Intel IT Center

PLANNING GUIDE

Data Center Optimization

Evaluating Your Data Center Strategy to Optimize Cloud Service Delivery and Move toward a Software-Defined Infrastructure

WHY YOU SHOULD READ THIS DOCUMENT

This planning guide provides IT managers with insight on why you should optimize your data center to deliver competitive advantage and:

- Achieve operational efficiency
- Deliver modern services such as cloud computing
- Take advantage of new business opportunities such as big data, high-performance computing, enterprise mobility, and social and collaborative computing

Most importantly, this guide offers practical guidance for getting started on your data center optimization effort in four steps that comprise:

- Creating a data center strategy
- Enabling an agile IT organization through virtualization and cloud
- Building out a cloud and turning IT into a broker of services
- Measuring your success

Contents

3 Data Centers under Stress

5 A Balanced and Optimized Data Center

7 How to Optimize your Data Center: Four Steps

12 Setting the Foundation for Software-Defined Infrastructure

14 Case Study: Intel IT

15 Summary

16 Next Steps: Where Are You in the Data Center Optimization Process?

17 Intel Resources for Learning More

Data Centers under Stress

These days, IT is expected to serve as a strategic partner for business innovation, while at the same time keeping the business running and reducing operating costs. At the focal point of this dilemma is the data center, traditionally a workhorse for enterprises that increasingly need more of a racehorse for rapid innovation and business opportunity.

Enterprise data centers must evolve to provide the agility and efficiency that accelerate business growth. Powerful technologies already exist to facilitate rapid service delivery—for example, cloud computing, high-performance computing, and big data. These technologies provide huge opportunities for companies that can deploy them successfully.

Data center technology continues to evolve at a rapid pace, and keeping up is one of the greatest challenges IT faces today. This planning guide looks at the issues behind data center optimization—transforming your data center to meet the requirements of today's business while laying the groundwork for a next-generation data center that supports even greater business innovation and efficiency.

Your data center optimization strategy is critical for your IT organization to stay competitive. By rapidly implementing or brokering the breakthrough solutions your business users need and offering services that help your company maintain governance, security, and compliance requirements, you can partner effectively with line-of-business managers. In turn, your business users will have less need to go out and buy services directly from a public cloud provider because they are faster and cheaper. In addition, you'll be able to protect data and intellectual property (IP) more effectively, as well as improve utilization of internal resources.

Aging Infrastructure Isn't Helping Cost or Performance

The most recent economic downtown has left many data centers behind in their infrastructure upgrade cycle. Aging data center infrastructure places IT and the entire organization at a greater security risk, and maintaining older systems typically costs more than newer, more efficient systems. But more importantly, aging equipment simply can't perform the way it needs to. The risk of obsolescence trumps all.

The latest infrastructure technology addresses these issues by delivering significantly better performance, reducing energy consumption, lowering operating and maintenance costs, and providing advanced security measures to ensure compliance and defend against the latest security threats. In addition, higher-performing technology builds flexibility and agility into your IT services so that you can capitalize on new business opportunities. With an updated infrastructure, you can convert your IT organization from a cost center to a strategic asset that will help drive business success.

This planning guide looks at the issues behind data center optimization—transforming your data center to meet the requirements of today's business while laying the groundwork for a next-generation data center that supports even greater business innovation and efficiency.

Decisions Now Have Implications for the Future

The risks of not upgrading and optimizing your data center can be significant. At the same time, a partially upgraded data center can also prevent the organization from taking full advantage of the latest technology and security capabilities. IT must take a thoughtful approach to data center optimization to get the most from the investment today while preparing for the next level of data center innovation—an automated and orchestrated environment via software-defined infrastructure (SDI).

SDI enables data center transformation from proprietary, fixed-function equipment to standard, agile, and cost-effective systems across compute, storage, and network resources. There are two key aspects of SDI:

- **Automation and orchestration** – An automated resource pool of virtualized compute, storage, and network capabilities enables provisioning, monitoring, and reporting on underlying infrastructure. Policy-driven workload and life-cycle management delivers greater efficiency, agility, and security across the data center.
- **Decoupled hardware and software** – SDI moves from proprietary tightly coupled hardware and software to open-standards-based systems automated by software.

SDI also promises to take the gains from cloud computing to the next level, increasing agility and providing even faster time to value through rapid provisioning, improving efficiency and reliability via virtualization, and increasing energy efficiencies through orchestrated power management. Operating on open-standards-based servers and pooling and assigning resources enables IT to lower costs, and built-in intelligence and automation will provide more time for IT staff to focus on strategic tasks.

Why You Still Need Your Data Center

Ultimately SDI requires the rearchitecting of the data center. With infrastructure becoming software defined, much of the work of the data center will be delivered through services. This transition will not happen overnight, but by updating your aging infrastructure for cloud deployments, optimizing applications for cloud service resiliency, and ensuring that your infrastructure foundation is in place, you are taking steps in the right direction.

Your data center remains central to the present and future delivery of IT services, even if you are taking advantage of public cloud for certain applications. Plus, some types of data may need to live in a secure, on-premises location—for example, to protect IP or ensure compliance with legal and regulatory requirements. Also, the best solution may not be offered by a public cloud provider or even exist for cloud infrastructure (for example, because of bandwidth limitations).

For the foreseeable future, the new data center will be a mix of traditional and cloud, on-premises and off-premises services. Optimizing for cloud and beyond will require architecture and solutions adapted to the best approach for delivering unique business functions.

Data Center Architecture Examples

Data center architecture is not a one-size-fits-all solution. One set of business processes may rely on compute-intensive workloads, while for others reliability, availability, and serviceability (RAS) capabilities are critical.

The following are three examples of data center architectures built around common business functions:

- **Compute-intensive, latency-sensitive workloads** – These workloads require enough compute capacity and performance to support requirements. Depending on those requirements, architecture may include high-performance computing (HPC), grid computing, or clustered local workstation computing with solid-state drives (SSDs) as fast-swap drives. Typically, users of these systems require access to data quickly, so consider investing in a combination of storage resources, including clustered and high-performance storage, scale-out network-attached storage (NAS), highly scalable parallel storage for any HPC needs, and storage area networks (SANs) for databases.
- **Business continuity scenarios** – For business operations that need to be available 24/7 such as enterprise resource planning (ERP) and other mission-critical systems, consider an architecture that might include dedicated data centers with RAS capabilities and redundancy spread across other environments. This approach can almost eliminate downtime from a catastrophic event and saves time in the deployment of new platforms and applications.
- **Agility and speed scenarios** – To improve agility and velocity, a private enterprise cloud built on a highly virtualized environment can provide rapid, on-demand services that significantly reduce the time to provision infrastructure for new business services. This type of environment may use SAN storage or NAS storage, depending on data access requirements.

For more on how to architect for specific workloads, view the video "Workload-Driven Solutions for the Data Center."

A Balanced and Optimized Data Center

What does it really mean to have an optimized data center? Advances in compute, storage, and networking technology combined with optimized software applications have dramatically increased data center efficiency and security. Virtualization is a key data center technology that enables more work by fewer machines, thereby saving IT energy, licensing, and real estate costs.

The path to transforming your data center serves three purposes that enable you to:

- **Deliver services** your business needs today and support short- to midterm growth.
- **"Buy ahead"** with technology that is also capable of taking the next step in your data center evolution while continuing to support business.
- **Save costs** by refreshing infrastructure, adopting cloud computing, updating your network, pursuing IT sustainability, and consolidating data centers.

Watch the video "Data Center Refresh for Operational Efficiency" for a quick overview of how upgraded and optimized technology can help you spend less time managing your data center and more time serving the business.

Optimizing Your Data Center: Three Stages

Every organization starts at a different place on the path to data center optimization. Each step forward requires business readiness for the technology and innovations that follow. This means that transformation of your data center will occur in stages, rather than as a complete "rip and replace." Each stage will provide clear benefits and lay the groundwork for the next.

There are three stages to optimizing your data center:

1. **Improve operational excellence.** The latest hardware and software capabilities are designed to minimize operating expenses, maximize efficiency, and help ensure security and compliance. This stage is focused on replacing aging infrastructure with the goal of supporting cloud computing.
2. **Deliver innovative services.** Cloud computing provides new ways to deliver services on demand to your workforce, customers, and partners. Take advantage of private, public, or hybrid cloud solutions to achieve the best total cost of ownership (TCO) for your applications.
3. **Take advantage of new business opportunities.** The latest infrastructure and cloud computing technologies also enable your business to embrace opportunities such as big data, Bring Your Own Device (BYOD) programs, and social and collaborative computing.

Operational Excellence: Upgrading Aging Infrastructure

The first step is to upgrade infrastructure that may not be performing well.

Compute

Server innovations have resulted in more powerful machines with faster processors, greater CPU capacity and memory, built-in security capabilities, and significantly less power consumption. You can literally do more with less by replacing a number of older servers with fewer new ones. Other types of server innovation include:

- True in-memory computing capabilities that make data-intensive workloads faster and can support real-time reporting and analytics
- Lower-cost , high-density, energy-efficient microserver form factors suitable for lightweight scale-out workloads such as static web page serving, basic content delivery, and entry-dedicated hosting

Intel IT's Data Center Transformation Creates Business Value

Intel IT's multiyear data center strategy for business transformation has generated new business value of more than USD 184 million from 2010 through 2013.

For more detail on how, read the white paper *Intel IT's Data Center Strategy for Business Transformation*.

Server architecture built with the latest Intel® processor-based systems can reduce IT complexity via interoperability. In addition, built-in capabilities enable key optimization technologies such as virtualization that can simplify your data center footprint and provide faster, more elastic compute capacity for both cloud and on-premises solutions. Intel processor-based servers also build data protection technologies and infrastructure security technologies into the CPU, which increases performance on heavy-load systems and can aid extract, transform, and load (ETL) data processing from on-premises to the cloud and vice versa.

Intel offers a full range of processors for the data center and works closely with a broad ecosystem of leading providers to design products that take advantage of Intel architecture capabilities and offer exceptional solution choice. Get more about Intel Xeon® processors.

Network

Existing 100-megabit-per-second (Mbps) and 1-gigabit-Ethernet (GbE) connections can't keep up with growing demands for bandwidth. Cisco's *Visual Networking Index* for 2014 predicts that broadband speeds will increase by 2.7 times globally by 2018—from 15 Mbps to 42 Mbps.[1] Forward-thinking data centers are replacing slower connections with 10, 40, and 100 GbE connections necessary to transport a threefold Internet traffic increase that is forecast to reach 1.6 zettabytes by 2018.[1]

Upgrading fabric design:

- Reduces data center complexity through fewer physical connections
- Lowers TCO in virtualized environments by 18 to 25 percent via simplification of LAN and cable infrastructures, and lowers space, power, and cooling requirements[2]
- Increases throughput with faster connections and reduced latency
- Improves agility by adapting more easily to changing business needs such as additional storage capacity

The latest Intel Xeon processors include hardware-assisted support for 10 and 40 GbE solutions, faster I/O, and enhanced virtualization performance. In addition, Intel's server network adapters make it easy to scale virtual workloads quickly and efficiently, help secure data, and support network virtualization. Find out more about Intel Ethernet Converged Network Adapters and Intel Ethernet Gigabit Server Adapters.

Storage

Advances in storage technology include intelligent storage solutions with advanced capabilities that make it more efficient to store and access data. The solid-state-drive medium provides exceptional speed, reliability, and consistency for mixed-use workloads. Storage upgrades should be based on specific business and user requirements.

High-performance Intel processors can power flexible, cost-effective storage solutions that accelerate data storage and retrieval. Built-in technologies also optimize performance of compute-intensive techniques to minimize storage capacity requirements, such as thin provisioning, data deduplication, data compression and decompression, and storage virtualization. As part of a storage solution, Intel Solid-State Drives for the data center provide fast data access while conserving power consumption, and can be flash-swapped as necessary in memory-intensive situations. Learn more about Intel storage solutions and Intel Solid-State Drives.

Facilities

The physical facility for your data center can be optimized for space, power management, and cooling, which in turn can impact technology performance and extend the life of your data center. Intel IT has found that retrofitting an existing data center can cost less than new construction if you follow a set of best practices at every stage of the data center life cycle, including:

- Establishing high-level requirements to determine user needs
- Conducting a feasibility study to evaluate retrofit options and redundancy levels
- Engaging in design with internal architects and engineers or an external firm
- Implementing construction
- Commissioning facility subsystem components via acceptance, functional, and integrated testing
- Sustaining operations at the best possible level by conducting ongoing strategic optimization for cooling, power, and space

For a detailed look at data center retrofitting, see *Data Center Efficiency and Retrofit Best Practices*.

How to Optimize Your Data Center: Four Steps

The following steps assume that you have already upgraded aging infrastructure and are ready to move from increasing operational efficiency to the next two stages: delivering innovative services and taking advantage of new business opportunities by implementing specific technology capabilities. Your next steps are:

1. **Create a data center strategy** – By looking at where your data center is now and where you need it to go, you can identify the sequence of steps that you need to take to get there and the key performance indicators (KPIs) that will measure your success.

2. **Enable an agile IT organization through virtualization and cloud** – Build on the inherent performance and efficiency of your upgraded hardware to implement virtualization for better resource utilization and then quality of service (QoS). As you start pooling resources such as CPU and storage, you are providing the foundation for cloud computing.

3. **Build out a cloud and turn IT into a broker of services** – Moving to the cloud means automating processes to provision and manage infrastructure from your pooled resources and delivering services to internal and external customers. By shifting the focus of your organization to cloud service brokerage, IT becomes a trusted advisor or intermediary that delivers accessible, integrated, and secure cloud solutions that solve business problems quickly.

4. **Measure your success** – Evaluate your progress against your data center strategy and goals. As you advance through your three-year plan, your KPIs will show your team and the business real results that can cement support and enthusiasm for the next steps.

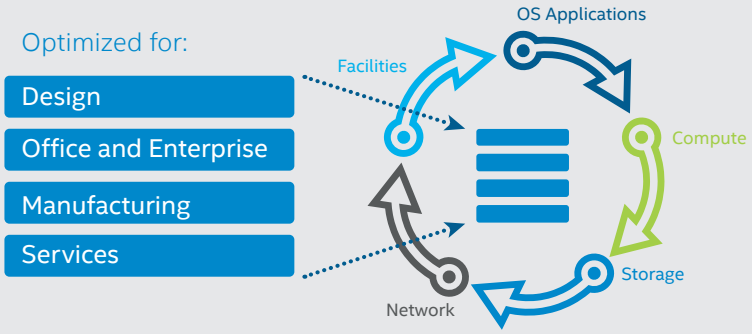
Step 1: Develop a Data Center Strategy

Your strategy provides the vision and approach for how your data center will further business objectives and deliver the agility and speed for the business to remain competitive. It also describes an implementation roadmap for IT. Your technology requirements and action planning can evolve more easily with a strategy in place that identifies specific business and technical goals.

Intel IT has built its strategy around a cycle of optimizing infrastructure to support critical business functions—in Intel's case, the Design, Office and Enterprise, Manufacturing, and Services environments. Continuous business innovation in areas of compute, storage, network, and facilities aligns Intel IT's data center investments with business goals.[3]

The Optimization Cycle

Ongoing IT innovation.



Intel IT's data center strategy maximizes business value and optimizes infrastructure to support critical business functions. (Source: *Intel IT's Data Center Strategy for Business Transformation*. Intel IT [January 2014].)

Include the following elements for a comprehensive data center strategy:

- Document an as-is state for your data center and develop an IT perspective on the gap between existing and future services.
- Survey the business units—those customers that use the data center—to test IT's perspective against business perceptions of gaps in service.
- Perform a Pareto analysis (people, processes, and technology) to align IT's perceived gaps with the results of the survey.
- Develop the future state of the data center and create a three-year data center transformation plan with short-, mid-, and long-term goals for data center improvement.
- Don't neglect physical data center considerations such as power and cooling.
- Establish KPIs to measure success.

Data Center Improvement Goals: Examples from Intel IT

A range of improvements can take you from operational excellence to cloud service delivery and beyond. The following are a few examples of improvements that Intel IT has made:

- Created a smaller data center footprint through consolidation, colocation, and automated management
- Improved overall storage practices, including better utilization and advanced capabilities (for example, implementing tiered and scale-out storage, a storage refresh cycle, and data deduplication)
- Improved network practices, including capacity and utilization (upgraded to 10, 40, and 100 GbE and migrated to a scalable, more resilient layer 3–based network)
- Adopted high-performance computing to meet the increasing demand for compute-intensive workloads
- Lowered unit cost for specific business environments by reducing physical infrastructure with fewer higher-performing and more-energy-efficient servers, storage drives, and networking

For more information and a detailed table of data center best practices for transformation, read *Intel IT's Data Center Strategy for Business Transformation*.

Intel IT Develops Investment Model for Data Center Innovation

In 2010, Intel IT began implementing a data center optimization strategy to better meet Intel's business requirements while providing optimal data center infrastructure capabilities and innovative business services to users. Part of the strategy included the development of a financial investment model that identifies the minimum amount of resources ideally needed to support business objectives and provide an optimal state by which to compare available technology. Closing the gap helps guide investment decisions based on the highest ROI and greatest benefits across the data center.

Intel IT's investment model has enabled the company to meet increasing growth and reduce unit costs without an increase in budget. For example, Intel's Design environment experienced 83 percent growth but was able to reduce unit cost by 44 percent from 2010 to 2012. In the Office and Enterprise area, growth of 62 percent was matched by a unit cost reduction of 34 percent for the same period.

Source: *Intel IT's Data Center Strategy for Business Transformation*. Intel IT (January 2014).

Step 2: Enabling an Agile IT Infrastructure

An agile infrastructure is the backbone of your data center. This is a crucial step toward implementing service delivery and an investment in the essential power and flexibility to further realize specific technology capabilities.

There's no single approach to an agile IT infrastructure. What is important is a focus on three key aspects:

- Higher asset and resource utilization
- Removing computing dependency on a particular physical piece of hardware
- Orchestration and automation

Two Examples of Agile Infrastructure

Highly utilized agile infrastructure can be virtualized or nonvirtualized, depending on your business purpose. Here are two examples that provide automation and orchestration, deliver on improved resources, and remove dependency on physical infrastructure:

Hyperscale and grid computing. Hyperscale computing is built on architecture that scales appropriately as demand increases—from several to thousands of servers. Typically this requires seamless provisioning of compute, memory, networking, and storage to a node or set of nodes in a larger distributed computing or grid computing environment. Hyperscale is often used for cloud or big data applications such as the Apache Hadoop* framework and can be found in large distributed sites. Increasingly, large enterprise data center operations are also turning to hyperscale computing.

Hyperscale differs from traditional computing environments, deploying cost-effective, stripped-down hardware designs dedicated for focused uses. For example, high availability in hyperscale environments is primarily achieved through software. In that case, organizations no longer need many of the redundant hardware components or availability tools included with other servers. With minimal configuration, a minimal level of hardware investment can run a base level of virtual machines (VMs) in a dedicated and private system. Hyperscale computing can also effectively operate thousands of VMs in large-scale implementations.

Hyperscale vendors design hyperscale hardware as modular commodity hardware that includes hard drives or solid-state drives (SSDs) within the modules. This gives the virtualization server and VMs access to very fast, persistent storage and eliminates the need for an expensive SAN to provide storage in the cloud. Because the hyperscale model is modular, you can build redundancies into the configuration for assumed-failure architecture. You can also maximize hardware density within the limitations of physical infrastructure and energy requirements.

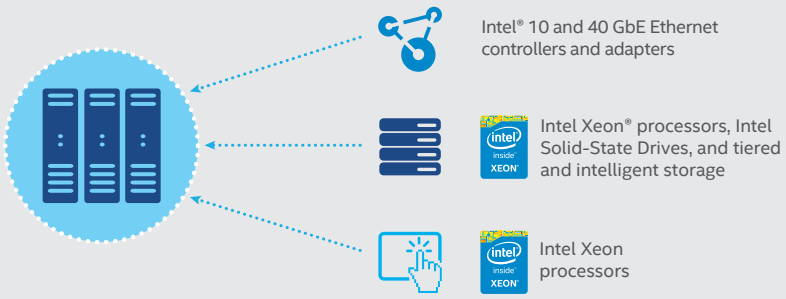
Virtualization. Virtualization is a second approach to building an agile infrastructure. Virtualization abstracts and isolates the underlying hardware as VMs in their own runtime environment and locates multiple VMs for computing, storage, and networking resources in a single hosting environment. These virtualized resources are critical for managing data, moving it into and out of the cloud, and running applications with high utilization and high availability. Host servers are designed to each run multiple VMs sharing multiple instances of guest operating systems.

Through virtualization, you can reduce CapEx through better resource utilization and begin to focus on QoS for mission-critical applications. As you gain confidence, you can virtualize multiple silos of resources to achieve more pervasive virtualization across the data center.

A virtualized infrastructure is also the underpinning for the majority of high-performing clouds. Virtualization provides several key capabilities for cloud computing, including resource sharing, VM isolation, and load balancing. In a cloud environment, these capabilities provide the building blocks to enhance agility and flexibility, enabling scalability, high utilization of pooled resources, rapid provisioning, workload isolation, and increased uptime.

Intel recommends virtualization as the first step on the path to a cloud computing environment and ultimately SDI. According to a Forrester Research report, more than 70 percent of organizations are planning to use server virtualization by the end of 2015.[4] This continuing growth makes cloud computing a logical next step for many organizations.

Intel Innovation for Data Center Optimization



The latest Intel technologies enable the most demanding private cloud workloads. A data center optimization strategy that refreshes infrastructure with Intel technologies can achieve greater performance, efficiency, and agility.

Step 3: Build Out a Cloud and Turn IT into a Broker of Services

Once your data center has become highly virtualized, the next leap forward is deploying cloud—which you can further scale by delivering applications and services to internal and external customers. This enables business and customer users to take advantage of opportunities such as big data analytics and high-performance computing. Finally, you may want to eventually move to some form of hybrid cloud that allows you to seamlessly connect multiple pools of resources, whether they exist in your corporate domain or with a public cloud vendor, and deliver insights with higher scalability and secure access to centralized data.

To determine the right cloud delivery model, you need to consider the factors specific to your data center and organization such as workload type (including demand and scale), security needs, service level expectations, legal and regulatory requirements such as data privacy and personally identifiable information (PII), and other requirements critical to your decision process. The best cloud delivery model for your business matches workloads to environments to deliver the services your end users need.

By moving first to private cloud, IT can fully support and secure applications and ensure that the business is not exposed to unnecessary risks. Public clouds can then be used for specific workloads. Others start by using public cloud first, sometimes bringing workloads with predictable performance back into the organization at a certain point. Enterprises that start in a public cloud have flexible capacity available and "pay-as-you-go" efficiencies available to them, but often struggle more with security concerns, lack of visibility, and governance and control challenges. For more detail on how to take a service-oriented approach to IT infrastructure, check out the *Cloud Services Starter Guide*.

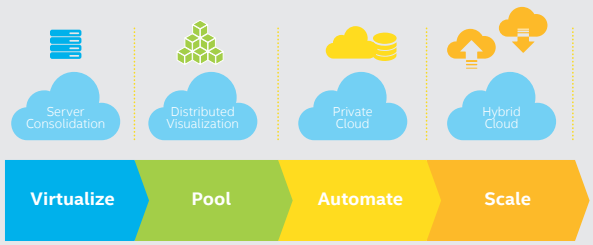
Hybrid Cloud for Greater Flexibility

A hybrid cloud enables IT to gain additional flexibility between private and public cloud resources via a single automated and orchestrated operating environment. A hybrid cloud also enables IT to optimize for disparate needs and diverse workload requirements. For example, quick-scaling, fast-to-market systems may have affinity with public cloud. Core business systems are typically run on an in-house private cloud. Hybrid clouds are also used to:

- Implement disaster recovery strategies.
- Cloud-burst workloads with unpredictable peaks in demand.
- Make services available quickly for a limited time via public cloud.

Hybrid cloud also helps organizations balance their need to invest in on-premises cloud technologies (CapEx) with utilization of off-premises public cloud services (OpEx) using a "build the base, rent the spike" deployment model to achieve an optimized TCO.

Enterprise Cloud Maturity Journey



As part of your data center optimization strategy, virtualization and pooled resources lead to a fully automated and orchestrated hybrid cloud.

IT as a Cloud Services Broker

Cloud computing is spurring the transformation of IT into a strategic role as a business enabler, freeing up resources to build IT into a competency center that delivers competitive advantage. The role of IT is moving from a reactive gatekeeper of technology to a cloud service broker focused on using technology to enable business innovation.

A cloud service broker keeps the focus on strategy, design, and governance and serves as a general contractor to research, plan, source, and negotiate with providers, as well as integrate and transition or manage cloud services.

The results? A strong partnership with business units, more effective management of IT and business unit costs, delivery of IT as a service, consolidated workloads, and effective management of TCO in a virtualized data center.

Watch the video "Building Your Own Private Cloud" to find out more about moving from virtualization to cloud computing. To learn more about offering cloud services, read *Planning Guide: Private Cloud Infrastructure as a Service* and the white paper *What Is PaaS?*

Step 4: Measure Your Success

Your data center strategy should have included KPIs to help you demonstrate to your team and the business that you've achieved your strategic goals. You can choose a wide range of data center KPIs, most of them measuring cost, quality of service, and efficiency. The IT Infrastructure Library (ITIL) offers white papers and templates for measuring data center services.

The following are examples of data center performance metrics:

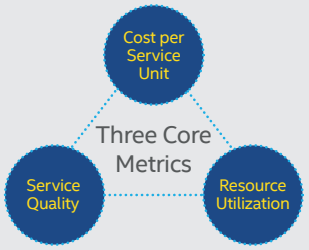
Metric	Description
Efficiency	
Power usage effectiveness	An industry standard for the energy efficiency of data center facilities.
Downtime	The amount of time service is unavailable.
Resource utilization	Percentage of resources (storage, network, server) in use.
Quality of Service	
Total service level agreement (SLA) violations	The number of times violations occur during a given period.
Mean time to resolve SLA violations	The average time it takes to restore SLA compliance when a violation occurs.
Cost	
Percentage of projects within budget	The percentage of projects that did not go over budget.
Total actual vs. budgeted costs	Total actual project costs as a percentage of budgeted project costs. Calculated for an entire project portfolio. A number over 100% indicates overspending.
Total cost of ownership	The financial estimate of the direct and indirect costs (both CapEx and OpEx) of a product or system.

Intel IT KPIs for Data Center Optimization

Intel IT's data center strategy included three key performance indicators (KPIs) to measure the effectiveness of the company's investments. Each year, Intel IT sets the best achievable service level agreement (SLA) levels, the lowest achievable cost, and the highest achievable resource utilization. These KPI goals serve as internal benchmarks and provide a basis for investment priorities.

- **Quality of service (QoS).** Uses a tiered approach to SLAs based on each business function's sensitivity to uptime, mean time to repair (MTTR), and cost. For example, first-tier applications should have higher performance to SLA than second-tier applications, which are less critical. The ultimate goal for QoS is zero impact from IT issues.
- **Cost efficiency (cost per service unit).** Established based on the capacity enabled for each business function. For example, Intel IT measures functions for the Office, Enterprise, and Services environments by cost per operating system instance. Manufacturing is measured by cost per integrated factory compute environment. Intel IT's goal for this KPI is 10 percent improvement every year. This may mean spending less but is more likely to result in getting more for each dollar, enabling the data center to do more.
- **Effective utilization of assets and capacity.** Measured by the actual output of an asset rather than how it's allocated, effective utilization measures how well jobs or storage actually perform. If a certain percentage of jobs cannot complete because of limited compute capacity, that reduces the utilization score. If only 30 percent of allocated storage is actually used, that's measured as wasted utilization. Intel IT has established a goal of 80 percent effective utilization of all IT assets.

Maximizing Business Value



Source: *Intel IT's Data Center Strategy for Business Transformation* Intel IT (January 2014).

Setting the Foundation for Software-Defined Infrastructure

Intel has established the hardware-level foundation now to enable a future where all data center infrastructure is autoprovisioned through software. SDI can free up IT to focus more time on strategic projects and less time with administration.

That's good news. The ideal ratio of a 50-50 budget split between maintenance and innovation continues to be elusive. Forrester reported in a 2013 survey of IT leaders in more than 3,700 companies that respondents estimated that they spend an average of 72 percent of the money in their budgets on keep-the-lights-on functions such as replacing or expanding capacity and supporting ongoing operations and maintenance, while only 28 percent of the money went toward new projects.[5] Freeing up time for IT innovation will drive value back into the organization.

Intel is actively involved in working with industry leaders to develop data center technology that will enable IT organizations to pursue greater innovation.

Compute

On the compute side, we are working on designing more robust and powerful processors that can deliver faster throughput, enhance virtualization, optimize storage and networking, and run SDI management applications. We're building a number of capabilities that directly relate to a software-defined future into our Intel Xeon processor families, including telemetry and support for advanced networking virtualization and advanced storage capabilities.

Network

Virtualized networking is the delivery of networking services (such as load balancing, firewall, and acceleration) via software, and runs on either standard x86 servers or as virtual machines. Virtualized networking goes hand-in-hand with software-defined networking (SDN). SDN decouples network control and forwarding functions, and makes network traffic flow fully programmable to enable dynamic traffic management.

Intel is building advanced networking capabilities into Intel Xeon processor-based servers that support network virtualization. The 10 and 40 GbE solutions have hardware offloads and accelerators to maximize the performance of virtualized networks with a minimum impact on CPU utilization. The hardware offloads and accelerators work with the latest encapsulation protocols, including virtual extensible LAN (VXLAN), network virtualization using generic routing encapsulation (NVGRE), and Geneve. Intel Xeon processor-based servers can also be optimized for packet processing to support the performance required for network functions virtualization (NFV) applications like firewalls and load balancers.

Intel IT Implements Software-Defined Networking

Intel IT is adopting SDN to remove barriers to services for customers and enabling them to deploy applications more quickly. Although Intel IT has made significant progress in self-provisioning server infrastructure (down from 90 days to minutes), networking remained a bottleneck. These customers need to be able to access network resources without having to negotiate delays created by configuring networks and provisioning services.

Intel IT decided that virtualizing the network through a programmable interface would provide better support for Intel application developers who work in a fast-paced, agile development environment.

The two-year project involved:

- Defining which use cases worked best for SDN
- Testing and analyzing SDN architectures to understand data flow between nodes
- Updating the roles and responsibilities of the employees who would be using the self-service environment—many of whom didn't have a background in network engineering

Preliminary results show that SDN is improving service provisioning time, thereby reducing pressure on network administrators to meet SLAs for network service requests. SDN is also simplifying the process of network provisioning, even though some users with little or no network experience required training. Another benefit is reduced service costs through improved network management efficiency, which enables Intel IT to retain its current infrastructure investment and rely less on proprietary hardware.

For more on how Intel IT is implementing SDN, read the Intel IT SDN case study.

Storage

We are continuing to work on improvements that enable storage virtualization and software-defined storage. Intel Xeon processors support the increased I/O bandwidths required to power virtualized storage while running multiple virtual machine workloads. Hardware-assisted capabilities optimize compute-intensive storage capabilities such as caching, erasure coding, data encryption, data compression, data deduplication, intelligent tiering, and thin provisioning for enhanced data reliability, security, and capacity. We are continuing to improve the speed, reliability, and data consistency of Intel SSDs to provide even higher performance and more energy-efficient storage with high capacity for growing storage needs.

For more information about Intel's vision of the optimized data center, see the video "The Future of Computing."

Case Study: Intel IT

From virtualization to automation and orchestration, IT transformation can lead to significant benefits over traditional IT, with progressive cost improvements. Intel IT's most recent efforts to actively upgrade and optimize its data center infrastructure began in 2010. It's been a successful undertaking, yielding an estimated 14 to 35 percent cost savings year over year. Throughout this guide, we've touched on parts of Intel's data center strategy. However, the strategy is a comprehensive approach to improving service delivery for four areas of the company: Design, Office and Enterprise, Manufacturing, and Service.

Intel IT's strategy focuses optimization on utilization, SLA, and costs via three perspectives: technology, solutions, and process. Already completed (2010 to 2013) focus areas include:

- Facilities consolidation and efficiency improvements
- Deployment of optimal foundational component infrastructure (server, storage, network)
- Increased automation for faster provisioning
- Virtualization of complex applications and changing processes from manual to automated
- Adoption of blade servers for virtualization to reduce costs via network-port-count reduction and storage optimization techniques

In 2014, Intel IT began to focus on SDI initiatives with plans for completion in 2016, including:

- Embrace disruptive server, storage, network, and data center facility technologies.
- Adopt software-defined storage.
- Drive network efficiencies. (Investment in SDN software capabilities to enable more orchestration benefits is one subset in this.)
- Increase data center facilities efficiency.

Intel IT's data center strategy has reaped the benefits of data center optimization, with business value in excess of USD 184 million from 2010 to the end of 2013. In addition, Intel IT has documented 14 best practices with assigned business value across facilities, compute, storage, and network.

Read more about the specifics of Intel IT's data center strategy and get the list of best practices.

More Data Center Optimization from Intel IT

Intel IT continues to share its experience and best practices related to data center optimization in these key papers:

Data Center Efficiency and Retrofit Best Practices

Intel IT has developed a set of best practices for increasing data center efficiency by retrofitting the physical space and infrastructure of existing facilities. Intel IT discovered that retrofitting can cost less than new construction and can help extend the life of Intel's data centers and adapt them to changing business needs. Following the best practices enabled the company to increase data center efficiency and capacity, optimize ROI capital, and decrease operating costs—without negatively affecting users.

Read about the best practices.

Intel IT Redefines the High-Density Data Center: 1,100 Watts/Sq. Ft.

Intel IT used design best practices to convert a 5,000-square-foot wafer-fabrication facility into a high-density data center. The results include rack power density of up to 43 kilowatts (Kw) per rack, which is 1.5 times higher than Intel IT had previously been able to deliver; reliance on free-air cooling for all but 39 hours per year; and a cooling density of 1,100 watts per square foot—10 times the industry average. In the next 12 months, Intel IT also expects to report an exceptionally low power usage effectiveness (PUE) score of 1.1.

Read the high-density case study.

Summary

The pressures on the data center are more extreme than ever before. Those pressures are not going away, and the risk to the organization for not having up-to-date and optimized technology will have a direct impact on the bottom line.

Enterprise data centers must evolve to provide the agility and efficiency that accelerate business growth. Powerful technologies for cloud computing, high-performance computing, and big data already exist that can help you deliver services to your business users and provide huge opportunities for companies that can deploy them successfully.

Intel has been working on enhancing data center technology for decades and partners with a broad ecosystem to provide solutions that run on powerful, efficient Intel architecture. Intel also has a clear path for you to upgrade and optimize your data center infrastructure. Please visit intel.com/datacenteroptimization to get the resources, guidance, and tools you need to get started.

Intel has established the hardware-level foundation to enable a future where all data center infrastructure is autoprovisioned through software. We are actively involved in working with industry leaders to develop data center technology that will enable IT organizations to pursue more innovation.

Next Steps: Where Are You in the Data Center Optimization Process?

The following is a set of considerations to help you think about where you are on your data center upgrade and optimization path, and then determine where you need to go next. Keep in mind, this list isn't all-inclusive, and is meant only to present some of the broad range of data center considerations.

Operational Excellence: Replace Aging Infrastructure

Answers the question, "Is your data center where you want it?"

- Have you created a data center strategy?
- Can you identify gaps in where you are now and where you want to be to support efficient virtualization and cloud services?
- What is your plan to upgrade infrastructure?
- Compute
  - Have you replaced aging servers?
  - How long does it take to provision services for users?
  - How much of the overall IT budget is committed to compute resources?
- Network backbone
  - Are you taking advantage of 10, 40, or 100 GbE?
  - How long does it take to provision services for users?
  - How much of the overall IT budget is committed to compute resources?
- Storage
  - How is your storage architecture organized?
  - Are you using tape, spinning disks, SSDs?
  - How long does it take to provision services for users?
  - How much of the overall IT budget is committed to compute resources?
- Facilities
  - Can you gain efficiencies by retrofitting existing data centers via consolidation, higher-density equipment, and increased energy efficiency?
-

- Have you established a regular refresh cycle to ensure that your infrastructure stays up to date?
- What percentage of your data center is virtualized?

Innovative Service Delivery: Move into the Cloud

Answers the questions, "Can my data center support cloud computing, and is my IT organization agile enough to broker services and respond quickly to users?"

- Do you have a cloud strategy in place to help guide governance, data location, security, privacy, and compliance issues?
- Have you evaluated which workloads belong in a private cloud? Public? Hybrid?
- Does your organization currently support public cloud software-as-a-service (SaaS) applications?
- Have you considered bringing any public cloud workloads into a private cloud environment?
- What types of automation tools have been implemented?
- How many of the systems are automated?
- Do you offer automated self-service provisioning via infrastructure as a service (IaaS)?
- Do you provide developers with access to platform as a service (PaaS)?
- Is your development team capable of designing scalable, cloud-aware applications?

Embrace New Business Opportunities: Implement Specific Technology Capabilities

- Is your basic infrastructure capable of supporting:
  - Big data projects?
  - An enterprise mobility program?
  - Social and collaborative computing across the organization?
- Are you considering implementing SDI?
  - Network virtualization or software-defined networking?
  - Storage virtualization or software-defined storage?

Intel Resources for Learning More

Check out these resources from the Intel IT Center that cover a broad range of content that can help you take the next step as you upgrade and optimize your data center.

Intel Data Center Product Web Sites

- Intel Xeon processors: intel.com/content
- Intel storage solutions: intel.com/storage
- Intel Solid-State Drives: intel.com/content/solid-state-drives
- Intel Ethernet Converged Network Adapters: intel.com/content/converged-network-adapters
- Intel Ethernet Gigabit Server Adapters: intel.com/content/gigabit-network-adapters

Data Center Upgrade Tools

Intel® Xeon® Processor-Based Server Refresh Savings Estimator

Enter data into this ROI calculator about your existing environment, and evaluate the benefits of replacing it with the latest generation of Intel based servers, Intel Ethernet products, and Intel Solid-State Drives.

estimator.intel.com/serverroi/

Intel IT Server Sizing Tool

Determine the optimal servers for your project life cycle based on actual data from your existing environment.

estimator.intel.com/serversizing/

Intel® Solid-State Drive Data Center TCO Calculator

Determine potential cost and energy savings for deploying Intel Solid-State Drives compared to your existing hard disk drive performance.

intel.com/content/www/us/en/solid-state-drives/ssd-data-center-tco-calculator-tool.html

Intel IT Resources about Upgrading and Optimization

Adopting Software-Defined Networking in the Enterprise

Intel IT has adopted SDN to enable on-demand provisioning of networks and network services, offering improved support for Intel application developers. (8 pages)

intel.com/content/www/us/en/it-management/intel-it-best-practices/adopting-software-defined-networking-in-the-enterprise-paper.html

Intel IT's Data Center Strategy for Business Transformation

Intel IT's data center strategy created new business value in excess of USD 184 million from 2010 to 2013. Find out how and what's next. (14 pages)

intel.com/content/www/us/en/it-management/intel-it-best-practices/data-center-strategy-paper.html

Data Center Efficiency and Retrofit Best Practices

Following a set of best practices enables Intel to increase data center efficiency and capacity, optimize return on investment capital, and decrease operating costs—without negatively affecting users. (20 pages)

intel.com/content/www/us/en/it-management/intel-it-best-practices/data-center-efficiency-and-retrofit-best-practices-paper.html

Intel IT Redefines the High-Density Data Center: 1,100 Watts/Sq. Ft.

Intel IT used design best practices to convert a 5,000-square-foot wafer-fabrication facility into a high-density data center. The results include rack power density of up to 43 Kw per rack, which is 1.5 times higher than Intel IT had previously been able to deliver; reliance on free-air cooling for all but 39 hours per year; and a cooling density of 1,100 watts per square foot—10 times the industry average. (8 pages)

https://www-ssl.intel.com/content/www/us/en/data-center/intel-it-redefines-high-density-data-center-1100-watts-per-sqft-paper.html

Adopting Software-Defined Networking in the Enterprise

To accommodate increasing demands on Intel's network, Intel IT is upgrading to a combination of 10 GbE and 40 GbE connections, replacing slower connections that can no longer support business requirements. (8 pages)

intel.com/content/www/us/en/it-management/intel-it-best-practices/adopting-software-defined-networking-in-the-enterprise-paper.html

Accelerating Silicon Design with the Intel® Xeon® Processor E7-4800 v2 Product Family

Intel IT shows how modernizing the data center enables company engineers to accelerate key design tasks in Intel's HPC environment. (4 pages)

intel.com/content/www/us/en/it-management/intel-it-best-practices/accelerating-silicon-design-intel-xeon-processor-e7-4800-v2-paper.html

Other Resources about Upgrading and Optimization

"Cloud 101" (video)

Discover how an optimized data center can help you deliver cloud services to your business users for exceptional efficiency and agility.

intel.com/content/www/us/en/cloud-computing/cloud-101-video.html

"Data Center Refresh: Optimizing Efficiency" (video)

Simplify IT management by upgrading to high-performing data center technologies. Learn how faster, more powerful infrastructure can provide advanced security, increase virtualization for greater agility, reduce operational costs through consolidation and greater efficiency, and streamline cloud service delivery.

intel.com/content/www/us/en/data-center/data-center-refresh-for-operating-efficiency-video.html

"Efficient Cloud Power Management with Intel® Xeon® Processors" (video)

This animation describes how Intel Data Center Manager and Intel Node Manager orchestrate power management at the server, rack, and data center level. (3:53 minutes)

intel.com/content/www/us/en/cloud-computing/cloud-computing-xeon-policy-based-power-management-animation.html

"Intel's Future of Computing Vision" (video)

Hear from futurist Steve Brown about Intel's vision of the next-generation data center and SDI. SDI offers a more flexible and responsive data center architecture that enables IT to focus on imagining and managing new services and capabilities.

intel.com/content/www/us/en/data-center/future-of-computing-vision-video.html

"Migrate the Data Center to Open Standards: Why It Makes Sense" (video)

Learn why migrating to open-standard, interoperable building blocks provides flexible, scalable infrastructure for a responsive, secure, and agile data center. (3:06)

intel.com/content/www/us/en/risc-migration/migrate-to-open-standards-part-1-video.html

Planning Guide: Private Cloud Infrastructure as a Service

Build a cloud service delivery model on the right infrastructure to help your organization take full advantage of the agility and efficiency benefits of cloud computing. (19 pages)

intel.com/content/www/us/en/cloud-computing/cloud-computing-private-cloud-infrastructure-as-a-service-guide.html

Why Choose a Data Center Class Solid-State Drive?

In this technology brief, tests on the performance of data center–grade SSDs demonstrate the performance and economic reasons for selecting these storage resources. (5 pages)

intel.com/content/www/us/en/solid-state-drives/data-center-class-solid-state-drive-brief.html

Endnotes

1. "Cisco Visual Networking Index: 2014 VNI Complete Forecast Introduction" (video). Cisco (June 18, 2014). youtube.com/watch?v=KUwQmS6Cmeg
2. Rungta, Sanjay, Matt Ammann, Mohammad Ali, Kevin Connell. *Preparing Intel's Data Center Network Architecture for the Future*. Intel IT (July 2014). intel.com/content/www/us/en/it-management/intel-it-best-practices/preparing-intel-data-center-network-architecture-for-the-future-paper.html
3. Krishnapura, Shesha, Shaji Achuthan, Bob Barnard, Vipul Lal, Raju Nallapa, Sanjay Rungta, Ty Tang. *Intel IT's Data Center Strategy for Business Transformation*. Intel IT (January 2014). intel.com/content/www/us/en/it-management/intel-it-best-practices/data-center-strategy-paper.html
4. *Strategic Benchmarks 2014: Server Virtualization*. Forrester Research (March 2014). forrester.com/Strategic+Benchmarks+2014+Server+Virtualization/fulltext/-/E-RES110021
5. Bartels, Andrew, Christopher Mines, Joanna Clark. *Forrsights: IT Budgets and Priorities in 2013*. Forrester (April 25, 2013). forrester.com/Forrsights+IT+Budgets+And+Priorities+In+2013/fulltext/-/E-RES83021?isTurnHighlighting=false&highlightTerm=Forrsights:%20IT%20Budgets%20And%20Priorities%20In%202013

More from the Intel IT Center

Planning Guide: Data Center Optimization 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, and client and infrastructure security. Visit the Intel IT Center for:

- Planning guides, peer research, and solution spotlights to help you implement key projects
- Real-world case studies that show how your peers have tackled the same challenges you face
- Information on how Intel's own IT organization is implementing cloud, virtualization, security, and other strategic initiatives
- Information on events where you can hear from Intel product experts as well as from Intel's own IT professionals

Learn more at intel.com/ITCenter.

Share with Colleagues

0415/LF/ME/PDF-USA 331087-001