Real-World Guide

Data Center Infrastructure Built on the Intel® Xeon® Processor E5 Family
What IT Managers Need to Know to Build Their Next-Generation Data Centers

Why You Should Read This Document

This guide explains how building data center infrastructure on the Intel® Xeon® processor E5 family can support new and innovative services such as virtualization and cloud computing by:

- Boosting server performance to support high-compute applications, handle more data, and manage greater virtual machine density
- Supporting unified networking through 10 gigabit Ethernet solutions that simplify data center infrastructure and provide greater 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 control at the server, rack, row, and data center level
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Data Centers under Pressure

These are exciting times in the data center! New technologies promise more innovative services to the business at lower costs. The strategic value of your data center is greater than ever.

The explosive growth of unstructured data puts new demands on your network and storage infrastructure and challenges your ability to deliver new services such as cloud computing. 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, more and more 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 service delivery? How can you support 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 offer opportunities for IT managers like you to take the next step in the evolution of your data center. Intel’s release of the Intel® Xeon® processor E5 family can help you forge ahead with your next-generation data center initiatives, including virtualization, cloud service delivery, and high-performance computing.

The Purpose of This Guide

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

These usage scenarios will help you evolve your data center and unlock the potential of solutions such as private cloud. You can implement them 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 the guide.

The remainder of this guide describes the practical considerations for implementing the Intel Xeon processor E5 family for the following usage scenarios:

- Stepped-up server performance
- Unified networking
- Increased data and infrastructure security
- Scaled-out storage for virtualized and cloud environments
- Optimized power across the data center

Data Center Challenges: Formidable and Diverse

- Explosive 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 your 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.
Platforms Based on Intel Xeon Processor E5 Family: The Heart of Your Data Center

The Intel Xeon processor E5 family provides a single platform that combines built-in capabilities and increased performance that support diverse needs in the data center. With the Intel Xeon processor E5 family, you can leverage the cloud and all it has to offer, as well as other emerging technologies.

The Intel Xeon processor E5 family raises the bar for data center efficiency while enabling your data center to handle increasing network, storage, security, and power demands.

Intel IT Refresh Central to Delivering Business Value

Intel IT technology refreshes have supported hundreds of millions of dollars in efficiencies, including:

- Server consolidation ratios up to 20:1 with the latest generation of Intel Xeon servers
- Private cloud savings of $9 million to date and $6 million annually expected over the next four years
- A determination that moving to blades improves cloud total cost of ownership by 29 percent

The Intel Xeon processor E5 family offers us increased opportunities to improve our own IT environment. We’ve tested and intend to refresh and deploy the Intel Xeon processor E5 family across the Intel IT environment and expect it to be the predominant platform across our environment. Already in the design area, testing has resulted in up to 55 percent performance improvements over the Intel Xeon processor 5600 series. For our cloud environment, the performance gain from the Intel Xeon processor E5 family will enable Intel IT to meet its future goals of federated clouds at 80 percent utilization.
Our data center strategy includes refreshing across storage, network, and facilities with a goal driving 80 percent effective utilization of Intel’s global data center resources. Already in progress are these initiatives:

- **Storage optimization.** In 2011 alone, we faced a 53 percent increase in storage capacity to 38.2 petabytes from 2010, and our private cloud build out would add even more demand. Using a variety of techniques, such as thin provisioning, tiering, storage refresh, use of solid state drives (SSDs), and increased utilization, our storage refresh and optimization are driving $9.2 million in savings.5

- **Upgrading to 10 gigabit Ethernet (GbE).** Upgrading our network architecture enables us to optimize data center infrastructure to accommodate current growth and meet increasing network demand in the future—including our design team’s high-intensity computing needs. Plus, we helped reduce network costs by up to 25 percent.6

- **Data center consolidation.** At the center of our data center strategy is the “model of record,” a new decision making model based on our highly regarded manufacturing environment. Using the model, we benchmark each data center against a best achievable model, which enables us to fill gaps to deliver the greatest improvements in velocity, quality, efficiency, and capacity. One result of applying this model is that we anticipate being able to reduce data center count by as much as 35 percent during the next few years.3

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**The Power to Do More in Your Data Center**

The Intel® Xeon® processor E5 family supports IT innovation with these key features:

- Performance for single and multithreaded applications, including high-performance computing
- Elastic scaling to adapt to fluctuating workload and increasing network and storage demands
- Hardware-based security to enable isolation, visibility, and control of dynamic, virtualized workloads and data center infrastructure
- Support for integrated 10 gigabit Ethernet (10 GbE) and simplified data center infrastructure
- Performance and I/O enhancements to improve and balance overall system performance and increase server efficiency
- More bandwidth for high-performance computing applications
- Server and data center-level power monitoring and management to optimize power consumption
- Accelerated encryption and decryption to allow more pervasive data protection uses
- Support for open and interoperable solutions
- Reduced power costs
Stepped-Up Server Performance

Performance demands on the data center require ever more powerful computing capabilities. Data centers need more powerful servers that can run compute applications for technical, financial, scientific, and content creation workloads; handle more data; and manage greater virtual machine (VM) density. This scenario applies to high-performance computing, virtualization, consolidation, and cloud computing.

How It Works

The Intel Xeon processor E5 family combines physical changes to the processor and built-in technologies to significantly boost performance.7

Physical Improvements to the Processor

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

- Up to two additional cores
- Up to 8 MB more last-level cache
- More memory: Six additional dual inline memory modules (DIMMs) 2S-platform systems and support for up to 32 gigabytes (GB) DIMMs, increasing memory capacity from 288 GB to 768 GB
- More integration: Intel Integrated I/O to reduce latency 30 percent,8 and offer up to 80 Peripheral Component Interconnect Express (PCIe*) lanes per system

Higher bandwidth is supported throughout the platform with contributions of additional speed via Intel QuickPath Interconnection (Intel QPI) (8.0 gigatransfers per second), more links between processors, support for DDR3-1600 memory, and the first enterprise support for PCIe 3.0.

Server Performance by the Numbers

- Up to 80 percent9 over previous generation (at a consistent power level)
- Reduced network latency by up to 30 percent7,8
- Increased floating point operations per clock (FLOPS) up to two times faster10
- Faster speeds and greater bandwidth through integrated support for PCIe 3.011
Built-in Capabilities

Intel Turbo Boost Technology 2.0

Intel Turbo Boost Technology 2.0 adds intelligence and adaptability to the chip by handling workload spikes. To do this, the processor increases frequency (“turbos up”) at the operating system’s request 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.

We’ve improved the turbo algorithm to assess if 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.

Intel Advanced Vector Extensions (Intel AVX) 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 (Intel AVX) accelerates floating point operations per clock (FLOPS) by as much as two times with instructions that double the length of the registers. This dramatic increase is because Intel AVX 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. Intel AVX is supported by Intel and third-party compilers that take advantage of the latest instruction to optimize code for significantly reduced compute time.
Unified 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 solutions can simplify your network infrastructure through port consolidation and the convergence of LAN and storage area network (SAN) traffic onto a single fabric.

Through port consolidation, you can combine multiple 1 GbE ports onto one or two 10 GbE ports, which streamlines cabling, reduces power, and improves bandwidth. The greater bandwidth provided by 10 GbE and 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. Plus, with 10 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.

Poised to become a compelling choice for 10 GbE server connectivity, 10GBASE-T is based on the familiar and well-understood RJ-45 cabling scheme. The technology is fully backward compatible with 1 GbE equipment, provides great flexibility in network design due to its 100-meter reach capability, and offers a cost-effective and transparent migration path to 10 GbE and unified networking.

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.

Physical Improvements to the Processor

In addition to more cache and main system memory, the Intel Xeon processor E5 family merged the I/O controller directly onto the processor die rather than on a separate component of the motherboard.

Built-in Capabilities

Intel Integrated I/O Technology

Intel Integrated I/O technology manages data traffic through:

- The integrated I/O controller, which significantly reduces latency
- Integrated PCIe 3.0 support with more lanes than previous generations for greater flexibility in connecting peripheral devices to the processor, which can double bandwidth

Networking Performance by the Numbers

General improvements:

- Reduced network latency by up to 30 percent8
- PCIe support6 for increased bandwidth by as much as 2 times14 per server
- I/O improvement by up to 2.3 times7, 15

With 10 gigabit Ethernet (GbE) consolidation16

- Up to 45 percent reduction in power per rack
- Up to 80 percent reduction in cables and switch ports
- Up to 15 percent reduction in data center infrastructure costs
• Support for a growing ecosystem of PCIe 3.0 add-in cards
• Intel Data Direct I/O Technology (Intel DDIO)

**Intel Data Direct I/O Technology (Intel DDIO)**

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 rearchitected 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 Virtualization Technology for Connectivity (Intel VT-c) is a collection of platform-level I/O virtualization technologies and initiatives that enables 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.

**Unified Networking from Intel**

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

**Intel Ethernet Controller X540**. The industry’s first fully integrated 10GBASE-T controller designed for low-cost, low-power LAN on motherboard (LOM) integration in mainstream servers includes:

• Unified networking support for Internet Small Computer System Interface (iSCSI) and Fibre Channel over Ethernet (FCoE)

• Advanced virtualization optimizations via Intel Virtualization Technology for Connectivity.

**Intel Ethernet Unified Networking**. Intel Ethernet Converged Network Adapters deliver high-performance unified networking using native operating system–based storage initiators for iSCSI and FCoE and intelligent hardware–based offloads. 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. Key capabilities include:

• Performance that scales with server refreshes by relying on the server’s multi-core processors to handle storage traffic rather than a discrete hardware engine. As server performance improves, so will performance of native initiator-based solutions.

• Ensuring quality of service (QoS) by keeping the flow of the various types of traffic visible to operating-system-based utilities, which enables taking full advantage of other operating system and hypervisor QoS tools.

More about I/O improvements:

intel.com/content/www/us/en/processors/xeon/xeon-e5-integrated-i-o-demo.html
Scale-out Storage for Virtualized and Cloud Environments

The explosion of digital content and the emergence of new usage models, such as cloud computing, demand new storage architecture. Data—much of it unstructured—must be readily available for business, regulatory, and compliance needs. Scale-out storage addresses three major challenges associated with managing unstructured data: increasing volume, inefficient data management, and cost.

How It Works

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

Intel Xeon processor E5 family-based storage devices enable massive scalability for usage scenarios that involve unstructured data (such as e-mail, instant messages, documents, spreadsheets, images, and video) but scale incrementally to avoid expensive overcapacity provisioning. Capacity is expanded 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 family also provides the performance within storage solutions to enable next-generation software capabilities like thin provisioning, compression, automated tiering of data, data deduplication, and erasure coding/RAID over nodes. These solutions optimize capacity and balance storage I/O, as well as keep costs down.

More about optimizing storage:

Increased Data and Infrastructure Security

Dynamic virtualization, multititenancy, 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 encrypt data.

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 emerging attacks such as virtual rootkits and the desire to move more critical workloads to the cloud, software-only approaches often fall short of the isolation needed to protect the contents of each VM.

Controlling the computing environment is difficult in cloud implementations. Traditional security tools are abstracted away or may not fit in to the new virtualized, cloud-oriented workflows or architectures. But sensitive workloads and policy or regulatory conditions demand knowledge of 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 family strengthens data and infrastructure protections with built-in capabilities that reduce security performance penalties and improve isolation and control of shared, virtualized environments. It establishes a hardware "root of trust" that enforces policies for platform integrity and encourages pervasive data encryption with acceleration, which lowers the performance tax. Combined, these capabilities provide a robust foundation to better address needs for security in data centers and shared infrastructures.

Encryption by the Numbers

- Seven instructions that accelerate encryption/decryption
- Up to 10 times faster than software-only Advanced Encryption System (AES) solutions

Built-in Capabilities

Intel Trusted Execution Technology (Intel TXT)

Intel Trusted Execution Technology (Intel 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. Intel TXT hardens the platform against attack, starting 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.

Intel 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. Intel TXT enforces this control by checking the hypervisor integrity at start-up, measuring the code of the hypervisor, and 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 onto trusted platforms.

Similarly, integrity-checking data from Intel 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.

Intel Advanced Encryption Standard New Instructions (Intel AES-NI)

Intel AES-NI provides performance benefits that make high-volume encryption faster and more efficient for data transport and storage workloads. Intel 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 AES-NI increases encryption speed via a set of seven new instructions that accelerate parts of the AES algorithm encryption and decryption execution. Intel AES-NI can accelerate performance up to 10 times faster than a software-only AES solution, making encryption practical, stronger, and more efficient. Intel AES-NI can be used in any of the growing set of optimized applications that use AES, including network, disk, and file encryption solutions.

More about trusted technology:


More about data encryption:

Optimized Power across the Data Center

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.

How It Works

The Intel Xeon processor E5 family combines built-in, intelligent power technology and sensors that provide advanced power and thermal instrumentation at the server level.

Physical Improvements to the Processor

The Intel Xeon processor E5 family provides up to 70 percent higher relative performance when tested at the same power. Plus, the processor's microarchitecture is designed to emphasize power reductions in both active and idle states.

To improve idle power as well as best match power draw to processor use, the Intel Xeon processor E5 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.

Power Improvement by the Numbers

- Up to 70 percent higher relative performance.
- Up to 40 percent greater rack density.
- Twenty OEMs and original design manufacturers (ODMs) support Intel Node Manager (learn more).
- Sixteen ISVs enable power management consoles (learn more).
**Built-in Capabilities**

*Intel Node Manager and Intel Data Center Manager Software*

One tool for data center administrators is Intel Node Manager 2.0, which monitors each system's power and thermal levels and gives granular control of each system. 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. Using a third-party console, you can set group policy at the rack level for individual servers running Intel Node Manager to ensure that the aggregated systems never exceed the rack's power budget.

For example, if the maximum power per system is 300 watts (W) but the average utilization is 180 W, you can aggregate 20 servers and set power policy to never exceed a rack-level limit of 3.6 kilowatts (kW). Intel Node Manager automates 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 is a software development kit (SDK) that ISVs or OEMs integrate into their management software. It is not sold as a separate Intel product. Together with third-party management consoles, Intel Data Center Manager provides automated control of power and cooling via policies, so you can monitor and manage energy demands deterministically for aggregated resources at the row or data center level. This enables you to manage within the power and cooling resources available and optimize productivity at the server, rack, row, or data center level. During an event, data center power is automatically reduced to extend operations and minimize potential damage. These tools also provide the instrumentation to enable power-based load balancing or load migration.

Intel Node Manager is currently supported by more than 20 leading OEMs and ODMs, as well as 16 ISVs enabling power management consoles.

More on improving power management:

Next Steps

With so many demands on the data center, where do you start?

Get started by identifying inefficiencies in your data center that may have prevented you from moving forward with new services in the past. Below is a high-level list of considerations to help you understand your current situation and plan for necessary improvement to your networking, storage, security, and power-management infrastructure. The Intel Xeon processor E5 family can support your initiatives in each of these areas as you take the next steps to evolve your data center.

Checklist for Identifying Data Center Inefficiencies

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; and 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?

☐ 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 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*)?
- 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 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 much of your data is encrypted?
- Would you like to increase the amount of data you encrypt, but you worry about performance?

Power Management

- What solutions do you currently use to optimize power and reduce costs?
- Would increased performance per watt reduce energy costs in your data center?
- 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?
## Intel® Xeon® Processor E5 Family Capabilities Summary

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<th>Capabilities</th>
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<td>Enables idle cores to go to near zero power draw</td>
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<tr>
<td>Intel® Advanced Vector Extensions</td>
<td>Increases floating point operations per second per clock up to 2 times²,¹⁰</td>
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<tr>
<td>Intel Advanced Encryption Standard New Instructions</td>
<td>Accelerates encryption by up to 10 times⁷,¹⁸</td>
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<tr>
<td>Intel Data Center Manager</td>
<td>Enables improved dynamic workload placement and migration</td>
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<td>Intel Hyper-Threading Technology</td>
<td>Doubles the number of threads per core</td>
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<td>Intel Integrated I/O Technology</td>
<td>Reduces I/O latency⁷,¹⁸ up to 30 percent and supports PCIe* 3.0</td>
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<td>Intel Node Manager 2.0</td>
<td>Monitors and limits power monitoring to maximize operating efficiency</td>
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<td>Intel QuickPath Interconnect</td>
<td>Delivers up to 3.5 times⁷,²⁵ the bandwidth with high-bandwidth processor interconnect</td>
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<td>Intel Trusted Execution Technology</td>
<td>Hardware-based root of trust defends against software attacks during launch</td>
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<td>Intel Turbo Boost Technology 2.0</td>
<td>Provides higher frequencies to reduce hard workload spikes</td>
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<tr>
<td>Intel Virtualization Technology</td>
<td>Delivers platform-level capabilities to enhance virtualization performance</td>
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Intel Resources for Learning More

Enhancing Security with Intel® Trusted Execution Technology
This animation describes the security issues facing today's data centers and describes how Intel TXT can provide hardware-based protection for data and data center infrastructure in virtualized environments. (Length: 4:04 min.)

Improve Power Management with Intel® Intelligent Power Node Manager
This animation describes how data centers can optimize power across the data center with built-in capabilities that help you manage power at the server, rack, row, and data center level. (Length: 2:38 min.)

Increase Server Performance: Intel® Xeon Processor E5 Family
An animated look at the performance increases in the Intel Xeon processor E5 family and how they can benefit data center infrastructure. (Length: 2:50 min)

Intel® AES New Instructions Demo
This animation describes how Intel AES-NI supports enterprise encryption strategies with accelerated encryption and reduced vulnerability to side-channel attacks. (Length: 2:31 min)

Meeting IT Demands: The Intel Xeon Processor E5-2600 Family
An animated overview about issues facing today's data centers and an explanation of how the Intel Xeon processor E5 family can help IT managers succeed in addressing them. (Length: 1:38 min.)
intel.com/content/www/us/en/processors/xeon/xeon-e5-overview-animation.html

Reduce Latency, Improve Data Throughput: Intel® Integrated I/O
An animated presentation about how the Intel Xeon processor E5 family enhances I/O throughput to take advantage of significantly greater server performance. (Length: 3:00 min.)
intel.com/content/www/us/en/processors/xeon/xeon-e5-integrated-i-o-demo.html

For more information about the Intel Xeon processor E5 family, visit intel.com/XeonE5.
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®, 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 Guide
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.

About Next-Generation Data Centers

Peer Research: Cloud Computing Research for IT Strategic Planning
Results of a survey of IT professionals describing the business and technology drivers for evolving networking and storage technologies to support cloud environments.
intel.com/content/www/us/en/cloud-computing/next-generation-cloud-networking-storage-peer-research-report.html

Inside Intel IT on Technology for Tomorrow's Cloud
In this podcast, Ajay Chandramouly, Intel's Cloud Computing and Data Center Industry engagement manager, and Terry Yoshii, enterprise architect for Intel IT Research, look at the business case for developing a private cloud and outline the basics of building a cloud for the future. (Length: 7:10 min.)

Planning Guide: Technology for Tomorrow's Cloud
Describes how IT managers can prepare their virtualized data centers for the cloud in three key areas with unified networking, scale-out storage, trusted server pools, and policy-based power management.

Vendor Round Table: Cloud Storage
Four vendors answer a standard set of questions about their cloud storage offerings to help IT managers better evaluate cloud storage technology. Vendors include Amplidata, DataDirect Networks, EMC, and NetApp.
Intel® Cloud Builders Program
Get guidance from this cross-industry initiative to build 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, secure, and increase the efficiency of cloud infrastructures.
intelsite.com/content/www/us/en/cloud-computing/cloud-builders-provide-proven-advice.html

Cloud Computing Infrastructure: Cloud Builders Reference Architecture Library
Explore proven cloud-building reference architectures developed by leading systems and solutions providers to help solve key IT challenges and improve security and efficiency and simplify your data center. Each reference architecture is based on real-world IT requirements and provides detailed instruction for how to install and configure a particular cloud solution using Intel Xeon processor–based servers and technologies.
intelsite.com/cloud-builders/library
Endnotes


7. 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.

8. Intel internal measurements of average time for an I/O device read to local system memory under idle conditions comparing Intel Xeon processor E5-2600 product family (230 ns) vs. Intel Xeon processor 5500 series (340 ns). Baseline Configuration: Green City system with two Intel Xeon processor E5520 (2.26 GHz, 4 C), 12 GB memory @ 1333, C-States Disabled, Turbo Disabled. New Configuration: Meridian system with two Intel Xeon processor E5-2665 (2.4 GHz, 8 C), 32 GB memory @1600 MHz, C-States Enabled, Turbo Enabled. The measurements were taken with a LeCroy® PCIe® protocol analyzer using Intel internal Rubicon (PCIe 2.0) and Florin (PCIe 3.0) test cards running under Windows* 2008 R2 w/SP1.


11. 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 performance of systems available for purchase.

12. 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 PC manufacturer. Performance varies depending on hardware, software, and system configuration. For more information, visit intel.com/go/turbo.

13. AVX performance: Intel AVX is a new 256-bit instruction set extension to SSE and is designed for applications that are Floating Point (FP) intensive. To learn more about Intel AVX information, visit software.intel.com/en-us/avx/.

14. Eight GT/s and 128 b/130 b 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
15. Up to 2.3x I/O performance is 1S with an Intel Xeon processor 5600 series vs. 1S Xeon Processor E5-2600 data for L2 forwarding test using 8x10 GbE ports. Configuration details: 64B L2 Forwarding Benchmark, Rose City CRB, 8x2GB DDR3-1333MHz, 1xSNB-EP 8C B0, 2.8GHz (2.7GHz + turbo), Green City Platform, 6x2GB DDR3-1333MHz, Xeon 5680 6C, 3.3GHz, 1-4x X520-DA2 Dual 10GbE Ethernet NICs, Linux* 2.6.32, lxqbe 2.0.94 (stackless driver w/ data touch), Intel Ethernet Labs, April 2011.

16. Ethernet consolidation source: Intel 10 GbE ROI Calculator. This ROI calculator is a cost comparison for a highly virtualized solution, using multiple 1 GbE connections, versus a dual-port 10 GbE implementation: event-management-online.de/LAD/calculator.aspx

17. Intel Virtualization Technology (Intel VT) requires a computer system with an enabled Intel processor, a BIOS, and a 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 PC manufacturer. For more information, visit intel.com/go/virtualization.

18. Source: Testing with Oracle* Database Enterprise Edition 11.2.0.2 with Transparent Data Encryption (TDE) AES-256 shows as much as a 10x speedup when inserting one million rows 30 times into an empty table on the Intel Xeon processor X5680 (3.33 GHz, 36 MB RAM) using Intel IPP routines, compared to the Intel Xeon processor X5560 (2.93 GHz, 36 MB RAM) without Intel IPP.

19. No computer system can provide absolute security under all conditions. Intel Trusted Execution Technology (Intel TXT) requires a computer with Intel Virtualization Technology, an Intel TXT–enabled processor, a chipset, a BIOS, Authenticated Code Modules, and an Intel TXT–compatible measured launched environment (MLE). Intel TXT also requires the system to contain a TPM v1.s. For more information, visit intel.com/technology/security.

20. Intel AES-NI requires a computer system with an AES-NI–enabled processor, as well as non-Intel software to execute the instructions in the correct sequence. AES-NI is available on select Intel Xeon processors. For availability, consult your reseller or system manufacturer. For more information, see software.intel.com/en-us/articles/intel-advanced-encryption-standard-instructions-aes-ni.

21. 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.

22. Source: Performance comparison between processors at the same TDP (130 W) using best publications of SPECfp_rate_base2006 benchmark available as of March 6, 2012. Score of 271 published on prior-generation 2S Intel Xeon processor X5690 (130W)-based platform. Score of 466 published on new 2S Intel Xeon processor E5-2680 (130W)-based platform. For additional details, please visit spec.org.

23. Source: Forty percent increase in density per published proof of concept: communities.intel.com/docs/DOC-4212

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

25. Intel internal measurement. (February 2009) Stream-Triad benchmark. Red Hat Enterprise Linux Server 5.3. Intel Xeon processor E5472, 3.0 GHz, 2x6 MB L2 cache, 1600 MHz system bus, 16 GB memory (8x2 GB FB DDR2-800) vs. Intel Xeon processor X5570, 2.93 GHz, 8 MB L3 cache, 6.4 QPI, 24 GB memory (6x4 GB DDR3-1333).
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