



# Planning Guide for Migrating to Microsoft® SQL Server® 2008 R2 and Intel® Xeon® Processor-based Servers

## Abstract

Today's IT organizations are being asked to provide greater levels of service and system reliability, while staying within shrinking budgets. Meanwhile, internal and external customers are demanding uncompromising access to increasing volumes of data 24 hours a day, seven days a week. As a result, many organizations are moving away from proprietary RISC-based database systems in favor of Microsoft® SQL Server® 2008 R2 running on servers equipped with Intel® Xeon® processors.

To successfully migrate a database management system to a new platform takes careful planning. Infrastructure architects must ensure that existing levels of reliability, security, performance, and availability are maintained or increased after the migration is complete. To achieve this, architects must carefully measure how their existing database systems are being utilized and plan accordingly when migrating to SQL Server 2008 R2 running on hardware equipped with Intel Xeon processors.

This white paper presents a high-level overview for planning a SQL Server 2008 R2 migration, including what factors to keep in mind when determining hardware and software requirements.



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## Migrating to Microsoft® SQL Server® 2008 R2 and Intel® Xeon® Processors

Organizations need a data management platform that can support the growing and dynamic nature of today's database workloads, such as enterprise resource planning (ERP), customer relationship management (CRM), and various business intelligence (BI) applications. SQL Server 2008 R2 running on servers equipped with Intel Xeon processors fulfills this challenge by offering:

- **High availability and reliability:** Database outages can cause loss of employee productivity and loss of revenue. Organizations need a database management platform that is highly available and reliable to help ensure that mission-critical applications are available 24x7. SQL Server 2008 R2 can utilize the new RAS features of the Intel Xeon processor 7500 series for optimal reliability and availability.
- **Scalable processing power:** Organizations are generating large amounts of data and need raw processing power to turn that data into usable information. With the Intel Xeon processor 7500 series, SQL Server 2008 R2 Datacenter Edition can scale up to 256 logical processors. This capability gives organizations the ability to scale their database applications to new levels, and requires a computing platform that has the processing power and I/O throughput to optimize the performance of these types of complex applications.
- **Flexible virtualization:** Employing "clouds" of virtual machines enables organizations to effectively handle spikes in demand while reducing the power and cooling consumption costs and datacenter footprint of large server deployments. SQL Server 2008 R2 can benefit from hardware-based virtualization features found in Intel Xeon processors, such as extended page tables (EPT) to accelerate virtual machine performance and increase the infrastructure's overall flexibility. Organizations that take advantage of SQL Server 2008 R2 in a virtualized environment are better positioned to handle spikes in demand and take advantage of new opportunities.

## Considerations When Migrating to Microsoft® SQL Server® 2008 R2

Many organizations are moving from proprietary RISC-based database management systems to Microsoft SQL Server 2008 R2 running on servers equipped with Intel Xeon processors. A well-designed SQL Server infrastructure, both physical and logical, allows flexibility and scalability while providing high availability and performance. When planning a migration to SQL

Server 2008 R2, architects and project managers should keep in mind several key items:

- Database workload types
- Necessary hardware
- SQL Server versioning
- Requirements for high availability
- Database manageability
- Database and application security

## Understanding Database Workloads

When migrating a database management system, architects must first understand the types of workloads running on their existing database systems and how those workloads will carry over to the new architecture. Different types of database workloads can require different hardware, tuning, and versions of SQL Server 2008 R2.

## Online Transaction Processing (OLTP)

Database applications such as ERP, CRM, and e-commerce fall into the category of online transaction processing (OLTP). The types of databases that drive these applications store and manipulate transactions as they happen and are optimized to support large numbers of inserts, deletes, and updates. They are also optimized to support large numbers of concurrent users. The physical infrastructure required to run these applications varies from only a few departmental servers to extensive clusters of high-powered servers for large, highly available enterprise-wide deployments.

### *What This Means for Your Migration Planning*

OLTP databases typically favor higher I/O throughput over raw processing power, though some applications, such as ERP—where reporting services are widely used—require more CPU processing power. Read speeds are critical in OLTP databases, as data is typically read from the database more often than it is written to. If the database application you are going to migrate is an OLTP-based application, you will want to plan for adequate I/O and CPU processing power.

High availability is critical in OLTP environments, as line of business and e-commerce applications are required to be accessible 24x7.

## Data Warehouse and Business Intelligence (OLAP)

Data stored in a data warehouse is typically used by BI and analytics applications, and relies on online analytical processing

(OLAP) multi-dimensional database designs. Data is typically moved from OLTP databases into the data warehouse, which allows processing of complex, ad-hoc queries.

### *What This Means for Your Migration Planning*

Data warehouses typically favor raw processing power and high I/O throughput since both default and ad-hoc queries can be complex and require more CPU processing power. OLAP databases require a fast disk I/O subsystem due to the large amount of data that is stored as well as the number of reads and writes that take place. Building an OLAP database also requires a high amount of I/O and CPU processing power for the extract, transform, and load (ETL) processes.

SQL Server 2008 R2 can bring BI applications to a wider number of users, so high availability may also be a key consideration.

## Choosing the Right Server Hardware

With the Intel Xeon processor 5600 and 7500 series, Intel provides server processors that scale from the smallest departmental server deployments to the largest enterprise-wide high availability implementations. When designing your SQL Server 2008 R2 architecture, keep in mind the various traits of the Intel Xeon processor 5600 and 7500 series and how they apply to your particular requirements. Database workloads differ among organizations, so certain SQL Server architectures may benefit more from a specific Intel processor family than another.

## Shared Processor Features

The Intel Xeon processor 5600 and 7500 series share features that increase the performance of memory- and CPU-intensive SQL Server applications, including:

- **Intel® Turbo Boost Technology:** This technology gives Intel Xeon processors performance on demand by allowing cores to run faster than their base operating frequency when specific power, current, and temperature thresholds are met. When the processor detects that it is below these thresholds, it increases its clock frequency of the active cores to boost performance. This can give database applications extra performance when it's needed, such as when generating complex reports or responding to queries against an OLAP database.

- **Intel® QuickPath Technology:** This technology increases data transfer performance for multiprocessor or multi-core environments using high-speed two-way interconnects between processors. Intel QuickPath Technology accelerates traffic between processors and I/O controllers because the processor does not have to communicate first with an external controller. This helps database applications where high I/O throughput is a key factor, such as in OLAP applications.
- **Intel® Hyper-Threading Technology:** This technology delivers parallel thread execution on each core, allowing multi-threaded SQL Server 2008 R2 applications to run more efficiently and deliver higher performance.
- **Intel® Virtualization Technology:** This technology enhances software-based virtualization by reducing virtual machine latency, allowing the guest operating system more direct access to the hardware and reducing the computing-intensive software translation from the virtual machine monitor. Key features such as EPT speed up memory access between the host machine and virtual machine, which accelerates SQL Server 2008 R2 instances running inside virtual machines.

## Intel® Xeon® Processor 5600 Series Features

The Intel Xeon processor 5600 series combines high performance, a reduced energy footprint, and lower costs for cost-conscious organizations. These processors deliver 12-core performance in dual socket configurations with six cores per processor. The Intel Xeon processor 5600 series also supports up to 12 threads and 12 MB of shared cache memory with an integrated memory controller and three DDR3 channels. Two Intel QuickPath Interconnect links enhance data transfer performance in multiprocessor and multi-core environments, providing two-way interconnects between processors that can reach speeds up to 25.6 GB per second. This processor series also includes 12 new reliability, availability, and serviceability (RAS) features that strengthen the platform against hardware failures.

### *What This Means for Your Migration Planning*

The Intel Xeon processor 5600 series is ideal in mainstream SQL Server 2008 R2 deployments where you are running smaller databases or where high I/O throughput and lower costs are required. This series is also ideal for smaller departmental or branch office deployments.

## Intel® Xeon® Processor 7500 Series Features

This processor series is designed for large-scale deployments and mission-critical applications where high availability and performance are key factors. It combines up to eight cores per socket, and can scale further with additional hardware. Each processor supports up to 16 threads. The processor can support up to 2 TB of memory in an eight-socket configuration, and offers four high-bandwidth interconnects that allow multiple processors to communicate directly with each other.

The Intel Xeon processor 7500 series augments the SQL Server 2008 R2 availability and reliability by offering 20 new RAS features. One key RAS feature is Machine Check Architecture Recovery, a mechanism that allows an operating system to recover from uncorrectable memory errors that would have otherwise lead to a system crash in prior processor generations. This capability was previously available only on RISC and mainframe systems, but is now incorporated into the Intel Xeon processor 7500 series. Other RAS features include dynamic reassignment of workloads across processors, interconnect error detection and recovery, and individual virtual machine recovery in virtualized environments.

### *What This Means for Your Migration Planning*

This processor series is ideal in SQL Server 2008 R2 deployments where raw processing power and high I/O throughput are required, such as in OLAP database environments. The Intel Xeon processor 7500 series can also be beneficial in high traffic, high-availability OLTP situations. With its RAS features, the Intel Xeon processor 7500 series is the best choice when reliability and high availability are key requirements.

## Factors Affecting Server Sizing

Database infrastructure architects should keep in mind several factors when designing the database hardware architecture:

- **Average utilization:** Determining the average utilization of your servers is critical in planning your migration deployment. Average utilization is the average load on your server processors and I/O subsystems. If your average utilization is 75 percent or higher, you may experience problems scaling your applications in the future or handling demand peaks. Architects should strive for about 30 percent utilization.
- **Datacenter footprint:** How many physical servers will be required to efficiently run your SQL Server 2008 R2 applications? If you have space, power, or cooling constraints, consider the physical size and power requirements of your servers, and determine what level of virtualization will be required.
- **Peaks in demand:** Aside from average utilization, a database application may experience peaks in demand at various times. For example, a SQL Server-driven e-commerce web site may experience higher demand leading up to certain holidays, or an ERP application may experience demand peaks when processing end-of-quarter reports. Determine how large these peaks will be and what hardware will be needed to handle them.
- **Workload growth projections:** Consider how your system will grow with your business. You may be able to start with a smaller architecture, but consider the future growth needs of your organization.
- **Clustering and failover:** Clustering and failover provide fault tolerance should failures occur. Determine what the clustering and failover needs are when planning the deployment and what hardware and software is needed. A highly available, fault tolerant environment demands a larger initial hardware outlay.
- **NUMA considerations:** Non-uniform memory architecture allows processors in a multi-processor environment to access local memory faster than memory located on another processor or shared between processors. A NUMA node is a collection of processor cores that share local memory. SQL Server 2008 R2 takes advantage of NUMA nodes by allocating the memory of running threads on the same NUMA node. SQL Server can be further tuned to direct all traffic from a specific network port or group of ports to a specific NUMA node, and can have certain processes run on pre-defined nodes. When planning your architecture, you may want to consider sizing your servers in such a way as to take advantage of NUMA tuning.
- **Storage considerations:** A storage area network (SAN) offers a number of benefits, such as consolidated storage, high availability features, storage tiering, and scalability. Consider how a SAN will be used in your deployment and how your infrastructure and database design can be optimized to take advantage of SAN features. If you are using direct attached storage (DAS), consider what demands will be placed on the DAS subsystem and the type of hard drives that are required. For example, Intel® Solid State Drives (SSD) provide a high-performance and more reliable alternative to traditional hard drives.
- **Networking considerations:** Depending on the database application, your deployment may require high network throughput. Consider network interface controllers (NICs) that offload networking functions from the CPU, such as Intel® Ethernet controllers which provide features such as TCP segmentation and checksum offload.

## Choosing the Right SQL Server Edition

Performance, reliability, and availability are key factors when architecting a database management system. SQL Server 2008 R2 comes in three enterprise-grade editions that are well-suited for OLAP and OLTP applications, with each edition focused on different types of applications and deployment scenarios. These are:

- Standard
- Enterprise
- Datacenter

NOTE: The following sections provide a brief feature overview of the SQL Server 2008 R2 editions. Architects should carefully consider the full SQL Server hardware requirements and feature sets against database application requirements. You can find a complete comparison of features between the various editions of SQL Server 2008 R2 at <http://www.microsoft.com/sqlserver/2008/en/us/editions-compare.aspx>.

### Microsoft® SQL Server® 2008 R2 Standard Edition

Microsoft SQL Server 2008 R2 Standard Edition provides smaller deployments with some benefits found in SQL Server Enterprise Edition. This version of SQL Server works well for deployments that do not have large numbers of users, do not have large processor and memory requirements, or in organizations that have limited IT administration resources. Key features of SQL Server 2008 R2 Standard Edition include:

- Support for up to four processors and 64 GB of RAM
- 2-node clustering
- Basic StreamInsight support for complex event processing
- Support for department/team business intelligence use
- Backup compression that helps reduce data backups by up to 60 percent
- The ability to be a managed instance for Application and Multi-Server Management capabilities found in SQL Server 2008 R2 Enterprise and SQL Server 2008 R2 Datacenter

### *What This Means for Your Migration Planning*

Organizations that need a reliable database management system that can be managed by limited IT resources, or that have applications that can be deployed on a smaller, departmental level should consider SQL Server 2008 R2 Standard Edition. If the database application limits are within the processor and memory requirements of SQL Server 2008 R2 Standard Edition, architects should verify that database application requirements are supported by this edition.

### Microsoft® SQL Server® 2008 R2 Enterprise Edition

Microsoft SQL Server 2008 R2 Enterprise Edition provides larger deployments with a comprehensive platform that provides security, high availability, and scaling features. This version also provides self-service business intelligence functionality while giving organizations the high levels of reliability for mission-critical workloads. Key features of SQL Server 2008 R2 Enterprise Edition include:

- Support for up to eight processors and 2 TB of RAM
- Table and index partitioning
- Scalable shared databases and large database partitioning
- Advanced high availability features such as database mirroring, 16-node clustering, and resource governor
- Built-in auditing
- Transparent database encryption and extensible key management
- Application and Multi-Server Management for managing up to 25 database instances
- Complex event processing with basic StreamInsight support
- Support for enterprise-scale business intelligence use
- Data warehousing
- Master Data Services for data consistency across heterogeneous systems
- PowerPivot for SharePoint
- UCS-2 Unicode data compression

### *What This Means for Your Migration Planning*

If your deployment includes up to 25 database instances and you require features such as data warehousing, Master Data Services, and PowerPivot, consider using SQL Server 2008 R2 Enterprise Edition. This version also provides support for tens of terabytes of data and data compression, support for more memory and processors, and the ability to hot-add memory and CPUs, as well as transparent database encryption.

### **Microsoft® SQL Server® 2008 R2 Datacenter Edition**

Microsoft SQL Server 2008 R2 Datacenter Edition is designed to provide the highest levels of scalability for large application workloads, virtualization and consolidation of database workloads, and management of an organization's entire database infrastructure. In addition to the features of SQL Server 2008 R2 Enterprise Edition, SQL Server 2008 R2 Datacenter Edition includes:

- Support for up to 256 logical processors for the highest levels of scalability
- Application and Multi-Server Management for managing over 25 database instances
- Support for very large-scale business intelligence use
- Large-scale data warehousing
- Highest virtualization support
- High-scale complex event processing with StreamInsight
- Support for the maximum amount of memory provided by the Operating System

### *What This Means for Your Migration Planning*

If your deployment includes more than 25 database instances or has large CPU and memory performance requirements, consider using SQL Server 2008 R2 Datacenter Edition. This edition provides the ability to scale up to tens of terabytes of data, and adds support for very large-scale business intelligence applications.

### **Storage Considerations**

SQL Server architects have three options for data storage: direct attached storage (DAS) connected directly to individual servers, network attached storage (NAS) which provides file-level network storage, or a storage area network (SAN) that centralizes storage on dedicated, networked disk arrays.

SANs offer several advantages over DAS in a SQL Server 2008 R2 architecture. These advantages include:

- Highly fault-tolerant disk arrays
- Dynamic allocation abilities such as thin provisioning
- Deduplication to reduce redundant data and save storage space
- Centralized storage management
- Shared data store for a high availability architecture

### **What This Means for Your Migration Planning**

When planning a SQL Server 2008 R2 migration, take into consideration the storage and high availability requirements your deployment requires and how a SAN will be used within that environment. SANs provide a number of benefits in a large, enterprise-wide deployment scenario, but may not be as cost-effective as DAS or NAS in smaller, departmental scenarios. Architects should also keep in mind that high throughput SAN I/O is critical to fast database response times, so they will want to carefully consider the various SAN options that are available and their specific I/O needs.

### **Considerations for High Availability**

SQL Server 2008 R2, combined with Windows Server® 2008 R2 and Intel Xeon processors, is designed to provide maximum uptime and reliability by offering multiple levels of redundancy and failover support. Also, organizations can get the same or higher levels of availability at a lower cost over the RISC-based database systems.

### **Virtualization**

Virtualization should be a key design element in any SQL Server 2008 R2 architecture. It provides numerous benefits, including cost savings through server consolidation and flexibility in deploying resources on-demand.

SQL Server 2008 R2 can support up to four logical processors in a virtual machine. It also supports Hyper-V live migration so that administrators can move running Hyper-V virtual machines between physical hosts with little downtime. Live migration can also help solve variable load issues by moving running virtual machines to a physical host that is best equipped to process the database workload.

### **RAS Features**

SQL Server 2008 R2, combined with Windows Server 2008 R2 and the Intel Xeon processor 5600 and 7500 series, provides RAS features previously found only on costly RISC/UNIX

platforms or mainframes. These features help increase system availability, protect data integrity, and allow maintenance of running servers with minimal interruption.

The Intel Xeon processor 7500 series contains 20 new hardware-based RAS features, and the Intel Xeon processor 5600 series contains 12 new hardware-based RAS features. These features strengthen reliability at all levels of the processor architecture—memory, CPU/socket, Intel QuickPath links, and I/O hub.

Windows Server 2008 R2 features reliability enhancements in the Windows Hardware Error Architecture (WHEA), which now supports the Machine Check Architecture Recovery RAS feature found on the Intel Xeon processor 7500 series. This feature helps the platform contain and recover from multi-bit ECC errors in memory and cache without interrupting the operating system or applications.

## Database Mirroring

Database mirroring allows changes that are made to a principal database to be automatically applied to a secondary copy of the database. If a failure occurs on the principal database server, applications can be automatically redirected to the secondary copy of the database. Database mirroring can provide very fast failover protection without the need for applications to be rewritten.

When planning your migration, keep in mind the number of databases you are deploying and the amount of hardware and software that will be needed to mirror those databases. A mirrored database requires a secondary database server to mirror to and optionally a third server that acts as a witness.

## Log Shipping

Log shipping allows SQL Server architects to provide multiple standby servers. While database mirroring can have only one mirror server, an architecture with log shipping can have multiple standby servers.

Log shipping works by copying the primary database to multiple secondary database servers, and then configuring SQL Server 2008 R2 to apply periodic log backups to the secondary databases. Log shipping runs on a schedule, so there is a delay between the time data is written to the primary database and when the changes are written to the secondary servers.

When designing a SQL Server architecture that implements log shipping, keep in mind the number of standby servers your

organization requires, as well as the load on those servers should your primary server experience a failure.

## Failover Clustering

Failover clustering is a feature of Windows Server 2008 R2 that provides clustering of up to 16 nodes. Clustering provides protection for the entire server, not just the databases.

In a clustering scenario, multiple nodes share a disk array. Should one of the nodes in the cluster fail or need to be taken offline for maintenance, the services running on that node can be restarted on another node in the cluster. Clustering prevents data loss and provides automatic client redirection.

In a SQL Server 2008 R2 environment, failover clustering requires multiple servers and a shared storage system, such as a SAN.

### *What This Means for Your Migration Planning*

Architects should carefully analyze the level of high availability needed by the organization in light of downtime tolerance and cost. High-traffic e-commerce sites may need 24x7 uptime and reliability such that higher costs are justified, whereas smaller departmental deployments may not need such levels of high availability and fault tolerance.

## Considerations for Managing Microsoft® SQL Server® 2008 R2

One of the key benefits of SQL Server 2008 R2 is ease of management, both in small-scale scenarios and large-scale enterprise deployments. SQL Server 2008 R2 provides a number of tools for managing and reporting on database instances.

## SQL Server Utility Control Point

The SQL Server Utility Control Point helps database administrators manage their multi-server and multi-application SQL Server deployment as a unified whole. It models an organization's SQL Server environment, providing a holistic view of SQL Server resources through an instance of SQL Server that serves as a utility control point (UCP). Administrators can view the following entities and resources through the UCP:

- SQL Server instances
- Storage volumes
- Database files
- Data-tier applications
- CPU utilization
- Storage utilization

Each database instance in your SQL Server environment can be monitored by the UCP. The UCP collects data every fifteen minutes and stores the data in a specialized data warehouse located on the UCP server. Data from each instance uses approximately 2 GB per year and can be rotated out, so ensure that the SQL Server database instance that hosts the UCP has enough storage capacity to handle the data from each instance.

## Microsoft System Center Operations Manager

Database administrators can manage SQL Server 2008 R2 instances using the SQL Server Management Pack for Microsoft System Center Operations Manager. This enables a broader and a more centralized system administration that is scalable across the enterprise since existing management tools and resources can be used to manage SQL Server 2008 R2 instances.

### *What This Means for Your Migration Planning*

Architects should look at how systems in their organization are currently being administered and what tools are already in place. High availability systems or systems that are running larger databases may need a deeper set of management and tuning tools than smaller deployments that can use existing management tools. Managers should also consider the IT staff resources that are available and plan how the systems will be managed accordingly.

## Considerations for Microsoft® SQL Server® 2008 R2 Security

With the increase in government regulation and corporate governance, as well as the threats from internal and external sources, security should be a key design consideration in any SQL Server 2008 R2 implementation. SQL Server 2008 R2 provides the tools necessary to secure access to your databases as well as the information they contain.

NOTE: This section provides a brief overview of common SQL Server 2008 R2 security considerations, but architects should carefully review the security-related documents available at <http://www.microsoft.com/sqlserver/2008/en/us/security.aspx>.

## Secure Installation and Configuration

Microsoft, as part of their Trustworthy Computing initiative, secures the initial configuration of SQL Server 2008 R2 by default. The SQL Server 2008 R2 installation program utilizes a System Configuration Checker that notifies you of any security issues. Installing SQL Server 2008 also does not enable all

features by default; it installs only the core essentials and the most widely used features. Features that may not be needed in a production environment are disabled or not installed, but can be enabled or installed as required.

## Windows Update

As new threats and vulnerabilities are discovered, Windows Update can ensure your organization's SQL Server 2008 R2 and Windows servers are up to date with the latest security patches. Windows Server Update Service can be configured within your organization's IT environment to automatically download, deliver, and install patches, or allow an administrator to test then distribute patches throughout the organization.

## Encryption

The data stored inside a database can contain sensitive material, such as business plans and sensitive customer data. Even with proper network perimeter security and internal authentication controls in place, physical theft can expose sensitive data if it is not encrypted. SQL Server 2008 R2 provides support for data encryption using symmetric and asymmetric keys and digital certificates.

When designing a SQL Server 2008 R2 infrastructure, keep in mind that enabling encryption on database instances requires additional CPU overhead.

### *What This Means for Your Migration Planning*

Security should be a key consideration in planning, and architects should carefully consider how security is implemented and maintained. SQL Server 2008 R2 provides a number of tools for protecting data, and architects should carefully consider what features to install, whether or not encryption will be used, and how servers will be secured, maintained, and updated.

## Conclusion

With data being created at an ever-increasing rate, Microsoft and Intel provide a solid, reliable, and extensible platform for managing your organization's data. Database infrastructure architects should carefully consider the performance, reliability, and availability of the applications that will be migrated and what server and software resources that will be required to duplicate or increase these key indicators. Architects should also consider future growth, peak demand, security, and manageability and how their deployments will scale to keep up with demand.

## Related Links

Intel and Microsoft Alliance

<http://www.intelalliance.com/microsoft/>

Intel Xeon processors

[http://www.intel.com/p/en\\_US/products/server/processor](http://www.intel.com/p/en_US/products/server/processor)

<http://www.intel.com/itcenter/system/server/index.htm>

Microsoft SQL Server 2008 R2

<http://www.microsoft.com/sqlserver/2008/en/us/>

Microsoft SQL Server 2008 R2 Security

<http://www.microsoft.com/sqlserver/2008/en/us/security.aspx>

Microsoft SQL Server 2008 R2 High Availability

<http://www.microsoft.com/sqlserver/2008/en/us/high-avail-ability.aspx>

Microsoft SQL Server 2008 R2 Manageability

<http://www.microsoft.com/sqlserver/2008/en/us/manageability.aspx>

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Intel® Hyper-Threading Technology requires a computer system with a processor supporting HT Technology and an HT Technology-enabled chipset, BIOS and operating system. Performance will vary depending on the specific hardware and software you use. For more information including details on which processors support HT Technology, see: <http://www.intel.com/technology/platform-technology/hyper-threading/index.htm>

Intel® Turbo Boost Technology requires a platform with a processor with Intel Turbo Boost Technology capability. Intel Turbo Boost Technology performance varies depending on hardware, software and overall system configuration. Check with your platform manufacturer on whether your system delivers Intel Turbo Boost Technology. For more information, see <http://www.intel.com/technology/turboboost>.

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