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# Oracle Enterprise Manager Ops Center: Datacenter Lifecycle Management

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## Introduction

Serving as a single platform for managing heterogeneity and complexity, Oracle Enterprise Manager Ops Center can be used to manage multiple server architectures and myriad operating systems (OSs). It manages these OSs when running on bare-metal hardware or in virtualized environments. It even manages virtualization itself by managing Sun chip multithreading servers from Oracle using Oracle VM Server for SPARC and Oracle Solaris Containers running on any Oracle Solaris instance, on any architecture server. Oracle Enterprise Manager Ops Center is an open, extensible system that can be integrated to drive, or be driven by, existing datacenter management tools.

In contrast to tools that automate within a small domain, Oracle Enterprise Manager Ops Center manages across the entire hardware and software stack and throughout the system lifecycle—from the moment power is applied to servers to the time when they're retired. The massively scalable Oracle Enterprise Manager Ops Center supports heterogeneous environments, automates workflow, works with virtualized and nonvirtualized systems, and enforces compliance—via policy-based management. And it does all of this through a single intuitive interface. This white paper provides an overview of Oracle Enterprise Manager Ops Center's features and architecture and demonstrates how it can be put to use in the datacenter.

## The Changing Nature of Datacenters

Today's increasingly heterogeneous, diverse, and complex datacenters use a variety of OSs, including Oracle Solaris, Linux, and Microsoft Windows, and a number of server architectures, including those based on x86 and SPARC processors. Running virtualized and nonvirtualized environments, these datacenters typically employ a variety of tools to manage their operations. The problem is that management tools tend to be niche products and limited in scope, designed as they are to solve just one piece of a much-larger challenge. The following are just some of the issues that arise from this scenario:

- Different tools must be used to manage various architectures.
- Management tools for one OS don't necessarily work with other OSs, making management difficult and requiring training for each system.
- Some tools manage physical servers, and some manage virtualized environments—but management tools for virtualized environments don't understand the underlying hardware, and server management tools don't understand the hypervisor, OS, or guest OSs that lie above.
- Different tools exist for various parts of the server lifecycle, but none encompasses the entire range from hardware discovery to OS patching.
- It's next to impossible to implement and ensure regulatory and best practice compliance—increasingly important for both regulatory and security reasons—using a collection of separate niche tools from a variety of vendors.
- To avoid these problems and stay ahead of the competition, today's datacenters need to be dynamic, swiftly aligning their services with the enterprise's overall business objectives. In an environment of resource scarcity, that means powering servers on and off and reorganizing the relationship of virtual to physical machines to make the most of limited power and cooling resources.
- Oracle Enterprise Manager Ops Center helps IT organizations achieve these goals by enabling them to create dynamic, virtualized datacenters where resources are grouped into pools, and virtual machines (VMs) are allocated to servers in those pools depending on current workload characteristics.
- Encounter an unexpected workload spike or enter into an expected period of higher workload intensity, and Oracle Enterprise Manager Ops Center can recruit new servers into a resource pool by powering them on; provisioning the entire firmware, guest OS, and application stack; and putting them to work to help meet required service levels. With just a few mouse clicks or on an automated schedule, Oracle Enterprise Manager Ops Center can reallocate virtual servers to physical ones, helping to even out workload spikes and make the most of capital investments.

### Introducing Oracle Enterprise Manager Ops Center

Oracle Enterprise Manager Ops Center cuts through the complexity of today's datacenters with “single pane of glass” management. It is a single, comprehensive, end-to-end system management tool that integrates physical and virtual management across the hardware and software stack and the entire

system lifecycle (see Figure 1). It supports both the heterogeneous and virtualized nature of today's datacenters, as well as the traditional model of one OS and application per server. Further, it's able to navigate the complex networks often found in application silos, helping solve the immediate problems of many datacenters.

Oracle Enterprise Manager Ops Center supports a fully virtualized environment with awareness of the entire stack up to the application, including hardware, firmware, hypervisor, VMs, multiple guest OSs, and applications. It not only provisions and updates these environments, but it also manages and monitors them, automatically reassigning VMs to servers to balance the workload across an entire pool of servers.

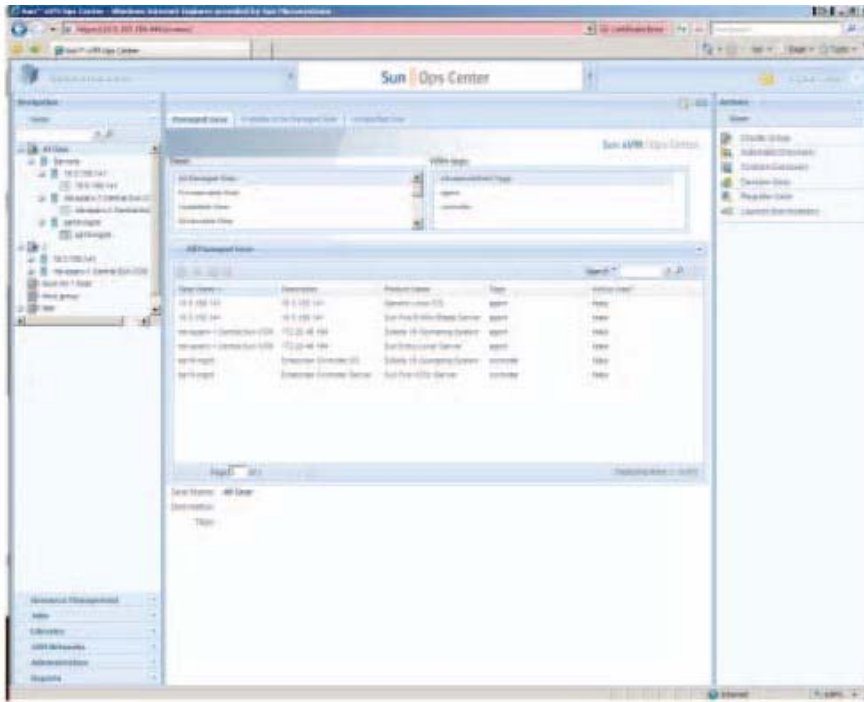


Figure 1. The Oracle Enterprise Manager Ops Center's graphical user interface presents the hardware inventory at left, lifecycle management at the lower left, contextual information in the center pane, and available actions on the right.

Oracle Enterprise Manager Ops Center is an open, extensible tool that can be integrated to work with existing third-party tools and invoked to perform tasks at the direction of enterprise management and orchestration tools. Likewise, it can be adapted to invoke third-party tools to accomplish activities that are part of the Oracle Enterprise Manager Ops Center workflow.

Oracle Enterprise Manager Ops Center provides a rich set of features through an intuitive Java-based graphical user interface (GUI) that includes

- **End-to-end systems management of both physical and virtual environments.** Oracle Enterprise Manager Ops Center manages a heterogeneous set of systems (from bare metal through OS), while also managing a server throughout its lifecycle—from the first time power is applied to the server's retirement.

- **Datacenter automation that increases productivity by allowing administrators to work on a massive scale.** Tasks that once had to be performed on a server-by-server or an OS-by-OS basis can now be performed across pools of resources. This not only increases productivity, but it also helps keep environments up to date, including the software and firmware patches that allow datacenters to operate securely.
- **Security and compliance features that help create and enforce policies across the datacenter.** These include reporting capabilities to document, track, and audit compliance measures.

## Underlying Design Philosophy

Designed to eliminate complexity in the datacenter and provide a single management interface, Oracle Enterprise Manager Ops Center reflects a deep understanding of both server technology and virtualization software, and the all-important relationship between the two. Without such a comprehensive management solution, it's all too easy to cause system failures and application downtime by installing system firmware, BIOS, or system controller settings that are incompatible with the OS or virtualization layers above them. Oracle Enterprise Manger Ops Center eliminates this problem by automating the management of every layer down to the bare metal. As a result, there's far less chance of error when managing firmware is a manual process, but managing the virtualization and OS layers is automatic.

## Taking a Lesson from High-Performance Computing

Although the specialized needs of complex high-performance computing (HPC) applications, such as those for scientific research, manufacturing, electronic design, and financial services, might seem to have little to do with the day-to-day operations of an enterprise datacenter, many of the trends embraced by these applications are now finding their way into datacenters. HPC design imperatives that also inform the design of Oracle Enterprise Manager Ops Center include the following:

- **Rack-at-a-time deployment.** Large HPC grids refresh their servers on a regular rotating schedule, bringing new racks of servers into the grid and retiring old ones on a monthly or quarterly basis. Today, many enterprise datacenters are also deploying servers on a rack-at-a-time basis. This model not only helps datacenters support rapid application growth, but it's also ideal for organizations with highly cyclical workloads.
- **Work at scale.** When tools work at scale, it's as easy to provision and manage 10, 100, or 1,000 servers as it is to handle a single one. This lesson from the HPC world is becoming increasingly relevant in enterprise datacenters deploying racks or pods of systems at once.
- **Hardware recognition.** When racks, pods, or containers full of servers are deployed at one time, it's important for tools to understand the server hardware. Effective tools perform bare-metal discovery and integrate new equipment into datacenter infrastructure in less time and without introducing the chance for human error. The result is that new resources can be put to work just hours—not days or weeks—after they arrive on the loading dock.

- **Heterogeneous environments.** With a constant flow of new equipment being introduced into both HPC grids and enterprise datacenters, heterogeneity is the norm. Management tools must be able to handle the latest innovations as well as equipment that's been on the datacenter floor for years.
- **Holistic approach.** On HPC grids, application instances must be assigned to servers based on an intimate knowledge of that server's connectivity to storage and adjacent servers with which it must share information. In today's enterprise datacenters, it's equally important for any management system to have a holistic view of server, network, and storage resources.

## The Importance of Workflow

Whether the environment is an HPC grid refreshing several racks of servers or an enterprise datacenter populated with hundreds of servers, workflow automation is what makes it possible to put new resources to work in minimal time,—with little to no chance of error. Workflow means the difference between an agile datacenter that can quickly adapt to changing workloads and business conditions, and a datacenter surpassed by its competition.

Good workflow support means discovering bare-metal hardware, virtualization software, VMs, and the OS instances that run on them. Once those resources have been discovered, they need to be incorporated under a management umbrella that orchestrates the provisioning of each layer without the risk of introducing inconsistencies. The management system must be able to provision firmware, virtualization software, and OSs, and quickly replicate “golden master” configurations that incorporate compliant, pretested stacks from the firmware up through preconfigured guest OS images. Ongoing support means updating and patching every software layer, and patching OSs whether they're running on bare-metal servers, Oracle Solaris Containers, Oracle VM Server for SPARC, or within VMs.

The table illustrates the estimated time saved when using Oracle Enterprise Manager Ops Center to perform a range of day-to-day activities in an enterprise datacenter. Reducing the time required to manage server infrastructure increases usage and puts capital investments to work more rapidly. Likewise, reducing the number of tedious administrative tasks means freeing administrators to focus on business-critical issues while increasing compliance and reducing the chance of human error.

**WORKFLOW IMPROVEMENTS WITH ORACLE ENTERPRISE MANAGER OPS CENTER**

<b>ACTIVITY</b>	<b>WITHOUT ORACLE ENTERPRISE MANAGER OPS CENTER</b>	<b>WITH ORACLE ENTERPRISE MANAGER OPS CENTER</b>
Identify 100 new assets on the network.	Days	Minutes
Compare inventory for 100 systems against a baseline.	Hours	Minutes
Obtain patches and validate package installation.	Days	Less than 6 hours
Identify patches required for more than 100 servers and the impact they have on the running system.	Hours	15 minutes
Deploy a new OS onto a set of powered-off, bare-metal servers.	Days	Hours
Apply a security fix to 100 servers.	1 day	20 minutes
Identify, validate, and deploy lights-out management firmware on 100 servers.	Days	Hours

## Architecture Overview

Oracle Enterprise Manager Ops Center is built using a scalable, distributed, and secure architecture. The three-tier architecture uses a centralized controller along with distributed proxies that keep data local and secure. This architecture improves performance by minimizing the amount of data that must be transmitted between the proxy controllers and the enterprise controller features in Oracle Enterprise Manager Ops Center. This architecture allows Oracle Enterprise Manager Ops Center to work within complex network and firewall configurations as well as application silos that might be distributed around the world.

### Deployment Architecture

Figure 2 illustrates an Oracle Enterprise Manager Ops Center deployment architecture. The enterprise controller is a centralized system that presents a GUI to a Java-enabled Web browser. The enterprise controller accesses virtual appliances, software updates, and a knowledgebase, some of which Oracle provides and some of which the customer maintains. The enterprise controller can manage servers directly or indirectly through proxy controllers. It provides an operational API that facilitates integration with third-party management tools and a driver API that allows it to control the operation of third-party management tools—in this example, a patching tool for Windows environments. The controller can be set up in a high-availability configuration.

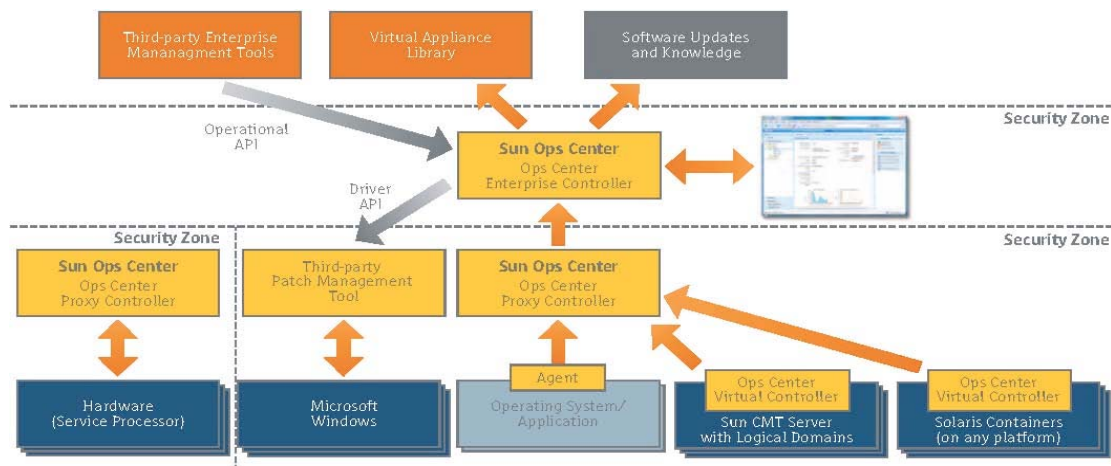


Figure 2. The Oracle Enterprise Manager Ops Center architecture supports scalability, security, and geographic distribution.

### Oracle Enterprise Manager Ops Center Proxy Controllers

The enterprise controller communicates with a proxy controller within each of an organization's security domains. The proxy controller monitors and manages systems within its domain, communicating status back to the enterprise controller.

The use of a proxy controller supports massive scalability because data is accumulated locally, and only a small amount of information needs to pass from the proxy to the enterprise controller. This allows a large number of proxy controllers—and an even-larger number of systems—to be managed by the central enterprise controller. Because communication requirements are minimized, proxy controllers and thus security domains can be distributed worldwide and effectively controlled by the central enterprise controller.

In addition to supporting scalability, the proxy controller architecture also contributes to security: each security domain managed by a proxy controller is isolated, and it can be either more or less secure than the security domain hosting the enterprise controller.

### Oracle Enterprise Manager Ops Center Virtual Controller

The virtual controller within Oracle Enterprise Manager Ops Center resides on servers running virtualization software—including Oracle VM Server for SPARC—and Oracle Solaris Containers. The virtual controller manages all aspects of the virtualization component, allowing virtualized environments to be managed by the enterprise controller.

### Operating System Agent

An optional OS agent can be installed onto individual OSs to provide more-complete status information back to the enterprise controller. The agent also facilitates patch management and compliance monitoring. Although individual OSs can be managed and monitored directly by the proxy controller, more functions are enabled with the OS agent.

### Integration Application-Programming Interface

The integration API includes an operational API that allows other tools to drive Oracle Enterprise Manager Ops Center's actions and a driver API that allows Oracle Enterprise Manager Ops Center to drive other third-party tools.

The operational API makes it possible to access every function available through Oracle Enterprise Manager Ops Center's GUI using a programmable interface as well. This eases the integration of Oracle Enterprise Manager Ops Center with third-party tools, including those for enterprise management tools, while facilitating the use of traditional user scripting languages. The operational API provides access through a Java Management Extensions API and through the WS-Management protocol.

The operational API could be used in the following situation: If a datacenter already uses a workflow orchestration tool, ad hoc integration can be accomplished through the operational API to invoke Oracle Enterprise Manager Ops Center for performing specific tasks, for example, patch management. Scripting can also be performed through a command-line interface.

The driver API can drive third-party tools to perform specific tasks as part of a workflow defined in Oracle Enterprise Manager Ops Center. As Figure 3 illustrates, the driver API might be used to drive a patch management tool or generate a patch-compliance report for Windows OSs. This extensibility allows Oracle Enterprise Manager Ops Center to incorporate an even greater range of capabilities within the same single-pane-of-glass management tool.

### Functional Architecture

The combination of the enterprise controller, proxy controller, virtual controller, and OS agent provides layer-by-layer, end-to-end management of the complete hardware and software stack up through the OS and into applications. As Figure 3 illustrates, the architecture is designed to support

- Traditional OS and application stacks running on x86 architecture and SPARC processor-powered servers. Oracle Enterprise Manager Ops Center manages Oracle Solaris, Windows, and Linux.
- Virtualized environments running Oracle VM Server for SPARC on chip multithreading servers with CoolThreads technology, and Oracle Solaris Containers on any server running Oracle Solaris. The virtual controller manages the hypervisor and VM layers and can perform tasks such as VM migration at the direction of the enterprise controller. Support for migration depends on the virtualization technology in use.

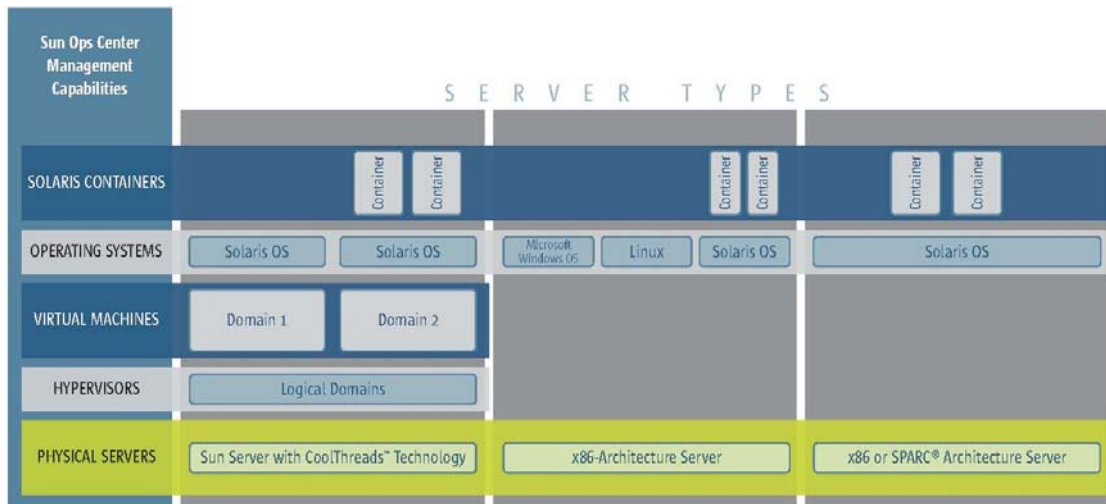


Figure 3. Oracle Enterprise Manager Ops Center architecture manages traditional OS and application stacks as well as virtualized environments on x86 architecture servers, Oracle VM Server for SPARC on CoolThreads technology-powered servers, and Oracle Solaris Containers on any server running Oracle Solaris.

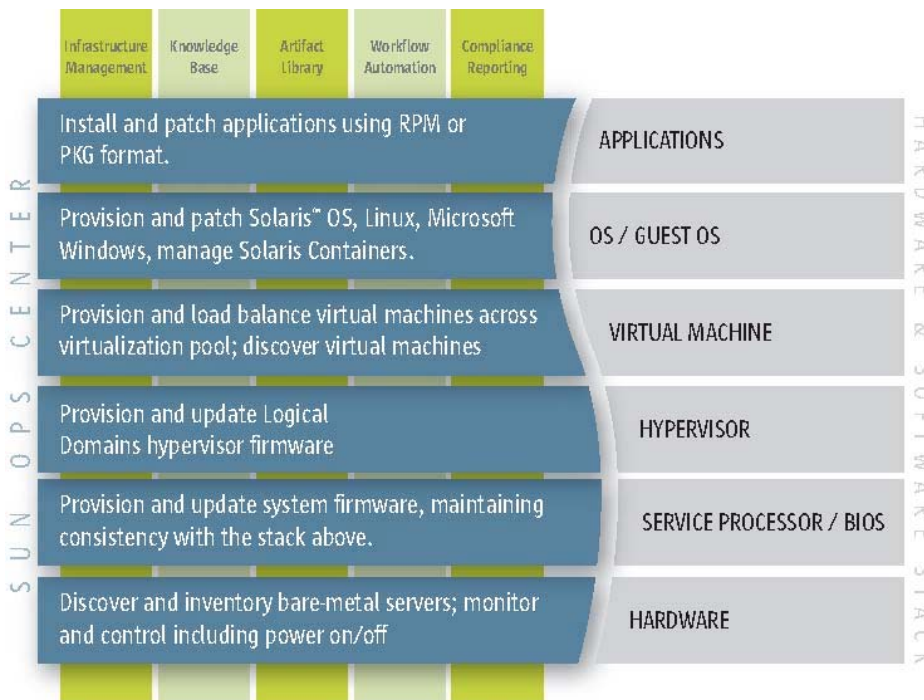
## A Comprehensive, Integrated Feature Set

Oracle Enterprise Manager Ops Center provides a comprehensive, integrated set of features for managing both traditional and virtualized systems from the time that power and networking are applied through the operational phase and their eventual retirement and replacement.

### Define, Reuse, and Operate

The system employs a define, reuse, and operate model. In this model, infrastructure, knowledge, and artifacts are defined, and then operations can be performed on them. For example, firmware from the artifact library can be installed onto systems that have been discovered, all in compliance with constraints in the knowledgebase. Workflow can be automated and performed to scale, and reports can provide an audit trail on standards compliance.

The vertical bars in Figure 4 represent the functions that span every layer in the hierarchy, while the horizontal bars show the kinds of operations that can be performed at each level in the hardware and software hierarchy.



**Figure 4.** Five high-level functions support Oracle Enterprise Manager Ops Center's actions across every infrastructure layer, from physical servers to VMs and applications.

The Oracle Enterprise Manager Ops Center features that are applicable to every layer include the following:

- **Infrastructure management.** Oracle Enterprise Manager Ops Center automatically discovers bare-metal servers, OSs, hypervisors, VMs, and applications, and then adds those resources to its inventory. Systems can be placed into logical groups based on their business context and added to virtualization pools where they can be harnessed as part of a uniform set of resources.
- **Knowledgebase.** This is where information on consistent, supported configurations is maintained. For example, a knowledgebase entry might specify that to run a specific OS release, the server must run a specific firmware revision and the OS must have a standard set of patches applied. Oracle provides knowledgebase information, and IT organizations might add their own standard configurations.
- **Artifact library.** The artifact library maintains OSs patches, firmware revisions, virtual appliance images, golden master images, and even application software and middleware.
- **Workflow automation.** Oracle Enterprise Manager Ops Center codifies specific sequences of administrator tasks so that they can be automated and executed on 1, 100, or 1,000 servers with equal ease.
- **Compliance reporting.** Compliance reporting helps ensure compliance with a number of standards. For example, governmental regulations might require specific security measures to be executed on every system, and best practices might dictate a set of standard configurations to be deployed

throughout the datacenter. Oracle-supplied baseline configuration requirements specify the combination of server firmware, OS revision, and patches that comprise a supported configuration.

## Oracle Enterprise Manager Ops Center Operations

Once systems have been discovered, artifacts defined, and the knowledgebase populated, operations can be performed on systems using the artifacts, limited by constraints defined in the knowledgebase. Administrators are authenticated by a pluggable authentication mechanism that can use external authentication, authorization, and accounting servers. The scope of their actions is constrained by their roles.

### Provisioning

Oracle Enterprise Manager Ops Center provisions systems using artifacts from the artifact library following the constraints specified by the knowledgebase. Having predefined artifacts and constraints on using them helps to ensure compliance with standard configurations.

The software can provision platform firmware, RAID controller software, hypervisors, OSs, VMs, and even application software provided in RPM or PKG formats.

### Patching

Intelligent, policy-based handling of software patches and updates can further prevent inadvertent downtime due to inconsistently applied system patches. As is the case with provisioning, Oracle Enterprise Manager Ops Center's patching mechanism uses the knowledgebase to help prevent inconsistent sets of patches from being applied.

With Oracle Enterprise Manager Ops Center, patching large numbers of systems is as easy as patching just one. Patch application can be simulated before patches are applied on a large scale, and patch consistency can be compared and audited across many systems. In addition, a rollback mechanism allows systems to be returned to a prior state in the event that a problem is detected.

### Management and Monitoring

Oracle Enterprise Manager Ops Center manages and monitors the entire hardware and software stack, provisioning APIs for integration with existing tools. The application manages physical servers through their lights-out management interfaces, hypervisors, VMs, virtual appliances, and OSs running on bare-metal servers as well as on VMs. Oracle Enterprise Manager Ops Center manages VM images and snapshots and is able to manage both physical and virtual networks. The optional OS agent provides enhanced management services at the OS level, including the ability to manage and report on applications and patches applied to them.

The system monitors a wide range of operating parameters, providing historical reports for trend analysis and event notification through on-screen alerts and e-mails. The range of parameters include

- Environment variables, including fan speeds, temperatures, disk status, and power supply voltages

- OS parameters, including CPU, memory, and swap space usage as well as file system and I/O activity
- Ecomonitoring of actual power consumption

### **Virtual Machine Management**

For virtualized environments, Oracle Enterprise Manager Ops Center provides complete lifecycle management for VMs. It can create, clone, and delete VMs, start and shut down guest OSs, and back up and restore guest OS images. Where the guest OS supports it, Oracle Enterprise Manager Ops Center can dynamically modify resources allocated to VMs. With OSs such as Oracle Solaris running as guests, the OS can dynamically adapt to changes in certain resources, such as the number of CPUs, without requiring a reboot.

Oracle Enterprise Manager Ops Center performs warm migrations of VMs from server to server within a virtualization pool using a suspend/resume cycle. This helps IT organizations optimize their resource allocation to support service levels while increasing availability by allowing VMs to be migrated off servers scheduled for maintenance.

High availability is supported by automatically restarting guest OSs on a different server in the event of a failure. Business continuity is supported through cold migrations, which move the virtual volumes and VMs to a backup site.

### **Resource Management**

Oracle Enterprise Manager Ops Center helps control physical and VM sprawl via its resource management capabilities. Automatically discovered resources—including physical hardware, the Oracle VM Server for SPARC hypervisor, VMs, and OSs—are added to the software's inventory management system. Once included in the inventory, keyword and user-defined, tag-based search capabilities simplify the task of scanning through thousands of resources. The GUI presents a datacenter topology that shows the relationships between guest OS, networks, storage, and images.

Resource pools are used to group similar resources that can be harnessed with dynamic allocation of VMs to server resources. See Figure 5. Oracle Enterprise Manager Ops Center supports policy-based resource optimization where, for example, the relationship between VMs and physical servers can be reassessed automatically on a periodic basis, with resource reallocation performed to balance workloads and available resources. Resource pools also provide a logical allocation of servers to applications for ease of management and accounting of resource use.

The system's GUI provides a status dashboard that provides general information on VMs, hypervisors, and physical systems, along with options for displaying hypervisor, system, and appliance use levels.

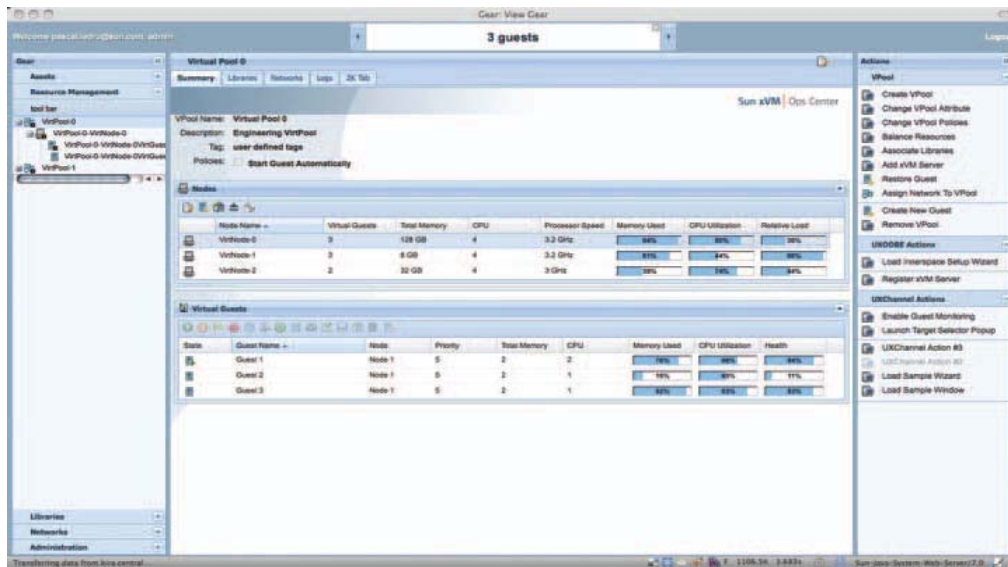


Figure 5. Virtualization pools group resources that can work as a single pool of resources. The left pane gives a topological view of available resources, the middle pane shows pool status, and the right pane presents actions that can be taken based on the context.

## Putting Oracle Enterprise Manager Ops Center to Work

Oracle Enterprise Manager Ops Center changes the way IT organizations operate their datacenters. It manages the increasing complexity of today's datacenters through a single pane of glass. It supports the server lifecycle from the time that power is first supplied through software provisioning and workload management and monitoring. It reduces management complexity through its ability to implement actions across large numbers of servers, virtualized or not, using a simple and intuitive GUI. And it increases compliance by standardizing and automating procedures and using only consistent sets of software images.

As IT organizations move to virtualized, dynamic datacenters, the support provided by Oracle Enterprise Manager Ops Center will become even more important. While other datacenters are becoming increasingly complex due to a proliferation of VMs and a multitude of tools for managing all of the infrastructure layers, those that employ Oracle Enterprise Manager Ops Center will find simplicity through end-to-end management of the underlying hardware through the software stack.

The integration of management and monitoring enables features such as the ability to rebalance workloads for optimum use of resources across an entire virtualization pool. Rebalancing can be done automatically or with a few clicks of the mouse. Because Oracle Enterprise Manager Ops Center understands the characteristics and resource use of every VM across a pool, it also understands how to allocate VMs to servers to best meet quality-of-service goals.

Most organizations experience spikes in workload due to events both expected and unexpected. End-of-month, end-of-quarter, and seasonal workloads can be predicted and responded to with Oracle Enterprise Manager Ops Center. Racks of powered-off servers can be powered on, added to a resource

pool, provisioned, and put to work to gracefully respond to periods of high demand. Short-term, unexpected spikes in workload can be accommodated by creating and distributing more VMs across a pool or by lighting up dark racks or pods of server resources and putting them to work.

This ability to recruit new resources to handle workload fluctuations—and to support the server lifecycle from power application to application provisioning—helps Oracle Enterprise Manager Ops Center match server use and power consumption to actual workload demands. The result is lower power and cooling costs and better use of capital investments.

## Conclusion

Helping your IT organization—and your business—stay one step ahead of the competition, Oracle Enterprise Manager Ops Center reduces complexity and manages heterogeneity in datacenters by adhering to the following key design principles:

- Provide single pane of glass systems management.
- Understand and manage every architectural layer—from bare metal to OS.
- Follow the entire server lifecycle—from power on to decommissioning.
- Allow datacenters to scale without growing more complex.
- Support heterogeneous environments, including x86 architecture and SPARC servers.
- Treat virtualized and nonvirtualized environments equally so that datacenters can use the same management infrastructure across both environments, and incorporate virtualization to meet business requirements.
- Automate workflow to reduce the number of administrator chores.
- Enforce compliance through policy-based management.



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