.

- **Intel Core i5 processor** supports up to 4 computational cores, supports Intel Turbo Boost Technology, but does not feature Intel HT Technology. The support for Intel Turbo Boost Technology accelerates single-threaded applications like CAD, but add-on applications that support opportunities like digital prototyping, rendering and ray-tracing options will have limited upside performance potential.

A 3.3 GHz Intel Xeon processor E3-1245 with Intel HT Technology turned on can deliver up to 25% better performance²

- **Intel Core i7 processor** supports 4 cores, fast frequencies, Intel Turbo Boost Technology and Intel HT Technology.

It is similar to the Intel Xeon processor E3-1200 family but trails in graphics performance and the availability of ECC memory.

- **Intel Xeon processor E3-1200 family** supports 4 cores and also supports the fastest available frequency (3.5 GHz Intel Xeon processor E3-1280), Intel Turbo Boost Technology, and Intel HT Technology.

It is similar to the Intel Core i7 processor, but supports accelerated graphics performance for professional applications, called Intel® HD Graphics P3000⁵ (available with specific SKUs), as well as ECC memory.

Processor Frequency

Processor frequency represents only one small part of delivering the best possible user experience. Possessing fast clocks with an inadequate infrastructure leads to stalls. Key components necessary to avoid processor stalls include bandwidth, memory capacity, and intelligent caching strategies that all help to accelerate data availability to the processors.

- Intel Xeon processor E3-1280 frequency is 3.5 GHz.
- Intel Core i7 processor highest frequency is 3.4 GHz.
- Intel Core i5 processor Highest Frequency is 3.3 GHz and is limited to 4 cores and only 4 threads.
- Intel Core i3 processor highest frequency is 3.3 GHz and is limited to 2 cores and 4 threads.

Over-clocking On Workstations

Intel Turbo Boost Technology represents the ideal method to achieve higher performance for technical workstations based on the Intel Xeon processor E3-1200 family. The Intel Xeon processor 1280 supports a maximum single-core frequency of 3.9 GHz.

Note: Fully unlocked Intel Core processor parts that target the consumer/enthusiast market are associated with Intel Core i5/i7 processor “K” SKUs and do not support Intel® vPro™ technology* designed to enhance manageability and security for small, medium, and enterprise businesses.

Cache Size

Cache for many applications remains an important contributor to performance. Users with smaller cache solutions found in Intel Core i3 and Intel Core i5 processor-based solutions should expect slower performance. For example, a workstation based on the 3.3 GHz Intel Xeon processor E3-1245 with an 8M cache outperforms a workstation based on the 3.3 GHz Intel Core i3-2120 processor with a 3M cache by up to 1.9X.³

- Intel Xeon processor E3-1200 family: 8M⁴
- Intel Core i7 processor cache: 8M
- Intel Core i5 processor cache: 6M
- Intel Core i3 processor cache: 3M

Professional Application Performance

SPECint*_rate_base2006 and SPECfp*_rate_base2006 are only secondary indicators of performance.

Intel has engaged with many leading ISVs for workstation vendors to create workload-optimized platforms that are capable of delivering end-user experiences in line with the ISV’s expectation. As an example, Intel Xeon processor E3 with Intel HD Graphics P3000 is certified as “advanced” by Adobe Photoshop.* This advanced mode is not available on Intel Core i7 processor with Intel HD Graphics 3000.

The following represents an abbreviated list of applications that we have engaged with delivering workload optimized platforms: Adobe Photoshop, Adobe Premier Pro,* Autodesk AutoCAD,* Autodesk Inventor,* Autodesk Revit,* Bentley MicroStation,* Solid Edge* and SolidWorks.

Memory Subsystems

Animators, artists, engineers, and analysts are high-value workers at any company. They are paid to create, test, and modify ideas that generate value for organizations. Providing a highly reliable system is paramount, as it reduces the risk of lost work and helps maintain highly productive content creation opportunities.

One critical difference between entry-level workstations based on the Intel Xeon processor E3-1200 family is the availability of ECC memory.

Quick Reference Tables – Processor Cores, Frequency Cache Sizes and Performance

Table 1. Ordered by Available Clock Frequency

Feature	Intel® Core™ i3-2100 processor	Intel® Core™ i5-2400 processor	Intel® Xeon® processor E3-1225	Intel® Xeon® processor E3-1235	Intel® Core™ i3-2120 processor	Intel® Core™ i5-2500 processor	Intel® Xeon® processor E3-1245	Intel® Core™ i7-2600 processor	Intel® Xeon® processor E3-1275	Intel® Xeon® processor E3-1280
Frequency (GHz)	3.1	3.1	3.1	3.2	3.3	3.3	3.3	3.4	3.4	3.5
Cores	2	4	4	4	2	4	4	4	4	4
Cache Size (M)	3	6	6	8	3	6	8	8	8	8
SPECint*_rate_base2006	70	116	116	142	73	120	145	148	148	151
SPECfp*_rate_base2006	68	100	100	109	71	104	110	111	111	113

Table 2. Ordered by Delivered Performance

Feature	Intel® Core™ i3-2100 processor	Intel® Core™ i3-2120 processor	Intel® Core™ i5-2400 processor	Intel® Xeon® processor E3-1225	Intel® Core™ i5-2500 processor	Intel® Xeon® processor E3-1235	Intel® Xeon® processor E3-1245	Intel® Core™ i7-2600 processor	Intel® Xeon® processor E3-1275	Intel® Xeon® processor E3-1280
Frequency (GHz)	3.1	3.3	3.1	3.1	3.3	3.2	3.3	3.4	3.4	3.5
Cores	2	2	4	4	4	4	4	4	4	4
Cache Size (M)	3	3	6	6	6	8	8	8	8	8
SPECint*_rate_base2006	70	73	116	116	120	142	145	148	148	151
SPECfp*_rate_base2006	68	71	100	100	104	109	110	111	111	113

Error-Correcting Code memory (ECC) – ECC includes special circuitry for testing the accuracy of data as it passes in and out of memory. In a recent study authored by Microsoft⁵ (*Cycles, Cells and Platters: An empirical analysis of hardware failures on a million commodity PCs*) they note that, “While ECC memory will detect and correct single-bit failures, that vast majority of commodity and business client machines have no such protection. Unfortunately, ECC memory is seen as a premium part. Therefore, most machines remain vulnerable.”

They go on to say that “once a machine suffers a single hardware failure, the probability of another hardware failure increases by two orders of magnitude.”

What is the value of the ECC premium?

A single blue screen can potentially cost a user as much as 8 hours of work – the 3 hours he or she spent creating an idea; the one hour to replace or repair the non ECC desktop, and 3 to 5 hours to recreate the lost work.

If the user’s billing rate is as low as \$40 an hour then one memory error could cost an organization up to \$320. If the user billing rate is \$80 an hour, then the cost of single blue screen could be as high as \$640. Both are well above the investment of the ECC premium.

Graphic Performance

“Intel HD graphics provides a significant change in how we deliver graphics to commodity, business and entry-level workstation users,” said Kirk Skaugen, Executive Vice President, Intel Architecture Group. Kirk noted at the Intel Developers Forum in China that “in 2006 we had promised that we would improve the graphics performance 10 times by 2010. Today, we are 25x better!”

Intel Core i3/i5/i7 processors provide support for Intel® HD Graphics 2000 and Intel HD Graphics 3000. Intel HD Graphics 2000 is limited to 6 execution units and is found on Intel Core i3/i5 processors. Intel HD Graphics 3000 has 12 execution engines and is available on either Core i5 processor- or Intel Core i7 processor-based platforms.

Intel HD Graphics P3000, only available on the Intel Xeon processor E3-12X5 series, provides for a powerful professional 3D and video-editing experience without the need to invest in an entry-level discrete graphics card.

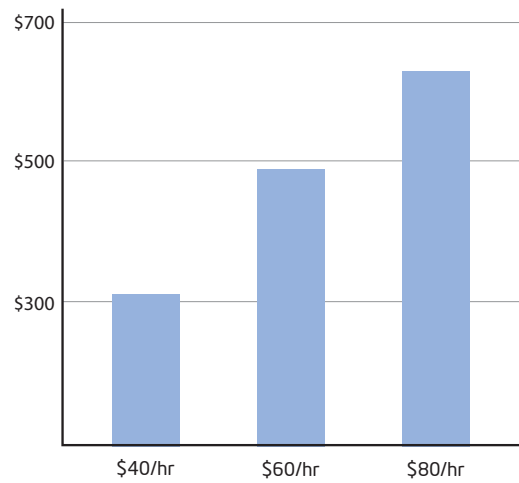


Figure 1. Potential cost if a single blue screen at various hourly wage points

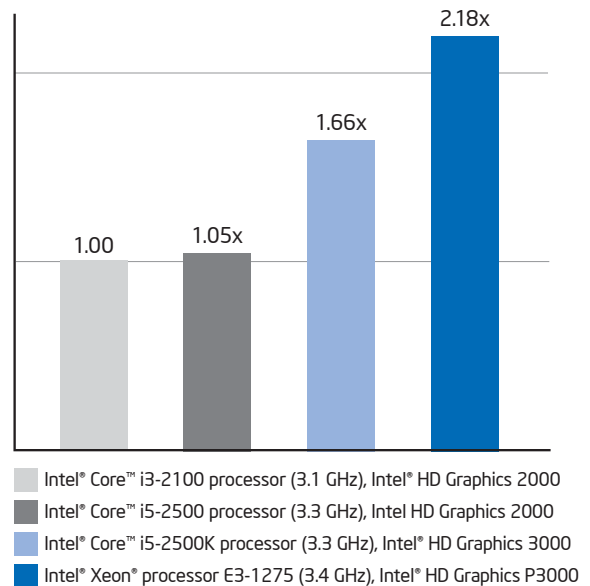


Figure 2. Intel® HD Graphics P3000 advantage⁶

Table 3. Top-Level Processor Comparison

Feature	Intel® Xeon® Processor E3-1200 Family	Intel® Core™ i7 Processor	Intel® Core™ i5 Processor	Intel® Core™ i3 Processor
Cache Size	8 MB	8 MB	6 MB	3 MB
Intel® Hyper-Threading Technology ³	●	●		●
Intel® Turbo Boost Technology 2.0 ²	●	●	●	
Intel® HD Graphics P3000 ⁵	●			

Intel HD Graphics P3000 is next-generation graphics technology from Intel. It integrates high-performance graphics and media processing right on the processor, putting the two key components – CPU processing and graphics – together on a single chip, thus significantly boosting performance, while eliminating the need for separate hardware and the design and performance challenges that accompany them.

Users of applications like Adobe Photoshop, Adobe Premier Pro, Autodesk AutoCAD, Autodesk Inventor, Autodesk Revit, Bentley MicroStation, Solid Edge and SolidWorks can now opt to invest in other technologies like Solid State Drives (SSDs) which can potentially improve the entire user experience when opening closing enormous work files.

Management and Security

Intel vPro technology simplifies and accelerates critical IT functions that help to maximize hardware-assisted security and manageability on all Intel Xeon processor E3-1200 family SKUs. Specific SKUs in the following Intel Core i5 and Intel Core i7 processors have Intel vPro technology: a) Intel Core i7-2600; b) Intel Core i5-2500; and c) Intel Core i5-2400.

Putting it All Together – How does a 3.3 GHz Intel Core i5-2500 processor compare to a 3.3 GHz Intel Xeon processor E3-1240?

A recently completed set of benchmarks from HP contrasts similarly configured HP Z210* entry workstations. It showed that a 3.3 GHz Intel Xeon processor E3-1240 outperformed a 3.3 GHz Intel Core i5-2500 processor by as much 34%.⁷

Table 4. Intel® Xeon® E3 Processor Performance Advantage vs. Intel® Core™ Processor (Performance results supplied by HP⁷)

Application	Result
3ds Max* V9	Intel® Xeon® processor E3-1240 outperformed an Intel® Core™ i5-2500 processor by 13%
LightWave*	Intel® Xeon® processor E3-1240 outperformed an Intel® Core™ i5-2500 processor by 24%
SunGard	Intel® Xeon® processor E3-1240 outperformed an Intel® Core™ i5-2500 processor by 34%

Summary

The Intel Xeon processor E3-1200 family represents Intel’s premier solution that is designed for professionals who are investing in an entry-level workstation.

It provides for improved performance and greater reliability than Intel Core i3, Intel Core i5 and Intel Core i7 processor-based business clients. Its processor-based graphics solution, Intel HD Graphics P3000, is optimized for professional applications listed above and provides users with an opportunity to invest other technologies (e.g., SSDs) that may improve a broader workstation experience beyond graphics.

Appendix. Intel® Xeon® Processors vs. Intel® Core™ Processors Graphics Performance

Feature	Intel® Core™ i3-2100 Processor ^a	Intel® Core™ i5-2500 Processor ^b	Intel® Core™ i5-2500K Processor ^c	Intel® Xeon® Processor E3-1275 ^d
3DMarkVantage 1.2.0 - 3DMark Score (Entry Preset @1024x768)	5,644.52	5,941.81	9,364.57	12,313
3DMarkVantage 1.2.0 - Graphics Score (Entry Preset @1024x768)	4,926.36	4,874.05	8,136.52	10,638
3DMarkVantage 1.2.0 - CPU Score (Entry Preset @1024x768)	10,031.80	17,334.03	17,113.40	23,337

^aIntel® Core™ i3-2100 processor SMD 3100/2C4T SMT On/N/A/2x256KB/3MB (No Turbo) DH67BL Micron 4 GB (2x2 GB) DDR3 1333, Seagate1 TB HDD, HD-100 with 8.15.10.2246 (BIOS:BLH6710H.86A.0079, Intel INF 9.2.0.1009).

^bIntel® Core™ i5-2500 processor (1024 MB L2 Cache, 6144 MB L3 Cache, 3.3 GHz), Intel® DH67BL (BIOS: BLH6710H.86A.0079, Memory: Micron_MT16JTF25664AZ-1G4 CL9 4 GB (2x2 GB), Graphics: HD-100 High Definition Graphics 200, driver: 8.15.10.2246, Storage: Seagate* 1073741824000 HDD) Windows* 7 Ultimate x64 N/A.

^cIntel® Core™ i5-2500K processor (1024 MB L2 Cache, 6144 MB L3 Cache, 3.3 GHz), Intel® DH67BL (BIOS: BLH6710H.86A.0079, Memory: Micron_MT16JTF25664AZ-1G4 CL9 4 GB (2x2 GB), Graphics: HD-200 High Definition Graphics 300, driver: 8.15.10.2246, Storage: Seagate* 1073741824000 HDD) Windows* 7 Ultimate x64 N/A.

^dIntel® Xeon® processor E3-1275 (Quad-Core, 3.40 GHz, 8 MB L3 cache, D2 stepping), BIOS version ASNBCPT1.86C.0061.P00, EIST Enabled, Turbo Enabled, HT Enabled, 8 GB memory (2x4 GB DDR3-1333 UDIMM), Intel® Integrated Graphics Card, graphic driver version 15.21.1.64.2259 (vertical sync: Application settings), one 21" LCD Display (1024x768, 32bit color quality, 75 Hz), 3 Gb/s SATA SSD 160G, Windows* 7 Ultimate x64 SP1 OS.

^Δ Intel processor numbers are not a measure of performance. Processor numbers differentiate features within each processor family, not across different processor families. See www.intel.com/products/processor_number for details.

[†] Requires an Intel® HT Technology enabled system, check with your PC manufacturer. Performance will vary depending on the specific hardware and software used. Not available on Intel® Core™ i5-750. For more information including details on which processors support HT Technology, visit <http://www.intel.com/info/hyperthreading>.

[°] Requires a system with Intel® Turbo Boost Technology capability. Consult your PC manufacturer. Performance varies depending on hardware, software and system configuration. For more information, visit <http://www.intel.com/technology/turboboost>.

[¶] Optimized Intel® HD Graphics P3000 only available on select models of the Intel® Xeon® processor E3 family. To learn more about Intel® Xeon® processors for workstations, visit www.intel.com/go/workstation.

[‡] Intel® vPro™ Technology is sophisticated and requires setup and activation. Availability of features and results will depend upon the setup and configuration of your hardware, software and IT environment. To learn more visit <http://www.intel.com/technology/vpro>.

[†] Claim of up to 2X better performance is based on Intel performance estimates for workstations based on the Intel® Xeon® processor E3-1245 and the Intel® Core™ processor i3-2100 on the SPECint*_rate_base2006 benchmark.

[‡] Claim of up to 25% better performance is based on Intel performance estimates for workstations based on the Intel® Xeon® processor E3-1245 and the Intel® Core™ processor i5-2400 on the SPECint*_rate_base2006 benchmark.

[§] Claim of up to 1.9X better performance is based on Intel performance estimates for workstations based on the Intel® Xeon® processor E3-1245 and the Intel® Core™ processor i3-2120 on the SPECint*_rate_base2006 benchmark.

[¶] Intel® Xeon® processor 1225 is limited to 6M LLC.

[§] Study can be found at <http://portal.acm.org/citation.cfm?id=1966477>.

[¶] Intel® HD Graphics P3000 performance advantage based on Intel internal data collection on 3DMark® Vantage as of April 2011.

[†] Benchmark tests were performed and submitted by HP's workstation performance marketing organization.

Software and workloads used in performance tests may have been optimized for performance only on Intel microprocessors. Performance tests, such as SYSmark and MobileMark, are measured using specific computer systems, components, software, operations and functions. Any change to any of those factors may cause the results to vary. You should consult other information and performance tests to assist you in fully evaluating your contemplated purchases, including the performance of that product when combined with other products.

For more information go to <http://www.intel.com/performance>

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