Management architecture of HP BladeSystem c-Class systems

Technology brief, 4th edition

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Introduction

Business pressures are driving IT to greater levels of efficiency and responsiveness. This increases the importance of simplifying management and resource provisioning. Required coordination between servers, network, shared storage, and facilities administrators can turn a simple process into a long ordeal. The HP BladeSystem environment eliminates or streamlines coordination challenges.

The HP c-Class system provides simple control interfaces and management software that let you manage the complete solution as one system. This paper describes management technologies for HP BladeSystem and integration of those technologies.

Enclosure models

HP offers two versatile c-Class enclosure models: the HP BladeSystem c7000 and the HP BladeSystem c3000. The c7000 (Figures 1 and 2) has sixteen device bays and eight interconnect module bays in a 10U rack-mount configuration. The c3000 has eight device bays and four interconnect module bays in a 6U rack-mount. Both enclosure models include the HP Onboard Administrator (OA) and Insight Display diagnostic LCD panel. Both also use the same hardware, software, and processes for management.

Figure 1. Front view of an HP BladeSystem c7000 enclosure
Enclosure-level management

HP BladeSystem enclosures support BladeSystem c-Class server blades, storage blades, and interconnect modules. The enclosure supports multiple tools to provide hardware management for remote administration, local diagnostics, and troubleshooting:

- **HP Onboard Administrator** delivers enclosure management functions like configuring power and cooling. It also discovers, identifies, and facilitates component management in the enclosure.

- **HP Integrated Lights-Out (iLO)** management processors embedded on c-Class system boards communicate with the OA to enable component management.

- **Virtual Connect** interconnect modules allow “wire once” network connection management. Virtual Connect modules plug into the interconnect bays and virtualize connections between BladeSystem servers and data center LANs and SANs. This lets you pool and share Ethernet and Fibre Channel connections within the enclosure. It also makes server swaps transparent to external networks.

- **HP Virtual Connect Enterprise Manager (VCEM)** provides a central console for managing network connections and adjusting workloads for hundreds of Virtual Connect domains.

- **HP Systems Insight Manager (HP SIM)** provides enhanced functionality and control for HP BladeSystem c-Class, including rack and enclosure visualization of blade resources and access to Onboard Administrator and iLO consoles.
HP Onboard Administrator

The OA module performs four management functions for the entire enclosure:

- Detecting component insertion and removal
- Identifying components and required connectivity
- Managing power and cooling
- Controlling components

The OA provides both i2C and Ethernet management networks to manage enclosure bays. iLO processors embedded in c-Class system boards manage each device, interconnect fan, and power supply. You can directly access each iLO processor through the OA Ethernet management network. Interconnect modules can also contain an interconnect processor that uses the management Ethernet connection to the OA. The signal midplane completely isolates management signals from the high-speed server-to-interconnect signals.

You can access the OA in the following ways:

- An Insight Display screen on each HP BladeSystem c-Class Enclosure provides access for quick setup and daily maintenance.
- A web GUI uses event-driven, push technology. If an event occurs, the OA immediately pushes its status to the web GUI.
- A Command Line Interface (CLI) provides command line and scripting interfaces.

An optional Enclosure KVM provides CLI, Insight Display, and KVM console connections to the OA. These connections let you control server power and connectivity to the enclosure DVD. They also give you access to server-embedded health status. An optional second OA module in either c-Class enclosure model can act as a redundant controller in active-standby mode. Redundant modules provide complete fault tolerance. The redundancy logic monitors a continuous heartbeat between the two modules over a dedicated serial connection. If the period between heartbeats exceeds a timeout, the standby module automatically takes control of the enclosure and becomes the active OA.

The OA lets you locally and remotely manage HP BladeSystem c-Class using the enclosure’s HP Insight Display. The OA provides the following management functions:

- Wizards for setup and configuration
- Secure access to the HP BladeSystem infrastructure
- Security roles for server, network, and storage administrators
- Automated power and cooling of the HP BladeSystem infrastructure
- Agent-less device health and status

To identify a component in a BladeSystem c-Class enclosure, the OA reads an EEPROM containing the component’s factory information (product name, part number, and serial number). The EEPROM runs on auxiliary power so the OA can identify the component before granting power requests.

Accessing the OA web interface requires the OA IP address and a compatible web browser. You can access the application only through HTTPS.

The OA allows access to Enclosure Dynamic Power Capping. You can use Enclosure Dynamic Power Capping to maintain an enclosure’s power consumption at or below a preset cap value by actively monitoring and adjusting server blade power consumption. This feature automatically changes server blade performance to keep enclosure power levels below the power cap.
iLO
An iLO management processor embedded on c-Class system boards communicates with the OA for component management. iLO lets you manage servers remotely, with access to a remote console, virtual media access, and a virtual power button. iLO provides a high-performance remote console (virtual KVM) and the virtual media functionality from a web browser, command line, or script. iLO uses auxiliary power and operates independently of the host processor and the OS.

iLO performs typical out-of-band management functions on c-Class server blades. It monitors a “sea of sensors” on each server blade to control enclosure fans and provide optimal cooling for each server. iLO passes sensor data to the OA. The OA uses the data to manage the system’s power use. iLO also gives you system management information such as hardware health, event logs, and power management with HP ProLiant Power Regulator. Power Regulator is an OS-independent power management feature that provides iLO-controlled speed stepping for x86 processors. This lets you control processor power use without significantly affecting server performance.

Insight Display
The Insight Display (Figure 3) is an enclosure-mounted information exchange device with access to all OA setup, management, and troubleshooting features. It provides a quick method for initially configuring the enclosure and information about enclosure health and operation.

Figure 3. BladeSystem c-Class Insight Display location and Main Menu

Configuration logic
To assist in configuration and setup, OA verifies the following attributes for each server blade and interconnect module installed in the enclosure:

- I/O configuration—OA automatically queries all FRU data for each server. OA verifies that the mezzanine card locations and I/O fabrics match the installed interconnect modules. If they do not match, OA issues a warning on the Insight Display and suggests corrective action.
- Enclosure configuration—OA makes sure that server blades, storage blades, Active Cool fans, and power supplies are in the correct enclosure locations to get proper cooling and to support the selected power configuration. For example, if you install only two server blades in the c7000 enclosure, OA ensures the blades are in bays 1, 2, 9, or 10. Fans must reside in bays 4, 5, 9, and 10.
- Available power—OA ensures sufficient power is available to power up a server blade or interconnect module.
• Cooling capacity—OA adjusts fan speed to ensure sufficient cooling for the server blade or interconnect module.
• Device—OA indicates device failure or degraded health. Typically, the corrective action is to replace a failed device.

OA configuration logic first powers up the interconnect modules. OA does not power up a server blade until it verifies the configuration. If there is a configuration issue, the Insight Display shows you the issue and possible remedies.

**Enclosure bay IP addressing**

OA gives you a single location where you can assign IP addresses to iLO and interconnect-module management ports. By default, OA, iLO, and interconnect management processors get an IP address using Dynamic Host Configuration Protocol (DHCP) on the external management network. If your environment uses static IP addressing, OA offers Enclosure Bay IP Addressing (EBIPA) as an alternative to manual configuration.

OA can manage IP address settings using EBIPA. You can input a range of IP addresses into the OA by using the autofill feature (Figure 4). For example, if you input the address of bay 1 as 10.128.1.30, autofill creates consecutively numbered IP addresses for bays 2 through 16. You can assign IP addresses to unpopulated bays. A server or interconnect module inserted into an EBIPA-enabled bay receives the pre-set IP address for that bay and the Shared Device Settings.

The First Time Setup Wizard also displays EBIPA settings. The Wizard provides the same functionality, but it allows the address range to span multiple enclosures.

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**Figure 4. Onboard Administrator web GUI – Device Bay EBIPA settings**

Addresses created by autofill capability
**OA GUI**

The GUI lets you perform remote administration from a desktop web browser. It simplifies tasks such as managing users and network settings, controlling boot order, and attaching enclosure DVDs to one or more blades. The GUI also makes it easy to perform identical operations on multiple server blades. The GUI displays graphical views for server-to-interconnect port mapping, zone cooling measurements, and power use history. A graphical view of the enclosures shows the status for each device, so you can see if any devices in the enclosure need attention. If you use enclosure links to connect multiple enclosures in a rack, you can view and control the enclosures from a single GUI. In Figure 5, all enclosure device bays show acceptable status.

**Figure 5.** Onboard Administrator GUI – Device Bay Summary showing the status for each device

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**OA CLI**

The OA CLI lets you use serial, telnet, or SSH connections to control enclosure and device operation. You can use scripts for automation. CLI includes commands for connecting to iLO on each server blade and to interconnect module management processors such as Virtual Connect. The CLI supports role-based user accounts, provides for auto login to iLO devices, and offers a utility for using existing XML scripts to configure or update iLO.
Enclosure DVD
The enclosure DVD feature lets OA provide USB optical drive connectivity to one or more servers in an enclosure. Plugging a USB key into OA lets you connect ISO files to one or more servers, update the OA firmware from a file, and save or restore the enclosure configuration from a file on the USB key. The enclosure DVD feature simplifies the firmware update of all servers or OA modules. It also simplifies initial enclosure setup from a custom configuration file.

Enclosure KVM
The enclosure KVM gives you an easy way to connect a standard VGA monitor, keyboard, and mouse to the enclosure. You can perform several functions using the KVM module:

- Control server power
- Connect to the enclosure DVD for software installation or firmware upgrades
- Connect to the OA CLI for full control of the enclosure
- Diagnose problems using an on-screen version of the Insight Display

The KVM user interface lets you use keyboard cursor keys to select a server console, to power the server on and off, and to connect to the enclosure optical drive.

Firmware updates
The OA manages firmware updates for enclosure management devices. You can update server blade firmware using HP System Update Manager with the HP Smart Update Firmware DVD. You can connect these utilities to all server blades in an enclosure using the OA enclosure DVD feature. OA scans any detected external USB optical drive. You can then connect the drive to multiple server blades simultaneously using the OA GUI, CLI, or Insight Display. HP also offers firmware release sets that combine firmware updates so you can apply all required updates at once.

HP Utility Ready Computing Service
The HP Utility Ready Computing Service gives you an alternative to purchasing BladeSystem equipment. It lets you pay for using server compute cycles through a monthly “pay-for-use” invoice. You can increase and decrease your use of server blades as your computing load changes and pay for only what you need. This avoids the risk of deploying and maintaining too much or too little server equipment to meet your needs.

Utility Ready Computing Service in a BladeSystem enclosure works like this: OA gathers usage data about the individual servers, combines it for all devices, and periodically communicates it across a secure channel to HP. OA sends the serial number, product name, and power-on hours to HP. Based on that usage data, plus pricing specified in a Utility Ready Computing Service contract, HP determines the monthly charge for hardware usage.

Provisioning and managing network and storage connections
HP Virtual Connect (VC) is an interconnect technology that simplifies blade server connectivity to production LANs and SANs. It cuts costs by reducing your hardware needs. HP offers VC as an alternative to traditional pass-thru and network switch options. VC virtualizes I/O connections with an abstraction layer between the servers and their external networks. The LANs and SANs see the network interface (NIC) or host bus adapter (HBA) addresses that the VC modules present (Figure 6).
Figure 6. Virtual Connect simplifies connectivity to LANs and SANs

VC saves you time and costs to configure and administer BladeSystem infrastructures:

- Lets you wire LAN/SAN connections once
- Reduces physical server-to-network cabling and requires fewer leased network ports
- Lets you pre-provision network assignments, even to empty server bays for rapid server deployment and fewer configuration errors
- Maintains established organization roles and procedures
- Separates server and network administration so server administrators can quickly add, replace, or recover servers without affecting network configurations and availability

During VC installation, LAN and SAN administrators define the server networks, subnets, and storage LUNs. Once implemented, VC lets you add, replace, and modify servers in minutes without affecting LAN and SAN availability or involving network administration staff.

Each VC module densely aggregates ports. That turns multiple physical network connections to each server into a few simple high-speed uplinks, which cuts infrastructure complexity and costs. VC uses connection profiles with dynamic pools of unique MAC addresses and World Wide Names (WWN) to establish server connections to LANs and SANs. The server connection profiles contain MAC, WWN, and boot-from-SAN definitions assigned to BladeSystem enclosure bays, not to individual servers. The physical server in each bay uses the MAC and WWN assignments in the bay profile. That means if you replace a server, the MAC and WWN assignments for the enclosure bay remain constant, and the change is invisible to the network.

HP BladeSystem enclosures configured with VC Ethernet and Fiber Channel modules are known as Virtual Connect domains. A VC domain can be a single enclosure with up to 16 servers, or up to 4 linked physical enclosures with up to 64 servers, managed as a single logical entity.

You can use HP VC Ethernet and Fibre Channel modules independently or as redundant pairs to increase the number of available uplinks and network connections. You can also stack VC Ethernet
modules for this purpose. VC provides high-speed connectivity for all servers in the blade enclosure with just a few high-speed uplinks.

HP provides options for configuring and managing VC domains in both small and large IT environments. Virtual Connect Enterprise Manager (VCEM) is ideal for environments with more than one rack of enclosures. It lets you manage VC across the data center. VCEM gives you centralized management for hundreds of Virtual Connect domains and thousands of BladeSystem c-Class servers.

Virtual Connect Manager (VCM) is ideal for environments with up to four enclosures. It lets you manage single VC domains from a simple web console. The firmware of VC Ethernet modules contains the web console. You can also access the VCM through OA.

Managing multiple network connections with Virtual Connect Flex-10

Virtual Connect Flex-10 technology lets you partition a single 10 Gb Ethernet port into four server NIC connections called FlexNICs (Figure 7). The Virtual Connect FlexFabric module and FlexFabric adapters expand Flex-10 capabilities to provide up to one HBA function per 10 Gb network port. HP calls that function FlexHBA. Using the Virtual Connect Manager, you can prioritize and allocate bandwidth for each FlexNIC or FlexHBA function, up to the total bandwidth of 10 Gb/s. A BladeSystem c-Class server with a dual-port Flex-10 or FlexFabric device can support eight individual network connections and 20 Gb of bandwidth. A BladeSystem c-Class server with Flex-10 modules and adapters can support up to 24 FlexNIC connections. With the Virtual Connect FlexFabric module and FlexFabric adapters, one port can become a FlexHBA adapter, for a total of 18 FlexNICs and 6 FlexHBAs per server.

Flex-10 hardware consists of a Virtual Connect Flex-10 interconnect module and either a 10 Gb Flex-10 LAN-on-motherboard (LOM) device or a Flex-10 mezzanine card. Each Flex-10 LOM or mezzanine card contains two physical network ports that connect to internal ports on the Flex-10 Ethernet modules.

Figure 7. Four FlexNICs share a 10 Gb/s physical link

Each FlexNIC appears to the server OS as a discrete NIC with its own driver. The FlexNICs share the same physical port, but traffic flow for each FlexNIC is isolated with its own MAC address and virtual local area network (VLAN) tags. The Virtual Connect Flex-10 Ethernet Module recognizes Flex-10...
connections from the server as part of a VC profile. Flex-10 offers network scalability with configuration flexibility and dynamic bandwidth allocations for each FlexNIC.

HP enhanced Virtual Connect Flex-10 technology to include FlexFabric adapters and interconnect modules. These modules eliminate up to 95% of network sprawl at the server edge. One device converges traffic inside enclosures and directly connects to LANs and SANs. HP FlexFabric adapters replace separate Flex-10 NICs and legacy Fibre Channel or iSCSI HBAs with a dual-port adapter that converges both Ethernet and storage traffic. You can partition the 10 Gb bandwidth into multiple bandwidths and preserve routing information for all data classes.

FlexFabric modules split the converged stream at external uplink connections to native Ethernet LANs and Fibre Channel SANs or SCSI storage. VC FlexFabric modules eliminate the need for multiple Ethernet and Fibre Channel switches, extension modules, and cables within the BladeSystem enclosure.

You can manage FlexFabric modules the same way as Flex-10 modules, with Virtual Connect Manager or VCEM. The wire-once connection management is built-in so you can add, move, and replace servers in minutes instead of in days or weeks.

Managing single Virtual Connect domains

HP Virtual Connect Manager has a web console built into the firmware of Virtual Connect Ethernet modules. You can use it to set up and manage individual VC domains in small environments. A VC domain can include a single enclosure or up to four physically linked enclosures in the same rack. In a multi-enclosure domain, Virtual Connect Manager can move server profiles between all physically linked enclosures in the domain.

Managing network connections across the data center

HP Virtual Connect Enterprise Manager (VCEM) centralizes network connection and workload management for hundreds of Virtual Connect domains and thousands of BladeSystem servers. You can use the VCEM software to complete core data center tasks more quickly without affecting the configuration and availability of production LANs and SANs:

- Deploy network server connections
- Perform cost-effective physical server recovery
- Complete planned system maintenance with minimal downtime
- Migrate and repurpose blade servers to meet changing workload and application priorities

VCEM provides an intuitive console incorporating four main functionality groupings (Figure 8). VCEM v1.40 and higher uses a central repository to administer and control 256K MAC addresses and World Wide Names. VCEM uses master configuration profiles for group-based configuration management of VC domains. Multi-enclosure domains can include up to 1,000 enclosures and 16,000 server blades when used with Virtual Connect. VCEM domain management increases infrastructure consistency and simplifies new enclosure deployment. It lets you make configuration changes once and then push them to multiple VC domains. You can also use VCEM group management to execute the movement and failover of server connections and their workloads for up to 250 VC domains across the data center.
VCEM works with VC hardware and OA to create new VC domains and to discover and import existing domains. You can import existing VC domains that retain their MAC and WWN assignments without downtime. You can install the VCEM console on system hosts running Microsoft® Windows® Server 2003 or 2008.

VCEM lets you move VC server profiles and their workloads between VC domains that are part of the same VC domain group. VC domains can include servers in an adjacent enclosure, a rack across the data center, or a remote location. When you move a profile, the LAN/SAN connections plus any boot-from-SAN credentials move with the profile to the target server. You can move server profiles manually through the VCEM user interface or scripted through a command line. VCEM profile failover can automatically move server connections and workloads to pre-defined spare servers.
Figure 9 illustrates moving a VC server connection profile from Server A to Server C. The LANs associated with each uplink port and the contents of the VC server profile remain the same. Only the location of the profile changes. The serial number, UUID, MAC address, WWN, boot-from-SAN parameters, and related workload always move with the profile.

Figure 9. Using VCEM profile options to move a profile from Server A (top drawing) to Server C (bottom drawing)
Infrastructure management and control

HP SIM gives you unified infrastructure management and control of your server and storage resources. It lets you centrally manage an entire environment of tens or hundreds of HP BladeSystem enclosures.

HP SIM supports multiple operating systems on a variety of platforms. It provides the basic management features of system discovery and identification, single-event view, inventory data collection, and reporting. Through a single view, HP SIM provides enhanced functionality and control for HP BladeSystem c-Class enclosures, including automatically generated rack and enclosure visualization of blade resources and access to OA and iLO consoles. It automatically draws views of blade rack topology and lets you quickly navigate your entire blade environment. You can do management tasks for individual units or groups of servers and storage resources.

Centralized management software for HP BladeSystem

You can extend HP SIM for HP BladeSystem with HP Insight Control and HP Insight Dynamics. HP Insight Control for BladeSystem deploys, migrates, monitors, configures, and controls HP BladeSystem servers. HP Insight Control for Linux discovers, images, deploys, monitors, and manages Linux-based platforms from a Linux-hosted central management server (CMS). HP Insight Dynamics adds powerful infrastructure service-level management, orchestration, and recovery functionality to BladeSystem c-Class enclosure environments.

HP Insight Control for BladeSystem

HP Insight Control software controls BladeSystem servers that run Microsoft Windows operating systems. It uses HP SIM as a central management console and one installer to deploy, migrate, monitor, configure, and control physical and virtual BladeSystem servers. HP Insight Control can integrate into Microsoft System Center and VMware vCenter Server for IT environments that have these management platforms.

HP delivers Insight Control on DVD with HP BladeSystem c-Class enclosures. You can install HP Insight Control on a Windows CMS. It manages servers running Windows, Microsoft Hyper-V, Linux distributions, VMware ESX, and Citrix XenServer. Insight Control for Linux has similar functionality in environments that primarily manage Linux servers and run the CMS on a Linux server.

You can purchase Insight Control as a stand-alone software license or bundled with HP ProLiant servers and BladeSystem enclosures.

HP Insight Control for Linux

This software lets you manage business-critical BladeSystem servers running Linux in both enterprise and scale-out environments. Insight Control for Linux integrates the best open source and HP technologies on HP SIM (running on Linux). You can use Insight Control for Linux for discovery, imaging and provisioning, rapid deployment, health and performance management, remote management, virtualization, and power management. Multisystem scaling, thermal and power management, and direct-to-the-hardware control complement lifecycle management.

HP Insight Control for Linux does not include a Linux distribution. You can choose from HP-supported RHEL or SLES distributions or select community-supported distributions.

Advanced infrastructure management

HP Insight Dynamics software helps you quickly adjust your infrastructure to business demands. It lets you move workloads from virtualized and non-virtualized environments across data centers. It integrates with VMware vCenter and Microsoft System Center to allow changes in converged infrastructures.
**Infrastructure orchestration and automated infrastructure provisioning**

HP Insight Dynamics automates provisioning of virtual and physical servers, associated storage, and networking connections. It lets you get a complex application infrastructure, such as a multi-tier enterprise application infrastructure, up and running in minutes, rather than weeks or months. Insight Dynamics infrastructure orchestration lets you design best-practice infrastructure templates. You can provision your infrastructure through a self-service portal for seamless integration with existing systems, management tools, and IT processes. Infrastructure orchestration includes an embedded workflow automation tool. Customizable workflows let you integrate existing IT processes for approvals, OS deployment, and storage provisioning.

**Infrastructure optimization through capacity planning**

HP Insight Dynamics captures key data points such as power, processor, memory, disk, and network utilization every 5 minutes. It collects the data from all discovered, managed nodes running HP Insight Dynamics and from nodes running HP Insight Capacity Advisor Consolidation software. It uses the data to generate consolidation scenarios. You can reduce weeks of tedious planning and implementation by combining this functionality with built-in rebalancing tools.

HP Insight Dynamics has a capacity-planning tool that gives you both real-time and historical system utilization and power. This is the industry’s first lightweight, integrated tool for ongoing capacity planning through workload simulation. It captures real-world server utilization data to pre-test different scenarios before making changes to critical applications.

The capacity planning software collects and analyzes more than 1,000 data-points per server per day from both virtual and physical resources to record server resource utilization. This data lets you easily detect systems that are over- or under-utilized. Then you can use HP Insight Dynamics to rebalance and consolidate server workloads to increase utilization, reduce power consumption, improve application performance, and meet other objectives.

**Protect continuity of services**

Insight Dynamics gives you advanced visualization for real-time planning and fast, easy movement of resources. You can quickly move server profiles to maintain availability, and you can activate stored templates for restarting applications to maintain the level of service quality.

You can shorten maintenance windows by using server profiles to create and move workloads. Insight Dynamics recovery management lets you move workloads to other servers or sites with a mouse click. This improves recovery time up to 80%. Insight Dynamics fails over workloads in as little as 5 minutes across physical and virtual servers.

These are core capabilities of Insight Dynamics recovery management:

- Failover and recovery for both physical and virtual environments
- Integration with VMware vSphere and Microsoft Hyper-V virtualization environments
- Integration with HP EVA and XP storage data replication solutions, which provides recovery for environments from metropolitan to continental distances
- User interface for creating and testing failover and recovery scenarios

Figure 10 shows the main hardware and software components of an Insight Dynamics Recovery solution. A Central Management Server at both primary and recovery sites hosts HP SIM and the Insight Dynamics software. The Insight Dynamics Recovery software runs on the CMS.
Figure 10. Insight Dynamics failover from the primary site to the recovery site

HP BladeSystem Matrix

HP BladeSystem Matrix is an example of HP’s Converged Infrastructure approach. BladeSystem Matrix provides converged pools of compute, network, and storage resources. It also provides the complete infrastructure management and orchestration capabilities to manage physical and virtual configuration, hardware and software policies, capacity optimization, and provisioning of IT services.
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