Why You Should Read This Document
This guide explains how building data center infrastructure on the Intel® Xeon® processor E5 v3 product family can support new and innovative services such as virtualization, cloud computing, and big data analytics by:

• Providing a platform for accelerated performance of compute, networking, and storage infrastructure
• Boosting server performance to support high-compute applications, handle more data, and manage greater virtual machine density
• Supporting unified networking through 10 and 40 gigabit Ethernet solutions that simplify data center infrastructure and provide greater speed and bandwidth
• Scaling out storage cost-effectively for virtualized and cloud environments
• Protecting data and infrastructure by encouraging pervasive encryption and creating trusted environments for virtualized and cloud computing
• Optimizing power in the data center with orchestrated control at the server, rack, row, and data center level
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Data Centers Are under Pressure

These are exciting times in the data center! New technologies promise more innovative services to the business at lower costs, and the strategic value of your data center is greater than ever. However, the explosive growth of unstructured data puts new demands on your compute, network, and storage infrastructure and challenges your ability to deliver new services such as cloud computing and big data analytics.

Business agility is now synonymous with IT agility. IT is partnering with line-of-business managers to develop new, innovative products and services. IT needs to respond rapidly to new and changing business demands, scale quickly and appropriately to fluctuating workloads, and accommodate business expansions. At the same time, increasingly sophisticated attacks from cybercriminals threaten your data and infrastructure. And keeping costs down is always a priority.

Delivering innovative services that drive value back into the organization is dependent on the flexibility and efficiency of your data center infrastructure. How can you scale storage and networking cost-effectively for cloud services delivery? What’s the best way to support advanced analytics or high-performance workloads such as technical, financial, and scientific computing? How can you protect it all from relentless cyberattacks?

Data Center Infrastructure Built to Scale

Today’s data center challenges also offer opportunities for IT managers to take the next step in the evolution of their data centers. Intel’s release of the Intel® Xeon® processor E5 v3 family can help you forge ahead with next-generation data center initiatives, including virtualization, cloud services delivery, and high-performance computing. With the Intel Xeon processor E5 v3 family at the heart of your agile, efficient data center, you can deploy a more secure private cloud with the same technology that is foundational to public clouds, process big data faster with increased compute performance, and curb energy costs with greater energy efficiency and power management.\(^1\)\(^2\) The Intel Xeon processor E5 v3 family creates a versatile, agile foundation that enables you to act quickly on opportunities that are critical to your business.

Each Intel Xeon processor E5 generation demonstrates improvement over previous generations. This release features a significant boost in energy efficiency, with even greater overall performance and more built-in hardware-assisted capabilities that help optimize your software, protect data and infrastructure, and optimize storage and networking. The Intel Xeon processor E5 v3 family set 27 two-socket performance world records\(^1\)\(^2\)\(^3\) and claims the title of world’s most energy-efficient server processor.\(^1\)\(^2\)\(^4\) Find out more about performance benchmarks for the Intel Xeon processor E5-2600 v3 product family.
**Data Center Challenges: Formidable and Diverse**

IT managers face significant challenges to keep the business running while experiencing pressure to support innovative services such as cloud computing, big data analytics, and Bring Your Own Device (BYOD) programs.

- Extreme growth of unstructured data strains storage capacity and puts increased demand on networks.
- Growing bandwidth requirements driven by greater virtual machine (VM) density and increasing network and storage traffic cause bottlenecks and greater network complexity.
- Dynamic virtualization, multitenancy, and automation create new security headaches and demand a different approach to protecting infrastructure and data.
- Resource sharing calls for standards for server, storage, and networking infrastructure that support open, interoperable solutions as they evolve.
- Power costs and availability continue to pressure IT budgets, reduce overall efficiency across the data center, and undermine “green” computing initiatives.
- Increasingly sophisticated cyberattacks target both software and platform.

**The Move to Software-Defined Infrastructure**

The challenges just described may offer opportunities for deployment of new and exciting technologies, but they also contribute to data center complexity. IT is beginning to look at software-defined infrastructure (SDI) as a way to deal with complexity and data growth as well as the need for agility, and to accelerate innovation costs. Although SDI is still in the early stages of development and adoption, Intel sees it as the next stage in the evolution of the data center. With the Intel Xeon processor E5 v3 family, Intel has established the hardware-level foundation to enable a future where all data center infrastructure is autoprovisioned through software. For more on the future of the data center, watch the “Data Center Architecture of the Future” video.

**The Purpose of This Guide**

The purpose of this guide is to introduce you to the Intel Xeon processor E5 v3 family of products. We’ll step through specific usage scenarios that address data center challenges. Then we’ll give you the nuts and bolts of how the specific capabilities of the Intel Xeon processor E5 v3 family can help you support your data center infrastructure initiatives.

These usage scenarios will help you further the optimization of your data center and unlock the potential of solutions for pervasive virtualization, private and hybrid cloud computing, big data analytics, and high-performance computing (HPC). With the Intel Xeon processor E5 v3 family, you have the flexibility to implement your top-priority initiatives incrementally to meet your business and technology challenges. With the vast array of capabilities built into our latest processor, the technology is there when you are ready. Look for a checklist for assessing your data center needs at the end of this guide.

The remainder of this guide introduces the Intel Xeon processor E5 v3 family-based platform and describes practical considerations for deployment in the following use cases:

- Accelerated server performance
- Enhanced server virtualization
- Unified networking
- Increased data and infrastructure security
- Scaled-out storage for virtualized and cloud environments
- Optimized power management
Why Is the Intel® Xeon® Processor E5 v3 Family at the Heart of Your Data Center?

The Intel Xeon processor E5 v3 family provides a single platform that combines built-in capabilities and increased performance to support diverse data center needs. The Intel Xeon processor E5 v3 family enables you to think differently about the data center. Designed for compute, storage, and networking to work better together, this new release delivers more automation and optimized storage and networking capabilities to better leverage the cloud at the speed of execution expected from today’s systems.

The Intel Xeon processor E5 v3 family also boasts greater data crunching performance for technical and analytical applications, provides a foundation for trust and security, and raises the bar for energy efficiency while enabling your data center to handle increasing performance, network, storage, security, and power demands. In addition, this processor provides advanced measurement and telemetry features, critical for orchestration software that needs continuous insight into utilization, power consumption, and temperature to maximize performance and efficiency.

Intel IT Data Center Optimization Strategy Delivers Business Value

As part of a complete data center optimization strategy, Intel IT created new business value in excess of USD 184 million between 2010 and today. Much of the success has been due to regularly refreshing servers using the latest generation of Intel Xeon processors, migrating from RISC to Intel architecture, adopting virtualization and cloud computing, and enhancing server performance through software optimization.

In addition to a sustained competitive advantage for Intel’s business, here are some of the specific benefits Intel IT has achieved just in compute:

- Achieved server virtualization ratios of up to 35:1.
- Reduced energy consumption in Intel’s Design environment by 10 percent annually since 2008.
- Virtualized more than 60 percent of Intel’s Office and Enterprise servers, reducing the number of servers by 4,000.
- Reduced the time it takes to provision a server from 90 days to 3 hours.
- Achieved USD 9 million in net savings to date by implementing cloud computing. From 2009 to 2015, we anticipate a total program net present value (NPV) of USD 20 million.
- Increased Design job throughput up to 49 percent.
- Delivered USD 55 million in additional capacity from 2010 to 2013 from implementing NUMA-Booster, a system software capability developed in-house.

Server Refresh Savings Estimator

You can evaluate the value and benefits of replacing aging servers with those based on the latest Intel® Xeon® processors. Using information about your current server environment, the Intel® Xeon® Processor-Based Server Refresh Savings Estimator tool can perform a custom analysis to help you evolve your next-generation data center.
Brilliantly Versatile for Business

The Intel® Xeon® processor E5 v3 family is built on Haswell microarchitecture using Intel’s industry-leading 22-nanometer (nm) 3-D Tri-Gate transistor technology for increased performance and energy efficiency. The processor supports IT innovation with these new key enhancements:

- Up to three times increase in performance (as compared to a previous-generation Intel Xeon processor-based server)\(^1,2,6\)
- Double the number of threads for single- and multi-threaded applications for increased processing efficiency and overall performance
- Adaptive performance for spikes in workload and increasing network and storage demands
- Optimized use and deployment of algorithm accelerators in security and networking applications
- Improved virtualization density, performance, and monitoring
- Hardware-based security features that build a foundation of trust for virtualized and cloud environments and accelerate data encryption
- Support for integrated 10 gigabit Ethernet (10 GbE) and 40 GbE solutions that simplify data center infrastructure and increase bandwidth
- Performance and I/O enhancements to improve performance and reduce latency for cloud applications
- Optimized storage with protection for data during power disruptions and the capability to offload compute to free up your CPU

For more about features, read the product brief.
Greater Server Performance to Support Cloud, Big Data, and High-Performance Computing

Today’s data centers demand ever-more-powerful performance. Data centers need more-powerful servers that can crunch more data faster; manage greater VM density; and run compute applications for technical, financial, scientific, and content-creation workloads. Accelerated server performance supports data center and server consolidation, virtualization, cloud computing, advanced analytics, and high-performance computing.

How It Works

The Intel Xeon processor E5 v3 family combines physical changes to the processor and built-in technologies that significantly boost performance. In addition to overall data center efficiency, this latest processor has the power to support cloud computing environments and big data environments with accelerated I/O and improved performance for Java*-based data platforms such as Apache Hadoop* and performance increases for intensive machine learning and analytics scenarios.

Physical Improvements to the Processor

A number of physical improvements to the processor contribute to increased performance, including:

- Up to 50 percent more cores and cache* over the previous generation.
- Up to 18 cores and 36 threads per socket
- Up to 45 MB of last-level cache (LLC)
- More memory: Up to 24 DIMMs (8R LRDIMMs) per two-socket server to support multiple data-hungry VMs
- Next-generation DDR4 memory support
- Faster maximum memory speeds than the previous generation (2,133 MHz versus 1,866 MHz)

- Double the number of execution threads: Intel Hyper-Threading Technology increases processing efficiency and overall performance for complex workloads.
- Greater integration: Intel Integrated I/O reduces latency with support for Peripheral Component Interconnect Express 3.0 (PCIe* 3.0), which can double bandwidth

Server Performance by the Numbers

As compared to the previous generation:

- Up to 3x more performance
- Up to 1.9x more performance with Intel® Advanced Vector Extensions 2 (Intel AVX2)
- Up to 1.7x increased virtual machine (VM) density
- Up to 1.4x increased memory bandwidth with DDR4
- Up to 2x greater bandwidth with support for PCIe* 3.0
- Up to 1.5x more cores and last-level cache
- Up to 3x improvement Java* VM (JVM) performance
- Up to 38 percent performance increase for compute-intensive machine learning and analytics scenarios

As compared to a typical 4-year-old server:

- Up to 8.7x increased performance
- Up to 6.3x increased performance with Intel AVX2
- Up to 3.3x increased virtual machine density
- Up to 3.2x increased memory bandwidth with DDR4
- Up to 3.1x increased energy efficiency
**Built-In Capabilities**

**Intel Turbo Boost Technology 2.0**

Intel Turbo Boost Technology 2.0 adds intelligence and adaptability to the chip to handle workload spikes. To do this, the processor increases frequency (“turbos up”) at the request of the operating system by redirecting power from the idle core to the active one. The processor keeps track of how hard it's running and modulates how far it will push itself in a turbo situation to provide the maximum frequency while meeting Intel's stringent reliability standards.

The turbo algorithm assesses whether the core speed is the limiter or if the processor is waiting for data from memory or I/O before it commits power to the burst of speed. If memory and I/O are the bottlenecks, then the turbo is not engaged. The goal is to get workload spikes dealt with as quickly as possible and to get back to a lower power state, which reduces average power draw and cost of operation.

This most recent version of Intel Turbo Boost Technology enables your server to go into turbo mode more often, for longer periods of time, and at higher clock frequencies. It also improves compute-intensive performance with Fused Multiply-Add (FMA), a set of instructions that speed up and improve the accuracy of computations.

**Intel Advanced Vector Extensions 2 (Intel AVX2) and Intel Hyper-Threading Technology (Intel HT)**

Together these two complementary technologies support high-compute applications such as financial analytics; image, audio, and video processing; scientific simulations; weather analysis; and 3-D modeling, rendering, and analysis. Intel Advanced Vector Extensions 2 (Intel AVX2) accelerates clock cycles for a broad range of workloads, doubling both floating point and integer vector operations instructions per clock. This dramatic increase is because Intel AVX2 utilizes 256-bit-wide single instruction, multiple data (SIMD) registers rather than the 128 bits in previous-generation processors—so the software can process twice as many instructions—new for integer vector instructions. Intel AVX2 also supports Float 16, which accelerates data conversion between 16-bit and 32-bit floating point formats. The technology is supported by Intel and third-party compilers that take advantage of the latest instruction to optimize code for significantly reduced compute time.

Intel Hyper-Threading Technology (Intel HT) enables multiple threads to run on each core, increases processor throughput, and improves overall performance on threaded software. Demanding applications can run simultaneously while maintaining system responsiveness.

**Intel QuickAssist Technology**

This technology accelerates hardware for efficient cryptographic, pattern matching, and data compression performance in networking and security applications. It also provides a uniform means of communication between applications, accelerators, and acceleration technology.
Accelerated Server Virtualization for Greater Flexibility and Agility

Server virtualization has evolved from a way to reduce costs by consolidating servers and data centers to increasing flexibility and agility. Pervasive use of virtualization can enable faster service deployment and dynamic placement of workloads. Virtualization is also the foundation for an agile, scalable cloud, providing several key capabilities, including resource sharing, VM isolation, and load balancing. These capabilities enable scalability, high utilization of pooled resources, rapid provisioning, workload isolation, and increased uptime. This scenario describes how the Intel Xeon E5 v3 processor product family can help you build a more agile, efficient, and secure data center by implementing server virtualization solutions—important for meeting today's challenges and critical for realizing the full potential of SDI. Intel's latest processor provides:

- Improved performance of your virtualization solutions
- Increased consolidation ratios
- Greater speed and reliability to support business continuity and increased user uptime
- A foundation of trust and compliance that enables you to verify the fidelity of virtualized platforms

How It Works

Intel Xeon processor E5 family-based platforms combine physical changes to the processor and built-in technologies that significantly boost virtualization performance.22

Physical Improvements to the Processor

Greater cache and main system memory and merging of the I/O controller directly onto the processor die rather than on a separate component of the motherboard support faster, more reliable processing of VMs.

Built-In Capabilities

Advanced Programmable Interrupt Controller Virtualization (APICv)

Virtualization can come with a performance penalty as fewer physical servers manage large numbers of VMs. Advanced Programmable Interrupt Controller Virtualization (APICv) reduces virtualization overhead, eliminating the need for many VM exits. VM exits are a source of performance degradation in virtualized systems. A VM exit marks the point at which a transition is made by the VM currently running and the hypervisor, which is managing system controls. That transition involves several steps followed by a VM entry transition once the hypervisor has done its job. By reducing the number of VM exits, the system experiences less overhead.

Intel Virtual Machine Control Structure (VMCS) Shadowing

This technology enables efficient nested virtualization usages with reduced overhead by eliminating the majority of nesting-induced VM exits and entries. This is useful for workloads that require ultrahigh isolation, such as for financial applications.

Cache Monitoring

Cache Monitoring improves virtualization platform quality and efficiency through greater insight into resource utilization. The processor assists to monitor last-level cache pace utilization per VM, which addresses “noisy neighbor” issues that can occur in virtualized environments.
Intel Virtualization Technology (Intel VT)

Intel Virtualization Technology\(^2\) (Intel VT) is a portfolio of hardware assists built into the processor that make running virtualization platforms faster, more reliable, and more secure. These technologies work with Intel Platform Protection Technology (with Trusted Execution Technology [TXT])\(^4\) to provide a trusted foundation against malicious attacks on the hypervisor, BIOS, firmware, and other prelaunch software components. (See more about Intel TXT in the section “Increased Data and Infrastructure Security.”) The Intel VT portfolio includes:

• **Intel Virtualization Technology\(^2\) (Intel VT) for IA-32 and Intel 64 (Intel VT-x)** enable faster performance for core virtualization processes, improving application performance, live migration, provisioning, dynamic load balancing, and disaster recovery.

• **Intel VT for Directed I/O\(^2\) (Intel VT-d)** provides built-in support and improved performance for I/O virtualization by reducing hypervisor involvement in managing I/O traffic. The result is improved I/O performance, increased system reliability, and enhanced memory protection.

• **Intel VT for FlexMigration\(^2\) (Intel VT FlexMigration)** enables the migration of virtual machines across multiple generations of Intel Xeon processor-based servers. This makes it possible to share resources among diverse operating systems and combine existing processor generations into the same virtualized server pool.

• **Intel Virtualization Technology\(^2\) for Connectivity (Intel VT-c)** is a collection of platform-level I/O virtualization technologies and initiatives that enable lower CPU utilization, reduced system latency, and improved networking and I/O throughput. Intel VT-c optimizes virtualized systems with a multifaceted approach to I/O virtualization:

  - Virtual Machine Device Queues (VMDq) improve traffic management within the server, helping to enable better I/O performance from large data flows while decreasing the processing burden on the software-based virtual machine monitor (VMM).
  
  - PCI-SIG\(^*\) single-root I/O virtualization (SR-IOV) provides near-native performance by providing dedicated I/O to virtual machines and bypassing the software virtual switch in the hypervisor completely. It also improves data isolation among virtual machines and provides flexibility and mobility by facilitating live virtual machine migration.

Virtualization Performance by the Numbers

• Up to 50 percent higher virtualization performance\(^1, 2\)

• Reduced number of virtual machine (VM) exits to lower system overhead
Unified Networking for Higher Throughput, Lower Latency, and Virtualized Networking

As desirable as improvements in processor performance may be, that extra boost can burden your network with increased network and storage traffic. The result? Increased network complexity, insufficient bandwidth, and I/O bottlenecks that slow everything down. This scenario describes how integrated support for 10 GbE and 40 GbE solutions can simplify your network infrastructure through port consolidation and the convergence of LAN and storage area network (SAN) traffic onto a single fabric as well as boost network performance with higher throughput and lower latency, and virtualized networking.

Through port consolidation, you can combine multiple 1 GbE ports onto fewer 10 GbE or 40 GbE ports, which streamlines cabling, reduces power, and improves bandwidth. The greater bandwidth plus support for Fibre Channel over Ethernet (FCoE) and Internet Small Computer System Interface (iSCSI) protocols makes it possible to move SAN traffic to ubiquitous, familiar Ethernet. Enhancements to the Ethernet protocol ensure no drops in performance.

With 10 GbE and 40 GbE solutions, you have enough bandwidth to take the next step—to a truly unified and single network that consolidates both LAN and SAN traffic onto a single fabric. With unified networking, you gain greater simplification, lower total cost of ownership due to data center infrastructure consolidation, and high flexibility.

Virtualized networking relies on software to provide networking services able to run on either standard x86 servers or as virtual machines. In virtualized environments, a virtual machine provides networking services within or between hypervisors. Virtualized networking provides exceptional agility (new networking VMs can be spun up as necessary), scalability (additional resources are assigned as network VM traffic grows), and utility pricing (costs are incurred only as new services are added). The Intel Xeon processor E5 v3 family enables network virtualization, critical for software-defined networking and ultimately realizing the full potential of SDI.

How It Works

Intel Xeon processor E5 family-based platforms are the first to support integrated 10 GbE for mainstream servers, with built-in technologies that enhance I/O throughput for network and storage traffic. With the Intel Xeon processor E5 v3 family, network support is also extended to 40 GbE and virtualized networking.

Physical Improvements to the Processor

In addition to more cache and main system memory, merging of the I/O controller directly onto the processor die rather than on a separate component of the motherboard makes the Intel Xeon processor E5 family better able to manage network traffic faster and with reduced latency.

Built-In Capabilities

Intel Integrated I/O

Intel Integrated I/O manages data traffic by:

- Merging the I/O controller onto the processor, which significantly reduces latency
- Supporting the PCIe 3.0 specification: provides up to 80 PCIe lanes per two-socket server with atomic operations support for improved peer-to-peer (P2P) bandwidth
- Supporting a growing ecosystem of PCIe 3.0 add-in cards
- Intelligently directing I/O packets to the processor cache, skipping main system memory
Intel Data Direct I/O (Intel DDIO)

Intel Data Direct I/O (Intel DDIO) is a key component of Intel Integrated I/O that increases performance by allowing Intel Ethernet controllers and server adapters to talk directly with cache and maximize throughput. Traditional I/O transfer must first be moved and stored in main memory before it can go to cache for processing. Then once processing is complete, the data has to reverse its course. With Intel DDIO, we have re-architected the processor and dedicated a portion of cache to I/O so that data transfers directly to cache and bypasses main memory. This places less demand on main memory to deliver greater bandwidth scalability, lower power utilization, and reduced latency.

Intel Virtualization Technology for Connectivity (Intel VT-c)

Intel VT-c\(^2\) improves the performance of network overlays in your private cloud or data center, with network virtualization offloads for VXLAN, NVGRE, and Geneve encapsulation protocols (when combined with the Intel Ethernet Controller XL710 family of 10 and 40 GbE adapter controllers).

Intel Ethernet Flow Director

Software-defined networking programmatic traffic-steering capability improves performance and reduces latency of cloud applications such as Memcached (when combined with the Intel Ethernet Controller XL710 family). [Watch the video to learn more.]

Unified Networking from Intel

Intel offers devices supporting 10 and 40 gigabit Ethernet (GbE) and unified networking that are optimized for best performance with the Intel® Xeon® processor E5 v3 family.

Intel Ethernet Controller XL710 Family (10/40 GbE).

The Intel Ethernet Controller XL710 family for 10 GbE and 40 GbE are completely architected from the ground up to work with highly virtualized Intel Xeon processor E5 v3 platforms that are deployed in public cloud, communication, infrastructure, and private cloud environments. The controller family extends Intel Virtualization Technology beyond server virtualization to the network with hardware optimizations and off-loads for the rapid provisioning of networks. The Intel Ethernet controller XL710 family is PCI Express* (PCIe\(^*\)) 3.0; x8; and available in dual 40 GbE, single 40 GbE/quad 10 GbE, and dual 10 GbE configurations. Find out more about the Intel Ethernet Controller XL710 family.

**Intel Ethernet Converged Network Adapters.** Intel’s Converged Network Adapters deliver high-performance unified networking using native operating system-based storage initiators for Internet Small Computer System Interface (iSCSI) and Fibre Channel over Ethernet (FCoE) and intelligent-hardware-based off-loads. Intel worked closely with leading operating system and hypervisor vendors to integrate open, native storage support in their products while optimizing Intel Ethernet hardware for these solutions. Converging data and storage onto one fabric eliminates the need for multiple adapters, cables, and switches. Furthermore, both 10 and 40 GbE provides the bandwidth to converge these multiple fabrics onto a single wire. Find out more about Intel Ethernet Converged Network Adapters XL710 (10/40 GbE).

More about I/O Improvements

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**Intel QuickAssist Technology**

This technology accelerates hardware for efficient cryptographic, pattern matching, and data compression performance in networking and security applications. It also provides a uniform means of communication between applications, accelerators, and acceleration technology.

**Intel Data Plane Development Kit (Intel DPDK)**

The Intel Data Plane Development Kit (DPDK) enables higher small-packet processing for Network Functions Virtualization (NFV) applications—for example, firewalls and load balancers (when combined with Intel Ethernet Controller XL710).
The explosion of structured and unstructured data and the emergence of new usage models, such as cloud computing and big data analytics, require new storage architecture. Data must be readily available for business, regulatory, and compliance needs. Scale-out storage addresses three major challenges associated with managing structured and unstructured data: the staggering increase in volume, velocity, and variety; inefficient data management; and the cost of sustaining traditional storage architectures.

How It Works

With the full capabilities of a converged storage server, the Intel Xeon processor E5 v3 family provides the foundation for scale-out architecture. Running intelligent solutions built specifically for virtualized and cloud environments, Intel Xeon processor E5 v3 family-based platforms maximize available capacity and centralize management of distributed data for improved performance.

Intel Xeon processor E5 v3 family-based storage devices enable massive scalability for use cases that involve huge volumes of structured and unstructured data (such as e-mail, instant messages, documents, spreadsheets, images, and video), but scale incrementally to avoid expensive overcapacity provisioning. Capacity is increased as needed by simply adding more nodes rather than installing additional discrete subsystems. With support for open standards and interoperability, you can reduce storage costs and lower your reliance on expensive proprietary interfaces.

The Intel Xeon processor E5 v3 family also provides the performance within storage solutions to enable advanced capabilities like thin provisioning, compression, intelligent tiering of data, data deduplication, data encryption, erasure coding/RAID over nodes, and caching. These solutions optimize capacity and balance storage I/O, as well as keep costs down. In addition, this latest processor enables software-defined storage, an important step in the realization of the software-defined data center.

Physical Improvements to the Processor

- Protects data during power disruptions with asynchronous DRAM refresh that helps protect data in memory.
- Supports key storage processor features, including x16 non-transparent bridging (NTB) versus x8 NTB, to increase scalability, and supports accelerated RAID for implementing RAID 5 and 6 without a custom ASIC.
- Supports PCIe 3.0:
  - Prevents fail-over with PCIe NTB that connects systems over a backplane.
  - Maximizes memory channel bandwidth with the capability to perform a single write transaction to two targets with PCIe dual-cast.
  - Allows host input/output controller (IOC) to write data directly to PCIe NTB and local memory.
- Supports Serial ATA 3.0 (SATA 3.0), providing faster data access, system startups, and application load times.
- Doubles data throughput versus previous generation for faster hard-drive performance (1.8.25).

Built-In Capabilities

Intel Rapid Storage Technology Enterprise 3.x (Intel RSTe)

Intel Rapid Storage Technology Enterprise 3.x (Intel RSTe) is a RAID driver that provides easy-to-use, enterprise-class data protection. In addition, Intel RSTe can increase the speed of...
RAID operations when combined with the servers running the Intel Xeon processor E5 v3 product family. Intel RSTe integrates serial attached SCSI (SAS) and SATA into the chipset, increasing overall I/O system performance, enabling RAID software to perform as well as or better than hardware RAID systems, and reducing overall solution costs. Intel RSTe can support RAID 0, 1, 10, and 5. Learn more from the product brief.

**Intel Cache Acceleration Software (Intel CAS)**

Intel CAS is intelligent server software that identifies and caches the most active data on solid-state drives (SSDs) to accelerate server applications at low costs. Combined with Intel Solid-State Drives (Intel SSDs), server applications run three times faster\(^1\)\(^,\)\(^2\)\(^,\)\(^7\) on transactional database processing and up to 20 times faster processing read-intensive business analytics.\(^3\)\(^,\)\(^7\) Watch this video to learn more.

**Intel Intelligent Storage Acceleration Library (Intel ISA-L), Intel QuickData Technology, and RAID-5 Acceleration Engine**

Further free up your CPU by offloading RAID calculations with hardware RAID acceleration.

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**Intelligent Storage from Intel**

Intel offers a range of integrated storage products and technologies designed to manage the exceptional demands of data-intensive enterprise and cloud environments. Combined with powerful Intel® Xeon® processor E5 v3 platforms, you can simplify storage delivery, increase storage utilization, and deliver breakthrough performance.

**Intel Solid-State Drives (Intel SSDs) Data Center family for PCIe.** Available in multiple form factors, Intel SSDs for the data center are designed for the most performance-hungry applications in your data center and deliver the highest levels of consistent performance while maintaining the end-to-end data protection and high endurance IT managers expect. In addition:

- NVM Express* (NVMe*), an interface specification optimized for PCI Express*-based storage solutions, defines a scalable architecture and delivers higher input/output operations per second (IOPS).

Intel Cache Acceleration Software (Intel CAS) is bundled with the newest Intel SSDs for data centers and reduces latency for “hot” data by using an Intel SSD as a cache for data.
Dynamic virtualization, multitennancy, and automation needs create new security headaches. With no relief from cybercriminals in sight, IT managers need a different approach to protecting data and data center infrastructure. The foundation for that approach is to create security layers at the hardware level that isolate workloads, enforce security limits, and accelerate data encryption.

VMs exist as independent entities on shared resources. Software layers arbitrate access to these shared resources and protect the contents of one VM from another. However, with the emergence of increasingly sophisticated cyberthreats such as virtual rootkit attacks, software-only approaches often fall short of the isolation needed to protect the contents of each VM in the cloud.

Controlling the computing environment is difficult in cloud implementations. Traditional security tools are abstracted away or may not fit into the new virtualized, cloud-oriented workflows or architectures. But sensitive workloads and policy or regulatory requirements demand that IT managers understand the environment and controls that are in place to enforce security policies. When physical control of data is reduced, one established way to protect it is with encryption, the last line of defense to protect from misuse. This is important in cloud and other shared infrastructures to protect data as it moves to the cloud or between clouds and while in storage. But encryption typically comes at a cost, a performance tax of sorts.

How It Works

The Intel Xeon processor E5 v3 family strengthens data and infrastructure protections with built-in capabilities that accelerate encryption, reduce security performance penalties, and improve isolation and control of shared, virtualized environments. This latest processor establishes a hardware “root of trust” that enforces policies for platform integrity. Accelerated encryption lowers the performance tax and encourages pervasive encryption across the data center. Combined, these capabilities provide a robust foundation to better address security in data centers and shared infrastructures.

Built-In Capabilities

Intel Platform Protection
- Intel Platform Protection Technology (with Trusted Execution Technology [TXT]) and Intel VT work together to isolate workloads and system execution from launch through runtime, helping to reduce the attack surfaces of shared environments such as cloud computing.

TXT helps protect platform firmware and the operating system kernel from preboot attacks. TXT now supports Trusted Platform Module 2.0 (TPM 2.0) with stronger cryptographic capabilities.

TXT works by hardening the platform against malicious software that attacks before the VM boots. TXT starts with a root of trust at the platform level that extends a chain of trust through measured firmware, BIOS, and hypervisor virtualization. A hardware-based root of trust is extremely difficult to defeat or subvert and provides an excellent foundation against increasingly sophisticated malware attacks. TXT helps provide assurances of platform integrity through the enforcement of platform trust in which a “known good” software environment is in control of the platform. TXT enforces this control by:
- Checking the hypervisor integrity at start-up
- Measuring the code of the hypervisor
- Comparing it to a known good value
Launch can be blocked if the measurements do not match, or the host can be allowed to launch and its untrusted status can be reported into the management environment. This information provides a useful control point for virtualized workloads. For example, with this knowledge, you can establish and enforce policies defining that critical workloads or sensitive data only be deployed to trusted platforms.

Similarly, integrity checking data from TXT is available for audit purposes and can be used with governance, risk management, and compliance (GRC) or security information and event manager (SIEM) dashboards for further reporting on the controls in place in your IT or cloud environment.

With TXT, you can combine servers from multiple generations into the same virtualized server pool to extend fail-over, load balancing, and disaster recovery capability.

- Intel Platform Protection Technology (with BIOS Guard)\textsuperscript{24} protects your system by increasing security against malware and denial-of-service (DoS) attacks.

- Intel Platform Protection Technology (with OS Guard)\textsuperscript{24} improves security by strengthening malware protection, helping to protect the operating system from escalation-of-privilege attacks.

- Intel Platform Protection Technology (with XD Bit)\textsuperscript{24} enhances overall system security by reducing platform surface attacks. It helps to prevent the execution of malicious code.

Intel Data Protection Technology

- Intel Data Protection Technology (with Advanced Encryption Standard New Instructions [Intel AES-NI])\textsuperscript{28} provides performance benefits that make high-volume encryption faster and more efficient for data transport and storage workloads. AES-NI also provides strengthening against side-channel attacks, which is an increasingly critical capability in shared compute usage models where multiple workloads could have visibility into subsystems used in computing encryption routines.

- Intel Data Protection Technology (with Secure Key)\textsuperscript{28} enhances security and performance for a wide range of security applications and enables faster, higher-quality cryptographic keys and certificates.

Intel QuickAssist Technology

This technology accelerates hardware for efficient cryptographic, pattern matching, and data compression performance in networking and security applications. It also provides a uniform means of communication between applications, accelerators, and acceleration technology.

Intel Advanced Vector Technology 2 (Intel AVX2)

Intel AVX2 instructions deliver great performance of compute-intensive cryptographic algorithms and efficiency in larger integer arithmetic operations, such as the Secure Hash Algorithm (SHA).

AES-NI increases encryption speed via a set of seven new instructions that accelerate parts of the AES\textsuperscript{29} algorithm encryption and decryption execution. AES-NI can accelerate performance up to two times faster\textsuperscript{1,30} than a software-only AES solution, making encryption more practical, stronger, and more efficient. AES-NI can be used in any of the growing set of optimized applications that use AES, including network, disk, and file encryption solutions.
Lower Your Energy Costs with Optimized Power Management

Power consumption is a significant element of most IT budgets, and data centers struggle to utilize power more effectively to cut operational costs. Virtualization has helped mitigate energy inefficiencies by reducing the number of physical servers required in the data center. However, power can be optimized for significant cost savings and less risk to data center infrastructure equipment and network availability by applying a combination of other approaches. These approaches include improved system power performance, real-time power awareness, rack density optimization, power load balancing, and energy reduction. Optimizing power management across the data center adds to an IT manager’s ability to orchestrate and configure the data center for improved utility.

How It Works

The Intel Xeon processor E5 v3 family delivers new platform telemetry enabled by Intel Node Manager to monitor power and utilization. The telemetry platform combines built-in, intelligent power technology and sensors that provide advanced power, thermal, and utilization instrumentation at the server level. This is an important advance over previous generations, which featured power monitoring only. The new telemetry platform expands the number of power metrics monitored and adds CPU, memory, and I/O utilization metrics important for today’s orchestration software.

In addition, because the Intel Xeon processor E5 v3 family is built using Intel’s industry-leading 22-nanometer (nm), 3-D Tri-Gate transistor technology, it benefits from enhanced energy efficiency and performance.

Physical Improvements to the Processor

• This microarchitecture (code-named Haswell) is designed to emphasize power reductions in both active and idle states.

• The Intel Xeon processor E5 v3 family demonstrates up to 24 percent increased power efficiency as compared to previous generations, making it the world’s most energy-efficient server processor. As compared to a typical 4-year-old server, Intel Xeon processor E5 v3 family-based servers are up to 200 percent (three times) more energy efficient.

• To improve idle power as well as to best match power draw to processor use, the Intel Xeon processor E5 v3 family scales the memory, cache, I/O, and other processor functions to support the compute cores. That way, the system only consumes power to provide the highest possible bandwidth when the cores are in high demand. With less demand, the processor shifts down to a high-efficiency, lower-power state.

• On-board sensors monitor power and thermal levels and take advantage of Intel Intelligent Power Technologies, such as integrated power gates. They also enable greater awareness of the running average power level (RAPL) to provide better control and adaptability to power management tools.

Built-In Capabilities

Intel Node Manager 3.0 Software

Intel Node Manager 3.0, an Intel server firmware feature built into the Intel Xeon processor E5 v3 family, monitors a server’s power and thermal levels and provides fine-grained controls to limit platform power. Because many data centers do not have tools to easily measure and manage power consumption at the individual server level, power and cooling are often overprovisioned compared to real usage conditions. Intel Node Manager runs on each individual server and communicates to an external management console, such as Intel Data Center Manager (Intel DCM) Energy Director.
Using the management console, a group policy can be set at the server, rack, and row level for all servers running Intel Node Manager 3.0 to ensure that the aggregated systems never exceed the allowed power budget. In addition to platform power, Intel Node Manager 3.0 now can monitor inlet temperature; outlet temperature; volumetric airflow; and CPU, memory, and I/O utilization, all using out-of-band communications.

As an example, if the maximum power per system is 300 watts (W) but the average utilization is 180W, you can aggregate 20 servers and set power policy to never exceed a rack-level limit of 3.6 kilowatts (kW). Intel Node Manager facilitates enforcement of that power limit. Early adopters of Intel Node Manager have seen up to 40 percent improvements in rack density.

**Intel Data Center Manager (Intel DCM) Software**

Intel DCM Energy Director is an Intel developed management console that provides power and thermal data in the data center. DCM can manage policies to monitor and manage energy demands deterministically for aggregated IT resources at the server, rack, row, and data center level. It enables you to operate within the DC power and cooling budget and optimize performance. It also provides access to server-level instrumentation to enable power-based load balancing or load migration. Intel DCM Energy Director is available as a software development kit (SDK) that independent software vendors (ISVs) or original equipment manufacturers (OEMs) can integrate in their management software offerings.

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**Power Improvement by the Numbers**

- Up to 24 percent greater energy savings (as compared to a previous-generation Intel® Xeon® processor-based server).
- Up to 200 percent (three times) more energy efficient (as compared to a typical 4-year-old server).

**More on Improving Power Management**

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"Power Improvement by the Numbers"

- Up to 24 percent greater energy savings (as compared to a previous-generation Intel® Xeon® processor-based server).
- Up to 200 percent (three times) more energy efficient (as compared to a typical 4-year-old server).

"More on Improving Power Management"
Take Your First Steps toward a Next-Generation Data Center

With so many demands on the data center, where do you begin? Get started by aligning an upgrade and optimization strategy with your strategic goals. Then look at the inefficiencies in your data center that may have prevented you from reducing costs or delivering new services. Servers based on the Intel Xeon processor E5 v3 product family and associated networking and storage technologies from Intel and its partners can help you move forward.

The first checklist identifies three strategic goals that many data centers are striving to achieve, including upgrading for operational efficiency, optimizing for cloud services delivery, and optimizing for a software-defined future.

The second checklist is more tactical in nature and can be used to identify specific inefficiencies related to networking, storage, security, and power management.

### Aligning Your Data Center Upgrade to IT Strategic Goals: Checklist

#### Upgrade for Operational Efficiency

Dramatic advances in compute, networking, and storage technologies can optimize data center performance, protect against cyberattacks, and reduce operational costs. Aging infrastructure poses a major business risk for security breaches, obsolescence, and loss of competitive advantage.

**Server Virtualization**

<table>
<thead>
<tr>
<th>Feature</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Consolidation</td>
<td>Fewer servers doing the same (or more) work and consuming less energy.</td>
</tr>
<tr>
<td>Rapid provisioning</td>
<td>Elastic capacity in less time.</td>
</tr>
<tr>
<td>Increased uptime</td>
<td>Virtualization platforms include technologies that enable servers to recover quickly from unplanned outages.</td>
</tr>
<tr>
<td>Isolation</td>
<td>Enables isolated applications in the same server.</td>
</tr>
<tr>
<td>Cloud-enablement</td>
<td>Server virtualization is a foundational technology for cloud.</td>
</tr>
</tbody>
</table>

**High-Speed Networking**

<table>
<thead>
<tr>
<th>Feature</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 or 40 gigabit Ethernet solutions</td>
<td>Lower latency, higher throughput.</td>
</tr>
<tr>
<td>Reduced complexity</td>
<td>Consolidate 1 GbE and 10 GbE ports.</td>
</tr>
<tr>
<td>Converged fabric</td>
<td>LAN can share a single fabric for network and storage traffic.</td>
</tr>
</tbody>
</table>
Intelligent Storage Capabilities

- **Compression**
  Uses algorithms to compress data to use space more efficiently.

- **Deduplication**
  Uses pattern matching to reduce large blocks of duplicate data.

- **Data tiering**
  Uses policies to move “hot” data to the highest-performance storage media and allocate cold data to storage optimized for cost ($/GB).

- **Thin provisioning**
  On-demand allocation of available storage based on current requirements for higher utilization.

- **Erasure coding**
  Enables reliable data durability and more-efficient data replication.

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Optimize for Cloud Services Delivery

More-powerful Intel infrastructure and optimized partner software can encourage pervasive virtualization. Cloud enables IT to further scale by delivering applications and services to internal and external customers. The following apply to private, public, and hybrid clouds.

- **Pervasive virtualization**
  Greater virtualization is the first step toward enabling the delivery of services via cloud, making more workloads available for faster provisioning.

- **Cloud management platform**
  With increased virtualization infrastructure, you also need greater management, automation, and orchestration capabilities.

- **Infrastructure as a service (IaaS)**
  Creating hosting platforms and implementing IaaS enables broader enterprise usage models.

- **Platform as a service (PaaS)**
  Offering PaaS encourages rapid, cloud-aware application development.

- **Hybrid cloud**
  Integrate private and public cloud services for greater visibility, application portability, and the ability to either “buy the space” or “rent the space,” depending on workload and demand.

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Optimize for a Software-Defined Future

Software-defined infrastructure is not yet a reality. Nevertheless, data centers can start now to put in place a technology foundation that will help you evolve into a fully orchestrated data center that will achieve even greater efficiencies and flexibility in the future.

- **Increased automation and orchestration**
  For improved efficiency, extend automation and orchestration to additional data center processes, such as energy management.

- **Network virtualization**
  Speed network provisioning and improve utilization by combining hardware and software network resources and network functionality into a single, software-based administrative entity.

- **Software-defined networking**
  For even greater efficiencies, provision and manage the network using SDN by controlling the network and network flows centrally via software that separates the control plane from the data plane devices and provides a programmable interface.

- **Storage virtualization**
  Reduce or eliminate storage silos by creating an open, extensible storage platform that pools storage hardware, software, and functionality.

- **Software-defined storage (SDS)**
  For even greater storage efficiencies, SDS orchestrates access to storage resources, including calls to underlying storage and offering storage services to users via a common portal.
Identify Data Center Inefficiencies: Checklist

No matter where you are in your data center refresh cycle, upgrading to the Intel Xeon processor E5 v3 family-based servers can make good business sense. The Intel Xeon processor E5 v3 family can support your initiatives in each of the following areas as you take the next steps to evolve your data center.

**Networking**

- Do you have sufficient bandwidth to support existing services?
- Can you currently support high-performance computing applications?
- Do you need to handle new workloads related to financial analytics, image, audio, and video processing, scientific simulations, weather analysis, or 3-D modeling, rendering, and analysis?
- How effectively does your network handle workload spikes?
- Does your network experience frequent I/O bottlenecks? How often does your network experience I/O latency?
- Do you currently support 10 GbE at the server and the switch? Are you considering 40 GbE networking?
- How many GbE ports do you have on a typical virtualized server?
- What kinds of cost and efficiency gains could you achieve through port consolidation?
- What protocols do you support for storage traffic (Fibre Channel [FC], FCoE, iSCSI, Network File System [NFS])?
- What kinds of cost and efficiency gains could you achieve by consolidating LAN and storage traffic onto a single fabric?

**Storage**

- With your current storage infrastructure, are you able to keep up with the growth of structured and unstructured data in your organization (such as e-mail, business intelligence, video, social media content, images, and office documents)?
- Do you support large relational databases (such as Oracle databases)?
- Is the majority of your storage infrastructure dedicated to scale-up storage?
- Can you scale out quickly and cost-effectively?
- Would you consider your current storage to be overallocated or underallocated?
- Do you support advanced storage solutions that optimize and improve data management via thin provisioning, compression, automated tiering of data, data deduplication, and erasure coding/RAID over nodes?
Data Center Infrastructure and Data Security

- Is your data center under increasing threat of attack from malware and other cyberthreats?
- Have you ever experienced a serious breach?
- Does your infrastructure include security built into the hardware?
- Can your systems establish a root of trust?
- Do you manage a trusted management platform of pooled resources for virtualized and other shared services?
- Have you resisted moving sensitive workloads to the cloud because of security concerns?
- Are you able to demonstrate that you can enforce security policies to comply with regulatory demands?
- How consistently do you use encryption with your data?
- Would you like to increase the amount of data you encrypt, but you worry about performance?

Power and Data Center Management and Orchestration

- What solutions do you currently use to optimize power and reduce costs?
- Do you have real-time power awareness of your individual systems?
- Can you extend control to aggregated resources (rack, row, and data center) by setting policies that optimize power and thermal utilization?
- Have you deployed as many servers as possible into the power allocated to your rack(s)?
- Do you have the tools to enable power-based load balancing or load migration?
- Can you monitor and automatically apply policies to manage CPU, memory, and I/O utilizations?
Intel Resources for Learning More

About the Intel Xeon Processor E5 v3 Family
For more information about the Intel Xeon processor E5 v3 family, visit intel.com/Xeone5.

Product Brief: The Heart of an Agile Data Center: Intel® Xeon® Processor E5-2600 v3 Product Family
This brief provides an overview of how the new processor family supports business growth by enabling new services faster and delivering new applications in the enterprise, technical computing, communications, storage, and cloud. This new generation of processors enables powerful, agile data centers by supporting a software-defined infrastructure for greater flexibility with higher levels of automation and orchestration.
intel.com/content/www/us/en/processors/xeon/xeon-e5-brief.html

Tools for IT Managers

Intel® Xeon® Processor-Based Server Refresh Savings Estimator
With this tool, you can enter data about your existing server environment to evaluate the value and benefits of replacing aging servers with those based on Intel Xeon processors. Generating a full report in Microsoft* Word or PowerPoint* software, you can create a simple or full custom analysis, or access resources to assist you in building a new data center or refreshing an existing data center.
intel.com/go/xeonestimator

Intel IT Server Sizing Tool
This tool is based on Intel IT’s methodology for determining the appropriate server sizing for our scale-up enterprise resource planning (ERP) environment. Enter data about your existing environment and evaluate the optimal servers for your project life cycle.
intelsalestraining.com/serversizing/

About Next-Generation Data Centers

Data Center Architecture of the Future
This video provides a look into the future of your data center. Learn about the technology possibilities enabled by next-generation data centers from Intel futurist Steve Brown. Intel’s vision shows a clear path to the future by modernizing infrastructure for cloud deployments and optimizing applications for cloud services delivery. (3:33 min.)

Data Center Requirements: Refresh for Operating Efficiency
This video provides an overview of how upgraded data center technology can help IT deal with the challenge of explosive data growth and spend less time managing the data center and more time serving the business. (3:20 min.)
Data Center Technology: Refresh for Competitive Advantage
This video demonstrates to IT the benefits of optimizing your data center to meet its challenges, including prepping for a software-defined future, by showing how a highly automated, intelligently orchestrated data center enables improved collaboration with the business to drive new business opportunities, innovate new ways to streamline core business processes, and strengthen relationships with customers, partners, and coworkers. (2:54 min.)

Intel Cloud Builders Initiative

Intel Cloud Builders Program
Get guidance from this cross-industry initiative to build a more simplified, secure, and efficient cloud infrastructure. Intel Cloud Builders provides a wide portfolio of proven reference architecture solutions from a broad range of leading systems and solutions providers, along with key learnings and best practices designed to simplify, better secure, and increase the efficiency of cloud infrastructures.
intel.com/content/www/us/en/cloud-computing/cloud-builders-provide-proven-advice.html

Intel Network Builders
Get guidance on how to accelerate proven solutions for software-defined networking and Network Functions Virtualization. Download solution briefs and reference architectures to help build and enhance your network, and search products and solutions across a wide range of networking categories.
networkbuilders.intel.com/

Partner Solutions using Intel Xeon Processor E5 v3 Family

Accelerating Personalized Medicine with Intel® Xeon Processor E5-2600 v3 Product Family
Eoin McConnell, product line director for the Intel Xeon E5 family, describes how the latest server release contributes to the effectiveness and quality of life for patients with personalized, precision medicine not possible before. Describes the features of the system and tools that contribute to an orchestrated platform as well as improved performance over previous generations of Intel Xeon processors. (4:28 min.)
youtube.com/watch?v=OCPw-zm0SAs

AT&T and Intel: Transforming the Network with NFV and SDN
The communications industry is at an inflection point, and Intel innovations are enabling transformation. AT&T's John Donovan, senior executive vice president, AT&T Technology & Network Ops, explains how Intel technology is enabling the transformation of AT&T's network. (2:11 min.)
youtube.com/watch?v=F55pHxTeJLc

Delivering on the Promise of Personalized Medicine
Life sciences and technology are coming together to revolutionize scientific and medical discovery—from human genome sequencing to worldwide healthcare collaboration to personalized medicine. This video features some of the newest Intel technologies, industry use cases, and innovations in this exciting field. (3:59 min.)
youtube.com/watch?v=rXRIF7CLKiA

IBM* Cloud Delivers Greater Security with Intel® TXT on the SoftLayer* Platform
SoftLayer, an IBM company, will be the first cloud vendor to offer its customers bare metal cloud servers powered by Intel Cloud Technology, leveraging capabilities that provide monitoring and security down to the microchip level for a deep level of assurance and root of trust in enterprise cloud deployments. (1:54 min.)
youtube.com/watch?v=dYcNOAh2qlA
Endnotes

1. 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.

2. Intel does not control or audit the design or implementation of third-party benchmark data or web sites referenced in this document. Intel encourages all of its customers to visit the referenced web sites or others where similar performance benchmark data are reported and confirm whether the referenced benchmark data are accurate and reflect the performance of systems available for purchase.

3. 

4. Comparison based on SPECpower_ssj2008 results published as of August 26, 2014, Sugon* i620-G20 platform with two Intel Xeon processor E5-2699 v3, 10,599 overall ssi_ops/watt.


7. Intel Xeon processor E5-2699 v3 (18C, 45M cache) compared to Intel Xeon processor E5-2697 v2 (12C, 30M cache).

8. Results have been estimated based on internal Intel analysis and are provided for informational purposes only. Any difference in system hardware or software design or configuration may affect actual performance.

9. 8 GT/s and 128b/130b encoding in PCIe 3.0 specification enables double the interconnect bandwidth over the PCIe 2.0 specification. Source: pcisig.com/news_room/November_18_2010_Press_Release/


13. Intel Xeon processor E5-2699 v3 (18C, 45M cache) compared to Intel Xeon processor E5-2697 v2 (12C, 30M cache).

14. Source as of June 2014: Intel internal measurements on SPECint* rate_base2006 on platform with two Intel Xeon processor E5-2697 v2, Intel HT Technology and Intel Turbo Boost Technology enabled, 8 x 16 GB DDR3-1866, RHEL 6, 3, 448.5(SIR-SSE4.2, SFR-AVX). Scores: SIR=910. Platform with two Intel Xeon processor E5-2699 v3 (18C, 2.3 GHz, 145W), estimated score: SIR=1,263. Results have been estimated based on internal Intel analysis and are provided for informational purposes only. Any difference in system hardware or software design or configuration may affect actual performance.


17. Source as of September 8, 2014. Baseline: Fujitsu* PRIMERGY* RX300 S6 with two Intel Xeon processor X5690, VMware* ESXi 4.1.1 U1, VMmark* v2.1.1. Score: 7.59 @ 7 tiles, source. New configuration: Fujitsu PRIMERGY RX2540 M1 platform with two Intel Xeon processor E5-2699 v3, VMware ESXi 5.5.0 U2, VMmark v2.5.2 score: 26.48 @ 22 tiles, source. VMware VMmark is a product of VMware Inc.
18. Source as of August 2014 TR#3044 on STREAM (Triad): Supermicro X8DTN+ platform with two Intel Xeon processor X5680, 18 x 8 GB DDR3-800 score: 26.5 GB/sec. New configuration: Intel Server System R2208WTTYS with two Intel Xeon processor E5-2699 v3, 24 x 16 GB DDR4-2133 @ 1,600 MHz DR-RDIMM, score: 85.2 GB/sec.

19. Requires a system with Intel Turbo Boost Technology. Intel Turbo Boost Technology and Intel Turbo Boost Technology 2.0 are only available on select Intel processors. Consult your system manufacturer. Performance varies depending on hardware, software, and system configuration. For more information, visit intel.com/go/turbo.

20. Intel AVX/AVX2 is designed to achieve higher throughput. Depending on processor power and thermal characteristics, system power, and thermal conditions, AVX/AVX2 instructions may run at lower frequency to maintain reliable operations at all times. Lower frequency may limit performance. Actual impact varies with the workloads and the minimum frequency of the part.

21. Available on select Intel Core™ processors. Requires an Intel Hyper-Threading Technology–enabled system; consult with your PC manufacturer. Performance will vary depending on the specific hardware and software used. For more information, including details on which processors support Intel HT Technology, visit intel.com/info/hyperthreading.


23. Intel VT requires a computer system with an enabled Intel processor, BIOS, and virtual machine monitor (VMM). Functionality, performance, or other benefits will vary depending on hardware and software configurations. Software applications may not be compatible with all operating systems. Consult your system manufacturer. For more information, visit intel.com/go/virtualization.

24. No computer system can provide absolute security. Requires an enabled Intel processor, enabled chipset, firmware, and software, and may require a subscription with a capable service provider (may not be available in all countries). Intel assumes no liability for lost or stolen data and/or systems or any other damages resulting thereof. Consult your service provider for availability and functionality. For more information, visit intel.com/go/anti-theft. Consult your system manufacturer and/or software vendor for more information.

25. The SATA 3x specification enables double the data rate (from 3 Gb/s to 6 Gb/s) of that enabled by the SATA 2x specification. Source: sata-io.org/technology/6 Gbdetails.asp.

26. Requires a select Intel processor, enabled chipset, and Intel Rapid Storage Technology (Intel RST) software.

27. Based on the following configuration: Intel Server Board 2600CO (Copper Pass); Intel Xeon processor E5-2680 (2.7 GHz), 32 GB DDR2/1333 memory; Windows* 2008R2 SP1, Intel CAS 2.0 release candidate 1; I/O meter 10.22.2009; 4K random read test; 32-queue depth; 800 GB Intel SSD 910 series, Intel RAID RS25AB080 with MRSap1 firmware; 8 x 10 K SAS HDD in a RAID-0 array with MRSap1 firmware; and 8 x 10K SAS HDD in a RAID-0 array. For more information, go to intel.com/performance.

28. No computer system can provide absolute security. Requires an enabled Intel processor and software optimized for use of the technology. Consult your system manufacturer and/or software vendor for more information.

29. The Advanced Encryption Standard (AES) is an encryption standard first adopted by the U.S. government in 2001. It is widely used to protect network traffic, personal data, and corporate IT infrastructures.

30. Source as of June 2014 on AES-128-GCM Encryption algorithm: Intel internal measurements using Aztec City platform with two E5-2658 v3, DDR4-2133, CentoS* v3.8.4, OpenSSL* v1.0.2-beta1. Baseline configuration: Intel internal measurements with two E5-2658 v2, DDR3-1866, CentOS v3.8.4, OpenSSL v1.0.2-beta1. 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 intel.com/performance.

31. Source as of June 2014: Intel internal measurements on Mayan City CR8 with one Intel Xeon E5-26xx v3 (14C, 2.3 GHz, 145W), 8 x 4 GB DDR4-1600, RHEL kernel 3.10.18, PCPS on 110W, PCPS off 70W on an internal web workload. 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 intel.com/performance.


33. Intel Node Manager requires servers with Intel Node Manager and enabled monitoring or management software, such as Intel Data Center Manager.

34. Source: 40 percent increase in density per published proof of concept: http://communities.intel.com/docs/DOC-4212.
More from the Intel IT Center

Real-World Guide: How to Build Next-Generation Data Center Infrastructure is brought to you by the Intel® IT Center, Intel’s program for IT professionals. The Intel IT Center is designed to provide straightforward, fluff-free information to help IT pros implement strategic projects on their agenda, including virtualization, data center design, cloud, big data, and client and infrastructure security. Visit the Intel IT Center for:

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• Information on events where you can hear from Intel product experts as well as from Intel’s own IT professionals

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Notice revision #20110804.

Relative performance is calculated by assigning a baseline value of 1.0 to one benchmark result, and then dividing the actual benchmark result for the baseline platform into each of the specific benchmark results of each of the other platforms, and assigning them a relative performance number that correlates with the performance improvements reported.

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.

Intel does not control or audit the design or implementation of third-party benchmarks or web sites referenced in this document. Intel encourages all of its customers to visit the referenced web sites or others where similar performance benchmarks are reported and confirm whether the referenced benchmarks are accurate and reflect the performance of systems available for purchase.

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