Why Scalable Blades: HP Integrity Server Blades (BL860c i2, BL870c i2, and BL890c i2)

World’s first scale-up blades built on the industry’s #1 blade infrastructure

Technical White Paper

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Executive Summary

The HP Integrity server blade architecture builds on the best of HP blade technology with new levels of scalability, spanning from the BL860c i2 single blade entry solution up to the BL890c i2 quad blade mid-range offering. Benefits of the HP integrity server blade solutions include scalability, ease of use, flexibility, best-in-class I/O solutions, and total cost of ownership (TCO). This provides a compelling mission-critical Converged Infrastructure strategy for Integrity server blades.

If you are considering upgrading from a current bladed or non-bladed server design to a next generation server, this white paper is intended to highlight some of the capabilities of the HP Integrity server blades to aid in your evaluation.

Product Family—A starting point

The HP Integrity server blades, as shown in Figure 1, are designed to provide a range of capabilities, replacing the prior Integrity generation BL860c, BL870c, and racked 4-processor module and 8-processor module rack mount servers. The Integrity server blades product line is composed of the BL860c i2 single blade server, BL870c i2 two-blade server, and BL890c i2 four-blade server. The processor, Memory, and I/O resources of the Integrity server blades can be adjusted, that is scaled, to meet application requirements. Integrity server blades enable compute, memory, and I/O capacity to scale across the product line, as shown in Table 1. In essence, the supported resources of the BL870c i2 are double those of the BL860c i2, and the BL890c i2 resources are double those of the BL870c i2.

A complementary part of the Integrity server blades story is that the Integrity blade products seamlessly coexist with other HP BladeSystem solutions within the c-Class enclosure, enabling mixed HP ProLiant and Integrity, and StorageWorks storage blade solutions within the same enclosure. The Integrity server blades and enclosure solutions are supported by the HP BladeSystem management suite of products.

The HP Integrity server blade family will support future enhanced capabilities, including memory, processor enhancements, operating system offerings, partitioning abilities, and field product upgrades to further extend its capabilities.
Figure 1: Integrity Server Blades Product Family

BL860c i2

BL870c i2

BL890c i2
Table 1: Blade Capabilities

<table>
<thead>
<tr>
<th>Integrity</th>
<th>BL860c i2</th>
<th>BL870c i2</th>
<th>BL890c i2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Processor module</td>
<td>Intel® Itanium 9300 processor series</td>
<td>2P/8C/16T</td>
<td>4P/16C/32T</td>
</tr>
<tr>
<td>Processor/Cores/Threads</td>
<td>2P/8C/16T</td>
<td>4P/16C/32T</td>
<td>8P/32C/64T</td>
</tr>
<tr>
<td>Chipset</td>
<td>Intel® E7500 Boxboro/Millbrook Chipset</td>
<td>24 DIMM slots</td>
<td>48 DIMM slots</td>
</tr>
<tr>
<td>Memory</td>
<td>Industry Standard DDR3</td>
<td>96 GB (w/4 GB)</td>
<td>192 GB (w/4 GB)</td>
</tr>
<tr>
<td>Internal Storage</td>
<td>2 hot swap SAS HDDs</td>
<td>4 hot swap SAS HDDs</td>
<td>8 hot swap SAS HDDs</td>
</tr>
<tr>
<td>Networking (built-in IO solution)</td>
<td>4 @ 10 GbE NICs</td>
<td>8 @ 10 GbE NICs</td>
<td>16 @ 10 GbE NICs</td>
</tr>
<tr>
<td>Mezzanine IO Slots</td>
<td>3 PCIe slots</td>
<td>6 PCIe slots</td>
<td>12 PCIe slots</td>
</tr>
<tr>
<td>Management</td>
<td>Integrity iLO 3 (Integrity Integrated Lights-Out 3), iLO 3 Advanced Pack license is included</td>
<td>HPUX 11i v3, OpenVMS v8.4*, Windows Server 2008 R2*</td>
<td></td>
</tr>
</tbody>
</table>

* (Future Support)

Future enhancements include 16 GB DIMM Memory, Product field Upgrades and Partition support.

Integrity server blades have an important set of reliability, availability and serviceability (RAS) features, provided in all key areas of the architecture. Capabilities such as, Intel Cache Safe Technology®, error hardened latches, register store engine, memory protection keys, double device data correction, and CPU sparing and migration as well as Advanced Machine Check Architecture (AMCA) for co-ordinated error handling across the hardware, firmware, and operating systems. RAS details are contained in the “Technologies in the HP Integrity Server Blades” white paper.

Virtual Connect Flex-10 features significantly expand the I/O capabilities of the Integrity server blades and will be described in more detail later in this white paper.

HP BladeSystem c-Class Enclosure Solutions and Integrity Server Blades

Integrity server blades may reside in the c7000 or c3000 BladeSystem enclosures. The HP BladeSystem c-Class enclosure story is composed of four key themes:

1. Simple to manage and easy to control: Onboard Administrator (OA), Integrity HP Integrity Integrated Lights-Out (iLO 3) Manageability, and HP Insight Control Environment
2. Agility: Pre-wired and pre-configured make adding a new server simple
3. Reduced capital and operating costs: Uses less power and less than half of the space compared with racked solutions.
4. Ease of Integration: Flexible power configuration, same management tools as HP rack-mount servers
These four elements are applicable to Integrity server blades and become even more important as the size and capabilities of the servers increase.

Table 2 details the capacity of the c3000 and c7000 enclosures for Integrity server blades.

<table>
<thead>
<tr>
<th>Enclosure Capacity</th>
<th>Integrity server blades</th>
</tr>
</thead>
<tbody>
<tr>
<td>c3000 (full height—4 bays)</td>
<td>BL860c i2: 4 servers, BL870c i2: 2 servers, BL890c i2: 1 server</td>
</tr>
<tr>
<td>c7000 (full height—8 bays)</td>
<td>BL860c i2: 8 servers, BL870c i2: 4 servers, BL890c i2: 2 servers</td>
</tr>
</tbody>
</table>

Building a Bladed Scalable System—Foundation Blade and the BL860c i2

All Integrity server blades are built on the same basic hardware structure. With the Intel QuickPath Interconnect (QPI) fabric, Integrity Blade Link and the extensible HP Integrity iLO 3 solution, HP defines a family of servers, scaling from the BL860c i2 two-processor module system all the way up to the BL890c i2 eight-processor module system.

The Integrity server blades are comprised of one to four physical blades, depending on the Integrity server blade product. Multi-blade solutions are regarded as being “conjoined” or interdependently linked together. The Integrity server blades design relies on a common foundation blade design that is replicated and configured based on the location, for example node address, within the QPI fabric topology, resulting in a scalable architecture. The Integrity server blade architecture can easily be increased in resources, for example processor modules, memory and I/O, with sufficient allocated QPI fabric bandwidth and I/O bandwidth to enable a balanced system as I/O resources are added.

As the Integrity server blade architecture is increased or scaled from a minimum configuration to a maximum configuration, all management resources, tools, and user interfaces behave consistently, simplifying administration of the entire product line.

HP Integrity BL860c i2 Server Blade

The foundation blade structure provides a set of blade features as shown in Figure 2. A foundation blade combined with a BL860c i2 Integrity Blade Link, will be configured to a BL860c i2 blade.

The BL860c i2 server blade supports two Intel® Itanium® processor 9300 series (quad-core or dual-core) processor modules. The two processors are linked together by a full width QPI link providing 19.2 GB/s of bandwidth. Each Itanium processor 9300 series module contains two memory controllers with an aggregate bandwidth of 28.8 GB/s. Each Processor Module supports up to 12 DDR3 memory DIMMs, or 24 memory DIMMs in total for the blade. The blade will support a memory capacity of 384 GB when 16 GB DIMMs are available.

The I/O subsystem is composed of built-in I/O functions and three I/O expansion slots. The I/O expansion slots are provisioned with x8 PCIe Gen2 links back into the IO Hub controller (IOH). This provides a raw total aggregate bandwidth of 10 GB/s per I/O Mezzanine card (send and receive).
The BL860c i2 server blade also has four 10 GbE Flex-10 NIC ports provided by two embedded dual LAN controllers. Each dual LAN controller is provisioned with x4 PCIe Gen2 links, providing a raw aggregate bandwidth of 5 GB/s (send and receive).

The BL860c i2 server blade contains an on-board SAS RAID controller and a separate PCIe Gen1 x4 path to an adjacent blade enclosure bay for support of partner blade SAS mass storage and tape backup options. A manageability subsystem also resides on the blade which works independently on a single blade basis or as an orchestrated manageability subsystem if multiple blades are conjoined together. As with all c-Class Integrity and HP ProLiant blades, the HP Integrity server blades provide a SUV (serial, USB, and video) port on the front of the blade for service and support.

As shown in Figure 2, each Itanium processor 9300 series module provides three QPI fabric links to support conjoining of blades, using the Integrity Blade Link. This architectural approach enables the future ability to upgrade the BL860c i2 product to a BL870c i2 product, resulting in the scaling up of interconnected resources by 2x. The BL870c i2 product could also be upgraded to a BL890c i2, resulting in a further doubling of resources.

Figure 2: Foundation Blade Architecture Diagram

The BL860c i2 server blade is designed to be socket compatible with the next generation of Itanium processor modules as well.
Table 3: Integrity Server Blades Supported Processors

<table>
<thead>
<tr>
<th>Feature</th>
<th>Intel® Itanium® processor 9300 series</th>
<th>Future Itanium</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cores per processor module</td>
<td>4</td>
<td>Enhanced</td>
</tr>
<tr>
<td>Multi-Threading Support</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Processor module Highest Level Cache Size</td>
<td>Up to 24 MB L3</td>
<td>Enhanced</td>
</tr>
<tr>
<td>DIMMs per processor module</td>
<td>2-12</td>
<td>2-12</td>
</tr>
<tr>
<td>DRAM Technology</td>
<td>DDR3</td>
<td>DDR3</td>
</tr>
</tbody>
</table>

Scalable Blade Architecture—Building larger systems

The Integrity server blade architecture is based on distributed shared memory (DSM) architecture, also known as cache coherent Non-Unified Memory Architecture (ccNUMA). The Integrity server blade architecture utilizes the Intel Quick Path Interconnect (QPI) point-to-point fabric to connect the primary system components. Each node in the DSM architecture has access to shared memory. To maintain coherency between all caches in the system, a cache coherency protocol is implemented over QPI. The cache coherency spans all the distributed caches and memory controllers.

Inter Blade QPI Fabric Communication

Inter Blade communication is achieved through a glueless structure composed of the Integrity Blade Link, HP Manageability architecture and QPI fabric topology.

Integrity Blade Link

For multi-blade products, for example BL870c i2 and BL890c i2, the Integrity Blade Link conjoins or ties together all the associated blades by providing a physical inter-blade path for the QPI fabric. Additionally, the Blade Link provides a path for auxiliary signals. An additional feature of the Blade Link is to provide description information for the manageability architecture, for use in configuration and initialization of the Integrity server blade hardware.

Initially, when the blades are inserted into the enclosure, only the manageability subsystem will be powered on. The attachment of the Integrity Blade Link is required to conjoin the blades into a server, enabling full power-on and boot.

The Blade Link physically attaches to the front of one or more blades and is unique for the BL860c i2, BL870c i2, and BL890c i2. The suffix of the Blade Link indicates the size of Blade Link, for example IBL-2 refers to a Blade Link which will support a conjoined two blade solution.
HP Manageability Architecture

The HP Integrity HP Integrity Integrated Lights-Out (iLO 3) Manageability system is an important aspect of the overall Integrity blades scalable architecture. From a user point of view, the Integrity iLO 3 access point for single and conjoined blades provides a manageability console as well as command and configuration abilities. As the product scales to larger sizes, the Integrity iLO 3’s on each blade scale as well, working together to manage the product, but providing the administrator with a single Integrity iLO 3 server user interface for simplicity. The enclosure Onboard Administrator (OA) behaves in a consistent manner with Integrity server blades and other blade hardware and tools. From an architectural point of view, the HP Manageability architecture is the back bone of the system, giving the ability for each blade to be configured, initialized, and then connected into a scalable set of nodes with distributed shared memory. Every blade ships with an iLO 3 Advanced license factory installed to enable advanced remote management features such as virtual media.

QPI Fabric and System Topology

The HP Integrity server blades are designed to be scalable. The BL890c i2 supports up to 8 processor module sockets, all accessible to each other through the low-latency high bandwidth system QPI fabric. Each of these processor sockets supports the Intel® Itanium® processor 9300 series module.

HP Integrity BL870c i2 Server Blade

Building a scalable system using the Foundation blade architecture shown in Figure 2, two foundation blades conjoined together with a BL870c i2 Blade Link yields the BL870c i2 topology shown in Figure 4. The BL870c i2 is a four process module system with a fully interconnected QPI fabric between all four processor modules.
The HP Integrity architecture can be scaled up to a larger system beyond the BL870c i2 server blade, using the foundation blade architecture shown in Figure 2. Four foundation blades may be gathered or conjoined together using a Blade Link to create the Inter-blade topology structure as shown in Figure 5, resulting in the HP Integrity BL890c i2 architecture.
Memory Architecture

ccNUMA stands for “cache coherent Non Unified Memory Access.”

For ccNUMA systems, CPU memory access time is related to the processor to memory location proximity. For example a given processor module can access its locally attached faster than memory that is attached to another processor. Stated in other words, processor module local memory, also known as SLM (socket local memory) has lower latency than accessing memory connected to another processor module’s memory controllers by sending memory requests through the QPI link across one or two nodes. Referring to Figure 5, a memory reference from one scalable node to an adjacent scalable node requires communication between the two nodes to access the memory at the target. With the Integrity server blades architecture, QPI fabric provides low latency and high bandwidth to facilitate node to node communication.

UMA or “Unified Memory Access” is a memory configuration in which all processor modules have uniform memory access latencies. The memory interleaving terminology for this configuration is ILM (interleaved memory). While it is possible for any processor module to communicate with any other within the server, an ILM configuration interleaves across either the top or bottom half of the cube of Figure 5, resulting in only one node hop for a memory access.

A feature of the Integrity server blades architecture is that the user may specify an optimal memory interleaving scheme that will be best suited to the user’s application and the host operating system. Different Operating Systems may prefer different configurations for better performance. The user can specify a range of options from full SLM to full ILM. The default interleaving setting at EFI is “Mostly NUMA” with 7/8th of the memory configured as SLM and 1/8th as ILM. For further details on the topic of memory configuration and optimization please refer to the “Memory Subsystem Information for HP Integrity Server Blades” white paper.

HP Integrity IO Subsystem

The Integrity server blade I/O subsystem brings a broad range of capabilities to the HP Integrity server product line. As noted earlier in this white paper, the I/O subsystem is supported by a low latency high bandwidth QPI fabric. Within the I/O subsystem, four categories of I/O are provided on a foundation blade:

1. Three general I/O mezzanine card slots
   - PCIe Gen2 x8 for each slot
   - VC Flex-10 capable
2. Four 10 GbE built-in LAN ports
   - Two dual-port NICs, PCIe Gen2 x4
   - VC Flex-10 capable
3. One built-in SAS RAID capable controller
   - Supporting two hot plug SAS drives
   - PCIe Gen2 x1
4. ICH Mezzanine built-in I/O capabilities
   - PCIe link for adjacent enclosure bay partner blade support
   - USB controller
   - VGA controller
   - PCIe Gen1 x4
As the Foundation blade architecture is conjoined to scale up to larger size servers, the I/O subsystem capacity scales linearly. For example the BL870c i2 provides double the capacity of the BL860c i2.

For further details please refer to the “Technologies in the HP Integrity Server Blades” white paper.

**Flex-10 and Virtual Connect**

The Virtual Connect Flex-10 capabilities of HP Integrity server blades set it apart from its competitors. It provides up to four virtual NICs over a 10 GbE LAN server connection, and bandwidth limits can be dynamically configured on each NIC. Virtual Connect Flex-10 can also reduce the number of Ethernet mezzanine cards and blade interconnect modules required within the Blade Enclosure.

Note that it is important to scale up the memory subsystem size as the I/O subsystem is scaled up. Please refer to the “Memory Subsystem Information for HP Integrity Server Blades” white paper for further details.

The Integrity BL890c i2 server blade configuration example, using Virtual Connect Flex-10, allows the system to expand from a physical implementation of 32 physical NIC ports into a maximum of 128 virtual NIC ports.

<table>
<thead>
<tr>
<th>Table 4: Flex-10 LAN Capacity</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Base Flex-10 LAN port Configuration</th>
<th>Maximum Flex-10 LAN port Configuration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical 10 GbE built-in NIC port count</td>
<td>Virtual Connect Flex-10 port count</td>
</tr>
<tr>
<td>BL860c i2</td>
<td>4</td>
</tr>
<tr>
<td>BL870c i2</td>
<td>8</td>
</tr>
<tr>
<td>BL890c i2</td>
<td>16</td>
</tr>
</tbody>
</table>

The maximum Flex-10 configuration, as shown in Table 4, leaves one general I/O mezzanine slot per blade within the server available to support an addition type of I/O interconnect, such as dual port 8 Gb Fibre Channel. A BL890c i2 System configuration example, customized for Storage Area Network (SAN), would support up to 12 2-port 8 Gb Fibre Channel cards, while still having 16 physical 10 GbE NICs that may be expanded to 64 virtual ports.

Other I/O configurations can be implemented to provide the best combination of Fibre Channel, Ethernet and SAS or other types of I/O to meet the user requirements.
Conclusion

HP Integrity server blades provide:

- A broad product offering within the current c-Class c7000 and c3000 enclosures
- Memory, storage, and I/O that scales linearly with compute power
- Improved total cost of ownership by increasing Integrity blade features within the existing c-Class enclosure.
- Consistent management and tools with existing c-Class blades
- Support for Integrity, ProLiant, and StorageWorks storage blades in the same enclosure.

With the rich set of features and choices, enabled for use within both the c7000 and c3000 blade enclosures, HP Integrity server blades provide a balanced, scalable system, for single blade and multi-blade conjoined configurations. The HP Integrity server blade architecture utilizes a low latency high bandwidth QPI fabric to tie together each of the nodes within the server. The architecture also provides a best in class I/O architecture, utilizing Flex-10 and Virtual Connect.