



# Technology and architecture of HP ProLiant Intel-based 100-series G6 (Generation 6) servers



Technology brief, 2<sup>nd</sup> edition

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# Abstract

This technology brief describes the key technologies implemented in Intel-based HP ProLiant 100-series G6 servers. The 100-series family includes the ProLiant DL100-series, the ML100-series, and the DL1000 Multi Node architecture. As of this writing, the Intel-based 100-series G6 servers include the ProLiant DL160 G6, DL180 G6, ML150 G6, DL170h, DL2x170h, and DL4x170h. Links to the QuickSpecs for each of these servers are listed in the “For more information” section at the end of this technology brief.

## Introduction

HP ProLiant G6 servers have been the focus of extensive engineering and development. Characterized by increased performance, better power efficiency, and more powerful management tools, the servers include these new technologies:

- The Intel® Xeon® Processor 5500 Series
- Double Data Rate-3 (DDR-3) memory DIMMs
- Thermal sensors incorporated throughout the ProLiant 100-series G6 servers
- The ProLiant Onboard Administrator Powered by Lights-Out 100i (LO 100i)
- Input/output (I/O) technologies such as PCIe generation 2 (PCIe 2.0) and faster Smart Array controllers that incorporate common form factor components
- “Right Size” Common Slot power supplies in multiple sizes to provide the required amount of power and improve power efficiency
- Management options accessed from the BIOS setup utility that can reduce power and thermal use by power supplies, I/O, processors, and memory

The technologies discussed in this paper are implemented in all Intel-based ProLiant 100-series G6 servers. Exceptions are noted where different levels of technology implementation or service exist among individual ProLiant 100-series G6 platforms.

For complete specifications of all ProLiant 100-series servers, see the HP website: [www.hp.com/products/servers/platforms](http://www.hp.com/products/servers/platforms).

## Intel Xeon 5500 Series processor technology

ProLiant Intel-based 100-series G6 servers contain the Xeon 5500 Series processors. They include an integrated memory controller and Intel QuickPath Technology to boost bandwidth between processors, memory, and I/O subsystems. Three memory channels from each integrated memory controller to its dedicated memory provide a total bandwidth of 32 gigabytes per second.

The 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>

### Multi-level caches

Xeon 5500 Series processors have a three-level cache hierarchy (Figure 1):

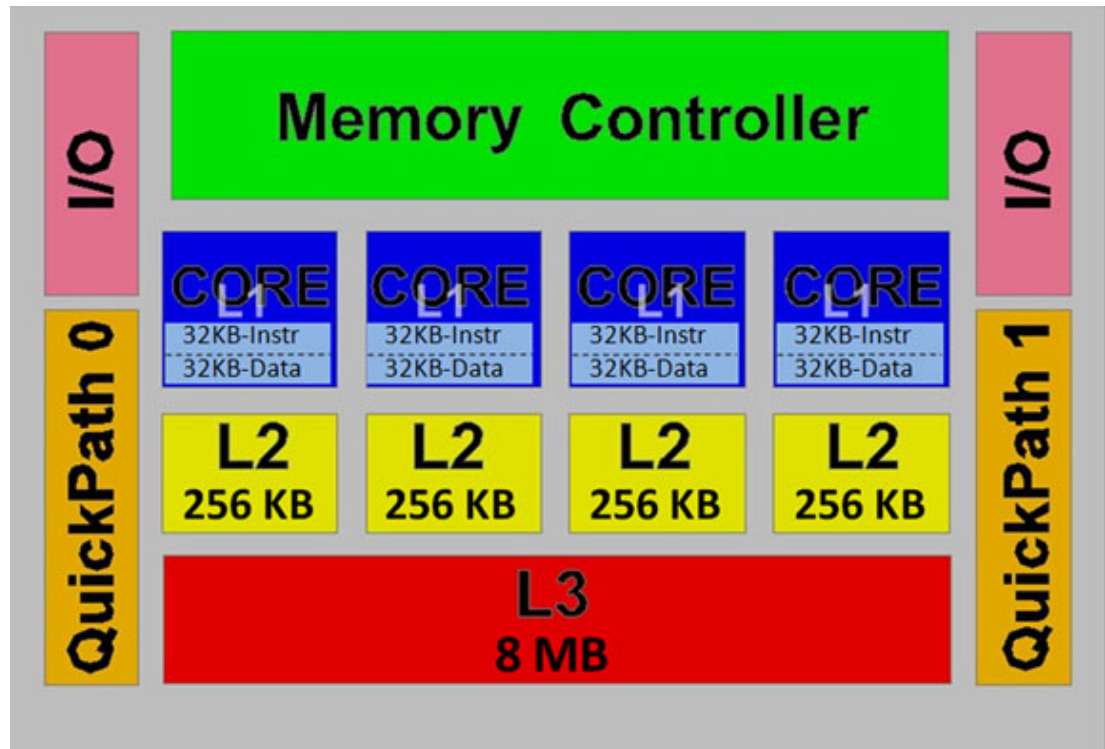
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<sup>1</sup> For additional information about Intel processors, see the HP technology brief titled “The Intel processor roadmap for industry-standard servers”:

<http://h20000.www2.hp.com/bc/docs/support/SupportManual/c00164255/c00164255.pdf>.

- 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 shared by all cores

**Figure 1.** Block diagram of three-level cache hierarchy for Intel Xeon 5500 Series processors



The Level 3 cache is shared and inclusive, which means that it duplicates the data stored in the Level 1 and Level 2 caches of each core. This guarantees that data is stored outside the cores and minimizes latency by eliminating unnecessary core snoops to the Level 1 and Level 2 caches. Flags in the Level 3 cache track which core's cache supplied the original data. Therefore, if one core modifies another core's data in Level 3 cache, the Level 1 and Level 2 caches are updated as well. This eliminates excessive inter-core traffic and ensures multi-level cache coherency.

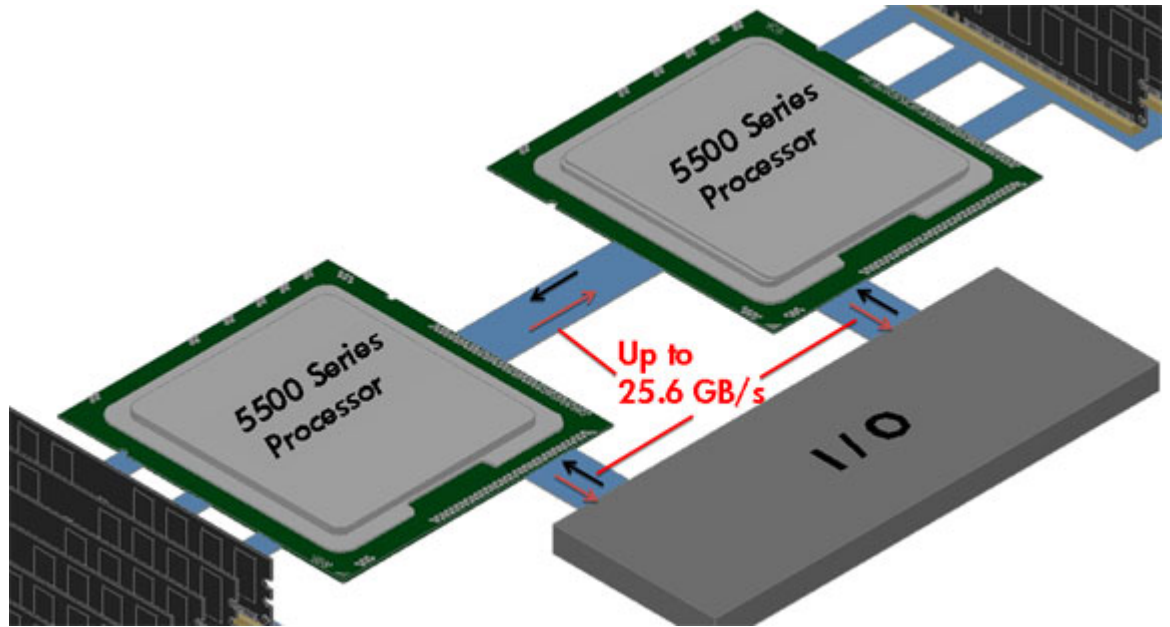
### QuickPath Interconnect controller

Xeon 5500 Series processors attain their performance potential through the Intel QuickPath Architecture (Figure 2): high-speed, point-to-point interconnects directly connect the processors with each other. The Intel QuickPath Architecture also connects each processor to distributed shared memory and to the I/O chipset.

Each QuickPath Interconnect consists of two unidirectional links that operate simultaneously in each direction using differential signaling. Unlike a typical serial bus, the QuickPath interconnects 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. A maximum of 16 bits are used to transfer data; the remaining 4 bits are used for the protocol and error correction. 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 QuickPath interconnect uses high-bandwidth inter-processor communication to retrieve the data.

**Figure 2.** Block diagram of QuickPath architecture



## Hyper Threading

Simultaneous Multi-threading Technology, or SMT, is an enhanced version of Intel's Hyper-Threading Technology. SMT lets each core execute two computational threads at the same time. A single processor can execute up to eight threads simultaneously. 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.

## Turbo Boost technology

Intel's Turbo Boost technology complements Simultaneous Multi-threading Technology 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 provide better performance. Turbo Boost is engaged by default and automatically increases the clock frequency of active cores operating below power and thermal design points determined by the processor. The maximum frequency depends on the number of active cores and varies based on the specific configuration on a per-processor-number basis. Turbo Boost technology is OS independent, and Advanced Configuration and Power Interface (ACPI) -aware operating systems require no changes to support Turbo Boost technology.

# Memory

Xeon 5500 Series processors connect directly to memory rather than through a chipset. They support only DDR-3 dual inline memory modules (DIMMs). HP manages all processor functionality options, including memory mirroring and memory channel interleaving, through the G6 server Basic Input/Output System (BIOS) and BIOS Setup Utility (BSU).

## DDR-3

DDR-3 has several key enhancements including an 8-bit prefetch buffer for storing data before it is requested. By comparison, DDR-2 has a 4-bit buffer. For DDR-3, the data signal rate can increase to 1333 Megatransfers per second (MT/s). While this is commonly referred to as having a speed of 1333 MHz, the maximum clock speed for the DIMMs is actually 667 MHz and 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. The three memory channels between each processor's integrated memory controller and its dedicated DDR-3 memory provide a total bandwidth of 32 gigabytes per second.

HP DDR-3 DIMM modules incorporate an integrated thermal sensor that signals the chipset to throttle memory traffic to the DIMM if its temperature exceeds a programmable critical trip point. Using the data from these thermal sensors, ProLiant G6 servers can reduce fan speed which reduces power consumption when memory is idle. 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 be forced to run at higher speeds (requiring more power).

### DIMM Choices

DDR-3 is available as both Unbuffered Dual In-line Memory Modules (UDIMMs) and Registered (buffered) Dual In-line Memory Modules (RDIMMs). Both RDIMMs and UDIMMs support error correcting code (ECC).

There are three types of DDR-3 available for ProLiant G6 servers:

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

Administrators can configure ProLiant 100-series G6 servers using either RDIMMs or UDIMMs but RDIMM and UDIMM memory cannot be mixed within a single server. ProLiant 100-series G6 servers have up to 18 DIMM slots, allowing larger memory capacities than with platforms that used DDR-2. ProLiant G6 servers optimize memory performance by operating DDR-3 memory at the maximum rate possible, based on the memory configuration and processor installed.

When choosing memory configurations for ProLiant 100-series G6 systems, the following guidelines should prove helpful:

- 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 in ProLiant 100-series G6 servers. Because they require fewer components, UDIMMs are typically less expensive than RDIMMs.
- RDIMM configurations can provide larger memory capacity configuration 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.

Processor SKU determines the ability of ProLiant G6 servers to run DDR-3 memory at a top speed of 1333 MT/s. The processor SKU also dictates the range of speeds possible in different DIMM per channel (DPC) configurations. DIMM operating speeds are also subject to memory slot configuration and to the number of slots, 12 16 or 18. Table 1 displays DIMM speeds possible in 100-series G6 servers with a Xeon X5500 (95W) or W5500 (130W) processor.

**Table 1.** DDR-3 memory options on 100-series G6 servers supporting Xeon 5500 Series processors running at 95W or 130W

DIMM	Type	Capacity (GB)	Rank	Max. data rate in MT/s DIMMs per channel (DPC)			
				1 DPC	2 DPC in 16** and 18 slots	2 DPC in 12 slots	3 DPC in 16** and 18 slots
PC3-8500R	RDIMM	4	quad-rank	1066	800	800	N/A
PC3-8500R	RDIMM	8	dual-rank	1066	1066	1066	800
PC3-10600R	RDIMM	2	dual-rank	1333	1333	1333	800
PC3-10600R	RDIMM	4	dual-rank	1333	1333	1333	800
PC3-10600R	RDIMM	8	dual-rank	1333	1333	1333	800
PC3-10600E	UDIMM	1	single-rank	1333	1066	1333*	N/A
PC3-10600E	UDIMM	2	dual-rank	1333	1066	1333*	N/A

\* UDIMMs will not run at 1333 MT/s data rates with two DIMMs per channel on systems that support three DIMM sockets per channel. Support for 1333 MT/s data rate with two DIMMs may require a ROM upgrade.

\*\* Applies to half-width system boards with 16 slots like the G6 DL170h

A BIOS setting on select ProLiant 100-series G6 servers allows the PC3-10600R memory modules to run at 1333 MT/s with two DIMMs per channel. HP design and testing have produced system boards with signal integrity that can operate at 1333 speeds in this configuration without degradation.

Only HP branded DIMMs have been fully validated to operate at this speed. Therefore, HP does not recommend configuring the BIOS setting for 1333 MT/s data rates with two DIMMs per channel when using third-party DIMMs, because they may not meet HP's stringent design requirements.

Operating the memory at 1333 MT/s is supported only on select 100-series G6 servers using Xeon 5500 Series processors operating at 95W or 130W. The HP ProLiant DL180 G6 and ML150 G6 cannot take advantage of this unique HP feature because they do not support the Xeon X5500 and W5500 processors.

For help configuring DDR-3 memory in ProLiant G6 servers, use the DDR-3 Memory Configuration Tool found at [http://h18004.www1.hp.com/products/servers/options/tool/hp\\_memtool.html](http://h18004.www1.hp.com/products/servers/options/tool/hp_memtool.html).

### Memory Mirroring with DDR-3

ProLiant 100-series G6 servers support memory mirroring, which protects the system against uncorrectable memory errors that would otherwise result in a system hang or crash. Mirroring occurs when all data is written to both sets of physical memory in channels one and two. Administrators can

configure memory mirroring through BSU. To implement mirroring with DDR-3, the two memory channels must be populated identically. The third memory channel must be empty.

If an uncorrectable error occurs, the system automatically directs the read to the mirrored location to obtain the correct data. The OS does not revert to Advanced ECC Mode until the DIMM is replaced and the server rebooted. Since each mirrored DIMM is one of a pair, one DIMM can be protected by mirroring while another is degraded. As a result, even after mirroring is degraded by a DIMM failure, the other DIMM in the mirrored pair is still protected by Advanced ECC.

### **Memory channel interleaving**

Xeon 5500 Series processors retrieve data from the memory DIMMs in 64-byte chunks. With channel interleaving, the system is set up so that each consecutive 64-byte chunk in the memory map is physically transferred by means of alternate routing through the three available data channels.

The result is that when the memory controller needs to access a block of logically contiguous memory, the requests are distributed more evenly across the three channels rather than potentially stacking up in the request queue of a single channel. This alternate routing decreases memory access latency and increases performance. However, interleaving memory channels increases the probability that more DIMMs need to be kept in an active state (requiring more power) since the memory controller alternates between channels and between DIMMs. This is discussed further in the “Power and thermal technologies” section.

### **Lockstep memory mode**

Lock-step mode is an advanced memory protection feature supported in ProLiant Intel 100-series G6 servers. It uses two of the Xeon 5500 processor's three memory channels to provide an even higher level of protection than Advanced ECC. In lockstep mode, two channels operate as a single channel—each write and read operation moves a data word two channels wide. The cache line is split across both channels to provide 2x 8-bit error detection and 8-bit error correction within a single DRAM. In three-channel memory systems, the third channel is unused and left unpopulated. The Lockstep Memory mode is the most reliable memory protection method, but it reduces the total system memory capacity by a third in most systems. Performance is measurably slower than normal Advanced ECC mode, and uncorrectable memory errors can only be isolated to a pair of DIMMs instead of a single DIMM. Lock-Step mode is not the default operation; it must be enabled in BSU.

For additional information about DDR-3 memory, see the technology brief titled “Memory technology evolution: an overview of system memory technologies” at <http://h20000.www2.hp.com/bc/docs/support/SupportManual/c00256987/c00256987.pdf>.

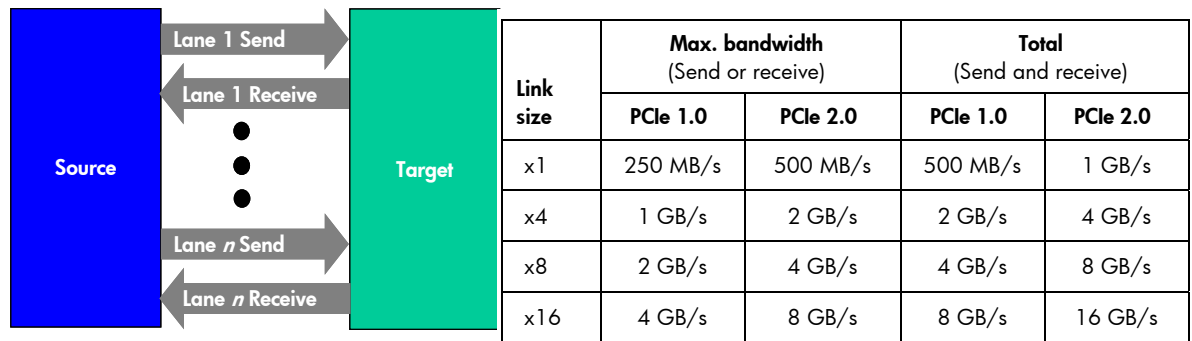
## **I/O technologies**

ProLiant 100-series G6 servers incorporate PCI Express, Serial-Attached SCSI (SAS), and Serial ATA (SATA) I/O technologies. PCI Express lets administrators add expansion cards with various capabilities to the system. SAS is a serial communication protocol for direct-attached storage devices such as SAS and SATA hard drives.

### **PCI Express technology**

All ProLiant G6 servers 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 3).

**Figure 3.** PCIe data transfer rates



PCIe 2.0 is completely 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. 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

## HP Smart Array and SAS/SATA technology

The newest serial PCIe 2.0-capable Smart Array controllers use SAS technology, a point-to-point architecture in which each device connects directly to a SAS port rather than sharing a common bus as with parallel SCSI devices. Point-to-point links increase data throughput and improve the ability to locate and fix disk failures. More importantly, SAS architecture solves the parallel SCSI problems of clock skew and signal degradation at higher signaling rates.<sup>2</sup>

The latest Smart Array controllers are compatible with SATA technology and include the following features to enhance performance and maintain data availability and reliability:

- SAS and SATA compatibility — The ability to use either SAS or SATA hard drives lets administrators deploy drive technology that fits each computing environment. HP Smart Array controllers can manage both SAS arrays and SATA arrays. Smart Array configuration utilities help administrators configure arrays correctly so that data remains available and reliable.
- SAS wide port operations — Wide ports contain four single lane (1x) SAS connectors and the cabling has all four lanes bundled together. SAS wide ports allow balanced SAS traffic distribution across the links for enhanced performance. In addition, wide ports provide redundancy by tolerating up to three physical link failures while maintaining the ability to communicate with the disk drives. The most common use of these wide links is to a JBOD or to an internal server expander connecting to large numbers of drives. No special configuration is required for this functionality.

<sup>2</sup> For more information about SAS technology, refer to the HP technology brief titled "Serial Attached SCSI storage technology" available at <http://h20000.www2.hp.com/bc/docs/support/SupportManual/c01613420/c01613420.pdf>.

- SAS expanders — Low-cost, high-speed switches called expanders can combine multiple single links to create wide ports and increase available bandwidth. SAS expander devices also offer higher system performance by expanding the number of hard drives that can be attached to an HP Smart Array controller. SAS expanders are an aggregation point for large numbers of drives or servers providing a common connection. By cascading expanders, administrators can chain multiple storage boxes together. For more information on the HP SAS Expander Card, go to <http://h18004.www1.hp.com/products/servers/proliantstorage/arraycontrollers/sas-expander/index.html>.

### **SAS-2 standard**

The second-generation SAS (SAS-2) link speed<sup>3</sup> of 6 Gb/s is double the SAS-1 transfer rate. SAS-2 link speeds require SAS-2 compliant hard drives. SAS-2 eliminates the distinction between fanout and edge expanders by replacing them with self-configuring expanders. SAS-2 enables zoning for enhanced resource deployment, flexibility, security, and data traffic management.

SAS-2 connections have the potential to deliver peak raw data bandwidth of up to 600 megabytes per second (MB/s) per physical link in each direction. SAS-2 devices are capable of sending and receiving data simultaneously across each physical link, which is known as full duplex. When effectively implemented, full duplex, 6 Gb/s SAS connections can deliver peak raw data bandwidth of up to 1200 MB/s between the controller and storage device. It is important to note that the SAS-2 data bandwidths described here are theoretical speeds identified by the SAS-2 standard. Real world performance will be affected by the performance of storage devices attached to the SAS-2 connection.

Smart Array controllers, with releases beginning in the first quarter of 2009, incorporate SAS-2 connections. The SAS-2 standard is compatible with both Serial SCSI and Serial ATA protocols for communicating commands to SAS and SATA devices. SAS-2 compliant controllers are fully compatible with 1.5 Gb/s and 3 Gb/s SATA technology.

For an up to date listing of HP Smart Array controllers that support the SAS-2 specification, see the Smart Array controller matrix: [www.hp.com/products/smarrays](http://www.hp.com/products/smarrays)

### **New generation HP Smart Array controllers**

The new Smart Array controllers are modular solutions with a common form factor, hardware, and firmware. The controllers are compatible with all ProLiant G6 servers. All ProLiant 100-series G6 servers incorporate embedded SATA storage controllers and the Smart Array B110i software RAID is available. The Smart Array 410 incorporates Zero Memory RAID (ZMR) and is available as an entry level hardware-based RAID, but users have the option to choose the cache size and to include the battery backed write cache (BBWC). These options provide upgradeability from ZMR to 512 BBWC.

### **Battery backed write cache**

The BBWC is required for capacity expansion (adding one or more physical disks to an existing array). The controller recalculates parity and balances the data across all the disks. During the expansion, the BBWC preserves data and logical structures on the array. The HP 650 mAh P-Series battery extends battery life up to 48 hours before recharging is necessary.

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#### **NOTE:**

The Smart Array P212 does not support 512 MB BBWC, and is only upgradeable to 256 MB BBWC

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<sup>3</sup> Serial Attached SCSI-2 (SAS-2) is an American National Standards Institute (ANSI) standard from the INCITS T10 Technical Committee on SCSI Storage Interfaces. SAS-2 is the successor to SAS-1.1 and SAS-1.

## Zero Memory RAID

Using Zero Memory RAID (ZMR), administrators can create a RAID 0-1 configuration without using any additional memory. Smart Array P410, P411, and P212 controllers include ZMR. The P212 controller does not include ZMR on the external connector. ZMR supports up to eight drives in Zero Memory Mode, or seven drives and one tape drive. ZMR mode does not support Modular Smart Array (MSA) products. ZMR does not include any caching. All systems can be upgraded to a BBWC memory module that can significantly increase performance.

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### NOTE:

Smart Array Advanced Pack is not available on Zero Memory configurations.

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## Software RAID

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

Supported on the ProLiant DL160, DL170h, DL180, and ML150 G6 servers, the B110i features an OS-specific driver from HP that uses the embedded ICH10R controller. It can utilize RAID 0, 1, and 1+0 and supports a maximum of two logical drives. The B110i supports up to four 1.5Gb or 3Gb SATA drives. Administrators can migrate 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, download the B110i user guide at

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

## Smart Array Advanced Pack

HP Smart Array Advanced Pack (SAAP) firmware provides advanced functionality within Smart Array controllers. This firmware further enhances performance, reliability, and availability of data. SAAP is hosted on the Smart Array controller hardware firmware stack. It can be enabled beginning with the present generation of Smart Array controllers.

SAAP requires a license key for activation. After activation, administrators can use several standard capabilities:

- RAID 6 with Advanced Data Guarding (ADG) protects against failure of any two drives. It requires a minimum of four drives, but only two will be available for data. ADG can tolerate multiple simultaneous drive failures without downtime or data loss and is ideal for applications requiring large logical volumes, because it can safely protect a single volume of up to 56 disk drives. RAID ADG also offers lower implementation costs and greater usable capacity per U than RAID 1.
- RAID 60 allows administrators to split the RAID storage across multiple external boxes. It requires a minimum of eight drives, but only four will be available for data.
- Advanced Capacity Expansion (ACE) automates higher capacity migration using capacity transformation to remove logical drives by shrinking and then expanding them online. Standard drive migration and expansion remain unchanged.
- Mirror Splitting and Recombining in Offline Mode breaks a RAID 1 configuration into two RAID 0 configurations. This is similar to a scaled down rollback functionality that requires two disk drives.
- Drive Erase completely erases physical disks or logical volumes. This capability is useful when decommissioning, redeploying, or returning hard drives.
- Video On Demand Performance Optimization optimizes performance of video on demand and improves latency during video streaming.

More information about SAAP is available at [www.hp.com/go/SAAP](http://www.hp.com/go/SAAP).

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**NOTE:**

At a minimum, a 256 MB cache and battery kit is required to enable the SAAP license key. SAAP is not available on Zero Memory Configurations.

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## Networking technologies

The NC522SFP is a Dual Port 10GbE eight lane (x8) PCI Express (PCIe) 10 Gigabit network adapter. It is supported on most ProLiant G6 servers. The NC522SFP uses two SFP+ (Small Form-factor Pluggable) connector cages, providing connectivity in copper or fiber optic environments. For complete specifications on this and other HP network adapter products, go to [www.hp.com/go/ProLiantNICs](http://www.hp.com/go/ProLiantNICs).

## Power and thermal technologies

HP engineers have developed a robust set of power and thermal technologies, and components to manage power within the ProLiant 100-series G6 servers. The technologies improve power efficiency throughout the power delivery chain in several ways:

- Efficient power delivery
- Improved thermal sensors and fan control
- Phase shedding
- Managing processor technologies
- Managing memory technologies
- Managing I/O technologies
- Power efficiency mode

Administrators can disable certain components and capabilities within the 100-series G6 servers or reduce capabilities to bring the components to a lower power state.

### Efficient power delivery

Power supplies for the ProLiant 100-series G6 servers are not hot-pluggable. Common Slot power supplies are an option in those G6 platforms supporting the Common Slot architecture. Those G6 servers not supporting Common slot architecture use HP industry standard<sup>4</sup> power supplies. All 100-series G6 servers use highly efficient power supplies and DC power regulators to deliver significantly higher power efficiencies.

#### Common Slot power supplies

The HP G6 Common Slot power strategy provides power supply commonality across supported ProLiant G6 server lines. HP reduced the number of power supply designs, which reduces the number of spares the customer must keep in the data center.

By incorporating "right-sizing," these power supplies have achieved efficiency ratings of up to 92%. With the exception of the 1200W power supplies, they meet Climate Savers Gold requirements. The 1200W power supplies (AC and 48VDC) meet Climate Savers Silver requirements.

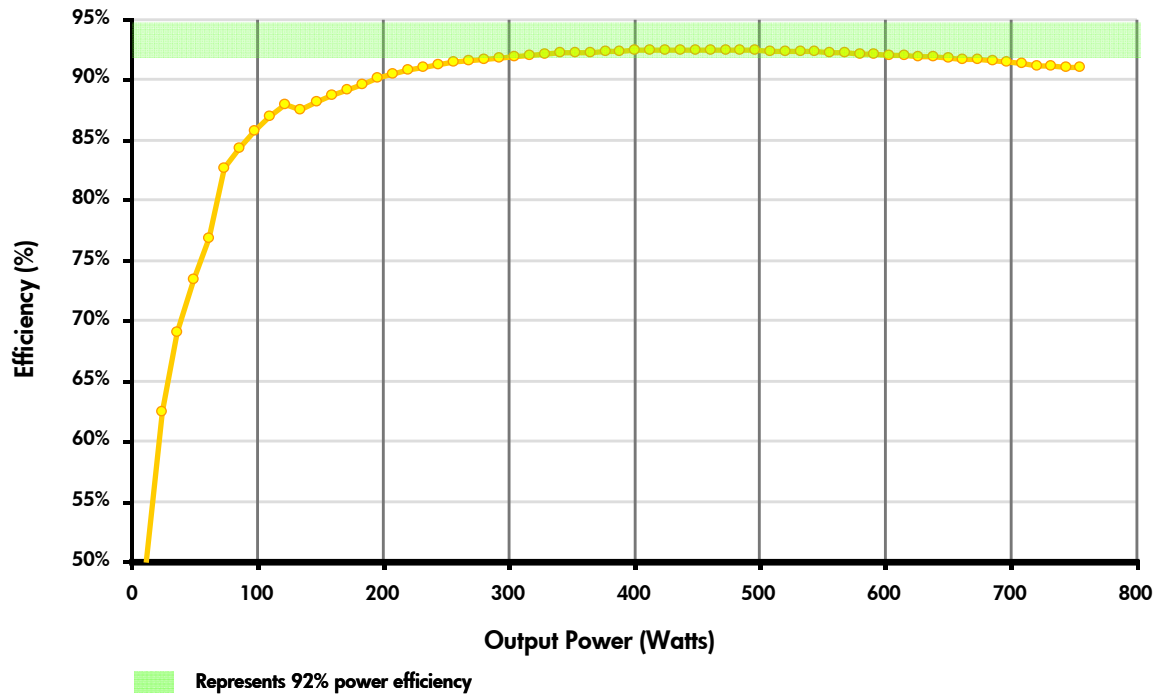
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<sup>4</sup> "Industry standard" power supplies refers to form factors, such as ATX or SSI, that are predefined within the computing industry

- 460W AC up to 92% efficiency
- 750W AC up to 92% efficiency
- 1200W AC up to 90% efficiency
- 1200W 48VDC up to 90% efficiency

The power loading efficiency curve for the 750W power supply shown in Figure 4 provides an example of the high levels of power efficiency present in all new power supplies used in the ProLiant G6 servers.

**Figure 4.** Power/Efficiency curve for the 750 W HP power supply



By introducing these different wattage power supplies, HP gives users the option to choose a power supply that meets, but does not exceed their needs. Oversized and lightly loaded power supplies do not run as efficiently as those that are heavily loaded.

Not all 100-series G6 servers have Common Slot power supply compatibility, and not all servers will support all available power supply wattages. Users can consult the server QuickSpecs or server documentation for supported power supply options. The HP Power Advisor is available at the following link to help users define the right power supply for their needs:  
[www.hp.com/go/hppoweradvisor](http://www.hp.com/go/hppoweradvisor).

**Redundant power operation**

With supported ProLiant 100-series G6 servers, redundant power supplies operate in “Balanced” mode, where power is drawn equally from both power supplies. This mode ensures full redundancy but can result in higher power consumption when power supplies are operating with reduced loads and lower power efficiency.

### **Voltage regulation**

Voltage regulators convert the 12V DC supplied from the server power supply into a variety of lower voltages used by the different system components. HP has developed voltage regulators that have higher peak efficiencies and maintain greater than 90% efficiency over a broad range of power requirements. The net result is about an 8% gain in DC power efficiency, which results in almost a 10% efficiency gain in AC input power.

These efficiency gains come with no loss in performance and require no configuration by the user.

### **Improved thermal sensors and fan control**

HP has added additional thermal sensors throughout the ProLiant 100-series G6 servers. The 100-series G6 servers have “zoned” fans that increase cooling and energy efficiencies in the server by adjusting cooling to those zones when called for by the sensors in that zone. Fan curve mapping firmware uses temperatures reported by the sensors to control cooling fans in each zone. Fan speed is based on the highest temperature readings reported by any of the sensors in a given fan zone.

### **Phase shedding**

HP incorporated phase shedding into ProLiant G6 voltage regulators. Modern digital voltage regulators deliver DC power at the proper voltage to components by using up to five different phases of high-speed power pulses that charge capacitors. Each phase delivers its power pulses in a rotating time window with the other phases in the voltage regulator such that the power pulses from one phase do not overlap with those of another. The width of each pulse determines the total power delivered by the particular phase.

Phase shedding enables the system BIOS to turn off one or more of the power phases if the BIOS determines that the power requirements are less than the full amount of power from the voltage regulator. This reduction in phases decreases the maximum power that the voltage regulator can deliver and increases overall efficiency.

### **Memory phase shedding**

Memory phase shedding operates much the same way as processor-based phase shedding. At power-up, the ROM BIOS determines the number of phases needed for the memory voltage regulator based on the number of DIMMs installed. Memory phase shedding can save up to 2.5 W per DIMM socket. This feature is less effective on servers whose DIMM sockets are fully populated since more phases are required to accommodate such a configuration. More phases mean more power consumption.

### **Dynamic CPU phase shedding**

On entry into a low power state (less than 20 W), the Intel Xeon 5500 Series processors will activate the Power Status Indicator (PSI). When PSI is engaged, ProLiant G6 servers turn off voltage regulator phases, thereby saving power and increasing power efficiency.

## **Managing processor technologies**

### **QuickPath Interconnect power**

The Xeon 5500 Series processor lets the QuickPath Interconnect (QPI) buffers enter a sleep state to reduce power requirements when the QPI links are not active. HP enables this Intel feature for G6 servers through RBSU. Once this feature is enabled, the Intel processor determines when to put the QPI buffers into a sleep state. It appears that QPI power management has no measureable impact on performance.

### **Disabling processor cores**

Through BSU, administrators can disable one or more cores in the Xeon 5500 Series processor (per physical processor). When enabled, the command will apply to all physical processors in the server. Engaging this capability saves power and has the potential to improve performance in servers running single workloads or applications with low threading requirements.

### **C-state package limit setting**

The Xeon 5500 Series processor supports C-states for each core within the processor. C-states define the power state of system processors and are an open specification of the ACPI group. The micro-architecture of the Xeon 5500 Series processor supports processor C-states C0, C1, C3, and C6. C-state C0 represents a fully active core that is executing instructions. The other C-states represent further power reduction levels for idle cores. Any core within the processor can change C-states independently from the other cores.

Parameters for the maximum C-state allowable for an idle processor are set through the BSU and initiated by the OS. The higher the C-state allowed at idle, the more power savings, but only at idle. Also, the higher the C-state, the higher the latency involved when the core returns to activity.

## **Managing memory technologies**

### **Memory channel interleaving**

As described in the memory section, the alternate routing used for channel interleaving decreases memory access latency and increases performance.

Memory interleaving is configured in the BSU. Disabling memory channel interleaving makes access to contiguous memory addresses revert to one channel. Single-channel access degrades performance, but makes it possible for the memory controller to place less frequently accessed DIMMs into a low power state which saves power. Memory interleaving can have a negative performance effect, based on the application load of the server. Administrators should perform testing in their application environment to determine the trade-off between power savings and performance.

### **Maximum memory data rates**

The maximum memory data rate is effectively 1333 MHz for ProLiant G6 Intel platforms.<sup>5</sup> Depending on the memory configuration and installed processor, the system may automatically reduce the Quick Path Interconnect speed. While the "Auto" setting (which equates to 1333 MHz) is the default setting, users have the option to manually lower the effective data rates to 1066 MHz or 800 MHz. This will save power, but may incur some performance penalty. Administrators can configure the maximum memory data rate through the BSU.

## **Managing I/O technologies**

### **Disable PCIe 2.0**

All ProLiant G6 servers include an option that allows all expansion slots to run at PCIe 1.0 speed rather than PCIe 2.0 speed. Enabling this option saves power and provides backward compatibility with cards that may not correctly operate in PCIe 2.0 slots. Administrators can control expansion slot speed through the BSU.

## **Power Efficiency Mode**

In the ProLiant 100-series G6 servers, the BSU can enable three different settings for the Power Efficiency Mode: Efficiency, Performance, and Custom. As implied, the Efficiency setting provides the

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<sup>5</sup> The memory operates in a double-pumped manner so that the effective bandwidth is double the physical clock rate of the memory. Mega-transfers/second describes the data rate.

greatest efficiency, while the Performance setting provides the highest performance. The Custom setting is simply any combination of user settings that do not match the pre-sets for Efficiency and Performance. The Power Efficiency Mode directly effects the operation of some power features identified earlier in this section.

## Power Performance Benchmarks

The Standard Performance Evaluation Corporation (SPEC) is a non-profit corporation formed to establish, maintain and endorse a standardized set of relevant benchmarks that can be applied to the newest generation of high-performance computers.

SPECpower\_ssj2008 is the first industry-standard SPEC benchmark that evaluates the power and performance characteristics of volume server class computers. As of this writing, SPECpower benchmark results are available for the ProLiant DL170h and the ProLiant DL380 G6 servers ([www.spec.org/power\\_ssj2008/results/power\\_ssj2008.html](http://www.spec.org/power_ssj2008/results/power_ssj2008.html)). The test results show performance gains achieved over the last generation of ProLiant servers.

## Security

The Trusted Platform Module™ (TPM) and Microsoft® BitLocker® technology are supported in all ProLiant 100-series G6 servers by means of the Trusted Platform Module option kit.

### Trusted Platform Module

The Trusted Platform Module v1.2 supported on ProLiant G6 servers is a microcontroller chip that can create, securely store, and manage artifacts such as passwords, certificates, and encryption keys that are used to authenticate the server platform. The TPM 1.2 chip provides a unique Endorsement Key (EK) and a unique Storage Root Key (SRK). It provides data encryption and uses RSA, SHA-1, RNG cryptographic functions to provide access protection, OS level protection, and stolen disk protection.

The TPM 1.2 chip can also store platform measurements (hashes) to help ensure that the platform remains trustworthy. TPM enables Microsoft BitLocker, part of Windows® Server 2008.

TPM is an option on all ProLiant 100-series G6 servers. For more information about TPM, go to [www.hp.com/go/TPM](http://www.hp.com/go/TPM)

### BitLocker Drive Encryption

Microsoft BitLocker Drive Encryption (BitLocker) is a data protection feature available in Windows Server 2008. BitLocker uses the enhanced security capabilities of TPM version 1.2 to protect data and to ensure that a server running Windows Server 2008 has not been compromised while the system was offline.

Implementing BitLocker requires the following:

- The Master Boot Record (MBR), a small, encrypted system partition of approximately 50 MB to contain boot utilities
- TPM version 1.2
- Trusted Computing Group (TCG) compliant firmware including support of “Static Root of Trust”
- Two NTFS partitions on the boot drive

During the boot process, the TPM will not release the encryption key until completing a comparison of operating system configuration information (or hash) with an earlier snapshot of the same data. If any

part of the hash is compromised (for example by introduction of malicious code), the TPM ensures that the volume encryption key is never released.

## Server management and deployment

ProLiant ML and DL 100-series G6 server users each have different computing requirements. Consequently, the way in which customers manage, deploy, and control servers can differ. With these requirements in mind, this section examines the following management topics:

- Systems management and monitoring
- Intelligent Platform Management Interface (IPMI) 2.0 and Data Center Management Interface (DCMI) 1.0 Standards
- HP ProLiant Onboard Administrator Powered by Lights-Out 100i remote management and control
- Server deployment

Some of these technologies are new tools for the ProLiant 100-series G6 servers, while others have been available with previous generations of ProLiant 100-series servers. Users may already be familiar with Agents, SmartStart Scripting Toolkit (SSSTK), and software Smart Components. These tools are now available for ProLiant 100-series G6 servers. The tools let users deploy many servers at once and manage them with HP SIM and Insight Management Agents.

### Systems management and monitoring

Unplanned downtime can be significantly reduced through alerting provided by Insight Management Agents, which are based on Simple Network Management Protocol (SNMP). SNMP is the protocol developed to manage nodes (such as servers, workstations, routers, switches and hubs) on an IP network. Network management systems learn of problems by receiving traps or change notices from network devices implementing SNMP.

#### **Insight Management Agents**

ProLiant 100-series G6 servers can use the same SNMP-based Insight Management Agents that are supported by other ProLiant servers. This means that administrators can use SIM 5.3 and greater to manage ProLiant 100-series G6 servers. Administrators can also use any other SNMP-based management tool. Support Automation Services are provided on 100-series G6 servers through these SNMP agents. The agents are included on the ProLiant 100-series model-specific “Easy Set-up” CDs. They are also available at [www.hp.com/servers/easysetup](http://www.hp.com/servers/easysetup).

The SNMP agents enable the following capabilities on 100-series G6 servers:

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

### Remote management and control

All ProLiant 100-series G6 servers include ProLiant Onboard Administrator Powered by LO100i. ProLiant Onboard Administrator represents the core embedded management functions in ProLiant DL and ML 100-series G6 servers. LO100i works in concert with HP SIM, BSU, and Option ROM Configuration for Arrays (ORCA) to provide remote management, deployment, and control functions without additional software. This functionality can be accessed locally through the BSU, or remotely with a web browser through HP SIM. Additional software functionality can be added with the HP

Lights-Out 100i Advanced Licenses which include Virtual KVM (remote graphical console) and virtual media capabilities.

### **HP Lights-Out 100i**

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 OS is not operating. The LO100i management processor obtains its power from the auxiliary power plane of the server, so it is available as long as the server is plugged into 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 (Microsoft Windows clients), Firefox 1.5 (Windows and Linux clients), and Mozilla 1.7.12 (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.

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#### **NOTE:**

ProLiant 100-series G6 servers do not support LO100i Select and LO100c.

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LO100i Advanced Pack capabilities can be obtained through an optional license key. Table 3 shows the differences in functionality between LO100i Standard, which comes with all 100-series G6 servers, and LO100i Advanced Pack.

**Table 3.** LO100i functionality

Features	LO100i Standard with every ProLiant 100- series server	LO100i Advanced (license upgrade options)
<b>Technical Support and Upgrade Licensing</b>		Yes – G6 only
<b>Flatpack and electronic key delivery</b>		Yes
<b>Host access to IPMI environment HW status</b>	Yes	Yes
<b>Unencrypted browser for power, SEL, health, and key activation</b>	Yes	Yes
<b>Shared and dedicated network port *</b>	Yes	Yes
<b>DCMI 1.0</b>	Yes – G6 only	Yes – G6 only
<b>SSL &amp; SSH security (setup in factory)</b>	Yes – Included with G6	Yes
<b>DNS registered names **</b>	Yes	Yes
<b>License manager support</b>	Yes – G6 only	Yes – G6 only
<b>IPv6 support (coexistence at launch)</b>	Yes – G6 only	Yes – G6 only
<b>Virtual KVM</b>		License Upgrade
<b>Virtual media (CD/DVD, floppy, ISO Image files)</b>		License Upgrade
<b>Power Capping</b>		Yes – DL1000 only

\* Shared and dedicated network port is currently an optional feature on some ProLiant 100-series G6 servers and may be purchased as an option.

\*\* The DNS registered names require high speed network ports to accommodate the large packet sizes associated with this feature. High speed network ports are included on ProLiant DL series servers. The shared low speed network ports on the ProLiant ML series servers do not support DNS registered names.

LO100i includes the following features:

- Improvements to HP SIM support through the addition of Insight Management (SNMP) Agents
  - A new Health driver supports the gathering and delivery of LO100i management information from SNMP Agents
  - SNMP agents store the information and deliver it to HP SIM through SNMP as requested
  - HP SIM discovers and makes associations with the LO100i instances in the network
  - HP SIM displays URL links to launch the LO100i web interface for a given server
- Host access to in-band IPMI 2.0 features supported by IPMI-aware operating systems
- DNS Registration — LO100i on 100-series G6 servers comes with default host names and will automatically register with the DNS if DHCP is enabled

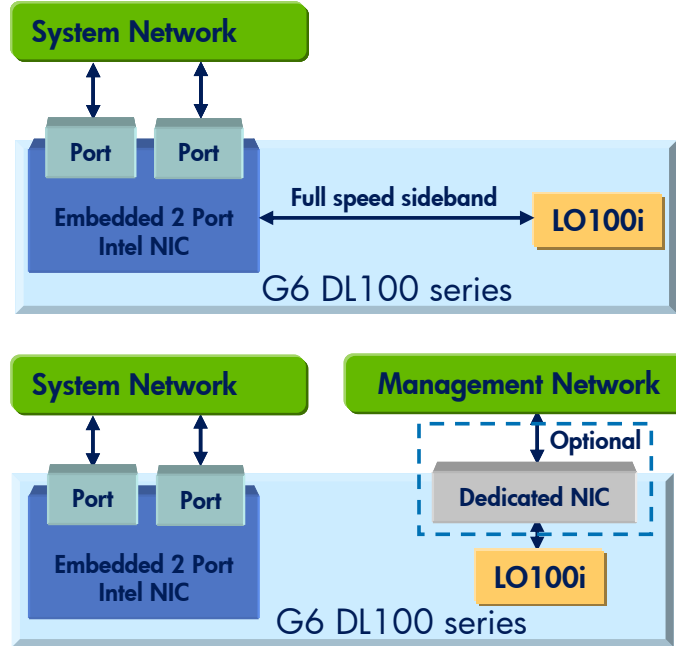
### LO100i shared and dedicated networks

In ProLiant DL 100-series G6 servers, LO100i supports a full-speed shared Ethernet port and a dedicated Ethernet port. LO100i and the server share the full-speed Ethernet port, utilizing 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 DL 100-series G6 servers by means of an optional mezzanine card and enables a separate management network. LO100i implementation varies depending on whether the 100-series G6 server is a DL, SL, or an ML platform.

Figure 5 shows the two implementations available for the DL 100-series G6 servers.

**Figure 5.** LO100i sideband architecture for DL00-series G6 servers

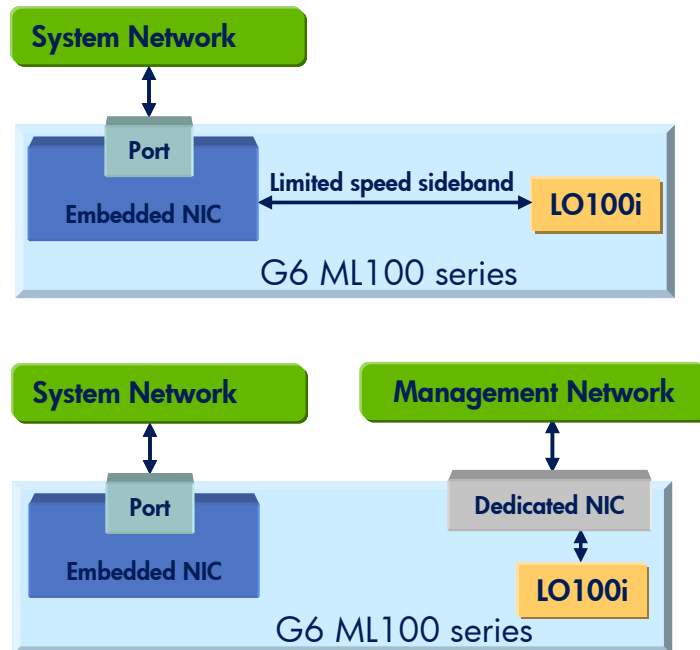


**Shared NIC DL100 G6 Configuration**  
The system NIC ports are shared with LO100i for management.

**Dedicated NIC DL100 G6 Configuration**  
A management network can be employed by adding an optional dedicated NIC via a mezzanine card. The management network is physically separated from the system network.

Figure 6 shows that the ML100-series G6 servers have a dedicated Ethernet management port. This port cannot be used by the system network.

**Figure 6.** LO100i sideband architecture for ML100-series G6 servers



**Shared ML100 G6 Configuration**  
A limited speed shared network configuration can be used for LO100 Standard features. LO100 Advanced features, including Graphic Remote Console and Virtual Media, are not supported in shared network mode

**Dedicated NIC ML100 G6 Configuration**  
The ML100 ships with a dedicated NIC port for management. This NIC port can be connected to the system network, or to a separate management network. Virtual KVM and Virtual Media, are supported in dedicated NIC configurations.

## IPMI 2.0 and DCMI 1.0

ProLiant 100-series G6 servers and LO100i conform to 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:

- The 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
- Per IPMI 2.0, console redirection over telnet or SSH
- Identification of the server by device ID, globally unique identifier (GUID), asset tag, and chassis ID
- Provides 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 Lights-Out 100i Remote Management, go to [www.hp.com/go/LO100](http://www.hp.com/go/LO100).

## Server deployment

Prior to G6, ProLiant 100-series server administrators could not deploy servers using methods similar to 300 series servers. The Easy Set-up CD now provides a user experience similar to SmartStart with deployment tools that reduce the time required for server setup and updates.

Easy Set-up CDs and their ISO images are provided with each ProLiant G6 100-series server and are used to perform assisted installations for one or two servers. Users performing multi-server installations involving large numbers of servers require the following deployment tools:

- Software Smart Components — Self-executable software consisting of driver and software
- SmartStart Scripting Toolkit (DL100s) — Automated scalable deployment utility

### HP ProLiant Easy Set-up CDs

Easy Set-up CDs are available on all 100-series G6 servers and are also available as an ISO image web download. HP ProLiant Easy Set-up CDs provide easy, step-by-step, single and multi-server server utilities to streamline server setup for 100-series G6 servers. Each Easy Set-up CD includes the following:

- 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. Refer to each server's QuickSpecs for supported versions)
- HP Insight Diagnostics
- Combined Array Configuration Utility (ACU) and Array Diagnostics Utility (ADU) to offer both array controller and storage device configuration and array controller hardware testing
- SmartStart Scripting Toolkit (SSSTK) and Smart Components for software and drivers

## OS support

HP performs extensive testing, qualification, and certification on the latest server operating systems to ensure maximum performance and reliability. HP resells and provides full service and support for Microsoft® Windows® operating systems, Red Hat Linux subscriptions, Novell SUSE Linux subscriptions, Sun Solaris subscriptions, Citrix XenServer, and VMware hypervisors. The latest information regarding support and deployment can be found at [www.hp.com/go/ossupport](http://www.hp.com/go/ossupport).

# DL1000 Multi Node server design for scale out computing

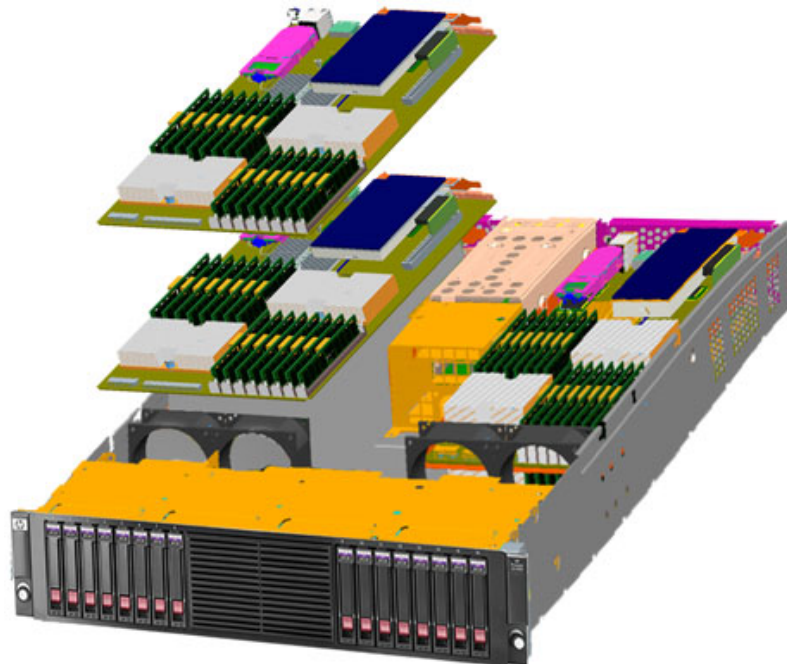
The HP ProLiant DL1000 G6 Multi Node system is designed for scale out computing, in environments in which failover is handled at the application level and where hardware redundancy plays a smaller role. These are environments that typically require greater compute density and additional cost efficiencies.

The HP ProLiant DL170h G6 server is the first server to launch in the HP ProLiant DL1000 system Multi Node series. The server can be used in a single node (DL170h), two-node (DL2x170h), or four-node configuration (DL4x170h) in the HP ProLiant h1000 G6 chassis. The DL1000 is mechanically unique in its chassis design, server node configuration, thermal management, and power supply utilization when compared to other ProLiant Intel-based G6 100-series DL traditional rack-mount servers. However, while the mechanical architecture of the DL1000 is unique, it uses the same HP certified components and management tools as the rest of the ProLiant 100-series G6 family.

## Chassis design

The HP ProLiant h1000 G6 chassis can hold up to four half-width HP ProLiant DL170h G6 server nodes in a 2U space (Figure 7). The HP h1000 chassis provides shared power supplies and fans across all server nodes, as well as the flexibility to configure for various application demands.

**Figure 7.** DL1000 platform in four node configuration



The h1000 G6 chassis design includes the following:

- Up to four independent ProLiant DL170h half-width server nodes, each using two Xeon 5500 Series processors and 16 DDR3 DIMM slots
- Choice of up to 16 small form factor (SFF) or 8 large form factor (LFF) hard disk drives
- Expanded PCIe Riser Options for 2-node configurations (half-width boards) requiring additional I/O

- HP Common Slot and industry-standard power supply options (all nodes share redundant power across the chassis)

### Shared power

The DL1000 system shares power supplies and thermal management across all nodes. Figure 8 displays the four server node configuration and available ports for each server node.

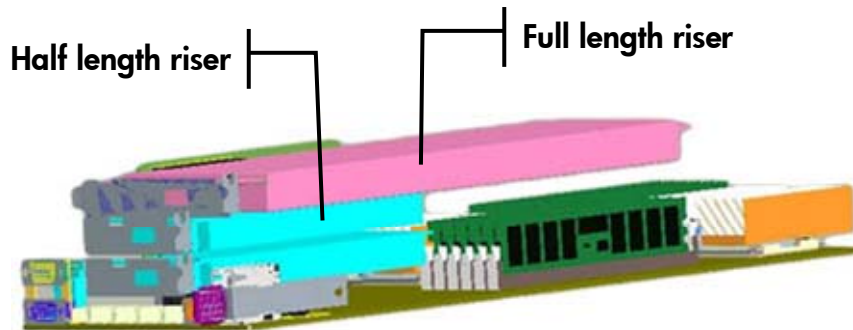
**Figure 8.** DL1000 four node configuration – rear chassis view



### Riser options

Three PCIe riser options are available for half-width servers. Available space in the h1000 chassis limits the riser options to two-node configurations only. The riser boards support both full and half length PCIe 2.0 cards (Figure 9).

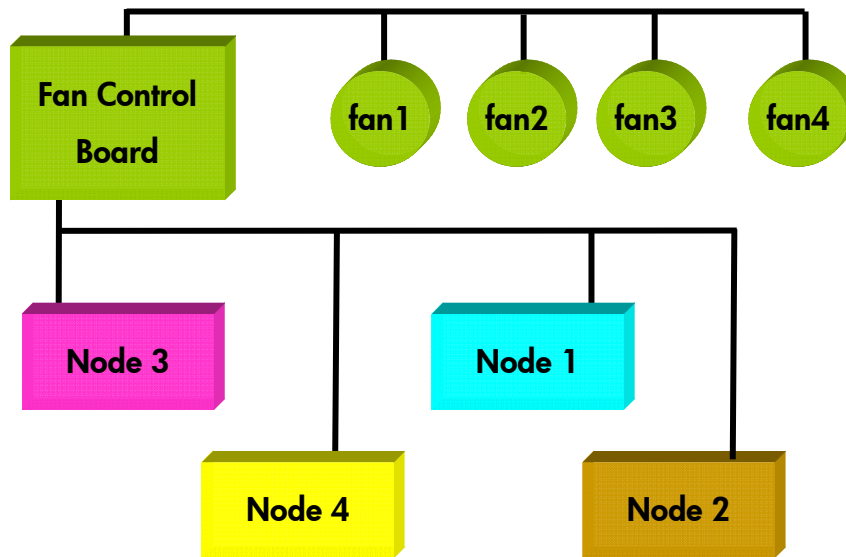
**Figure 9.** 2U riser options



### Fans and fan control

Standard fan configuration for the h1000 chassis includes four, 80mm non-redundant fans. Figure 10 illustrates how the server nodes share thermal management.

**Figure 10.** Thermal management across server nodes as seen in the front view of the DL1000 G6 system



## Power supply support

The DL1000 Multi Node server supports both HP Common Slot and HP industry standard power supplies. Three Common Slot power supply options allow users to choose the best power supply for each configuration to maximize efficiency and performance: 460 W, 750 W, or 1200W.

The DL1000 system also can use a low cost, industry-standard 750W power supply option that does not support hot-plug or power capping functionality (it is not a “common slot” power supply).

For more information on HP Common Slot and Industry Standard power supplies, see the section titled [“Efficient power delivery”](#).

## Advanced Power Management

In addition to the efficiencies gained by the shared power infrastructure, the DL1000 system contains advanced power metering and capping technologies. The Power Interface Controller (PIC) lets users configure the system for full AC redundancy or AC redundancy with power throttling, depending on the system configuration. With the optional power capping mode, the DL1000 system can boost data center capacity by reclaiming trapped power and cooling capacity.

### Power Interface Controller

In order to maintain a pre-set power budget, the embedded Power Interface Controller monitors power consumption and throttles processors and memory speed in each node within the chassis. HP provides a simple command-line utility for reading and configuring the power control logic of the server nodes. Versions are available for MS Windows Server OS (2003 and 2008) and Linux OS with the requirement that the OS IPMI Driver be installed. Administrators can configure the controller for the following Power Management modes:

- Power Control Disabled - No power throttling will occur.
- Maximum Performance with Redundancy (AC Redundancy with power throttling) - This mode is the default setting and allows all nodes to share both power supplies and run at maximum performance with no power caps. Power control logic will only throttle performance of each node if the chassis

only has one operational power-supply. In this mode, the chassis is expected to survive an unexpected AC power loss to one of power supplies.

- Maximum Redundancy (Full AC/DC Redundancy) - Power control logic will maintain a power cap value for the chassis at the DC rating of a single power supply (460W, 750W, or 1200W). If one power supply experiences a DC or AC failure, the chassis should remain on-line and operational.
- User Selectable Power Cap Mode (Optional) - The user specifies the power envelope for the 2U chassis within the capabilities of the installed hardware. Users run a utility to calibrate the minimum and maximum power consumption envelope for the chassis. To avoid any performance impact from throttling, the Power Cap value should not be set below the minimum power value provided by the utility. This functionality is available with Lights Out 100 Advanced Pack.

## Summary

The HP ProLiant 100-series G6 servers help administrators increase business performance, lower power costs, and manage their server hardware more easily. To improve performance, the 100-series G6 servers use Intel 5500 processor technologies with integrated memory controllers and DDR-3 memory with increased bit rates. The latest Smart Array controllers use serial SAS 2 technology as well as improved firmware capabilities to double the RAID performance compared to the previous generation of controllers. HP spent significant engineering time improving the thermal controls — incorporating multiple thermal sensors and allowing customers to constrain server power according to their needs. Using HP common power supplies is another means for customers to refine and constrain server power based on their data center requirements. ProLiant OnBoard Administrator Powered by Lights-Out 100i and the Insight Management Agents facilitate management by incorporating HP Systems Insight Manager. Servers can be easily deployed with the Easy Set-up CD and its ISO image or with the multi-server deployment capabilities for the DL 100-series G6 servers. Finally, the multi node server DL1000 architecture brings a new level of density and power sharing to rack-based servers. With up to four nodes in a single chassis, the DL1000 architecture lets customers maximize data center floor space while providing flexible configurations that fit into existing industry standard racks. The embedded Power Interface Controller monitors and throttles power usage across the multiple nodes in the chassis for optimum power efficiency.

## For more information

For additional information, refer to the resources listed below.

Resource description	Web address
DDR-3 Memory Configuration Tool	<a href="http://h18004.www1.hp.com/products/servers/options/tool/hp_memtool.html">http://h18004.www1.hp.com/products/servers/options/tool/hp_memtool.html</a>
SAS and SATA technology	<a href="http://www.hp.com/go/serial">www.hp.com/go/serial</a>
Smart Array Advance Pack	<a href="http://h18004.www1.hp.com/products/servers/proliantstorage/arraycontrollers/smartarray-advanced/index.html">http://h18004.www1.hp.com/products/servers/proliantstorage/arraycontrollers/smartarray-advanced/index.html</a>
Smart Array controllers	<a href="http://www.hp.com/products/smartarray">www.hp.com/products/smartarray</a>
HP Network Adapters for ProLiant DL and ML Servers	<a href="http://media.hpvitc.veplatform.com/content/HP_Network_Adapters_for_ProLiant_DL_Family_data_sheet_1237839147.pdf">http://media.hpvitc.veplatform.com/content/HP_Network_Adapters_for_ProLiant_DL_Family_data_sheet_1237839147.pdf</a>
HP ProLiant 100-series Easy Set-up CDs	<a href="http://www.hp.com/servers/easysetup">www.hp.com/servers/easysetup</a>
HP ProLiant DL160 G6 Server	<a href="http://h18004.www1.hp.com/products/quickspecs/13247_na/13247_na.html">http://h18004.www1.hp.com/products/quickspecs/13247_na/13247_na.html</a>
HP ProLiant DL180 G6 Server	<a href="http://h18004.www1.hp.com/products/quickspecs/13248_na/13248_na.html">http://h18004.www1.hp.com/products/quickspecs/13248_na/13248_na.html</a>
HP ProLiant ML150 G6 Server	<a href="http://h18004.www1.hp.com/products/quickspecs/13249_na/13249_na.html">http://h18004.www1.hp.com/products/quickspecs/13249_na/13249_na.html</a>
HP ProLiant DL170h G6 Server overview	<a href="http://www.hp.com/servers/proliantdl170h">www.hp.com/servers/proliantdl170h</a>
HP ProLiant DL1000 G6 Multi Node Server	<a href="http://www.hp.com/servers/proliantdl1000">www.hp.com/servers/proliantdl1000</a>
HP ProLiant Onboard Administrator Powered by LO100 (remote management)	<a href="http://www.hp.com/go/lo100">www.hp.com/go/lo100</a>
ISS Technology Communications briefs: Memory technology evolution: an overview of system memory technologies	<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>
ISS Technology Communications briefs: Serial Attached SCSI storage technology brief	<a href="http://h20000.www2.hp.com/bc/docs/support/SupportManual/c01613420/c01613420.pdf">http://h20000.www2.hp.com/bc/docs/support/SupportManual/c01613420/c01613420.pdf</a>
ProLiant 100 Series Core Management Software	<a href="http://www.hp.com/go/coremanagement">www.hp.com/go/coremanagement</a>

# Call to action

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TC090815TB, August 2009

