Hewlett Packard Enterprise

# Technologies in HPE ProLiant Gen9 c-Class server blades

**Technical white paper**

# Contents

## Introduction

HPE ProLiant Gen9 server blades and the HPE BladeSystem infrastructure incorporate wire-once, cloud-ready technologies that deliver the right compute for the right workload at the right economics every time. By abstracting the servers from their uplinks, HPE liberates administrators from traditional infrastructure constraints and simplifies management between networks and servers. This allows the creation of pools of network, storage, and compute resources you can add, move, or change in minutes.

HPE BladeSystem provides an intelligent infrastructure, controlled by the Onboard Administrator that monitors health and allocates power and cooling resources dynamically to keep everything operating optimally and at maximum efficiency. HPE Thermal Logic technologies such as Active Cool fans and features such as Dynamic Power Capping ensure that you will use less energy consumption, reclaim capacity, and extend the life of your data center. With the high capacity of the NonStop signaling midplane, you can meet the performance needs of your most demanding applications and their availability requirements as well. And because of the Systems Insight Display, administrators can perform many functions locally without having to run to remote console stations or tether to the enclosure just to examine a message or change a basic configuration.

HPE hardware design and engineering give HPE ProLiant Gen9 server blades industry-leading performance—up to a 40 percent increase over previous generations. Embedded management enhancements include Integrated Lifecycle Automation capabilities enabled by innovations such as Intelligent Provisioning for easy system set-up, Active Health for agentless hardware monitoring and alerting, and Smart Update for automated firmware and system software maintenance. ProLiant Gen9 server blades utilize HPE Insight Control and OneView to automate key management processes, including a system's physical deployment, configuration, and problem management. ProLiant Gen9 server blades enable your organization to consolidate physical servers and components while still maintaining the same workload capacity and performance.

We've engineered ProLiant Gen9 server blades to get the most out of the latest advances in processors, memory, networking technology, and new management solutions through the following new features:

- Up to two Intel® Xeon® E5-2600 v3 or v4 processors per HPE ProLiant BL460c Gen9 blade and HPE ProLiant WS460c Gen9
- Up to four Intel Xeon E5-4600 v3 or v4 per HPE ProLiant BL660c Gen9 blade
- DDR4 HPE SmartMemory, with up to 2400 MT/s for increased bandwidth
- Workload acceleration with NVMe Solid State Drives (SSDs) for HPE ProLiant servers
- 20 Gb FlexFabric adapters and modules providing greater bandwidth for converged networking
- On Premise, On System, and On Cloud management capabilities

## HPE BladeSystem infrastructure

HPE BladeSystem infrastructure has become essential as businesses look for increasing levels of operational flexibility to meet changing needs and require an IT infrastructure that embraces convergence. A converged infrastructure allows you to pool resources and eliminate technology silos.

HPE BladeSystem is a change-ready converged infrastructure focused on simplicity, integration, and automation. You can deploy HPE BladeSystem infrastructure today and scale it over time as you require. HPE BladeSystem is a cloud-ready infrastructure—easily deployed into traditional enterprise solutions, but adaptable with applications and virtualization to become a cloud-based environment.

Budget constraints and investment preservation are always a concern. We've engineered the HPE BladeSystem infrastructure with underlying technologies to help maximize every hour, watt, and dollar associated with your operation. HPE BladeSystem implementation is not a "rip and replace" proposition, but allows you to deploy an infrastructure and upgrade it as your needs change. Once installed, HPE BladeSystem infrastructure maximizes power and cooling efficiency with industry leading hardware and management technologies.

HPE BladeSystem combines server, networking, storage, and management into a modular infrastructure well suited for virtualization. We've enhanced HPE BladeSystem virtualization capabilities with ability to directly integrate with VMware® vCenter and Microsoft® System Center to better manage these virtualization environments. HPE BladeSystem infrastructure efficiently connects to shared storage, and Virtual Connect FlexFabric allows you to use one set of wires for both storage and networking capability.

The HPE ProLiant Gen9 BladeSystem infrastructure is management and serviceability-centric, using a modular architecture of enclosures populated with server blades, interconnect modules, and power and cooling components.

## HPE c-Class enclosures

An HPE ProLiant c-Class server blade is a complete server that installs into an HPE BladeSystem c-Class enclosure. There are two different c-Class enclosures available to meet the needs of large or small IT environments:

- The HPE BladeSystem c3000 rack enclosure is 6U high and holds up to eight half-height or four full-height (mixed configuration supported) HPE ProLiant and Integrity c-Class server blades.
- The HPE BladeSystem c7000 rack enclosure is 10U high and holds up to 16 half-height or eight full-height (mixed configuration supported) HPE ProLiant and Integrity c-Class server blades.

HPE ProLiant c3000 Platinum Enclosure

HPE ProLiant c7000 Platinum Enclosure

**Figure 1.** HPE ProLiant c-Class enclosures

The HPE BladeSystem enclosures contain management, thermal, and power technologies that enhance the performance, efficiency, and reliability of c-Class server blades:

- Onboard Administrator module, which provides a single point of control for intelligent management of the entire enclosure, with an optional redundant Onboard Administrator system management module.
- Systems Insight Display powered by the Onboard Administrator provides local management through an LCD display conveniently sited on the front of the system.
- Up to ten hot-plug HPE Active Cool fans in the c7000 enclosure and six in the c3000 enclosure.
- Up to six hot plug high efficiency power supplies per enclosure, with a choice of AC high-line single-phase intelligent and non-intelligent, AC high-line three-phase, universal AC-DC high voltage, or 48 V DC power.
- Redundant rack enclosure power (dual-grid) feeds to the blade chassis with N+1 or N+N power supply redundancy.
- Up to four redundant I/O fabrics providing a wide selection of interconnects including Ethernet, Fibre Channel, InfiniBand, and SAS.

The c-Class enclosure's System Insight Display (figure 2) makes administrators more efficient. It lets you to set up a bare-metal enclosure for access. The display also allows you to perform routine administration functions without a crash-cart of other equipment attached to the enclosure.


**Figure 2.** HPE ProLiant c-Class enclosure System Insight Display

## HPE ProLiant Gen9 server blades

**The half-height ProLiant BL460c Gen9 server blade (figure 3) leads the industry in engineering excellence with the following features:**

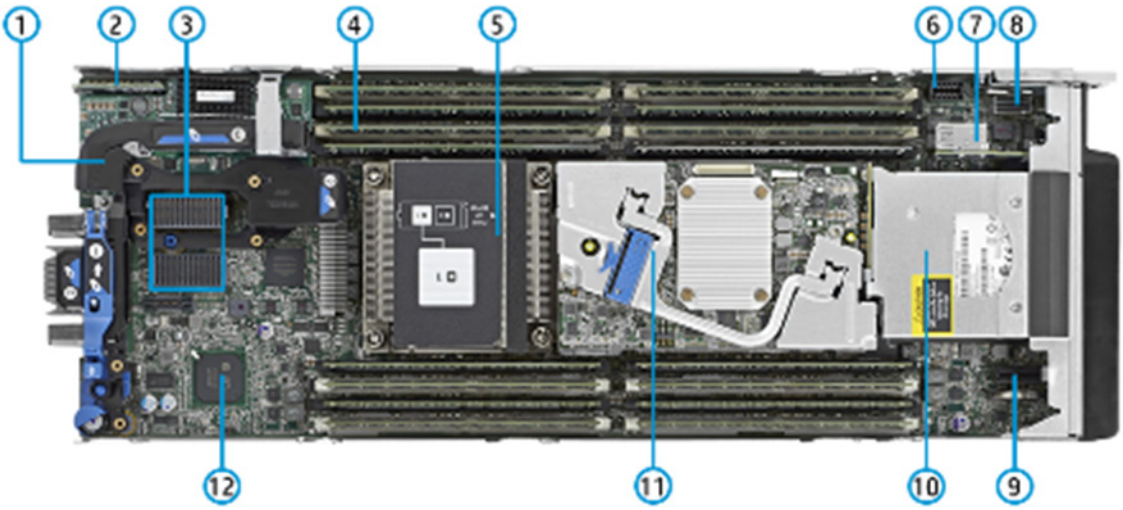
- Intel®-based blades: sockets for up to two Intel Xeon E5-2600 v3 or v4 processors with up to 22 cores each
- 16 DDR4 DIMM sockets for up to 2 TB of HPE SmartMemory and a maximum memory speed up to 2400 MHz
- Workload acceleration with NVMe Solid State Drives (SSDs)
- Connectors for up to two PCIe mezzanine cards (two x16)
- On-board storage with flexible HPE Smart Array controller options
- HPE FlexibleLOM technology with 10 Gb and 20 Gb adapters
- Internal USB 3.0 port
- Solid-state M.2 64 GB or 120 GB Kit available for configuration of system boot options
- HPE Power Regulator for ProLiant
- Unified Extensible Firmware Interface (UEFI) for full configuration and management flexibility (with legacy BIOS mode still supported)

The new Intel Xeon E5-2600 v4 processors and the DDR4 memory offer a performance increase of up to 21 percent bin-to-bin over previous server blades.[1] The HPE ProLiant BL460c Gen9 Server Blade comes with iLO 4 v2, the latest iLO firmware for the iLO management engine. For detailed specifications on the ProLiant BL460c Gen9 Server Blade, refer to the HPE ProLiant BL460c Gen9 data sheet.

**The half-height ProLiant WS460c Gen9 server blade (figure 4) leads the industry in engineering excellence with the following features:**

- Intel-based blades: sockets for up to two Intel Xeon E5-2600 v3 or v4 processors with up to 22 cores each
- 16 DDR4 DIMM sockets for up to 1 TB of HPE SmartMemory and a maximum memory speed up to 2400 MT/s[3]
- Workload acceleration with NVMe Solid State Drives (SSDs)
- Support for NVIDIA® Tesla M6, the first mezzanine graphics adapter offering GRID hardware virtualization technology
- Support for AMD S7100X mezzanine graphics adapter
- Support for NVIDIA M6000 and M5000 graphics adapters
- Wide range of sustaining workstation class graphics adapters from NVIDIA and AMD
- On-board storage with flexible HPE Smart Array controller options
- HPE FlexibleLOM technology with 10 Gb and 20 Gb adapters
- Internal USB 3.0 port
- Solid-state M.2 64 GB or 120 GB Kit available for configuration of system boot options
- HPE Power Regulator for ProLiant
- Unified Extensible Firmware Interface (UEFI) for full configuration and management flexibility (with legacy BIOS mode still supported)

[1] Intel performance testing, intel.com/performance, comparing measurements on platform with two E5-2600 v3 vs E5-2600 v4. November 2015.



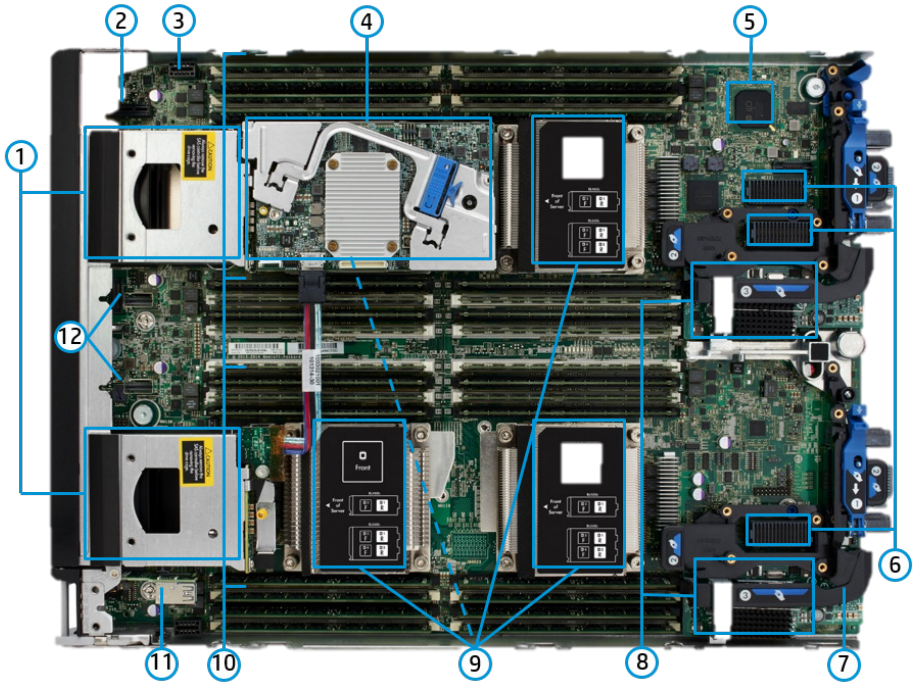

| Item | Component | Item | Component |
|---|---|---|---|
| 1 | FlexibleLOM adapter | 7 | USB 3.0 and TPM |
| 2 | NAND Flash & microSD | 8 | Embedded SATA Connector |
| 3 | Mezzanine Slots (x16 PCIe 3.0) | 9 | M.2 Option Connector |
| 4 | Sixteen (16) DDR4 DIMM memory slots (8 per processor) | 10 | Two hot-plug drive bays |
| 5 | Up to two (2) Intel Xeon E5-2600 v3 or v4 family processors | 11 | HPE Smart Array P244br Controller with 1 GB FBWC |
| 6 | HPE BLc 12W Smart Storage Battery connector | 12 | iLO Management Engine |

**Figure 3.** Half-height HPE ProLiant BL460c Gen9 server blade component layout

**Figure 4.** Full-height and half-height HPE ProLiant WS460c Gen9 server blades and HPE Multi-GPU Carrier

**The full-height ProLiant BL660c Gen9 server blade (figure 5) leads the industry in engineering excellence with the following features:**

- Intel-based blades: sockets for two or four Intel Xeon E5-4600 v3 or v4 processors with up to 22 cores each
- 32 DDR4 DIMM sockets for up to 4 TB of HPE SmartMemory and a maximum memory speed up to 2400 MT/s
- Workload acceleration with NVMe Solid State Drives (SSDs)
- Connectors for up to three PCIe 3.0 mezzanine cards (three x16)
- Four internal drive bays for SAS or SATA SSDs and HDDs
- On-board storage with flexible HPE Smart Array controller options
- HPE FlexibleLOM technology with 10 Gb and 20 Gb adapters
- Internal USB 3.0 port
- Solid-state M.2 64 GB or 120 GB Kit available for configuration of system boot options
- HPE Power Regulator for ProLiant
- Unified Extensible Firmware Interface (UEFI) for full configuration and management flexibility (with legacy BIOS mode still supported)




| Item | Component | Item | Component |
|---|---|---|---|
| 1 | Four hot-plug drive bays | 7 | microSD slot |
| 2 | M.2 Option Connector | 8 | FlexibleLOM adapters |
| 3 | HPE BLc 12W Smart Storage Battery connector | 9 | Two or four Intel Xeon E5-4600 v3 family processors |
| 4 | HPE Smart Array P246br Controller with 1 GB FBWC | 10 | Thirty two DDR4 DIMM memory slots (8 per processor) |
| 5 | iLO Management Engine | 11 | USB 3.0 and TPM |
| 6 | Mezzanine Slots (x16 PCIe 3.0) | 12 | Embedded SATA Connectors |

**Figure 5.** Full-height HPE ProLiant BL660c Gen9 server blade component layout

The new Intel Xeon E5-4600 v4 processors and the DDR4 memory offer a performance increase of up to 21 percent over previous server blades.[2] The HPE ProLiant BL660c Gen9 Server Blade comes with iLO 4 v2, the latest iLO firmware for the iLO management engine. For detailed specifications on the ProLiant BL660c Gen9 Server Blade, refer to the HPE ProLiant BL660c Gen9 data sheet.

**On-board storage with flexible Smart Array Controller options**

Each ProLiant Gen9 server blade (the BL460c Gen9 includes two hot-plug drive bays) an embedded Smart Array storage controller that you can upgrade as your needs change. The embedded Smart Array B140i Controller offers the following baseline functionality:

- Connectivity: ten 6 Gb/s SATA ports
- RAID: RAID 0, 1, 10 (drive mirroring), and 5
- UEFI support

The embedded Smart Array B140i Controller can be upgraded with an HPE Smart HBA H244br or HPE Smart Array Controller P244br daughter card on the ProLiant BL460c Gen9 server, or the HPE P246br Smart Array Controller on the ProLiant BL660c Gen9. These controllers are described in detail in the HPE Smart Array Controllers and storage technologies section.

**FlexibleLOM network adapter technology**

FlexibleLOM technology, introduced with ProLiant Gen8 servers, is included on HPE ProLiant Gen9 server blades to provide you network adapter flexibility in the choice of technologies offered, transmission speed, and number of ports. FlexibleLOM adapters install as a daughter card on the server blade board. The latest FlexibleLOM adapter types available for ProLiant Gen9 servers include 10GbE and 20GbE solutions and are discussed in the "Network and virtualization technologies" section.

**Mezzanine expansion slots**

The ProLiant BL460c Gen9 Server Blade features two PCIe 3.0 mezzanine expansion slots, while the ProLiant BL660c Gen9 Server Blade offers three PCIe 3.0 slots. These expansion slots accept high performance I/O cards with up to x16 bandwidth.

**HPE Power Regulator for ProLiant**

HPE Power Regulator for ProLiant is a hardware feature that enables ProLiant servers to dynamically control performance states (p-states) of the system processors. Insight Control Power Management monitors and uses HPE Power Regulator technology. P-states are affected by processor frequency and voltage:

- Processor frequency—A lower p-state causes the processor to operate at a lower frequency. For example, a 3.773 GHz processor might operate at 3.0 GHz in a lower p-state.
- Processor voltage—A lower p-state causes the processor to operate at a lower level of voltage. For example, a processor operating at 1.4 V at maximum p-state might operate at 1.2 V in the minimum p-state.

Power Regulator operates in HPE Static Low Power Mode, HPE Static High Performance Mode, HPE Dynamic Power Savings Mode, and OS Control mode.

## Processor technologies

We use the Intel Xeon E5-2600 v3 and v4 series processors in the ProLiant BL460c Gen9 c-Class Server Blade and ProLiant WS460c Gen9 c-Class Graphics Server Blade. These processor have from four to 22 cores (in increments of two), and feature an integrated Northbridge and a quad-channel DDR4 memory controller that works with registered DIMMs (RDIMMs) and load-reduced DIMMs (LRDIMMs). The Intel E5-2600 v4 processor offers a maximum QPI speed of 9.6 GT/s and includes a last-level cache (LLC) of up to 55 MB (Xeon E5-2699 v4).

We also use the Intel Xeon E5-4600 v3 and v4 series processors in the ProLiant BL660c Gen9 c-Class Server Blade. This processor has from four to 22 cores (in increments of two), and features an integrated Northbridge and a quad-channel DDR4 memory controller that works with registered DIMMs (RDIMMs) and load-reduced DIMMs (LRDIMMs). The Intel E5-4600 v4 processor offers a maximum QPI speed of 9.6 GT/s and includes a last-level cache (LLC) of up to 55 MB (Xeon E5-4669 v4).

[2] HPE internal testing: Up to 39 percent general compute throughput claim based on est. SPECint_rate_base2006 results comparing 4x Intel Xeon processor E5-4669 v3 to E5-4657L v2.

ProLiant Gen9 server blades feature these Intel Xeon processor capabilities:

- Processor Internal Sensors and Thermal Control—Protection against over-temperature conditions.
- Cache parity/ECC—Protects cache data from accidental data corruption due to particle hits, etc.
- Legacy Error Mode—Corrupt data is contained before it is consumed to ensure data corruption does not occur.
- QPI Protocol Protection via Cycle Redundancy Check (CRC)—Automatically detects data errors using a checksum of either 8 bits or 16 bits.
- QPI Link Level Retry—Retransmits when a transient error is detected on the QPI link.
- PCIe Advanced Error Reporting—Enhanced PCIe reporting features such as finer granularity in defining the error type, ability to specify the severity of each uncorrectable error, error logging, ability to identify the source of an error, and more.
- Direct Media Interface link (DMI)—An x4 bidirectional chip-to-chip interconnect between the processor and chipset. The DMI link provides 2.0 GB/s of bandwidth in each direction (Upstream and Downstream).
- Internal processor sensors and thermal control—Protection against over-temperature conditions.

## Memory technologies

ProLiant Gen9 server blades feature HPE DDR4 SmartMemory and enhanced memory protection with HPE Advanced Memory Error Detection Technology.

### DDR4 HPE SmartMemory

IT trends such as server virtualization, cloud computing, and high-performance computing place significant demands on server memory speed, capacity, and availability. These increasing demands define the system's reliability, performance, and overall power consumption to a much greater extent than before. Therefore, choosing the right memory is the key to ensure high reliability and performance, and to deliver a faster return on your IT investment.

DDR4 HPE SmartMemory offers significant improvements over previous memory generations. DDR4 HPE SmartMemory provides up to 2400 MT/s bandwidth[3] for up to a 33 percent increase[4] in throughput over DDR3 memory. In addition, DDR4 HPE SmartMemory RDIMMs are engineered to achieve the higher performance level at 1.2 volts, saving as much as 35 percent when compared to DDR3-1866 DIMMs running at 1.5 volts. For applications that required maximum memory capacity, HPE SmartMemory LRDIMMs reduce the electrical load to the memory controller allowing higher capacity memory to run in three DIMMs-per-channel configurations.

Unlike other third-party memory, HPE SmartMemory authenticates whether memory has passed HPE's rigorous qualification and testing to ensure that customers are getting the highest quality, genuine HPE Qualified Server Memory. HPE SmartMemory unlocks certain performance and high efficiency features optimized for HPE ProLiant Gen9 Servers:

- HPE SmartMemory uses up to 35 percent less power than third-party memory while achieving the same performance. At low voltage (1.2 V), HPE SmartMemory operates at DDR4-2400 MT/s with one and two DIMMs per channel.
- 128 GB LRDIMMs increase capacity by 100 percent enabling HPE ProLiant Gen9 server blades to provide up to 2 TB total memory on 2-socket servers and 4 TB on 4-socket servers.

HPE SmartMemory features enhanced reporting through the HPE Active Health System and HPE iLO (see the "HPE iLO Management Engine" section later in this document). Because of some ProLiant Gen9 SmartMemory features, DDR4 and DDR3 memory is not interchangeable. One example is the SmartMemory 32 GB quad rank DIMM that appears to the processor as a dual rank type allowing is to use all the lanes. HPE SmartMemory is ideal for HPE ProLiant Gen9 customers who are looking to extract all the memory performance, dependability, and power savings that ProLiant Gen9 servers are designed to deliver.

[3] Depending on processor model installed.

[4] Based on similar capacity DIMM running on HPE server compared to a non-HPE server with DDR4. Under a fully loaded system, HPE Blades will work at 2133 MHz as opposed to suggested 1600 MHz ([2133-1600]/1600) * 100 = 33 percent.

### HPE Advanced Memory Error Detection Technology

Uncorrectable memory errors can cause applications and operating systems to crash, so they are costly in terms of downtime and repairs. The best way to prevent unnecessary DIMM replacements is to filter out superfluous errors and identify critical errors that can lead to a shutdown. You can no longer rely on simple error event counts on systems containing up to 14 trillion memory transistors. With HPE Advanced Memory Error Detection Technology, we re-invented a precision system that pinpoints errors that cause downtime. HPE Advanced Memory Error Detection Technology seeks out specific defects that either cause performance degradation or significantly increase the probability of an uncorrectable (non-recoverable) memory condition. By improving the prediction of non-recoverable memory events, this technology prevents unnecessary DIMM replacements and increases server uptime.

The ProLiant BL460c and BL660c Gen9 Server Blade include these advanced memory protection features:

- Advanced ECC/SDDC—Continued memory operation in the event of a single memory device failure. Allows removal of a single DRAM from the memory map if it exhibits a failure and recovers its data into a new device. Support for both x4 and x8 SDDC.
- Rank Sparring (Online Spare)—Dynamic fail-over to a spare DIMM rank or spare rank pair behind the same memory controller. No OS involvement. You cannot enable this feature concurrently with memory mirroring. HPE offers the rank sparing rather than DIMM sparing as rank sparing uses less spare memory resulting in less overhead.
- Demand Scrubbing—Writes corrected data back to the memory once a correctable error is detected on a read transaction.
- Patrol Scrubbing—Proactively searches the system memory repairing correctable errors. Patrol and Demand scrubbing work together to prevent accumulation of correctable errors and reducing the likelihood of unplanned downtime.
- Memory Thermal Control—Used to prevent DIMMs from overheating. Achieved by slowing down the memory access rate. The temperature is monitored by a DIMM sensor.
- DIMM Address/Control Bus Parity Protection—Methods to detect and protect command and address errors.

## I/O Interconnect and convergence technologies

HPE ProLiant Gen9 server blades support PCI Express (PCIe), serial attached SCSI (SAS), serial ATA (SATA) I/O technologies, 10 Gb Ethernet, 10- and 20-Gb FlexFabric, 10 Gb Flex-10, 8- and 16-Gb Fibre Channel, and 4X Fourteen Data Rate (FDR, or 56 Gb) InfiniBand. Beyond the I/O technology and performance characteristics described in this section, I/O convergence is an increasingly important factor in current and future data center infrastructure. HPE Converged Infrastructure and Virtual Connect technology address the need for a common, virtualized network fabric. HPE ProLiant Gen9 server blades also support I/O convergence with HPE optional mezzanine cards and FlexibleLOMs.

### PCI Express technology

The PCI Express (PCIe) serial interface provides point-to-point connections between the chipset I/O controller hub and I/O devices. Each PCIe serial link consists of one or more dual-simplex lanes. Each lane contains a send pair and a receive pair to transmit data at the signaling rate in both directions simultaneously. ProLiant Gen9 server blades support PCIe 3.0 slots, which have a signaling rate of 2.5 Gb/s per direction per lane. After accounting for 20 percent serializing/deserializing encoding overhead, the resulting effective maximum bandwidth is 2 Gb/s (250 MB/s per direction per lane). Therefore, an x4 link with 4 send and receive pairs has an effective bandwidth of 2 GB/s. An x8 link has an effective bandwidth of 4 GB/s. This flexibility allows slower devices to transmit on a single lane with a relatively small number of pins while faster devices can transmit on more lanes as required.

### NVMe technology

Starting with the Intel Xeon E5-2600/4600 v4 processors, the HPE ProLiant BL460c, BL660c and WS460c Gen9 support new NVMe SSD drives to accelerate workloads. HPE NVMe PCIe 2.5" SSDs talk directly to your applications via the PCIe bus, boosting I/O and reducing latency to scale performance in line with your processing requirements. This means, for example, that you can host your entire database on one or more HPE NVMe PCIe 2.5" SSDs for enhanced in-memory access and performance. NVMe or Non-Volatile Memory Express, is a from-the-ground-up industry specification that focuses on efficiency, scalability, and performance. Customers can shrink their data center storage footprint, and lower TCO—while supporting data-intensive application workloads. NVMe drives are available in read-intensive, write-intensive and mixed-use capabilities with capacities up to 2.0 TB.

## Serial Attached SCSI technology

Serial Attached SCSI (SAS) is a serial communication protocol for direct-attached storage devices such as SAS and SATA Small Form Factor (SFF) and Large Form Factor (LFF) disk drives. It is a point-to-point architecture in which each device connects directly to a SAS port rather than sharing a common bus, as parallel SCSI devices do. 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 high signaling rates.

## Optional mezzanine cards

HPE offers a variety of optional mezzanine cards to connect to outside networks and storage. HPE ProLiant c-Class Gen9 Server Blades support up to two mezzanine cards (Type A and Type B) that connect to the various interconnect fabrics such as Fibre Channel, Ethernet, SAS, and InfiniBand. Type A and Type B mezzanine cards differ only in the amount of power allocated to them by the server and in the physical space they occupy on the server blade. Type A mezzanine cards have slightly less power available to them and are slightly smaller than Type B cards.

Both types of mezzanine cards use a 270-pin connector, enabling up to eight lanes of differential transmit and receive signals. Because the connections between the device bays and the interconnect bays are hard-wired through the signal midplane, the mezzanine cards must be matched to the appropriate type of interconnect module. For example, a Fibre Channel mezzanine card must be placed in the mezzanine connector that connects to an interconnect bay holding a Fibre Channel switch. For the most up-to-date information about the c-Class mezzanine card options, go to the HPE website: hpe.com/servers/ProLiantNICs.

## Network and virtualization technologies

ProLiant Gen9 blade servers can be configured with the latest HPE FlexibleLOM 10GbE or 20GbE FlexFabric adapters. These adapters offer enhanced functionality that increases server performance and networking efficiency.

**Flex-10 and Flex-20**—Provides superior utilization of the network connection. Flex-10 and Flex-20 adapters allow for up to 4 (or 8 in a dual-port adapter) configurable virtual network adapters, also known as FlexNICs. These FlexNICs can be configured for specific traffic types, such as storage, management, VM migration, and VM traffic, among others. Bandwidth is assigned to each FlexNIC to fine-tune performance, and eliminate hardware.

**FlexFabric**—Combined with Flex-10 and Flex-20, Fibre Channel over Ethernet and accelerated iSCSI, HPE FlexFabric adapters provide a lossless network environment for storage. Additionally, the FlexFabric adapters offload the storage protocols, improving CPU efficiency and storage performance.

**RDMA over Converged Ethernet (RoCE)**—Dramatically increase data transfer efficiency with very low latencies for applications such as Microsoft Hyper-V Live Migration, Microsoft SQL, and Microsoft Storage Spaces with SMB Direct 3.0. RDMA over Converged Ethernet (RoCE) reduces CPU utilization and helps maximize host VM density and server efficiency. Using SMB with RoCE, Hyper-V Live Migration is **seven times faster** than TCP/IP.

**Tunnel offload**—Minimize the impact of overlay networking on host performance with tunnel offload support for VXLAN and NVGRE. By offloading packet processing to adapters, customers can use overlay networking to increase VM migration flexibility and network scale with minimal impact to performance. HPE Tunnel Offloading increases I/O throughput, reduces processor utilization, and lowers power consumption up to 122 percent.[5]

**TCP/IP Offload Engine (TOE)**—The increased bandwidth of Gigabit Ethernet networks increases demand for CPU cycles to manage the network protocol stack. This means that performance of even a fast processor will degrade while simultaneously processing application instructions and transferring data to or from the network. Computers most susceptible to this problem are application servers, Web servers, and file servers that have many of concurrent connections.

The ProLiant TCP/IP Offload Engine for Windows® increases execution of network-intensive applications by offloading TCP/IP-related tasks from the processors onto the network adapter. TOE network adapters have on-board logic to process common and repetitive tasks of TCP/IP network traffic. This effectively eliminates the need for the processor to segment and reassemble network data packets. Eliminating this work significantly increases the application performance of servers attached to gigabit Ethernet networks.

TOE is included on integrated Multifunction Gigabit Ethernet adapters and optional multifunction mezzanine cards. It is supported on Microsoft Windows Server® 2012 operating system.

[5] Testing was conducted turning on or off offload for measurement of VXLAN bidirectional throughput, VXLAN Tx/Rx physical CPU effectiveness, and host server power efficiency.

**Receive-side Scaling (RSS)**—RSS balances incoming short-lived traffic across multiple processors while preserving ordered packet delivery. Additionally, RSS dynamically adjusts incoming traffic as the system load varies. As a result, any application with heavy network traffic running on a multi-processor server will benefit. RSS is independent of the number of connections, so it scales well. This makes RSS particularly valuable to Web servers and file servers handling heavy loads of short-lived traffic. Windows Server 2012 supports RSS as part of the operating system.

**iSCSI Acceleration**—iSCSI Acceleration offloads the iSCSI function to the NIC rather than taxing the server CPU. Accelerated iSCSI is enabled by the HPE ProLiant Essentials Accelerated iSCSI Pack that is used with certain embedded Multifunction adapters in Windows and Linux® environments.

**iSCSI boot for Linux**—iSCSI boot for Linux is available on HPE FlexFabric 10Gb 536FLB and 534M adapters. iSCSI boot for Linux allows the host server to boot from a remote OS image located on a SAN within a Red Hat® or SUSE Linux environment. The host server uses an iSCSI firmware image (iSCSI boot option ROM), making the remote disk drive appear to be a local, bootable "C" drive. Administrators can configure the server to connect to and boot from the iSCSI target disk on the network. It then downloads the OS image from the iSCSI target disk. This boot solution also includes scripts to significantly simplify the installation process. Adding an iSCSI HBA card is not required.

For complete specifications about HPE network adapter products, go to hp.com/go/ProLiantNICs.

### Virtual Connect and Virtual Connect Manager

HPE Virtual Connect is hardware abstraction technology that lets you configure and connect physical and virtual servers. Through its ability to virtualize BladeSystem server connections to external networks, HPE Virtual Connect lets you add, move, and change servers inside BladeSystem domains without affecting access to LAN and SAN within the domain. HPE Virtual Connect and converged networking are key components of HPE Converged Infrastructure. Convergence of networking and storage data traffic over HPE FlexFabric converged network adapters and interconnect modules are supported in all ProLiant server blades.

We initially converged networks using Virtual Connect Flex-10 technology to replace multiple lower bandwidth physical NIC ports, but now are using Virtual Connect FlexFabric to implement LAN/SAN convergence technology. HPE Virtual Connect FlexFabric broadens Flex-10 technology to provide solutions for converging these different network protocols.

You can use Virtual Connect Manager (VCM) to change, move, or redeploy any server within a single Virtual Connect domain. VCM is embedded firmware on the Virtual Connect Ethernet Module and the FlexFabric Module. Virtual Connect Enterprise Manager (VCEM) extends the Virtual Connect architecture to large multi-domain environments. You can use VCEM to change, move, or redeploy any server within the VC domains that VCEM controls. VCEM is a plug-in for HPE Systems Insight Manager (HPE SIM) and benefits from the rich feature set offered by HPE SIM. These features include centralized authentication, enclosure discovery, and security. VCEM is supported in all ProLiant server blades, Virtual Connect Flex-10 adapters, FlexFabric adapters, and interconnects.

More detailed information about Virtual Connect technology is available in the technology brief titled "Overview of HPE Virtual Connect technologies" on the HPE technology website: h20195.www2.hp.com/V2/GetDocument.aspx?docname=4AA4-8174ENW&cc=us&lc=en.

### HPE Virtual Connect FlexFabric-20/40 F8 module and FlexFabric 20G adapters

The new HPE Virtual Connect FlexFabric 20/40 F8 Module and HPE FlexFabric 20 Gb 630FLB and 650FLB FlexibleLOM adapters bring 20 Gb throughput capability to HPE ProLiant c-Class BladeSystem. These components offer an immediate 20 Gb upgrade path for existing c-Class enclosures, allowing those systems to achieve 240 Gbps total bandwidth with the LAN or SAN—a 3X improvement over legacy VC FlexFabric 10 Gb modules.

### HPE Virtual Connect 16 Gb 24-port Fibre Channel Module and HPE 16 Gb Host Bus Adapters

The new HPE Virtual Connect 16 Gb Fibre Channel Module coupled with 16 Gb QMH2672 and 16 Gb LPe1605 adapters enable full Gen5 Fibre Channel 16 Gb throughput for SAN connectivity to HPE ProLiant c-Class BladeSystem. The new Gen5 technology enables data centers to meet demanding I/O needs while seamlessly interfacing to the server infrastructure with Virtual Connect wire-once simplicity.

### Virtual Connect direct-attach Fibre Channel using HPE Flat SAN technology

Fibre Channel is the storage fabric of choice for most enterprise IT infrastructures. In the past, Fibre Channel required an intermediate SAN fabric to create your storage solution. However, this fabric can be expensive, and can result in increased complexity and IT infrastructure costs.

We have improved efficiency of server and storage connectivity with HPE Virtual Connect direct-attach Fibre Channel for HPE 3PAR StoreServ Solutions with Flat SAN technology. You can now connect HPE 3PAR StoreServ systems directly to the HPE Virtual Connect FlexFabric Modules (figure 6). That eliminates the need for an intermediate SAN switch complex, multi-tier SANs, and excess networking equipment. This innovative solution requires no SAN fabric licenses. In an existing fabric-attach environment, you can use the HPE 3PAR StoreServ Solutions with Flat SAN technology to direct-attach and fabric-attach storage simultaneously.

### HPE 6127XLG 10/20Gb Ethernet Blade Switch

The 6127XLG Ethernet Blade Switch is designed to support virtualized server environments with exceptional bandwidth of 10GbE and 20GbE to each and every server, while providing a mix of 40GbE and 10GbE links (with an aggregate of 240 Gb) to the core network. Combined with hardware support for VXLAN encapsulation, this provides the capabilities for driving Private/Public/Hybrid Cloud applications and provides a converged fabric solution that supports Ethernet, iSCSI, Fibre Channel over Ethernet (FCoE), and Fibre Channel Forwarder (FCF) protocols enabling connectivity for multiple storage topologies. A full complement of Layer 2/3 protocols, IRF support with HPN switches, and the latest in network security features round out the latest offering in HPE BladeSystem Ethernet switches.

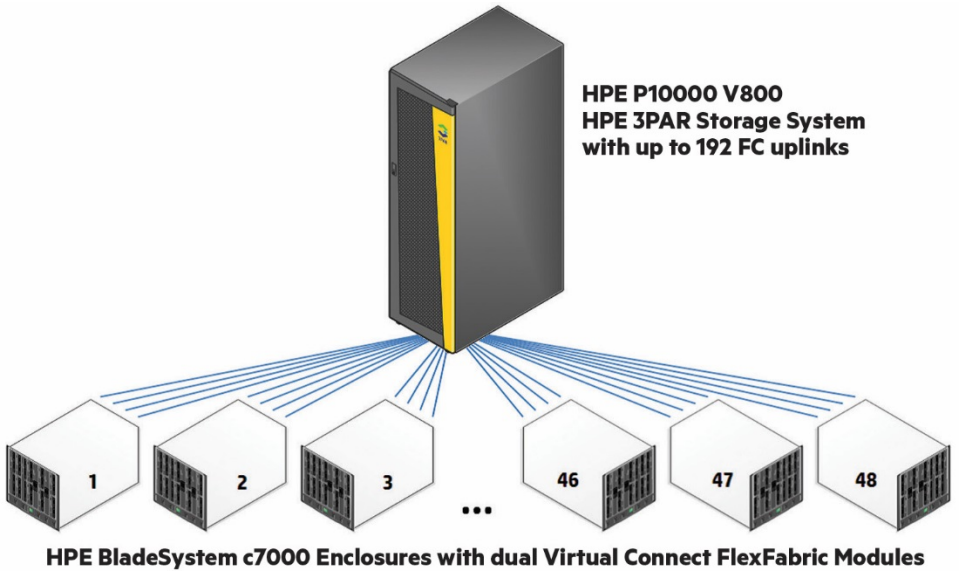



**Figure 6.** HPE Virtual Connect direct-attach Fibre Channel (FC) with HPE 3PAR Storage System

More information is available in "HPE Virtual Connect direct-attach Fibre Channel for HPE 3PAR Storage Systems solution brief" at http://h20195.www2.hpe.com/V2/GetDocument.aspx?docname=4AA4-1557ENW&cc=us&lc=en.

## HPE ProLiant Smart Storage

Over the last several years, the bandwidth and throughput of the memory and processor subsystems has grown exponentially with advent of additional processor cores, higher bandwidth, more DIMMs, and other advances. While storage performance has grown steadily, it has not kept pace with other system advances. One such example of this performance gap is in the area of database applications. In order to achieve industry leading benchmark numbers, HPE matches a number of hard drives to balance the load of ever-increasing processor and memory speeds.

We've addressed the storage performance gap with solid state drive (SSD) and SSD-optimized Smart Array controllers. Compared to a 1,000-spindle hard drive solution, we've been able to achieve maximum performance with less than 100 SSDs. A key to achieving this performance was to remove controller bottlenecks associated with improved SSD performance. We've removed those performance bottlenecks in Smart Array controllers for ProLiant Gen9 servers. Compared to previous generation controllers, the new Smart Array controller delivers more than four times the I/O rate for read operations and more than six times the IOPS rate for database workloads.

### HPE Smart Array controllers and storage technologies

The HPE ProLiant BL460c and BL660c Gen9 Server Blades include the HPE Dynamic Smart Array B140i Controller. This controller provides essential support of drive arrays without the need for adding an option card and consuming an expansion slot.

The embedded HPE Dynamic Smart Array B140i Controller is upgradeable with a daughter card. The new P244br and H244br Smart Array Controller options utilize the PCI Express 3.0 host interface and 12 Gb SAS storage interfaces. Technology enhancements for these controllers include increased performance and Smart Array Advanced Pack (SAAP) 2.0 features. These controllers also provide Active Health Logging and Predictive Spare Activation.

Table 1 compares the embedded and optional Smart Array controllers for ProLiant Gen9 server blades.

**Table 1.** Comparison of HPE Smart Array controllers for ProLiant Gen9 server blades

| | HPE Smart Array B140i Controller (embedded) | HPE Smart Array H244br Controller (optional for BL460c) | HPE Smart Array P244br Controller (optional for BL460c) | HPE Smart Array P246br Controller (optional for BL660c) |
|---|---|---|---|---|
| **Form factor** | Embedded on blade | Daughter card | Daughter card | Daughter card |
| **Storage protocol** | 6 Gb/s SATA | 6 & 12 Gb/s SATA/SAS | 6 & 12 Gb/s SATA/SAS | 6 & 12 Gb/s SATA/SAS |
| **Memory bus speed** | DDR3—1866 MHz | DDR3—1866 MHz | DDR3—1866 MHz | DDR3—1866 MHz |
| **Cache memory size** | n/a | n/a | 1 GB FBWC | 1 GB FBWC |
| **Connectivity/# of drives** | 10 SATA ports/2 drives | 2 SATA ports/2 drives | 2 SATA ports/2 drives | 4 SATA ports/4 drives |
| **RAID support (see note)** | 0, 1, and 10 (drive mirroring) | 0, 1 (drive mirroring) | 0, 1, and 10 (drive mirroring) | 0, 1, 5, and 10 (drive mirroring) |
| **HPE Secure Encryption** | Not supported | Optional (RAID mode only) | Optional | Optional |
| **HPE SmartCache** | Not supported | Not supported | Optional | Optional |

**Note**
RAID support dependent on number of HDDs attached.

### Smart Storage battery

Smart Array Controllers for ProLiant Gen9 servers feature a backup battery that is electrically shared across all controllers that require a battery to support Flash Backed Write Cache (FBWC). This design offers the following benefits:

- Cable-less backup power connection
- Battery monitored by iLO
- Diagnostic data available in Active Health
- Longer backup time

### Predictive Spare Activation technology

Predictive Spare Activation technology protects data by rebuilding an identified problem drive to a spare drive before it is needed. This eliminates a period of exposure during the drive rebuild when an additional drive could fail. HPE drives can report a predictive failure before an actual drive failure occurs. Predictive Spare Activation automatically copies the data from a predictive failure drive to a global spare drive. The copy operation reduces the time before the spare drive becomes active. After the copy completes, the predictive failure drive is marked as a drive failure. You can then remove it from the RAID set for servicing.

### Advanced Data Mirroring

HPE Smart Array Advanced Pack 2.0 features Advanced Data Mirroring (ADM). ADM uses additional drives for redundancy, with data actively read from and written to the drives. ADM allows triple mirroring of RAID 1 and 1+0 configurations, which provides the highest level of fault tolerance offered by Smart Array. ADM is considerably more reliable than two-drive mirroring, since three copies of data offer protection from two drive failures. Performance is significantly improved as well.

### HPE SmartCache

HPE SmartCache utilizes SSDs for caching to accelerate workload performance. This solution uses HPE Smart Analytics technology to intelligently assign frequently accessed “hot data” to high-performance SSD drives. By providing workload-aware intelligence to optimize system operations, this smart caching capability helps clients achieve higher performance for transactional workloads. HPE SmartCache performance outcomes are application dependent.

### Dynamic Workload Acceleration

To optimize solid state media performance and eliminate controller bottlenecks, Smart Array controllers for Gen9 servers are optimized for SSDs with six times the performance of previous-generation controllers. This technology has helped HPE ProLiant achieve the TPC-C 10 benchmark in the industry.

## Drive technology

We continue to focus on the need to meet and exceed the industry's growing requirement for storage. ProLiant Gen9 platforms have very flexible storage configurations to scale to various capacity points. Dealing with that storage density can be even more important. The new Smart Array controllers incorporate new resiliency features to focus on density including:

- RAID advanced data mirroring (ADM) for three-drive mirroring
- Predictive Rebuild to eliminate fault tolerant downtime exposure windows
- Rapid parity initialization to deploy new RAID volumes up to 95 percent faster than previous generations

### HPE SmartDrive

HPE ProLiant Gen9 servers use HPE SmartDrive designed to improved drive density and serviceability. The drive's front bezel includes a blue backlight for locating a specific SmartDrive selected from within the storage software. An icon-based display reports the drive's status. A "do-not-remove" LED helps prevent a drive failure whenever anyone tries to remove the wrong drive. Other serviceability improvements include authentication, failure logging, and integration with the HPE Active Health System.

### SAS and SATA Small Form Factor hard drives

The SAS architecture enables system designs that deploy high-performance SAS and high-capacity SATA SFF and LFF drives. This capability provides a broad range of storage solutions that give IT managers the flexibility to choose storage devices based on reliability, performance, and cost.

SFF drives provide higher performance than large form factor drives. The smaller SFF platters reduce seek times because the heads have a shorter distance to travel. RAID performance improves by increasing the numbers of spindles. For more information about these features, refer to the technology brief "Serial ATA technology": h20564.www2.hpe.com/hpsc/doc/public/display?docId=emr_na-c00301688&DocLang=en&docLocale=en_US&jumpid=reg_r11944_usen_c-001_title_r0001.

### Solid state drives

HPE server solid state drive (SSD) allow you to more easily achieve data center performance goals by offering superior performance over conventional hard disk drive media. HPE SSDs achieve a level of reliability equivalent to or slightly greater than current HPE Midline disk drives for servers. HPE server SSD interfaces are compatible with traditional disk drives connected to a SATA (or SAS) controller. This allows benchmarking and direct comparison of their external performance with that of disk drives to determine their suitability in various application environments.

SSDs are known to have a limited write cycle lifetime. HPE Smart SSD Wear Gauge offers unique HPE technology that monitors the lifespan of solid state drives and calculates how much life remains on your SSDs so you can plan for their replacement ahead of time.

## HPE Smart Storage Administrator

HPE Smart Storage Administrator (HPE SSA) provides comprehensive configuration and management for all HPE Smart Storage solutions. Using a simplified and intuitive interface, HPE SSA offers the following configure, monitor, and maintenance functions:

- Configure RAID mode, HPE Smart Path, Advance Capacity Expansion
- Replicate configuration from host to host thru CLI scripting
- Monitor drive usage with the HPE Smart Wear Gauge Utility
- Monitor drive rebuilds and surface scans
- Verification of drive firmware
- Move logical drives/replace arrays
- Invoke Heal Array for hands-off movement using spare drive system

## Management technologies

We provide a comprehensive set of management offerings purposely designed and packaged for small and large companies, and can meet your management needs at every stage of the server lifecycle with three types of server management solutions:

- On Premise management
- On System management
- On Cloud management

### On Premise management

On Premise management refers to infrastructure management practices conducted primarily within the data center facility. We offer several solutions for conducting On Premise management; HPE OneView, HPE Insight Control, and HPE Systems Insight Manager.

#### HPE OneView

For data centers with a large number of devices that require 24x7 management, maximum uptime, and infrastructure management that spans servers, storage, and networking, HPE delivers HPE OneView.[6] This converged management platform provides powerful software-defined process templates for automating infrastructure configuration and provisioning, as well as for robust infrastructure health and monitoring. HPE OneView integrates into existing enterprise management tools such as VMware vCenter Server and Microsoft System Center to streamline operations—saving you time and cost. Learn more at hpe.com/info/oneview.

#### HPE Insight Control and Systems Insight Manager

HPE Insight Control and Systems Insight Manager (SIM) support the HPE ProLiant server portfolio including Gen9. While HPE OneView can coexist with HPE Insight Control, Virtual Connect Enterprise Manager, and SIM, HPE OneView is designed to replace these products. To learn more about Insight Control and SIM visit hpe.com/info/servermanagement.

### On System management

All HPE ProLiant Gen9 servers include a set of essential yet powerful server management capabilities. These "On System" management capabilities are designed to meet the needs of any organization, from small to enterprise IT environments. On System management provides embedded tools and system utilities that increase server administrator productivity. New features are available for HPE ProLiant Gen9 only, unless noted, and include the following:

- **Unified Extensible Firmware Interface (UEFI)**—firmware interface that simplifies server configuration, reduces boot time, enhances server security with Secure Boot and leverages HPE RESTful API. All ProLiant Gen9 servers ship with UEFI as the default boot mode, but can be re-configured for legacy BIOS operation if your existing environment requires it.
- **HPE RESTful Interface Tool**—utility that leverages HPE RESTful API to simplify customized scripting for UEFI.
- **HPE Smart Update Manager (HPE SUM)**—utility enabled by iLO Federation delivers improved performance during discovery and deployment of firmware updates in iLO groups. New capabilities for HPE SUM include baseline enhancements and validation, baseline assignments in guided updates, dynamic filtering, the ability to download baselines from an http server, and live logs to provide detailed information of the target update process.
- **HPE iLO**—includes iLO Federation Discovery that recognizes numerous servers at once using multicast discovery methods supporting both IPv4 and IPv6 environment. An iLO Advanced license gives you full implementation of iLO Federation Management including: Group Firmware Update, Group Power Control, Group Power Capping, Group Configuration, Group Virtual Media, Group License Activation. Additional new iLO features for Gen9 servers include:
  - HPE RESTful API implementation into iLO architecture[7]
  - iLO Reboot Switch—allows you to reset the iLO or HPE ProLiant hardware via the UID button when iLO is not responding
  - Pre-Boot Health Summary—allows you to troubleshoot and view iLO diagnostic information prior to powering on
  - 1 GB Embedded User Partition—accessible for additional use or storage with 4 GB iLO NAND installed in the server
  - Agentless data now visible through the iLO Graphical User Interface (GUI)

[6] HPE OneView will support ProLiant Gen9 BL servers before the end of 2014.
[7] Backwards compatible for iLO 4 in Gen8 and Gen9 servers.

- **Intelligent Provisioning**—offers a new simplified GUI and opt-in access to download the Virtual Storage Appliance software and take advantage of the free 1 TB storage program.

Click here to learn more about UEFI, HPE RESTful Interface Tool, HPE SUM, iLO, or Intelligent Provisioning.

### On Cloud management

Taking a cue from the universal appeal of online banking, HPE Insight Online enables you to see everything IT from anywhere at any time so you can work smarter and stay informed and in control of your IT infrastructure. HPE Insight Online and related remote support tools are available at no additional cost to you, as part of your HPE warranty or support agreement.

HPE Insight Online provides automated support for your converged infrastructure of servers, storage, and networking devices through a personalized cloud-based dashboard available anywhere, anytime to save you time and resources and reduce unplanned downtime. It provides easy access to IT health and support information for small environments that have little or no IT staff, where a trusted channel partner assists with server and support, and enterprises that want a global support view of their IT infrastructure. This is the ideal solution for providing 24x7 automated support and tracking device health and support status for faster problem resolution. In addition, you can use the HPE Insight Online dashboard in the HPE Support Center mobile app to remain up to date on what's happening with your IT environment, whether you're in the office or on the road. Learn more at hpe.com/support/insightonline/info.

For details about ProLiant Gen9 management, see the "HPE ProLiant Gen9 Server manageability innovations" technical white paper.

## Data security technology with the Trusted Platform Module

The Trusted Platform Module (TPM) is a hardware-based system security feature 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 Gen9 server blades support an optional TPM v2.0. A rivet supplied with the optional TPM v2.0 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 from the board once it has been installed.

For additional information about the TPM, see the HPE technology brief titled "Data security in HPE ProLiant servers using the Trusted Platform Module and Microsoft Windows BitLocker Drive Encryption": h20565.www2.hpe.com/hpsc/doc/public/display?docId=emr_na-c01681891&lang=en-us&cc=us.

## Quick reference access with QR codes

All HPE ProLiant Gen9 servers include an on-chassis Quick Response (QR) code (figure 7) that provides access to mobile-friendly support for the particular ProLiant server. The QR code provided with each ProLiant server offers quick access to support information such as:

- Out-of-box setup, configuration, and installation information
- Troubleshooting and error message data
- Illustrated parts diagrams and spare parts lists

The QR code sticker is located on the pull out tab located next to the iLO label on the server blade.


**Figure 7.** QR code sample

## Conclusion

Designed to get the most out of Intel Xeon E5-2600/4600 v3 and v4 processors and DDR4 memory, the HPE ProLiant Gen9 c-Class server blades and the latest HPE SmartMemory, Smart Storage, and 20 Gb-FlexFabric solutions significantly enhance virtualization performance—as much as 40 percent over previous generation components. Whether moving to the HPE ProLiant c-Class BladeSystem or updating an existing system, ProLiant Gen9 server blades and solutions bring the highest performance and the latest technologies to an architecture proven in converged infrastructure environments.

Figure 8 shows the transition of previous generation ProLiant server blades to current ProLiant Gen9 server blades.

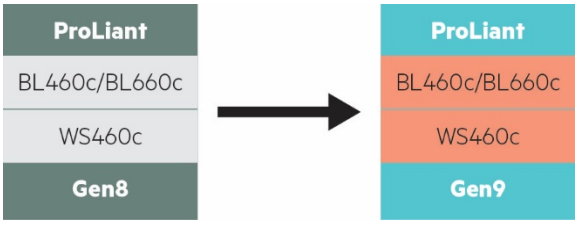



**Figure 8.** Model transition of previous generation server blades to HPE ProLiant Gen9 server blade

**Resources**

HPE ProLiant and BladeSystem White Papers

HPE BladeSystem

HPE ProLiant Gen9 Manageability Innovations Technical White Paper

HPE Smart Storage for HPE ProLiant Gen9 Servers Technical White Paper

Technologies in HPE ProLiant Gen9 c-Class Server Blades Technical White Paper

Networking Innovations for HPE ProLiant Gen9 Servers Technical White Paper

HPE iLO Management Engine Technologies Technical White Paper

HPE iLO 4 User Guide

HPE Service Pack for ProLiant

HPE Smart Update Manager

HPE Insight Online

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