



# HP ProLiant SL6000 Scalable System technology

technology brief

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# Abstract

The HP ProLiant SL6000 Scalable System implements an entirely new mechanical design and architecture in the industry-standard server market. The SL6000 server family is optimized for extreme scale-out computing applications such as High Performance Computing, large-scale enterprise server deployments, and the latest web and cloud computing applications. HP expertise in design and technology implementation in the SL6000 system led to achieving a record-setting performance in the SPECpower\_ssj2008\* benchmark: In the benchmark report published on November 4, 2009, HP ProLiant SL2x170z G6 server garnered the SPECpower\_ssj2008 result of 2316 overall ssj\_ops/watt\*.

Based on industry-standard components, the ProLiant SL6000 Scalable System provides extreme density and high performance at low acquisition costs. SL6000 servers are uniquely serviceable in racks and are optimized for power and cooling efficiency. Simplified management and monitoring of each server reduce the cost and effort needed to manage thousands of servers.

## Mechanical design for extreme scale-out computing

Computing environments such as High Performance Computing, large-scale enterprise server deployments, and the latest web and cloud computing applications require unusually high processing power and density plus maximized operating efficiency. For the ProLiant SL servers, HP developed a new mechanical design and infrastructure to meet several customer needs:

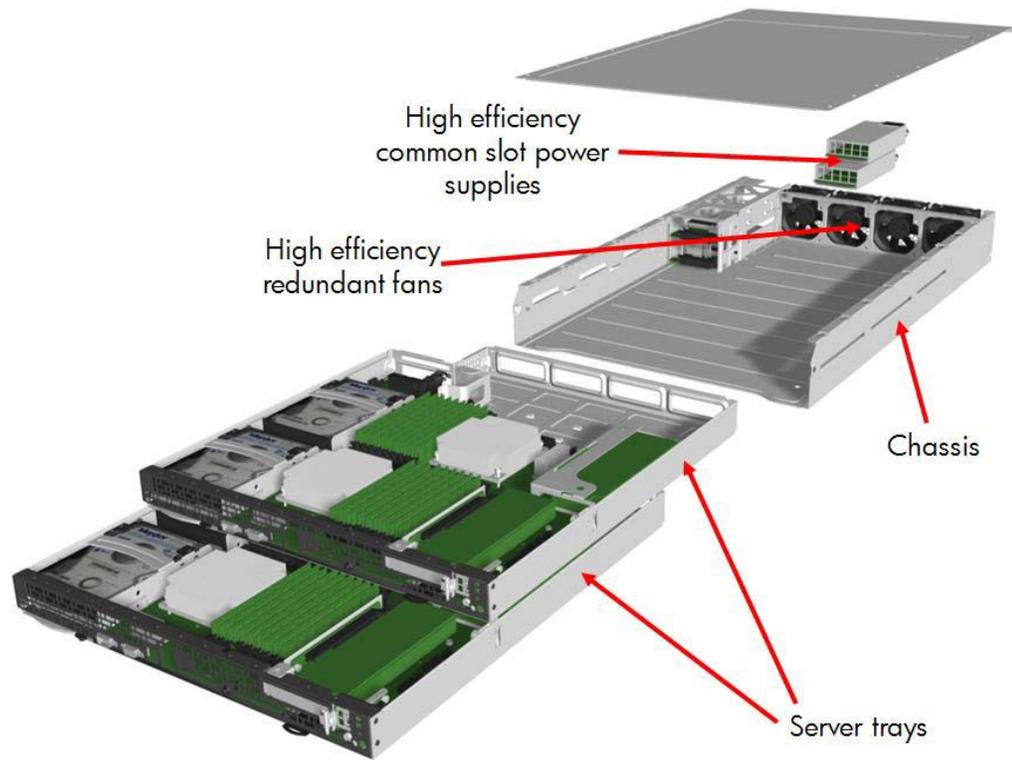
- Economical purchase price
- Extreme density
- High performance
- Programmable power supplies for maximizing power efficiency
- Highly efficient and inexpensive cooling subsystem
- Integrated remote system management
- Easy, in-rack serviceability

A ProLiant SL6000 Scalable System consists of a 2U ProLiant z6000 G6 chassis and two self-contained 1U server trays, each with its own industry-standard processors, Double Data Rate-3 (DDR3) memory, I/O, and storage (Figure 1). The rack-mountable chassis includes a highly efficient and modular power and cooling infrastructure that supports the slide-in pluggable server trays. More information about the ProLiant SL6000 Scalable System is available at <http://www.hp.com/servers/SL6000>.

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\* SPEC® and the benchmark name SPECpower\_ssj® are registered trademarks of the Standard Performance Evaluation Corporation. Benchmark results stated above reflect results published on [www.spec.org](http://www.spec.org) as of 11/04/2009. For the latest benchmark results, visit [http://www.spec.org/power\\_ssj2008/](http://www.spec.org/power_ssj2008/).

**Figure 1.** HP ProLiant SL6000 Scalable System



## HP ProLiant z6000 G6 chassis

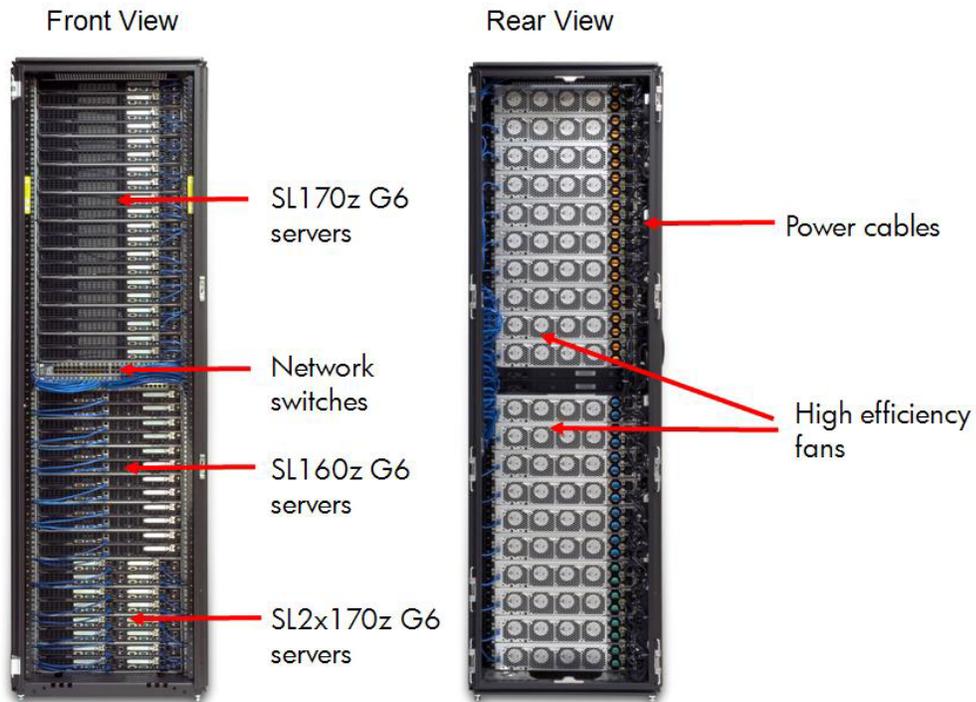
The HP ProLiant Scalable System implements a new chassis/rack architecture in the industry-standard server market space. The chassis provides shared power and cooling to the system components by means of one or two high efficiency, HP common slot power supplies and up to four system fans. Each 2U chassis contains an embedded microcontroller that provides power metering and throttling capabilities for the entire chassis. The chassis has no midplane and the I/O connectors are at the front of the chassis to optimize serviceability and to provide unrestricted airflow to the two server trays.

## Rack and cabling options

The z6000 G6 chassis mounts into an industry standard 19-inch rack using standard mounting hardware or an HP rack using a more cost-effective 10U bulk rail system (only for HP racks). The standard rail kit or the 10U bulk rail kit can be mixed within the HP rack to optimize the deployment. In a 42U rack, it is possible to install 21 z6000 G6 chassis containing a total of 42 server trays. To avoid risk of personal injury or damage to the equipment, HP ProLiant z6000 G6 chassis should be installed first in the bottom of a rack and added from the bottom to the top until the rack is fully populated. Network switches provide an aggregation point for all network cables and are typically installed in the middle of the rack to accommodate shorter cable lengths and to optimize serviceability. In the rear, all power cables are cleanly installed on the right side of the cabinet (Figure 2). For detailed information about rack and cabling options, refer to the HP ProLiant SL6000 Scalable System Cabling Guide at this website:

<http://bizsupport2.austin.hp.com/bc/docs/support/SupportManual/c01769895/c01769895.pdf>.

**Figure 2.** Front and rear views of HP 42U rack fully populated with SL6000 systems



## SL6000 server trays

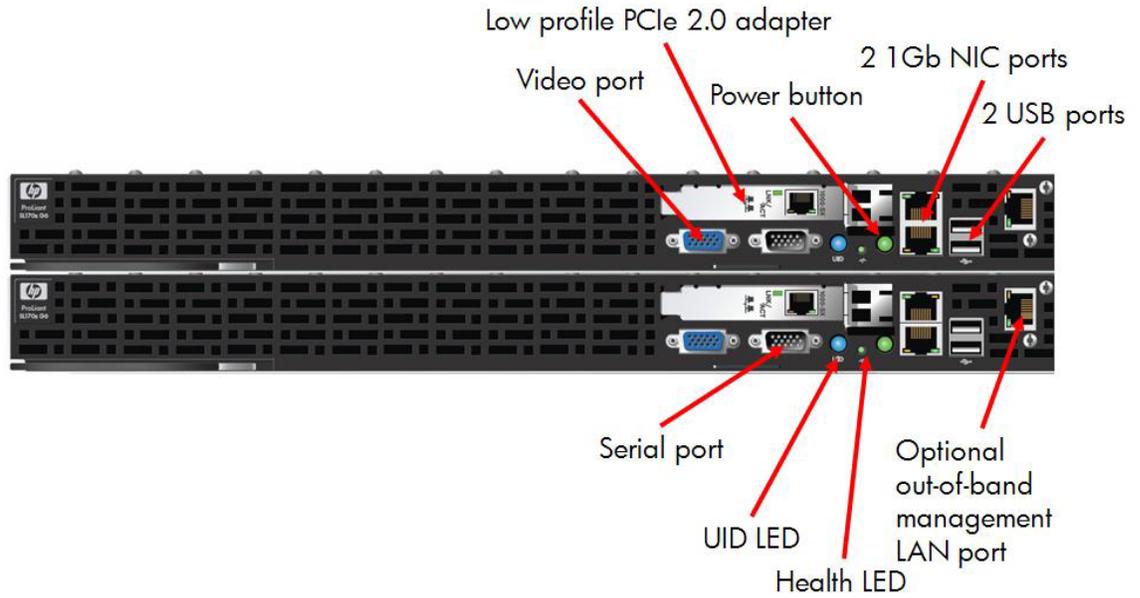
HP developed multiple SL6000 server trays to meet various customer needs: memory capacity, internal storage, or compute density. The chassis supports two server trays of the same model within an SL6000 chassis. To optimize air flow, if one server tray is removed for maintenance, fan speeds increase to ensure adequate cooling of the other tray. If a server tray is removed and a replacement tray is not immediately available, users should install a tray blank within two minutes to maintain proper cooling. The z6000 tray blank kit is a core option available for the z6000 G6 chassis.

Each server tray accommodates Intel® Xeon® 5500 Series processors, DDR3 memory, an integrated Serial ATA (SATA) controller with HP Smart Array software RAID, non hot-plug SATA storage drives housed in quick-release drive carriers, an integrated dual-port 1 gigabit network adapter, and an optional PCIe 2.0 x16 slot available on a riser.

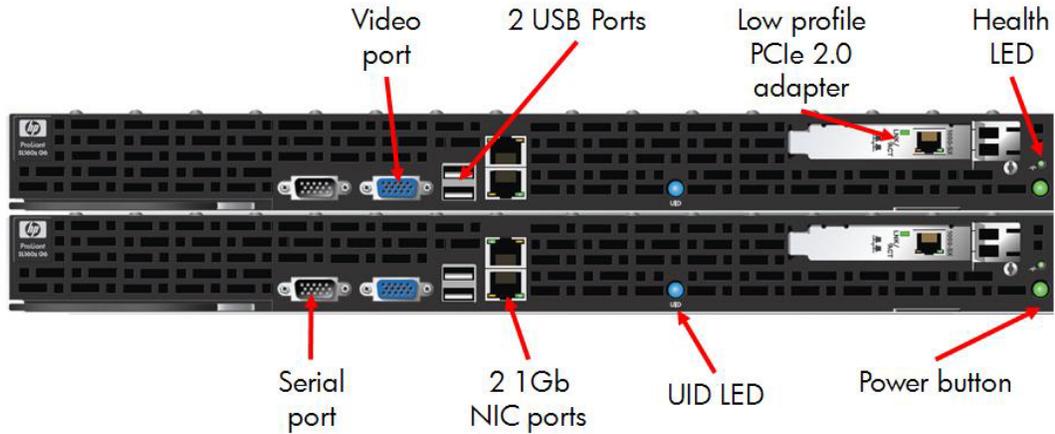
While SL6000 server trays include an integrated SATA RAID controller, they also support optional HP Smart Array SAS controllers and SAS hard drives. For specific information on supported SAS controllers, SAS hard drive options, and server node storage configuration, refer to the HP technology document "Configuring SATA and SAS in HP ProLiant SL6000 servers" at <http://h20000.www2.hp.com/bc/docs/support/SupportManual/c01893303/c01893303.pdf>.

For easy servicing, video and serial ports, USB ports, NIC ports, and optional out-of-band management LAN ports are located on the front panel of each server tray. Also on the front panel are two LEDs for health and UID status, and an access port for a low profile PCIe 2.0 adapter (Figures 3 and 4).

**Figure 3.** Front view of a ProLiant z6000 G6 chassis fully populated with two HP ProLiant SL170z G6 server trays



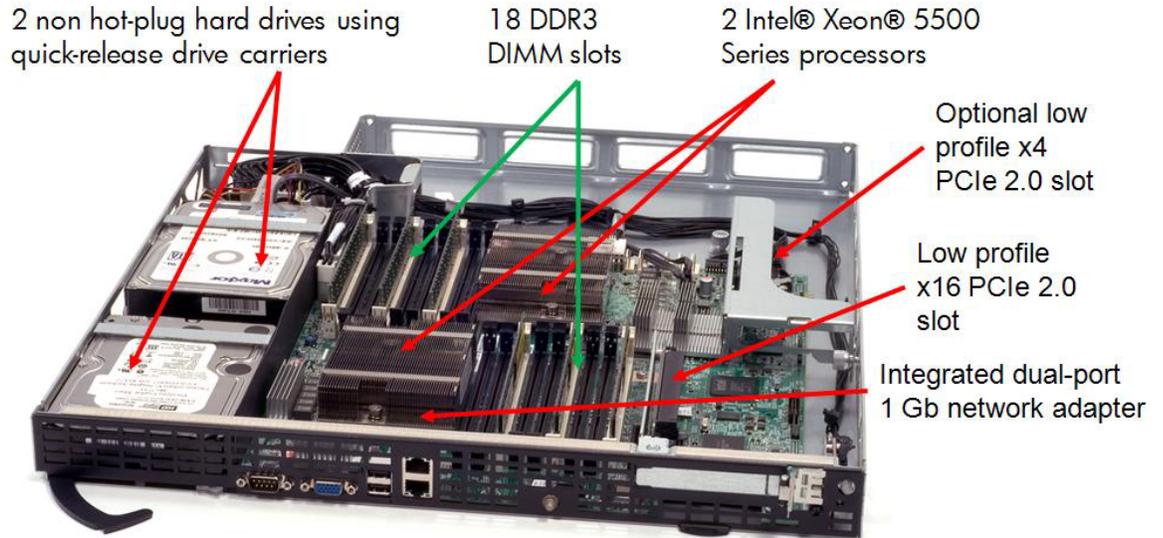
**Figure 4.** Front view of a ProLiant z6000 G6 chassis fully populated with two HP ProLiant SL160z G6 server trays



## HP ProLiant SL160z G6 server

The SL160z G6 server tray is optimized for maximum expansion (Figure 5). The system board accommodates up to two Intel Xeon 5500 Series processors and up to 18 slots for DDR3 memory modules (nine per processor). In addition to the optional PCI Express (PCIe) 2.0 x16 slot, there is room for another optional internal PCIe 2.0 x4 slot. The SL160z G6 server can support large form factor (LFF), small form factor (SFF), or solid state (SSD) SATA storage drives housed in quick-release drive carriers. More detailed information about memory configuration and internal drive support is available in the QuickSpecs at this URL: [www.hp.com/servers/SL160z](http://www.hp.com/servers/SL160z).

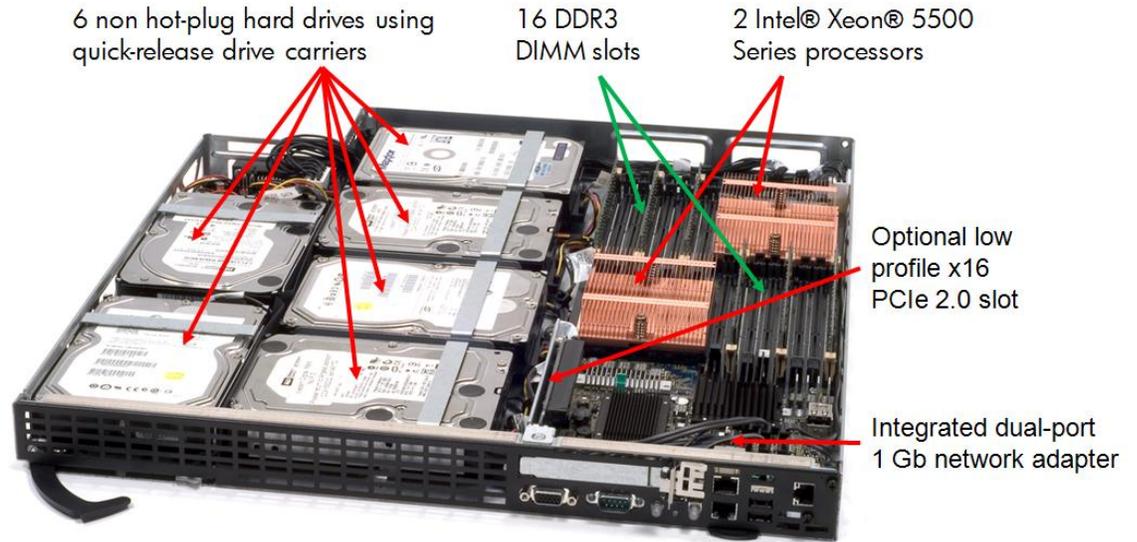
**Figure 5.** Internal view of the HP ProLiant SL160z G6 server tray



## HP ProLiant SL170z G6 server

The HP ProLiant SL170z G6 server tray is optimized for maximum storage capability (Figure 6). It supports LFF, SFF, or SSD SATA storage drives housed in quick-release drive carriers. The system board accommodates up to two Intel Xeon 5500 Series processors and provides up to 16 slots for DDR3 memory modules (eight per processor). More detailed information about memory configuration and internal drive support is available in the QuickSpecs at this URL: [www.hp.com/servers/SL170z](http://www.hp.com/servers/SL170z).

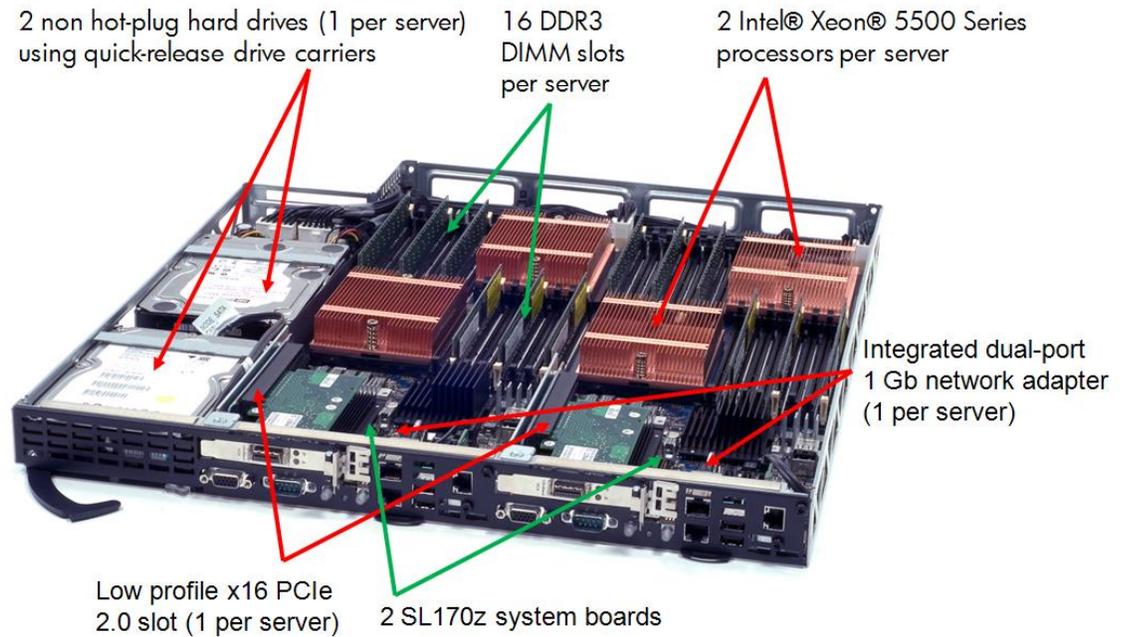
**Figure 6.** Internal view of the HP ProLiant SL170z G6 server tray



### HP ProLiant SL2x170z G6 server

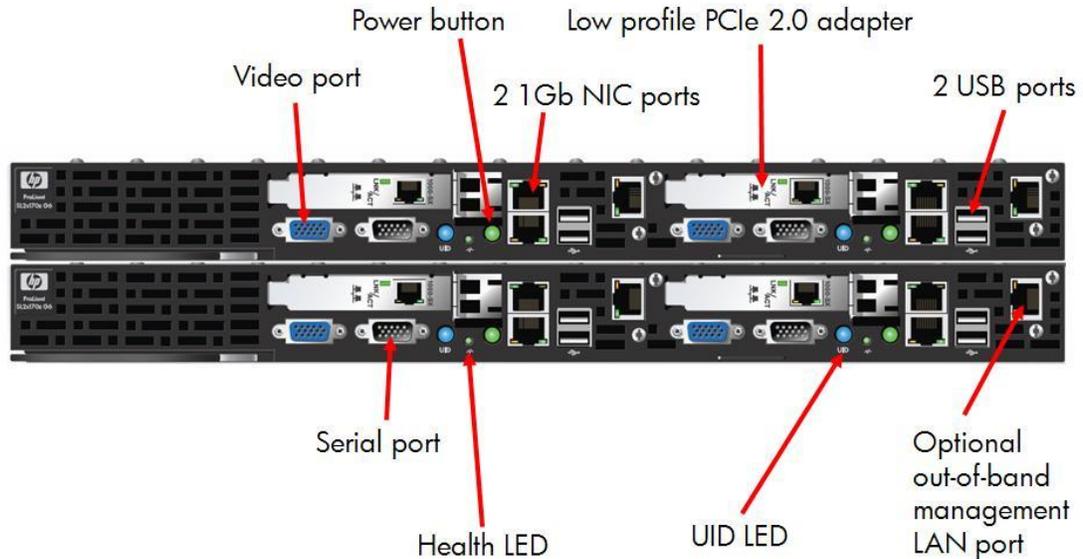
The HP ProLiant SL2x170z G6 server tray is optimized for compute power and density (Figure 7). It contains two SL170z G6 server nodes side-by-side in the tray. This means it has up to four sockets for Intel Xeon 5500 Series processors and 32 slots for DDR3 memory modules (eight per processor). Each server node has its own embedded SATA controller that accesses one of the two LFF, SFF, or SSD SATA storage drives housed in quick-release carriers. More detailed information about memory configuration and internal drive support is available in the QuickSpecs at this URL: [www.hp.com/servers/SL2x170z](http://www.hp.com/servers/SL2x170z).

**Figure 7.** Internal view of the HP ProLiant SL2x170z G6 server tray



Because two server nodes are installed side-by-side, the front of the unit has twice as many ports and LEDs as the SL170z G6 server. Each server node has its own video and serial connectors, USB ports, NIC ports, health and UID LEDs, optional out-of-band management LAN port, and a slot for an optional PCIe 2.0 adapter (Figure 8).

**Figure 8.** Front view of a ProLiant z6000 G6 chassis populated with 2 HP ProLiant SL2x170z G6 server trays



## Intel Xeon 5500 Series processor technology

HP ProLiant SL6000 Scalable Systems use Xeon 5500 Series processors that include multi-level caches, an integrated memory controller, and Intel's QuickPath Technology to boost bandwidth between processors, memory, and I/O subsystems.

The Intel Xeon 5500 Series microarchitecture is built on hafnium-based, 45-nanometer, high-k metal gate, silicon technology to reduce electrical leakage. These small, energy-efficient, high-performance processors support distributed shared memory, Intel Hyper-Threading technology, and Intel Turbo Boost Technology with Intelligent Power Technology.<sup>1</sup>

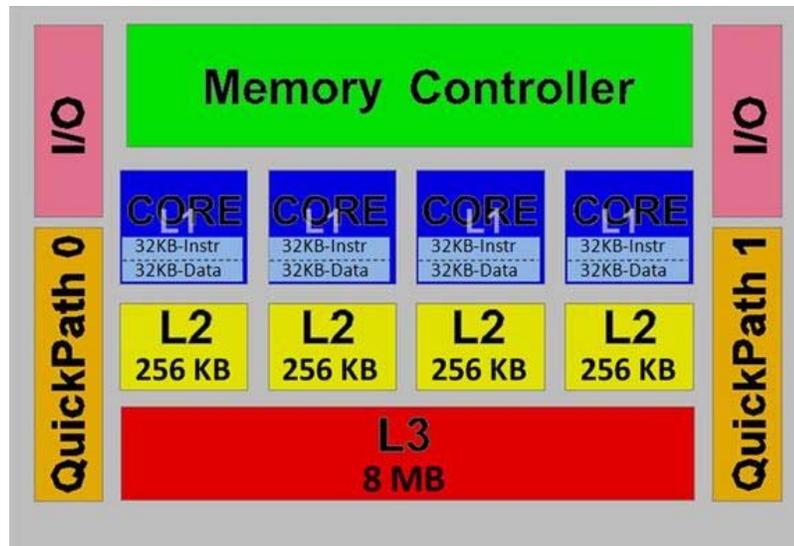
<sup>1</sup> For additional information about Intel processors, see the HP technology brief titled "The Intel processor roadmap for industry-standard servers" at <http://h20000.www2.hp.com/bc/docs/support/SupportManual/c00164255/c00164255.pdf>.

## Multi-level caches

Intel Xeon 5500 Series processors have a three-level cache hierarchy (Figure 9):

- An on-core 64-kilobyte Level 1 cache, split into two 32-kilobyte caches: one for data and one for instructions
- 256-kilobyte, Level 2 cache for each core to reduce latency
- A Level 3 cache of up to 8 megabytes

**Figure 9.** Block diagram of three-level cache hierarchy for Intel Xeon 5500 Series processors



The Level 3 cache is shared by all cores. It is inclusive, which means that it duplicates the data stored in each core's Level 1 and 2 caches. This duplication minimizes latency by eliminating unnecessary core snoops to the Level 1 and 2 caches. Flags in the Level 3 cache track the cache source of data. If one core modifies another core's data in Level 3 cache, the Level 1 and 2 caches of those cores are updated as well. This eliminates excessive inter-core traffic and ensures multi-level cache coherence.

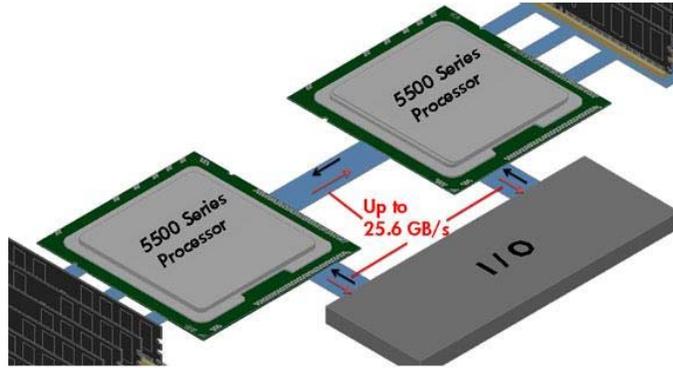
## Integrated memory controller

Instead of sharing a single pool of system memory, each processor accesses its own dedicated DDR3 system memory directly through an integrated memory controller. Three memory channels from each memory controller to its dedicated DDR3 memory provide a total bandwidth of 32 gigabytes per second. The three memory channels eliminate the bottleneck associated with earlier processor architectures in which all system memory access was through a single memory controller over the front side bus. When needed, a processor can access another processor's memory through the QuickPath Interconnect.

## QuickPath Interconnect controller

Intel Xeon 5500 Series processors attain their performance potential through Intel QuickPath architecture (Figure 10). High-speed, point-to-point interconnects directly connect the processors with one another. Intel QuickPath architecture also connects each processor to distributed shared memory and to the I/O chipset.

**Figure 10.** Block diagram of QuickPath architecture



Each QuickPath Interconnect (QPI) consists of two unidirectional links that operate simultaneously in opposite directions using differential signaling. Unlike a typical serial bus, the QPIs transmit data packets in parallel across multiple lanes, and packets are broken into multiple parallel transfers. Each link is comprised of twenty 1-bit lanes. Data transfer uses a maximum of 16 bits, while the protocol and error correction use the remaining 4 bits. The interconnect performs a maximum of 6.4 gigatransfers per second and has a bandwidth of 12.8 gigabytes per second in each direction, for a total bandwidth of 25.6 gigabytes per second. If an application requests data from the memory of another processor, the QPI uses high-bandwidth inter-processor communication to retrieve the data.

To reduce power requirements, administrators can use the ROM-Based Setup Utility (RBSU)<sup>2</sup> to set QPI links to enter a low power state when the QPI links are not active. Once this feature is enabled, the Intel processor determines when to put the QPI links into a low power state. This reduces power use with minimal performance impact.

## Hyper-Threading

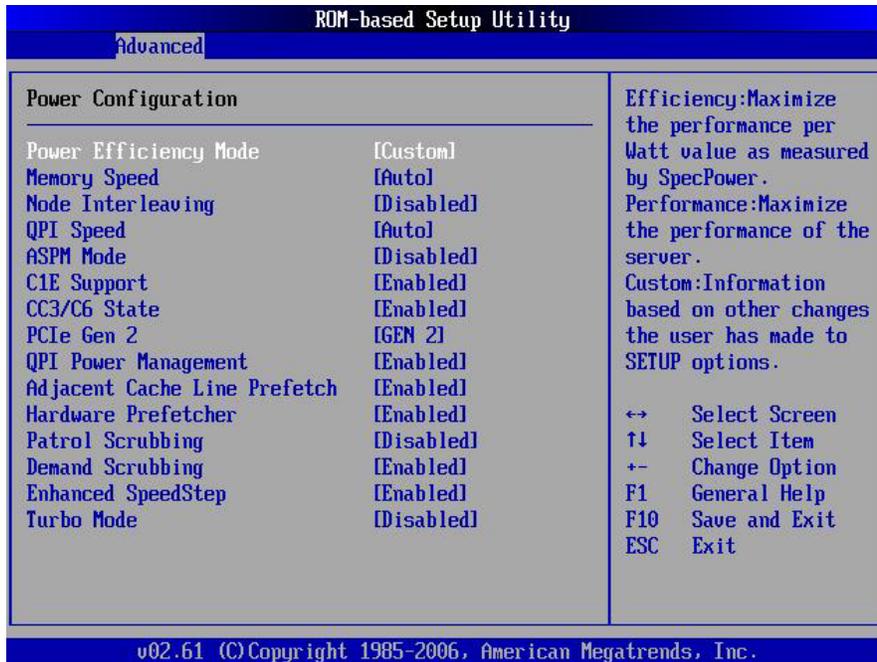
With Intel Hyper-Threading Technology, also called Simultaneous Multi-threading Technology (SMT), each core can execute two computational threads at the same time. This means that a single processor can simultaneously execute up to eight threads. In addition, the high-bandwidth memory subsystem supplies data faster to the two computational processes than traditional front side buses, and the low-latency cache hierarchy allows more instructions to be processed simultaneously. Hyper-Threading improves performance per watt, allowing Intel-based ProLiant G6 servers to accomplish more using the same or less power than servers based on previous-generation Intel processors.

<sup>2</sup> RBSU information is provided in the software configuration guide for each server tray. Additional information is provided in the "HP ROM-Based Setup Utility User Guide" at <http://h20000.www2.hp.com/bc/docs/support/SupportManual/c00191707/c00191707.pdf>.

## Turbo Boost technology

Intel Turbo Boost Technology complements Hyper-Threading by increasing the performance of both multi-threaded and single-threaded workloads. For workloads and applications that do not benefit from multi-threading, Turbo Boost Technology can increase performance. Turbo Boost is engaged by enabling the Turbo Mode option in the Advanced Power Configuration submenu in RBSU (Figure 11). It automatically increases the clock frequency of active cores operating below power and thermal design points determined by the processor.

**Figure 11.** Example of RBSU Advanced Power Configuration submenu with default settings



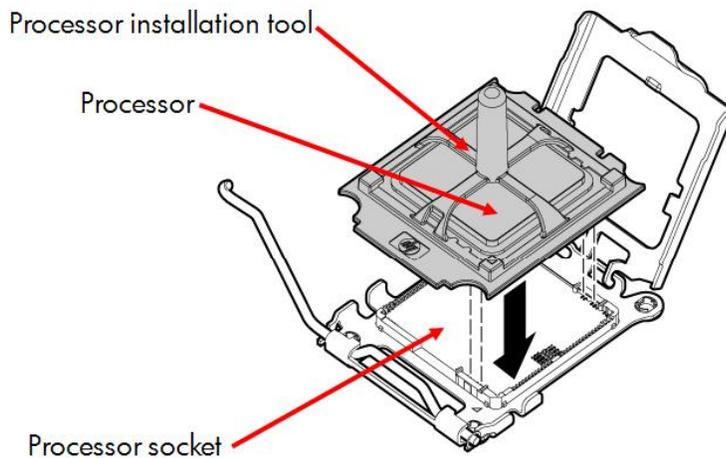
Turbo Boost Technology is operating system independent, which means that Advanced Configuration and Power Interface-aware (ACPI) operating systems require no changes to support it. However, it is application dependent and increases processor power consumption.

## Processor socket technology

The latest Intel 5000 Sequence processors use a processor socket technology called Land Grid Array (LGA). The processor package designs no longer have pins. Instead, the processor package has pads of gold-plated copper that touch processor socket pins on the motherboard.

Technicians must be careful when installing processors to avoid damaging the delicate processor socket pins. Because pin damage could require replacing the motherboard, HP engineers developed a special installation tool to simplify processor installation and reduce the possibility of damaging the socket pins (Figure 12).

**Figure 12.** Diagram showing how the processor installation tool simplifies installation



## Memory technologies

Xeon 5500 Series processors connect directly to memory rather than through a chipset. These processors support only DDR3 dual inline memory modules (DIMMs). DDR3 is part of the synchronous dynamic random access memory (SDRAM) group of technologies. Administrators control all processor functionality options, including memory mirroring and memory channel interleaving, through the G6 server RBSU.

### DDR3 memory enhancements

DDR3 has several key enhancements over DDR2 memory, including an 8-bit prefetch buffer for storing data before it is requested. DDR2 has a 4-bit buffer. For DDR3, the data signal rate can increase to 1333 megatransfers per second (MT/s). Although this is commonly referred to as having a speed of 1333 MHz, the maximum clock speed for the DIMMs is actually 667 MHz. The signal is double-pumped to achieve the data rate of 1333 MT/s. DDR3-1333 DIMMs can operate at clock speeds of 667 MHz, 533 MHz, and 400 MHz with corresponding data rates of 1333, 1066, and 800 MT/s.

#### Controlled fan speed

HP DDR3 DIMM modules have an integrated thermal sensor that signals the chipset to limit memory traffic to the DIMM if the DIMM temperature exceeds a programmable critical trip point. Using the data from these thermal sensors, ProLiant G6 servers can reduce fan speed when memory is idle, which reduces power consumption. The BIOS in ProLiant G6 servers verifies the presence of the thermal DIMM sensor during POST. Some third-party DIMMs may not include this DIMM thermal sensor. If the thermal sensor is absent, a POST message will warn that the DIMM does not have a thermal sensor, and the fans will run at higher speeds (requiring more power).

#### Reduced operating voltage

Operating voltage for DDR3 has been reduced: DDR2 operates at 1.8V, while at this writing DDR3 operates at 1.5V and consumes less power than DDR2 DIMMs at the same capacity and speed. Even though DDR3 DIMMs and DDR2 DIMMs are the same size and have the same number of pins, they have different key notch locations and are electrically incompatible.

## Unbuffered and registered DIMMs

DDR3 DIMMs are available as both Unbuffered (UDIMMs) and Registered (RDIMMs). Both UDIMMs and RDIMMs support error correcting code (ECC). There are three types of DDR3 memory:

- PC3-8500R (RDIMM) — 1066 or 800 MT/s data rate, depending on memory configuration and processor
- PC3-10600E (UDIMM) — 1333, 1066, or 800 MT/s data rate, depending on memory configuration and processor
- PC3-10600R (RDIMM) — 1333, 1066, or 800 MT/s data rate, depending on memory configuration and processor

Administrators can use either RDIMMs or UDIMMs, but RDIMM and UDIMM memory cannot be mixed within a single server. When choosing memory configurations using DDR3 memory, the following guidelines are useful:

- UDIMM configurations are limited to a maximum of two UDIMMs per memory channel because the memory controller must drive the address and command signals to each DRAM chip on a channel. This results in a 24 GB maximum configuration. Because they require fewer components, UDIMMs are typically less expensive than RDIMMs.
- RDIMM configurations can provide larger memory capacity because the memory controller only drives the address and command signals to a single register chip, thereby reducing the electrical load on the memory controller. Users requiring large memory footprints can install three 8-GB RDIMMs per channel for a total of 144 GB.
- For smaller memory configurations, installing only one or two DIMMs per memory channel can potentially increase memory performance. In many instances this allows administrators to clock the memory channel at a higher data rate.

Table 1 summarizes the choices available for DDR3 memory.

**Table 1.** DDR3 memory options

	Type	DIMM capacity (GB)	Rank	Max. data rate in MT/s (1 or 2 DIMMs/channel)	Max. data rate in MT/s (3 DIMMs/channel)
<b>PC3-8500R</b>	RDIMM	4	quad	1066	800
<b>PC3-8500R</b>	RDIMM	8	dual	1066	800
<b>PC3-10600R</b>	RDIMM	2	dual	1333	800
<b>PC3-10600R</b>	RDIMM	4	dual	1333	800
<b>PC3-10600R</b>	RDIMM	8	dual	1333	800
<b>PC3-10600E</b>	UDIMM	1	single	1333	N/A
<b>PC3-10600E</b>	UDIMM	2	dual	1333	N/A

An RBSU setting allows PC3-10600R memory modules to run at 1333 MT/s with two DIMMs per channel and without performance degradation. Only HP branded DIMMs have been fully validated to operate at this speed. Third-party DIMMs may not meet stringent design requirements; therefore, HP does not recommend configuring third-party DIMMs for 1333 MT/s data rates with two DIMMs per channel. At this writing, operating the memory at 1333 MT/s is supported only on select ProLiant SL G6 server trays using the Xeon 5500 Series processors operating at 95W.

For detailed memory configuration guidelines, use the Online DDR3 Memory Configuration Tool available on the HP website: [www.hp.com/go/ddr3memory-configurator](http://www.hp.com/go/ddr3memory-configurator).

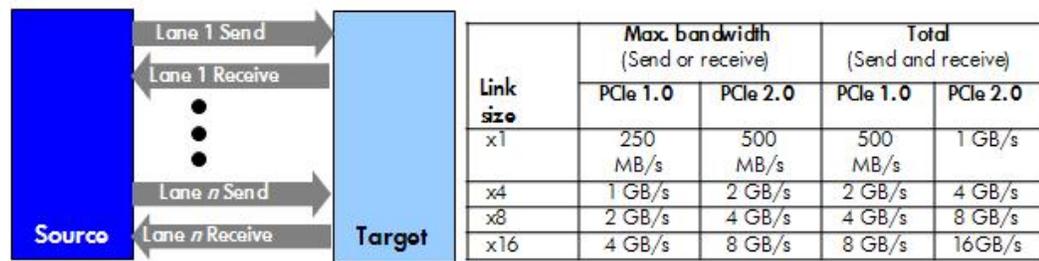
## I/O technologies

ProLiant SL G6 server trays incorporate PCIe and SATA I/O technologies. PCIe lets administrators add expansion cards with various capabilities to the system. SATA is a serial communication protocol for direct-attached storage devices such as SATA hard drives.

### PCI Express technology

All ProLiant SL G6 server trays support the PCIe 2.0 specification. PCIe 2.0 has a per-lane signaling rate of 5 Gb/s, which is double the per-lane signaling rate of PCIe 1.0 (Figure 13).

**Figure 13.** PCIe data transfer rates



PCIe 2.0 is backward compatible with PCIe 1.0. A PCIe 2.0 device can be used in a PCIe 1.0 slot and a PCIe 1.0 device can be used in a PCIe 2.0 slot. For best performance, however, each card should be used in a slot that supports its logical link size. A ProLiant SL series G6 option allows all expansion slots to run at PCIe 1.0 speed rather than at PCIe 2.0 speed. Enabling this option saves power. Administrators can control expansion slot speed through the RBSU under the Advanced Power Configuration submenu.

Table 2 shows the level of interoperability between PCIe cards and PCIe slots.

**Table 2.** PCIe device interoperability

PCIe device type	x4 Connector x4 Link	x8 Connector x4 Link	x8 Connector x8 Link	x16 Connector x8 Link	x16 Connector x16 Link
x4 card	x4 operation	x4 operation	x4 operation	x4 operation	x4 operation
x8 card	Not allowed	x4 operation	x8 operation	x8 operation	x8 operation
x16 card	Not allowed	Not allowed	Not allowed	x8 operation	x16 operation

### Serial ATA technology

Serial ATA (SATA) technology uses a point-to-point architecture in which each device connects directly to the controller rather than sharing a common bus as parallel devices do. SATA technology transmits signals in a single stream rather than in multiple parallel streams. Point-to-point links increase data

throughput and improve the ability to locate and fix disk failures. More importantly, serial architecture solves the problems of clock skew and signal degradation at higher signaling rates.<sup>3</sup>

HP has developed a software RAID solution based on Smart Array firmware. The B110i SATA Software RAID supports the Array Configuration Utility (ACU), ACU command line interface (CLI), Simple Network Management Protocol (SNMP) agents, and Web-Based Enterprise Management (WBEM) providers.

B110i includes an OS-specific driver from HP that uses the embedded controller. It can use RAID 0, 1, and 1+0 and supports a maximum of two logical drives. The B100i supports up to four 1.5 Gb/s or 3 Gb/s SATA drives. Administrators can move drives to a hardware-based Smart Array controller in a seamless procedure that maintains the user data and RAID configuration.

For a listing of the complete feature set and support information for the B110i SATA Software RAID, refer to the B110i user guide at

<http://h20000.www2.hp.com/bc/docs/support/SupportManual/c01706551/c01706551.pdf>.

## Networking technologies

SL G6 servers have an integrated NC362i dual port, 1 Gb network adapter. These servers also support optional multifunction 1 Gb or 10 Gb Ethernet network adapters that provide several advantages, depending on the adapter:

- TCP/IP Offload engine (TOE) for Microsoft® Windows® operating systems improves CPU efficiency.
- Receive-side Scaling (RSS) for Windows dynamically load balances incoming traffic across all processors in a server.
- iSCSI Acceleration (available on some integrated network adapters) offloads some of the work in creating iSCSI packets from the processor onto the network controller, freeing up the processor for other work.
- iSCSI boot for Linux® operating systems enables booting the server from a storage area network (SAN) and eliminates the need for disk drives in a server.

More information about ProLiant Ethernet network adapters is available at

<http://h18004.www1.hp.com/products/servers/networking/index-nic.html>.

## High Performance Computing technologies

High Performance Computing (HPC) interconnect technologies are available for the ProLiant SL G6 server trays under the HP Cluster Platform product portfolio. HP fully supports these high speed interconnects when they are part of these configure-to-order clusters. For additional information and configuration tools, refer to the HP Cluster Platforms website at

<http://www.hp.com/techservers/clusters/ucp/index.html>.

## Power and thermal technologies

To increase power efficiency without degrading server performance, HP has developed high-efficiency, right-size power supplies and a common slot (CS) power supply bay that are used in multiple ProLiant server platforms. Like many other ProLiant G6 servers, the SL6000 Scalable System supports these common power supplies. By reducing the number of power supply designs for ProLiant servers, HP effectively reduces the number of spares customers must keep in their data centers.

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<sup>3</sup> For more information about these features, refer to the technology brief “Serial ATA technology” at <http://h20000.www2.hp.com/bc/docs/support/SupportManual/c00301688/c00301688.pdf>.

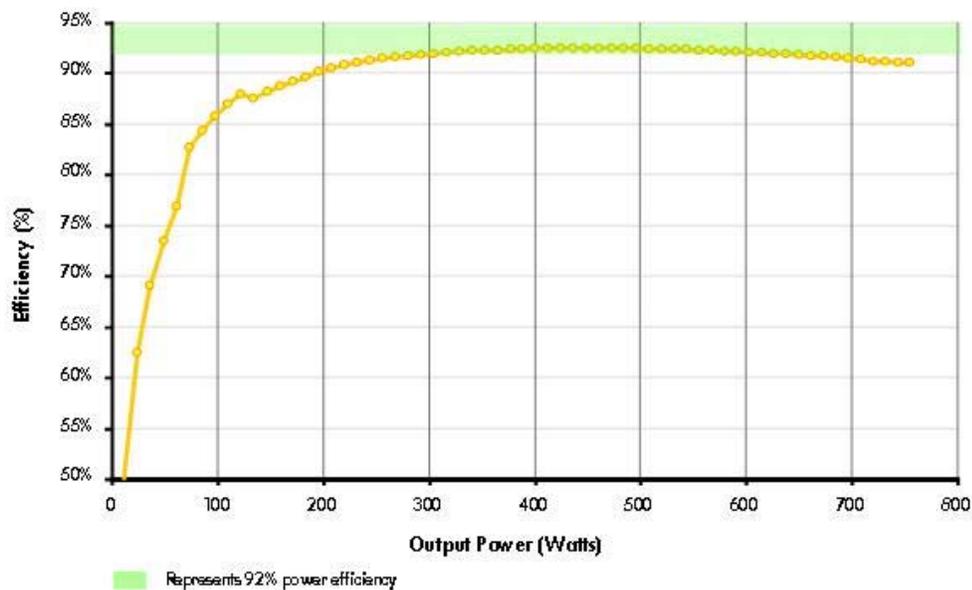
## Power supply options

Common slot power supplies come in multiple power ratings and have achieved efficiency ratings of up to 92 percent. Three power supply options are available for the SL6000 Scalable System:

- 460W AC                    up to 92% efficiency
- 750W AC                    up to 92% efficiency
- 1200W AC                  up to 90% efficiency

Common slot power supplies provide improved power delivery and the advantage of reclaiming lost power. With the exception of the 1200W power supply, they meet Climate Savers Gold requirements. The 1200W power supply meets Climate Savers Silver requirements. The power loading efficiency curve for the 750W power supply (Figure 14) provides an example of the high levels of power efficiency achieved by power supplies used in ProLiant G6 servers.

**Figure 14.** Power/Efficiency curve for the 750 W HP power supply



Oversized and lightly loaded power supplies do not run as efficiently as those that are heavily loaded. Therefore, HP recommends using the HP Power Advisor to identify the optimal power supply for each SL6000 configuration. With a choice of three power supplies of different wattage, customers can choose the power supply option that meets, but does not exceed their needs.

The HP Power Advisor is available online at [www.hp.com/go/hppoweradvisor](http://www.hp.com/go/hppoweradvisor).

## Redundant power operation

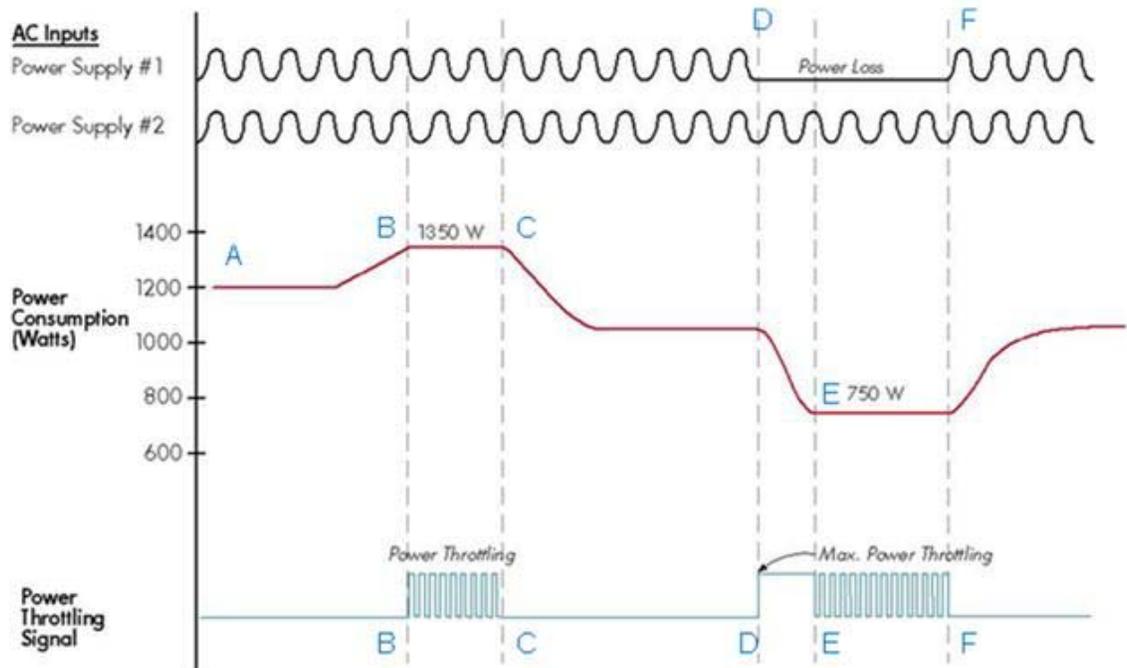
The SL6000 Scalable System has four redundancy modes: User configurable, full AC or DC redundant, AC redundant with throttling, and no redundancy mode.

The user configurable mode can be used to allocate power levels to each chassis, ensuring that total power is within the data center budget. The Power Management Controller monitors the chassis power and uses HP power capping technology to limit the AC input power. This feature is enabled as part of the LO100i Advanced Pack software license for the nodes.

Full AC or DC redundancy requires two power supplies to run the z6000 chassis. If one power supply fails and the remaining power supply can meet power demands of both server trays, both servers will continue to run without interruption.

AC redundancy with throttling requires two power supplies to run the z6000 chassis. If one power supply fails and the remaining power supply cannot support the full load of both server trays, the servers will throttle using HP power capping technology so that the remaining power supply can support both trays (Figure 15). Although performance is reduced, the chassis continues to operate until the failed power supply is replaced. This is the default mode when two power supplies are installed in the system.

**Figure 15.** Example of AC redundancy with throttling (default mode)



- A. System consists of four nodes and two 750W power supplies. Usable power is 1350W or 10% less than total power. System runs normally using 1200W of power.
- B. When power consumption increases to 1350W, power controller asserts power throttling signal to cap power usage at 1350W.
- C. When power consumption drops below 1350W, system de-asserts power throttling signal.
- D. When AC input from power supply #1 is lost, power throttling signal is asserted again at maximum to quickly reduce system power consumption to 750W, which can be supported by a single power supply.
- E. When power consumption is reduced to 750W, power throttling signal frequency is adjusted to allow maximum power usage, but still under 750W cap.
- F. When AC input to power supply #1 is restored, system de-asserts power throttling signal to allow system to return to normal operation.

Running the entire z6000 chassis with one power supply provides no redundancy. The single power supply will provide power to both trays.

In a multimode environment, it is important to ensure that planning is completed prior to selecting the right power supply for the desired redundancy mode. Use of the HP Power Advisor is highly recommended for identifying the optimal power supply for each SL6000 configuration. The HP Power Advisor is available online at [www.hp.com/go/hppoweradvisor](http://www.hp.com/go/hppoweradvisor).

## Management and deployment

IT administrators using ProLiant SL6000 Scalable Systems will have different computing requirements. Consequently, the way they manage, deploy, and control servers can differ. With these requirements in mind, this section examines the following management topics:

- Systems management and monitoring
- Power and thermal management with the Power Management Controller
- Remote management and control with HP ProLiant Onboard Administrator powered by LO100i
- Intelligent Platform Management Interface (IPMI) 2.0 and Data Center Management Interface (DCMI) 1.0 standards
- Server deployment

### Systems management and monitoring

The SL6000 Scalable System infrastructure operates through its extensive integrated management capabilities. These capabilities are based on the Power Management Controller and ProLiant Onboard Administrator powered by LO100i integrated on each server tray. Insight Management Agents provide alerts that can significantly reduce unplanned downtime. The Insight Management Agents are based on SNMP, the protocol developed to manage nodes (such as servers, workstations, routers, switches, and hubs) on an IP network. Network management systems detect problems by receiving traps or change notices from network devices implementing SNMP.

The ProLiant SL6000 Scalable System uses the same SNMP-based Insight Management Agents supported by other ProLiant servers. As a result, administrators can use HP Systems Insight Manager (SIM) 5.3 and greater to manage SL6000 servers. Administrators can also use any other SNMP-based management tool. The agents can be downloaded from the ProLiant model-specific “Easy Set-up” CDs or from the Internet at <http://www.hp.com/servers/easysetup>.

SNMP agents enable the following capabilities:

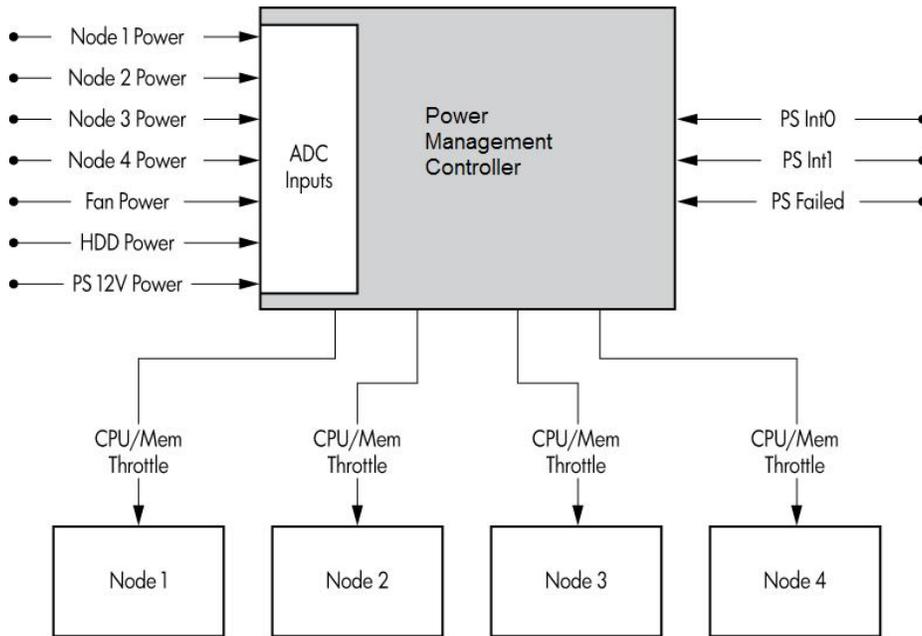
- Health monitoring for drives, fans, network, power supplies, and temperature
- Alerting, including basic alert notification for Smart Array drive pre-failure only
- Performance monitoring that provides information on processor, memory, free disk space, network utilization, and I/O

### Power and thermal management with the Power Management Controller

Each 2U chassis contains an embedded microcontroller that provides advanced power metering and capping capabilities for the entire chassis (Figure 16). The Power Management Controller manages the power capping technology built into the chassis, making extreme density in the rack possible. The embedded Power Management Controller monitors power consumption throughout the chassis and throttles processor speed and memory in each node to maintain a preset power budget.

HP provides a simple command-line utility, called PPIC, for reading and configuring the power control logic of the SL6000 Scalable System. Versions are available for Microsoft Windows Server 2003 and 2008 and for the Linux operating system if the OS IPMI driver is installed. Refer to the appendix for PPIC command line utility use.

**Figure 16.** HP ProLiant z6000 G6 chassis node, fan, and power control block diagram



Power control logic in the z6000 G6 chassis operates in one of four possible modes as shown in Table 3.

**Table 3.** HP ProLiant G6 chassis power control logic modes

Mode	Function
0	No Redundancy. Power Control Disabled. No power throttling will occur.
1	AC Redundancy with throttling. This is the default mode. It provides maximum performance with power supply redundancy. Power control logic will throttle the performance of each node if the chassis has only one operational power supply. In this mode, the servers are expected to survive an unexpected AC power loss to one of the power supplies.
2	Full AC/DC Redundancy. Power control logic will maintain a power cap value at the DC rating of a single power supply (460W, 750W, or 1200W), such that if one power supply experiences a DC or AC failure, the chassis should remain online and operational. Users should be aware of the minimum power consumption of the chassis. It must be less than the rating of a single power supply. Running the PPIC utility with the <code>-c</code> option will provide this information.
3	User Configurable (enabled with LO100i Advanced Pack purchase on the nodes). The user specifies the total power required to operate the 2U chassis, within the capabilities of the hardware installed. Before setting this mode, users are strongly advised to run the PPIC utility with the <code>-c</code> option to calibrate the minimum and maximum power consumption for the chassis. For accuracy, the <code>-c</code> command should be run after installing and configuring all hardware and bringing all nodes online in the 2U chassis. To avoid reduced performance due to throttling, a user configurable power cap value should not be set below or within 20% of the minimum power value provided by the <code>-c</code> option.

## Remote management and control with ProLiant Onboard Administrator

All ProLiant SL servers include ProLiant Onboard Administrator powered by LO100i. ProLiant Onboard Administrator provides the core embedded management functions in all ProLiant servers. LO100i works with HP SIM, RBSU, and Option ROM Configuration for Arrays (ORCA) to provide remote management, deployment, and control functions without additional software. Administrators can access this functionality locally through the RBSU, or remotely with a web browser through HP SIM. Additional software functionality can be added with HP LO100i advanced licenses.

HP LO100i Remote Management is hardware and firmware that provides remote server access and control capabilities through an Ethernet interface. The HP LO100i management interface is active even when the operating system is not running because it obtains its power from the auxiliary power plane of the server. It is available as long as the server is connected to an active power source. HP LO100i Remote Management is compatible with industry standards including IPMI 2.0 for hardware health, DCMI 1.0, and Secure Sockets Layer (SSL) and Secure Shell (SSH) technology for secure communications over public and private local area networks. HP LO100i is fully accessible using popular web browsers including Microsoft Internet Explorer 6.0 (for Microsoft Windows clients), Firefox 1.5 (for Windows and Linux clients), and Mozilla 1.7.12 (for Windows and Linux clients). HP LO100i is also accessible using System Management Architecture for Server Hardware Command Line Protocol (SMASH CLP) for Telnet and SSH sessions.

LO100i Advanced Pack contains all the features of LO100i Standard. Purchasing an optional license key provides access to Advanced Pack functionality:

- Improvements to HP SIM support through the addition of Insight Management (SNMP) Agents
- Host access to in-band IPMI 2.0 features supported by IPMI-aware operating systems
- DNS Registration—LO100i comes with default host names and will automatically register with the DNS if DHCP is enabled.

LO100i supports a full-speed shared Ethernet port and a dedicated Ethernet port. LO100i and the server share the full-speed Ethernet port, using the system network for both. Since the connection is full speed, it supports Graphic Remote Console and virtual media.

The dedicated Ethernet port is provided for SL series G6 server trays through an optional mezzanine card and enables a separate management network.

### IPMI 2.0 and DCMI 1.0

ProLiant SL G6 server trays and LO100i include IPMI 2.0 and DCMI 1.0 standards so that customers in heterogeneous environments can manage these servers with either industry standard.

The following are basic compliance mandates:

- Implementation of all mandatory IPMI 2.0 and DCMI 1.0 in-band and out-of-band commands
- Reliable local and remote power on/off/reset through IPMI chassis commands
- Serial over LAN console redirection from a remote server (IPMI 2.0)
- Server identification by device ID, globally unique identifier (GUID), asset tag, and chassis ID
- Accurate system event logging using IPMI
- Reliable in-band keyboard controller style (KCS) interface and out-of-band LAN interface

For more information on HP LO100i remote management, go to [www.hp.com/go/LO100](http://www.hp.com/go/LO100).

## Server deployment

The HP ProLiant Easy Set-up CD provides easy, step-by-step, single- and multi-server server utilities to streamline server setup. It provides a user experience consistent with SmartStart:

- Boot environment and GUI
- Assisted Installation: Windows 2003 Server and Windows 2008 Server drivers
- Manual installation: Windows 2003 Server, Windows 2008 Server, and Linux drivers (Specific OS support varies by server. For supported versions, refer to QuickSpecs for each server.)
- HP Insight Diagnostics
- Array Configuration Utility (ACU) to configure array controllers and storage devices
- Array Diagnostics Utility (ADU) to perform array controller hardware tests
- SmartStart Scripting Toolkit and Smart Components for software and drivers

## Data security technology with the Trusted Platform Module

The Trusted Platform Module (TPM) is an optional hardware module that can securely store information such as passwords and encryption keys to authenticate the platform. Administrators can also use TPM to store platform measurements that help ensure that the platform remains trustworthy. ProLiant G6 servers support an optional TPM v1.2. A rivet supplied with the optional TPM v1.2 module attaches and secures the module to the system board. To prevent possible damage to the TPM module or to the system board, the TPM cannot be removed once it has been installed.<sup>4</sup>

## Summary

The HP ProLiant SL6000 Scalable System is a highly efficient, modular power and cooling infrastructure with a suite of pluggable server modules designed for extreme scale-out deployments. It provides right-sized dense server solutions based on industry standards with lower acquisition cost than traditional rack servers. Designed from the ground up for power efficiency, the ProLiant SL6000 includes server solutions that enhance power efficiency by sharing power supplies and fans to significantly reduce data center costs. The modular design works with existing data center infrastructure to provide a tailored solution that provides for easy serviceability in standard racks.

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<sup>4</sup> For additional information about the TPM, see the HP technology brief titled "Data security in HP ProLiant servers using the Trusted Platform Module and Microsoft® Windows® BitLocker™ Drive Encryption" at <http://h20000.www2.hp.com/bc/docs/support/SupportManual/c01681891/c01681891.pdf>.

## Appendix: PPIC command line utility

HP provides a simple command line utility, called PPIC, for reading and configuring the power control logic of the SL product line. Running the PPIC utility from the command line without any command-line options will provide the options shown below.

```
HP ProLiant Power Interface Control Utility v.1.09
```

```
Copyright (c) 2003, 2009 Hewlett-Packard Development Company, L.P.
```

```
Usage: POW [Options]
```

```
options:
```

```
-d Display and Log Power Status and Configuration
```

```
-v verbose data displayed
```

```
-s Set Power Configuration Mode
```

```
-m<mode>
```

```
00= No Redundancy Mode (Power Throttling  
Disabled)
```

```
01= AC Redundancy with Throttling Mode (Max  
Performance w/  
Redundancy)
```

```
02= Full AC/DC Redundancy Mode
```

```
03= User Configurable Mode (LO100 Advanced
```

```
License
```

```
Required)
```

```
-l<power limit> (in Watts - Required for <Mode 03>)
```

```
-c Calibrate and Display Power Limits
```

```
-p Poll and Log Power Readings
```

```
-v verbose data logged
```

```
-f<frequency> (in secs)
```

```
-t<duration of run> (in secs)
```

```
-o<name> override output log filename
```

```
(default log filename= ppic.log)
```

## For more information

For additional information, refer to the resources listed below.

Resource description	Web address
HP ProLiant SL160z G6 Server Software Configuration Guide	<a href="http://bizsupport2.austin.hp.com/bc/docs/support/SupportManual/c01778682/c01778682.pdf">http://bizsupport2.austin.hp.com/bc/docs/support/SupportManual/c01778682/c01778682.pdf</a>
HP ProLiant SL170z G6 Server Software Configuration Guide	<a href="http://bizsupport2.austin.hp.com/bc/docs/support/SupportManual/c01814434/c01814434.pdf">http://bizsupport2.austin.hp.com/bc/docs/support/SupportManual/c01814434/c01814434.pdf</a>
HP ProLiant SL2x170z G6 Server Software Configuration Guide	<a href="http://bizsupport2.austin.hp.com/bc/docs/support/SupportManual/c01769955/c01769955.pdf">http://bizsupport2.austin.hp.com/bc/docs/support/SupportManual/c01769955/c01769955.pdf</a>
HP ProLiant SL6000 Scalable System Cabling Guide	<a href="http://bizsupport2.austin.hp.com/bc/docs/support/SupportManual/c01769895/c01769895.pdf">http://bizsupport2.austin.hp.com/bc/docs/support/SupportManual/c01769895/c01769895.pdf</a>
HP Power Interface Controller User Guide	<a href="http://bizsupport2.austin.hp.com/bc/docs/support/SupportManual/c01828162/c01828162.pdf">http://bizsupport2.austin.hp.com/bc/docs/support/SupportManual/c01828162/c01828162.pdf</a>
HP ROM-Based Setup Utility User Guide	<a href="http://h20000.www2.hp.com/bc/docs/support/SupportManual/c00191707/c00191707.pdf">http://h20000.www2.hp.com/bc/docs/support/SupportManual/c00191707/c00191707.pdf</a>
"The Intel processor roadmap for industry-standard servers" technology brief	<a href="http://h20000.www2.hp.com/bc/docs/support/SupportManual/c00164255/c00164255.pdf">http://h20000.www2.hp.com/bc/docs/support/SupportManual/c00164255/c00164255.pdf</a>
"Memory technology evolution: an overview of system memory technologies" technology brief	<a href="http://h20000.www2.hp.com/bc/docs/support/SupportManual/c00256987/c00256987.pdf">http://h20000.www2.hp.com/bc/docs/support/SupportManual/c00256987/c00256987.pdf</a>
"Serial ATA technology" technology brief	<a href="http://h20000.www2.hp.com/bc/docs/support/SupportManual/c00301688/c00301688.pdf">http://h20000.www2.hp.com/bc/docs/support/SupportManual/c00301688/c00301688.pdf</a>
HP Cluster Platforms	<a href="http://www.hp.com/techservers/clusters/ucp/index.html">http://www.hp.com/techservers/clusters/ucp/index.html</a>
Online DDR3 Memory Configuration Tool	<a href="http://www.hp.com/go/ddr3memory-configurator">www.hp.com/go/ddr3memory-configurator</a>
HP Power Advisor	<a href="http://www.hp.com/go/hppoweradvisor">www.hp.com/go/hppoweradvisor</a>

## Call to action

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