Intel® Cloud Builder Guide
Intel® Xeon® Processor-based Servers
Novell* Cloud Manager

Intel® Cloud Builder Guide: Cloud Design and Deployment on Intel® Platforms

Novell* Cloud Manager

Intel® Xeon® Processor 5500 Series

Intel® Xeon® Processor 5600 Series

Novell.

AUDIENCE AND PURPOSE

Cloud computing offers a path to greater scalability and lower costs for large enterprises, service providers, and infrastructure hosting companies. The establishment of an infrastructure that can provide such capabilities requires experience. Intel has teamed up with leading cloud vendors through the Intel® Cloud Builder program to help customers design, deploy, and manage a cloud infrastructure.

The Intel Cloud Builder program provides a reference architecture in the form of a basic hardware blueprint with Intel-based servers running cloud software management solutions such as Novell* Cloud Manager. The use cases described in this paper can be used as a baseline to build more complex usage and deployment models to suit specific customer needs.

The audience for this reference architecture is Enterprise IT organizations looking to realize the revenue potential of their existing data center infrastructure and offering cloud computing services to their internal customers or users (aka an internal private cloud). The goal of this paper is to reduce the learning curve involved when you build and manage your first internal private cloud.

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Executive Summary

The ideas and principles of cloud computing are of great interest to the business community because of the promises of elasticity, lower TCO, and economies of scale. In recent years, many companies have set up private cloud infrastructures that are available to internal IT customers to host their applications.

Given the myriad of choices, trade-offs, and decisions, it is clear that the ability to build on top of a known and understood basic design is very desirable. This reference architecture summarizes key lessons about design, implementation, and management of an internal private cloud using Intel® Xeon® processor 5600 series-based servers[1] and Novell* Cloud Manager, and provides a frame of reference for future implementations.

Our test bed consists of eight Intel Xeon processor 5600 series-based servers exposed as a compute service in the cloud. The first four run the VMware* ESX hypervisor, while the other four run the Xen* hypervisor. In this reference architecture, we focus on how Novell Cloud Manager[2] provides a very simple yet powerful portal interface to configure and manage an Enterprise level infrastructure as a service (IaaS) with connected storage. Novell Cloud Manager also offers Enterprise IT organizations the ability to support multi-tenancy, which enables their infrastructure to securely host virtual machines (VMs) belonging to different internal IT customers, and to offer isolation of storage and network.

Our design consists of two disparate compute clusters, each with its own storage resources. One cluster is VMware-based; the other is Xen-based. In theory, there is no upper limit on the number of virtual machines that can be provisioned using Novell Cloud Manager, which can support very large clouds with many thousands of servers in more complex architectures than the one implemented here. Depending on the internal IT customer's resource requirements, the number of virtual machines allowed per server can be defined as needed. Our test bed had a total of 192GB RAM across eight servers (24GB RAM per server). The number of VMs that can be run on a server depends on the requirements of the customers and applications, as well as the capability of the server. The Intel Xeon processor 5600 series-based servers are ideal for very dense cloud architectures because of the optimized power footprint, features like the Intel® Intelligent Power Node Manager, and automated energy efficiency.

Using Novell Cloud Manager's portal interface, which is accessible through any modern browser, we provisioned business services for two business groups in different datacenters, and scaled out these business services in reaction to higher demand. We connected to these resources using remote connection protocols such as remote desktop protocol (RDP) and virtual network computing (VNC). We were also able to transparently scale out the cloud infrastructure when we added physical servers that were rapidly deployed. We demonstrated the viability and ease of deployment of a business service that spanned datacenters, each running different hypervisors and guest operating systems. We quickly generated detailed cost reports and implemented network isolation between two internal IT customers with the help of VLAN packet tagging. Finally, we demonstrated the seamless failover that Novell Cloud Manager provides when a physical server goes offline as we simulated a power loss.

In our specific cloud configuration, the storage for the virtual image repository was provided using the network file system (NFS) on Linux*. NFS on Linux was chosen because of its ease of use and its ability to be deployed quickly. For production purposes and in parallel or cluster configurations, more robust storage architectures must be used. Some options to consider include Cluster File System solutions such as OCFS2 (available with major Linux distributions, and supported by Novell* Inc.), which may be combined with internet small computer system interface (iSCSI) or Fibre Channel storage area network (SAN) storage from any of a large number of vendors. Lighter-weight solutions based on network-attached storage (NAS) technologies, as well as simpler server-based storage solutions supplemented with high-performance or bonded network links can also be considered; this depends on the scale of the cloud deployment and need of applications that run in the cloud.

One of the most common system bottlenecks in a modern datacenter is network throughput. In our test bed, we used 10Gb Ethernet to help address the growing bandwidth needs of a dense cloud computing environment. Novell Cloud Manager server and agent components were installed on Intel Xeon processor 5600 series-based servers.

Introduction

The idea of cloud computing is driven by a need to consolidate applications to make better use of existing resources, to improve the ability of applications to scale up and down in a relatively smooth manner, and to lower operational costs.

To achieve the lowest operational costs for the hardware infrastructure, a homogeneous pool of compute and storage with uniform connectivity was used as it is the simplest to manage, easiest to troubleshoot, and easiest on which to add and/or remove capacity. We employed virtualization to allow multi-tenancy with strong isolation between the multiple applications hosted on the servers.

Lastly, to account for the fact that hardware components of the cloud (VM hosts, network switches, storage arrays, etc.) can potentially fail, individual applications themselves or the cloud management infrastructure need to provide the failover features necessary for seamless recovery. Security requires that the state of each compute element be maintained in shared storage or that the application accept responsibility for retrying the actions on a failing device. For a typical non-cloud-aware enterprise workload, this requires the application to run in a virtual machine and all the corresponding data to be stored in a shared storage. In this manner, whenever a server fails, the cloud management infrastructure can simply migrate or restart the virtual machine on another server.

Some design considerations used for building the Novell Cloud Manager reference architecture in the Intel Cloud Builder test bed include:

- The use of standard Intel Xeon processor-based servers as building blocks so that any server in the rack can be used for any purpose. In this configuration, there are no special-purpose servers and no special connections — all servers are physically configured the same way. This homogeneity allows for simple replacement and reassignment/ migration of workloads and the simple automation of workload configuration at the time it is provisioned.
- A flat-layer 2 network enables us to reduce the implementation costs and to retain the flexibility to assign any workload to any server. This approach is flexible for small clouds, but may create bottlenecks for a larger number of servers when this design is aggregated at a larger data center level. Novell Cloud Manager supports much more sophisticated network topologies, but they were not required for the purpose of this reference architecture.
- We used Xen and VMware ESX Hypervisors to provide isolation for the workloads on the servers, and we segregated network traffic using network packet tagging (VLAN) and routing. In addition to Xen and VMware, Novell Cloud Manager also supports the Microsoft* Windows Server* 2008 (Hyper-V*) hypervisor.
- We used a Linux-based NFS server in combination with a direct attached storage (DAS) as a convenient and low-cost way to provide storage accessible to the clusters. This storage was also used to host the VM image repository. Novell Cloud Manager also supports the use of sophisticated storage architectures such as cluster file systems and SAN, and can avoid the use of node-local storage.

Novell Cloud Manager Implementation Overview

Built to operate with the VMware, Microsoft Windows Server 2008 R2 hypervisor, or Xen servers you already own, Novell Cloud Manager automates the approval workflow to create live workloads provisioned from service catalog templates, with pricing and service level management.

Traditional virtualization solutions once thought to be the solution to such problems as limited data center space, underutilized servers, and runaway power and cooling costs, have created almost as many problems as they solve. The promise of an agile, cheap, and flexible virtual infrastructure has been replaced with the realities of service level agreement (SLA) challenges and virtual machine sprawl, with far too many bloated virtual machines allocated for more resources than they need.

With Novell Cloud Manager, you can build a secure, compliant cloud computing environment on top of the virtual infrastructure and resources you have today. Architected from the ground up for massive scalability, Novell Cloud Manager is the perfect solution for enterprises and service providers of any size.

Controls Virtual Sprawl with Cost Visibility

One of the main benefits of virtualization also creates one of the most significant issues: when virtual machines are effectively free and can be created almost instantly, demand for virtual machines can quickly consume all the available capacity. When we reevaluate the concept of cost, Novell Cloud Manager allows IT departments to expose the real price of workloads, resources and service levels, and enables business service owners to select and pay for only what they really need. Costs can be linked to nearly all items that are relevant to a business service: workloads, associated resources (virtual CPUs, memory, virtual network cards and disk space), and service levels. Infrastructure managers have the flexibility to maintain different pricing for different end-user groups.

Delivers Business Services Faster with Automated On-Demand Workload Provisioning

Novell Cloud Manager automates the process that provisions new workloads. Beyond just managing the request and approval workflow, Novell Cloud Manager automatically creates and deploys workloads into the virtual environment based on a service catalog of pre-defined workload templates. Template-based provisioning standardizes workloads with the corporate service catalog and ensures adherence to corporate policy. If necessary, customized configuration changes, such as increased memory or disk space, can be

made at the time of the request. Novell Cloud Manager determines the optimum location to deploy the new workload. Workload provisioning times are shortened, which makes the entire process that deploys new business services both faster and more efficient.

Establishes a Transparent Provisioning Workflow

For many organizations, the workload provisioning process is a black box. The request goes in, and then days, weeks, or even months later, the workload is provisioned—or perhaps denied. Novell Cloud Manager opens up this process, establishing a transparent workflow that ensures visibility every step of the way, from the initial request until the workload has been deployed.

Provides a Secure Self-Service Request Portal

Novell Cloud Manager features a self-service request portal that customizes itself based on the user's profile. IT administrators can predetermine which workload templates individuals or groups can select from the catalog, and whether they can modify the base templates. The portal interface dynamically displays available configuration options, which ensures that all workload requests are standardized and align with IT policy and security privileges.

Purges Unused and Expired Virtual Machines

Many types of virtual machines, especially those used for evaluation, test, and development purposes, are temporary by nature. Many organizations have dozens or hundreds of unused virtual machines, each of which still consumes valuable allocations of CPU, memory, and disk resources. With built-in expiration dates, Novell Cloud Manager prevents these workloads from permanently clogging up the virtual farm, and allows you to purge expired virtual machines to reclaim and redeploy their resources.

Integrates with Best-In-Class Security and Business Service Management

A built-in connector to Novell Sentinel* allows security managers to correlate events coming from Novell Cloud Manager with other events that are detected in the cloud or any other Sentinel-aware location. Novell Cloud Manager also integrates with Novell Operations Center to enhance visibility into business efficiency.

Creates a Secure And Compliant Environment

Novell Cloud Manager can help you build a secure, compliant cloud computing environment which utilizes your existing virtual infrastructure and resources. It provides the simplest way for you to build and manage your cloud.

Key Features and Differentiation Summary

- Minimize manual effort when you create templates for common workload types
- Control resource usage as you specify user and workload policies
- Track resource utilization to control infrastructure expenses
- Reduce the cost of providing new business services as you streamline processes
- Designed for today's mixed IT environments; works across all major hypervisors
- Massively scalable to public cloud capacity
- Workflow is aligned to information technology infrastructure library (ITIL) roles and supports flexible service level management
- Integration with Novell Sentinel for event correlation and Novel Operations Center for increased visibility into business efficiency

Novell Cloud Manager Architecture and Design Principles

Product Component Overview

Novell Cloud Manager consists of two services. Each service is installed in a highly available physical or virtual instance of SUSE* Linux Enterprise Server. There is also an agent component that is installed on the hypervisors, or on the VMware vCenter* Server in the case of VMware vSphere* 4.[3] Each service plays a distinct role.

Novell Cloud Manager Orchestration Service: In Novell Cloud Manager 1.0, PlateSpin* Orchestrate 2.5 is used as the Orchestration Service. PlateSpin Orchestrate 2.5 is shipped as part of Cloud Manager 1.0, so no additional purchase is needed. PlateSpin Orchestrate 2.5 is a highly advanced, policy based virtual resource manager, capable of managing virtual resources on VMware vSphere 4, SUSE Linux Enterprise Server, Xen, and the Microsoft Windows Server 2008 R2 (Hyper-V) hypervisor. PlateSpin Orchestrate 2.5 abstracts hypervisor-specific functionality, and optimizes resource usage and VM placement on all managed hypervisors. The functionality of PlateSpin Orchestrate 2.5 is exposed through a simple object access protocol (SOAP) API, which is consumed by the Cloud Manager Application Service.

Novell Cloud Manager Application Service: This service generates the web 2.0 UI of Novell Cloud Manager, and manages the product's users, groups, workload templates, and provisioning workflows. Whenever virtual resources need to be manipulated, the Application Service contacts an Orchestration Service over the SOAP API. The Application Service stores its data in a structured query language (SQL) based database.

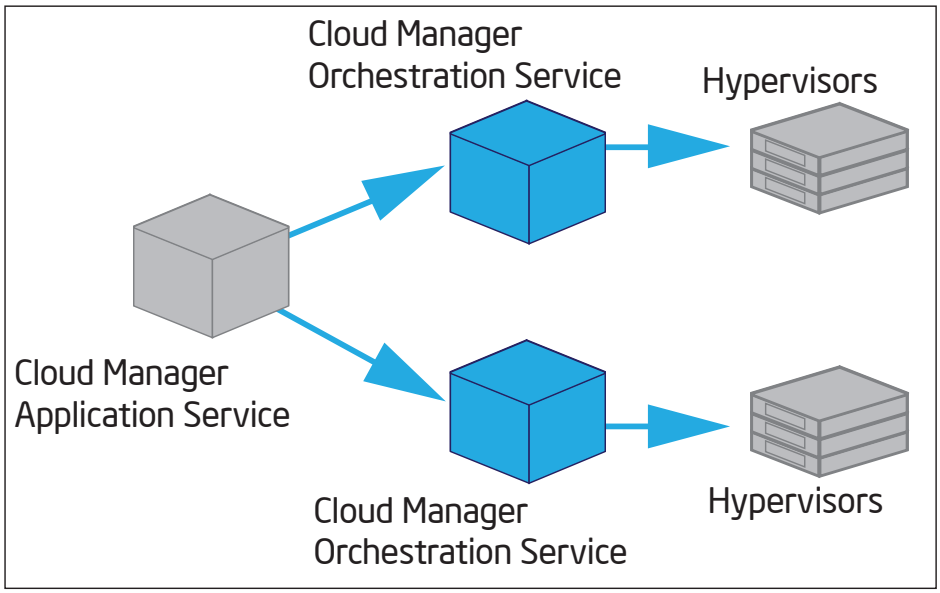

Figure 1: Novell Cloud Manager Architecture

Agents: Agents need to be installed on each hypervisor for Xen and the Microsoft Server 2008 (Hyper-V) hypervisor. These agents take care of the communication between the hypervisor and the Orchestration Service that manages the hypervisor. For VMware vSphere 4, the agent is not installed on the ESX VM host, but rather on the system (virtual or physical) that hosts the vCenter Server.

Cloud Deployment and Scalability

Many of today's Enterprises are involved in a process to consolidate widespread IT resources into a set of strategic, concentrated IT locations. Each such location will typically host one or more physical data centers. Internal IT customers are serviced in the data center that's physically closest to them.

To cope with this reality, Cloud Manager implements the concept of a "zone" to represent the location or region where a set of IT services need to be provisioned. Just like in the real world, a zone can contain one or more physical data centers. Virtual resources in one zone are managed by exactly one (highly available) Cloud Manager Orchestration Service. As an example, a fictitious enterprise called "ACME", with IT activity in the USA and in Europe, could have a zone in Dallas and a zone in Brussels. More zones can easily be added when ACME expands into other regions.

While each zone runs it own Orchestration Service, only one active (highly available) Cloud Manager Application Service is needed to manage these Orchestration Services. In other words, the Application Service manages all the cloud zones, using the Orchestration Service that runs in each zone. In the case of ACME, the Application Service could run in either the Dallas or the Brussels data center, on a physical or virtual system. For example, the Application Service can be installed in a VM running on vSphere 4, which could be managed by the Orchestration Service in Dallas.

Test Bed Blueprint

Logical Architecture

As outlined above, our hypothetical ACME corporation has two datacenters, one in Dallas, and one in Brussels, both of which will be part of a private internal cloud that ACME wants to build and manage with Novell Cloud Manager. The hypervisor of choice in the Dallas data center is VMware ESX, part of VMware vSphere 4. In Brussels, all hypervisors are Xen-based and implemented using SUSE Linux Enterprise Server Service Pack 1.

The logical architecture for the internal private ACME cloud is shown in the diagram below. The Cloud Manager Application Service (called "cmas1.cfr.infra") is configured to communicate with two Cloud Manager Orchestration

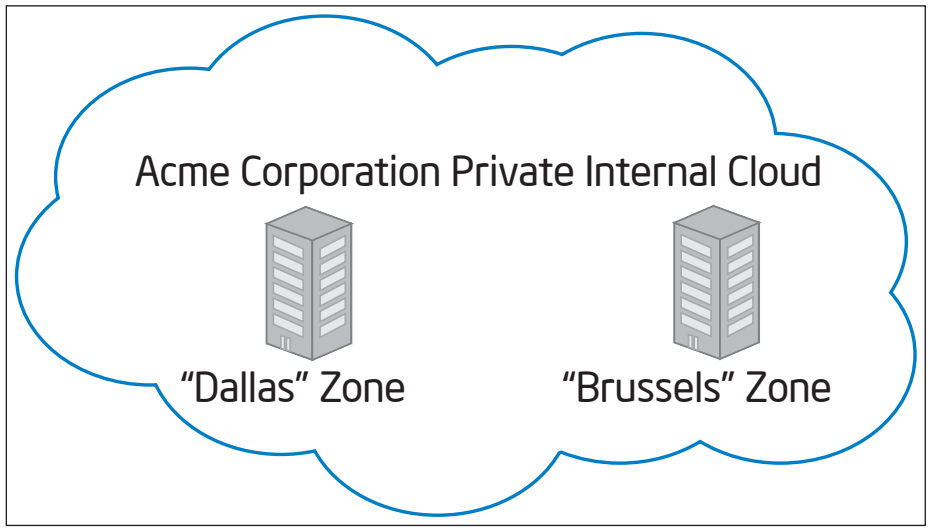

Figure 2: Novell Cloud Manager Zones

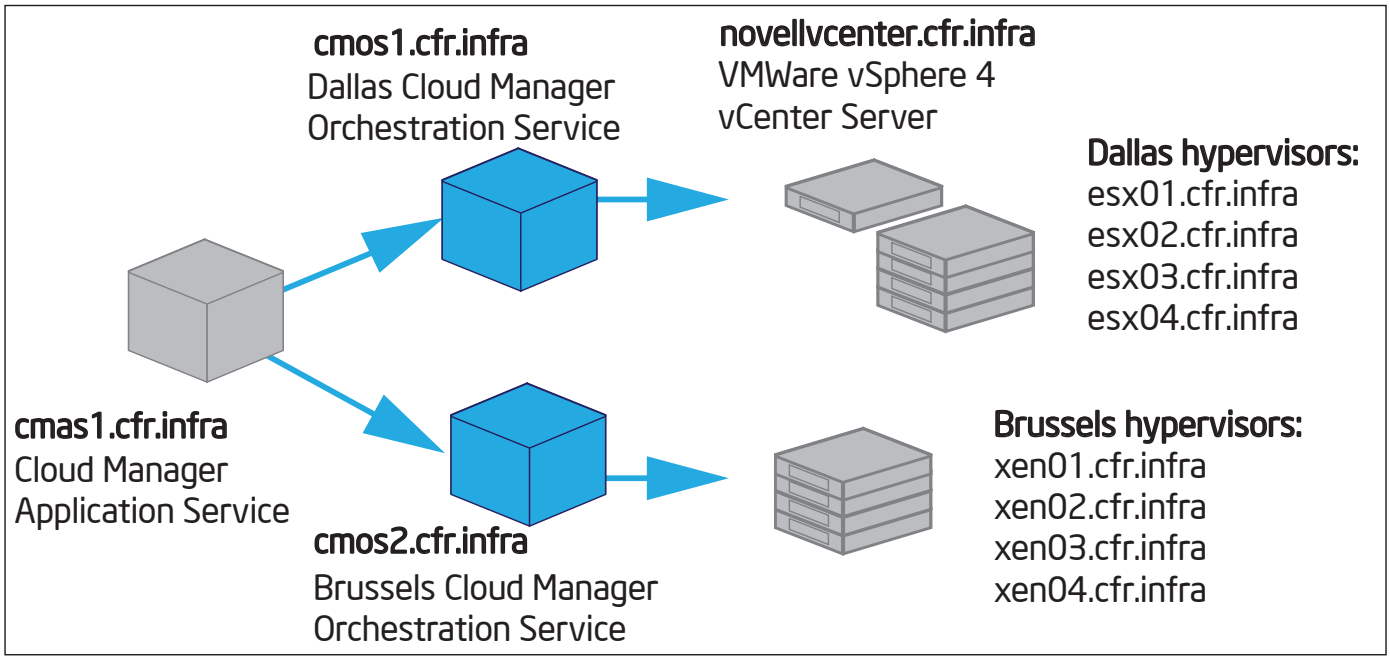

Figure 3: Novell Cloud Manager Test bed Logical Architecture

Services; one for the Dallas zone, and one for the Brussels zone. The Cloud Manager Orchestration Service in Brussels manages the Xen hypervisors directly using agents installed on each hypervisor. In Dallas, the Cloud Manager Orchestration Service manages a cluster of ESX based VM Hosts using the VMware vSphere 4 vCenter Server. A Novell Cloud Manager agent is installed on the physical system that hosts the VMware vCenter Server, called "novellvcenter.cfr.infra".

Physical Architecture

An Enterprise cloud hardware infrastructure requires various hardware components for internal IT customers to host their cloud-based services. Typical hardware components include dual-processor server platforms to host the compute loads, storage platforms to host data, network components to manage internal and external traffic, and other data center infrastructure components.

To implement the logical architecture from the previous paragraph, we used twelve physical systems. For the hypervisors, we installed VMware ESX 4.0 and SUSE Linux Enterprise Server 11 Service Pack 1 on eight of the twelve servers. The Dallas site hosted the Cloud Manager Application Service, as well as its own Cloud Manager Orchestration Service, both running in VMs in a VMware cluster that contained all four ESX 4.0 VM Hosts. The Brussels site ran an additional fifth physical system to host its Cloud Manager Orchestration Service.

In our test bed, we used the Intel® Xeon processor X5670, which provides a foundation to design new cloud data centers, and achieves greater performance while using less energy and space, which dramatically reduces operating costs.

The Intel Xeon processor X5670 offers several features that help make it the best performing server processor for the cloud. Some of these features include:

- Intelligent performance that automatically varies the processor frequency to meet the business and application performance requirements.
- Automated energy efficiency that scales energy usage to the workload to achieve optimal performance/watt and reduce operating costs.
- Intel® Virtualization Technology (Intel VT) and Intel® VT FlexMigration offer best-in-class performance and manageability in virtualized environments to strengthen the infrastructure and reduce costs.

For storage, both zones used the same NFS server, accessed through a dedicated 10 Gbit Ethernet network. We implemented the NFS server by means of the SUSE Linux Enterprise Server 11 Service Pack 1. Two NFS shares were exposed: one was configured in Dallas as a VMware Data Store called "NFS", the other was connected to the Xen VM hosts in Brussels as a Linux NFS mount. In a production implementation, each site would typically run its own storage infrastructure, but for the purposes of the lab tests, the same shared infrastructure was used.

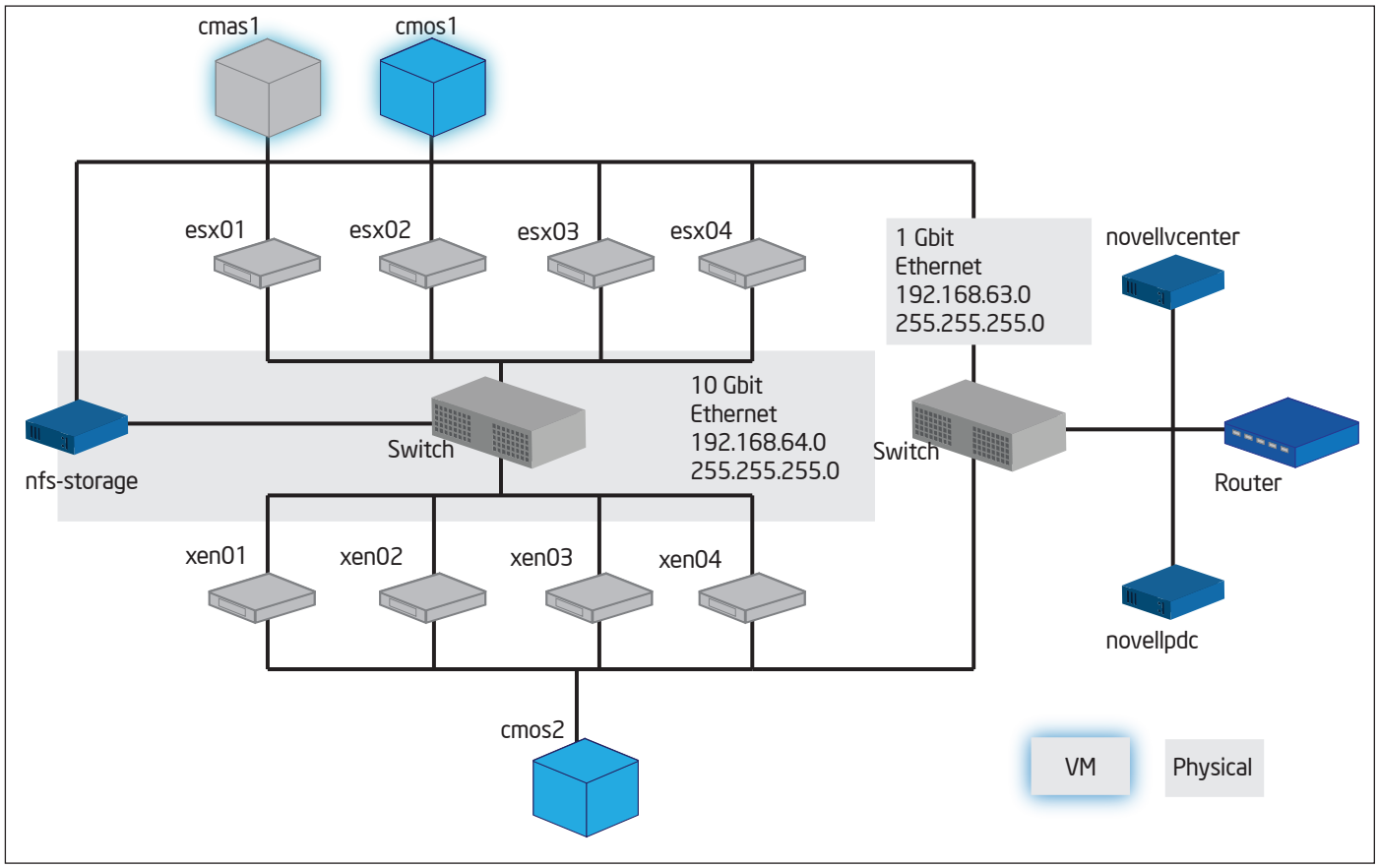

Figure 4: Novell Cloud Manager Test Bed Physical Architecture

As Novell Cloud Manager requires a lightweight directory access protocol (LDAP) server for user authentication, we set up a Microsoft* Active Directory server, running on a server called "novellpdc".

We connected all physical systems to a 1 Gbit management network, which was discovered as the "VM Network" in the vSphere 4 virtual infrastructure.

Use Case Context: ACME Corporation

We exercised the system through a variety of real-world tests and scenarios, ranging from those covering basic system functionality to more advanced use cases, like business service administration delegation and network isolation support.

We performed all use cases on behalf of employees of the fictitious ACME Corporation. At ACME, an employee called Jim is in charge of the physical and virtual infrastructure that will be used for ACME's internal private cloud. He is in charge of the procurement, provisioning, deployment, and management of the shared infrastructure. As a cloud administrator, Jim will build and manage workload templates, manage a centralized services catalog, and play a key role in provisioning workload review and approvals. In a real world scenario, Jim's role would probably be fulfilled by multiple people or teams of people.

On the internal IT customer side, two groups of ACME application administrators will have access to the cloud:

- The ERP application administrators: the employees in this group architect, build, and manage ERP applications across both sites.
- The Corporate IT services administrators: the employees in this group architect, build, and manage general purpose applications, like mail servers and web servers.

In Novell Cloud Manager, individual internal IT customers are grouped together in "business groups." It is Jim's responsibility to create these groups, and to populate them with users. Each group contains a sponsor. The sponsor could be a vice president or manager of the business unit, and plays the approval role for new business services in the cloud to ensure business alignment. The sponsor also oversees budget for the business unit.

For the purpose of the use cases, Jim creates and populates the following two business groups in Novell Cloud Manager:

ERP Application Administrators Team

- Kelly (Architect)
- Diana (Administrator)
- Bob (Administrator)
- Ron (Sponsor)

Corporate IT Services Team

- Fred (Architect)
- Tom (System Administrator)
- Lee (System Administrator)
- Jenny (Sponsor)

In our use cases, Diana and Tom are responsible for provisioning end user workloads in the form of business services to the cloud.

Use Case Review

Overview

1. Jim sets up the Novell Cloud Manager software.
2. Jim manages the workload template and service level catalog.
3. Jim manages users and business groups.
4. Diana and Tom provision new business services in the cloud.
5. Diana and Tom check their received services as they log in to the workloads.
6. Diana scales out an existing business service.
7. Diana delegates business service rights to Bob and Kelly.
8. Jim generates detailed cost reports.
9. Jim seamlessly manages different hypervisor types in the ACME cloud.
10. Jim scales out the cloud as he adds more compute resources.
11. Jim tests a physical server failure scenario.
12. Tom is able to isolate his network from other cloud users (VLAN).

Detailed Description of Use Cases

Use Case 1: Jim Sets Up the Novell Cloud Manager Software

Novell Cloud Manager makes it very easy to set up your own internal private cloud. After initial installation, Jim (cloud administrator) is guided through a sequence of setup screens, where he can add zones, configure and test LDAP connectivity, and tune the most important Novell Cloud Manager settings.

The steps to achieve this are as follows:

1. Jim logs in to Novell Cloud Manager as shown in Figure 5.

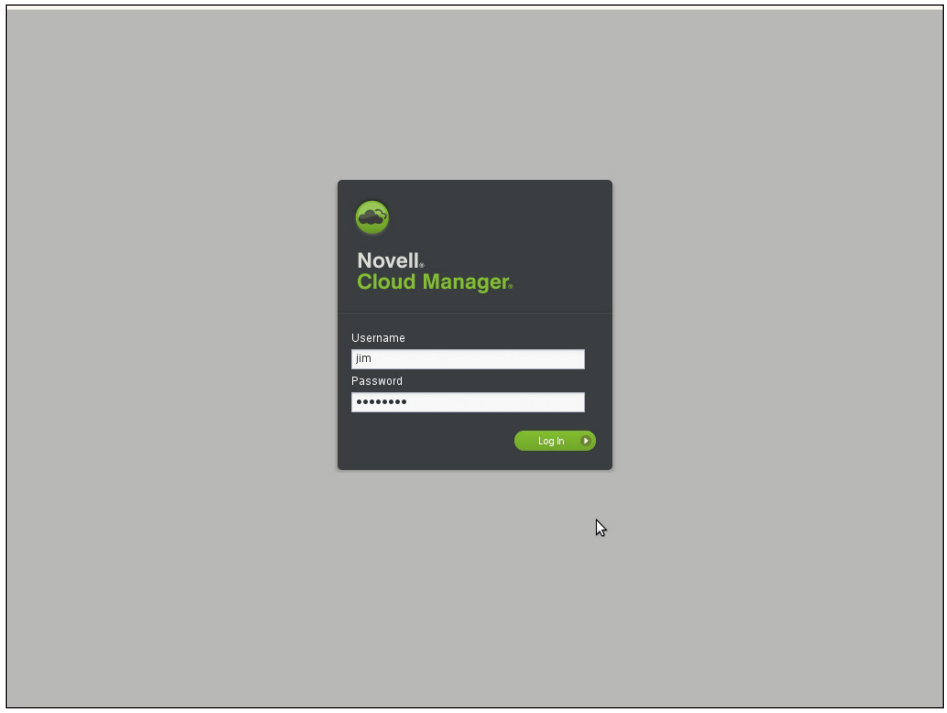

Figure 5: Jim's log on screen

2. Once logged in, Jim adds the Dallas and Brussels zones.

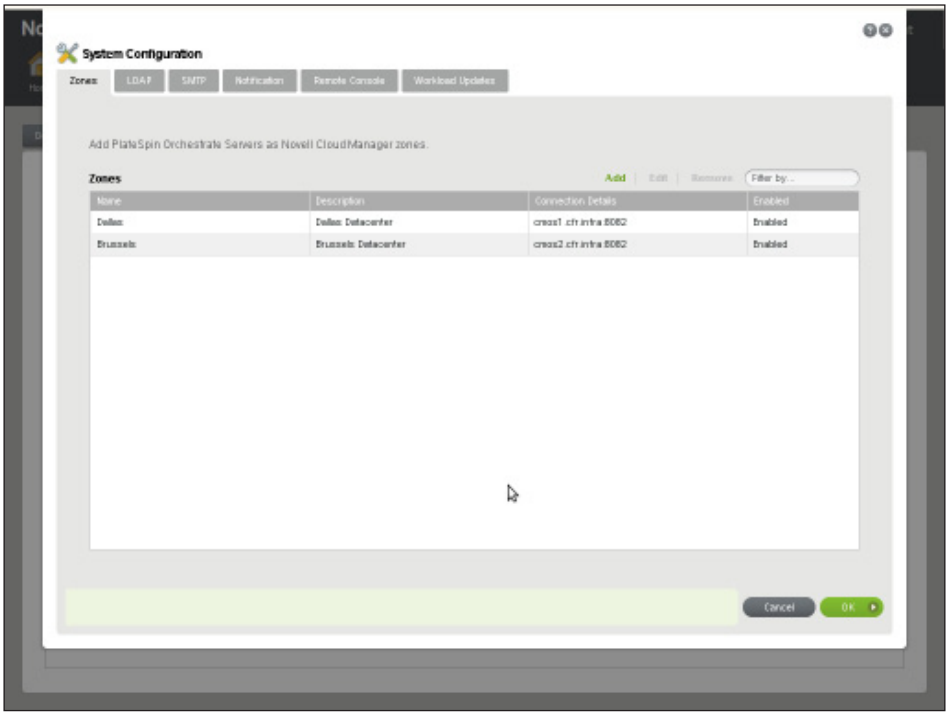

Figure 6: Jim adding the Dallas and Brussels Zones

3. Jim then configures LDAP connectivity. A built- in test widget makes it very easy to verify if users can be authenticated through LDAP.

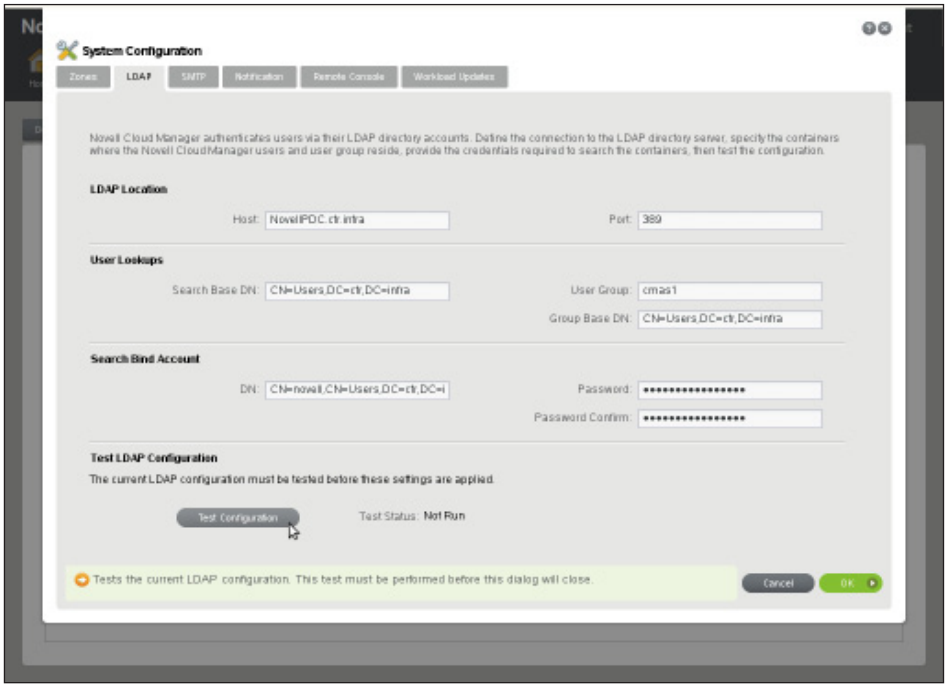

Figure 7: Jim configuring LDAP connectivity

4. After successfully configuring Novell Cloud Manager, the "Hosts" view shows the VMware cluster in Dallas and the Xen cluster in Brussels. The information about these zones is transmitted through the Orchestration Services that run in these zones.

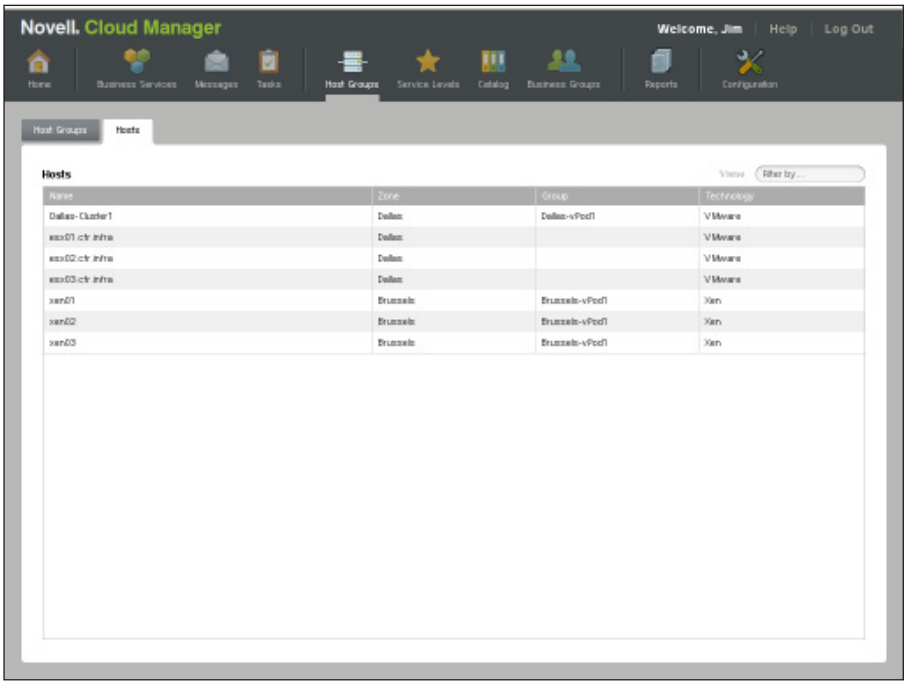

Figure 8: The Hosts view displaying the newly added Zones

5. Jim can now inspect the information on his landing page. The CPU and RAM resources shown in the Capacity section represent the resources taken up by the Cloud Manager Application Service and Orchestration Service VMs that are already running in the Dallas zone.

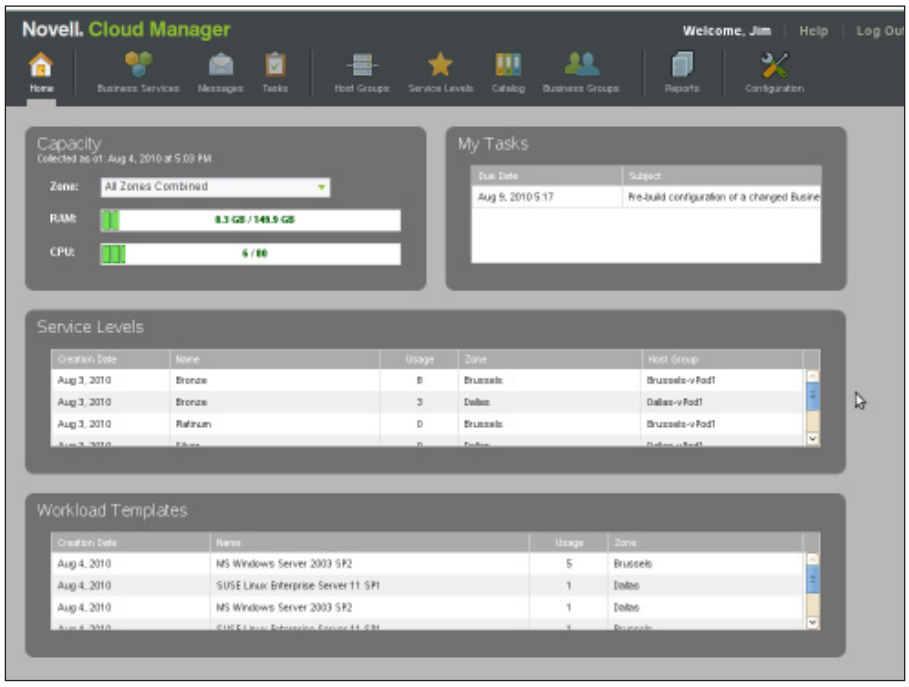

Figure 9: Jim's landing page after adding the two Zones

Use Case 2: Jim Manages the Workload Template and Service Level Catalog

A key concept in cloud computing is self-service – internal IT customers can order services when they need them, and the services are rapidly provisioned in the cloud using an automated workflow. Novell Cloud Manager features a catalog for workload templates and service levels. Internal IT customers can pick what they need from this catalog, and fine-tune their needs to the extent that Jim, as cloud administrator, allows them. Fast and easy business service delivery means lower TCO and satisfied internal IT customers.

The steps to achieve this are as follows:

1. Jim (cloud administrator) discovers VM templates in the ACME virtual infrastructure, and creates a Cloud Manager workload template for each of them, on a per zone basis.

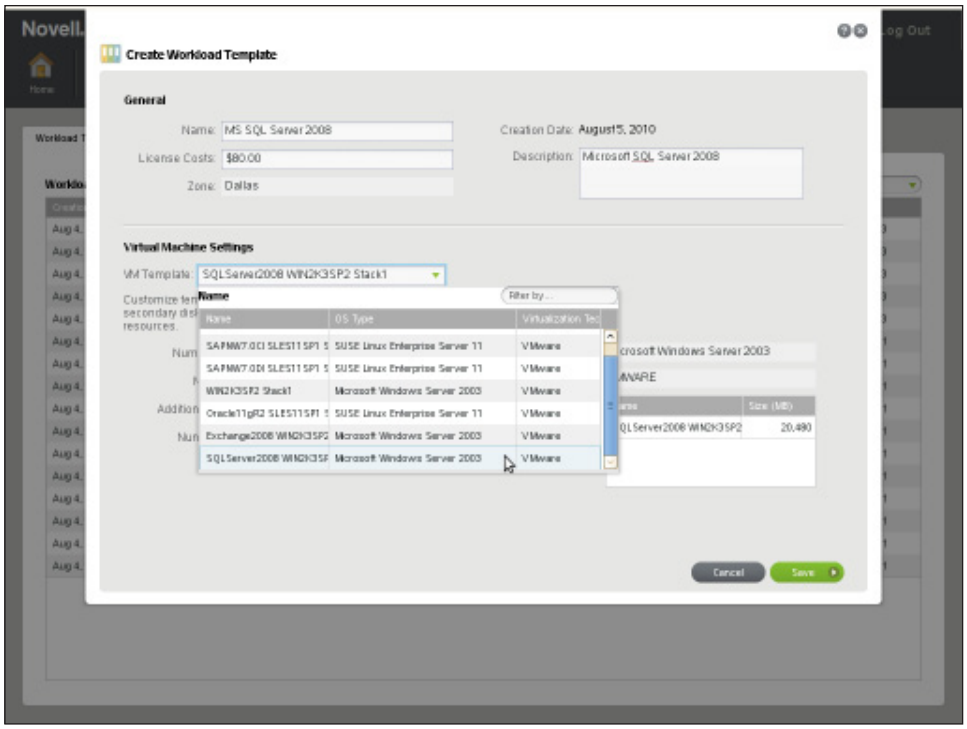

Figure 10: Jim creating a Workload Template

2. As Jim creates a workload template, he can give it a name, add a license cost, and open up or lock down the virtual resource settings. When these settings are locked down, the internal IT customer cannot change them.

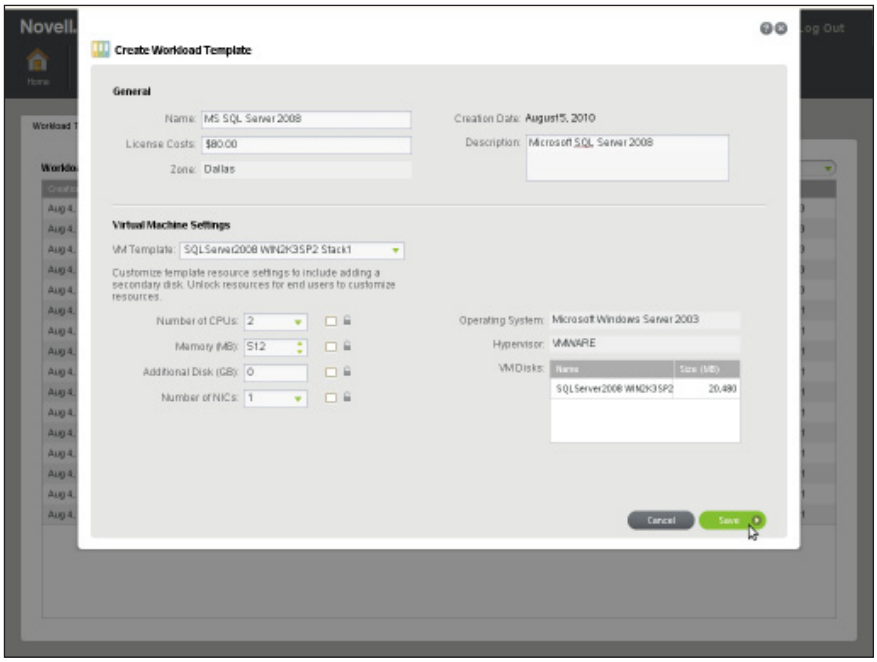

Figure 11: Jim configuring new Workload Template

3. Jim populates the catalog with various workload templates.

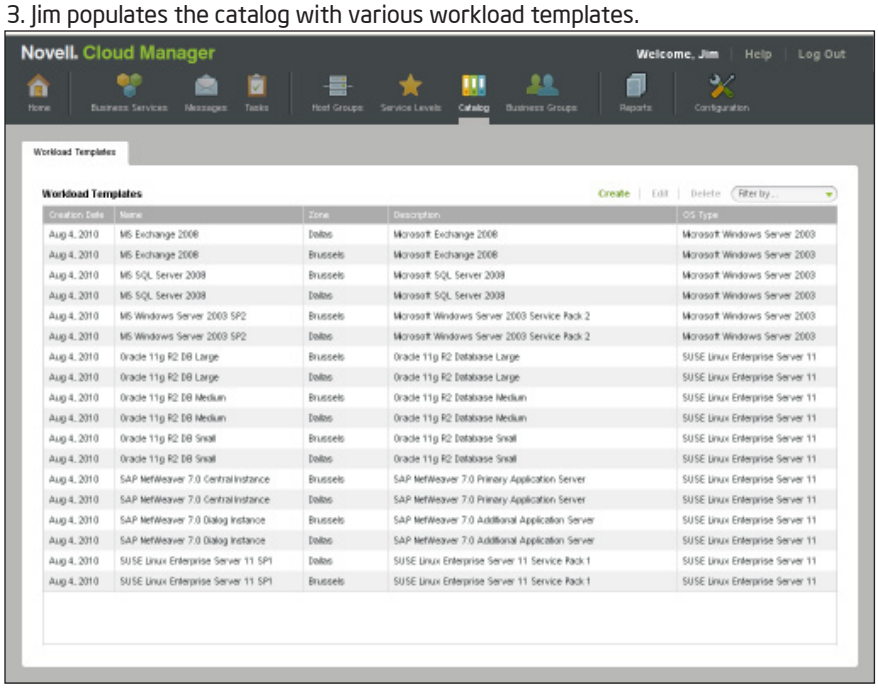

Figure 12: Jim populating the catalog with workload templates

4. Once all workload templates are configured, Jim also adds service levels to the catalog. The service levels used for our use cases are called Bronze, Silver, Gold, and Platinum, and offer increasing levels of service availability at an increasing cost.

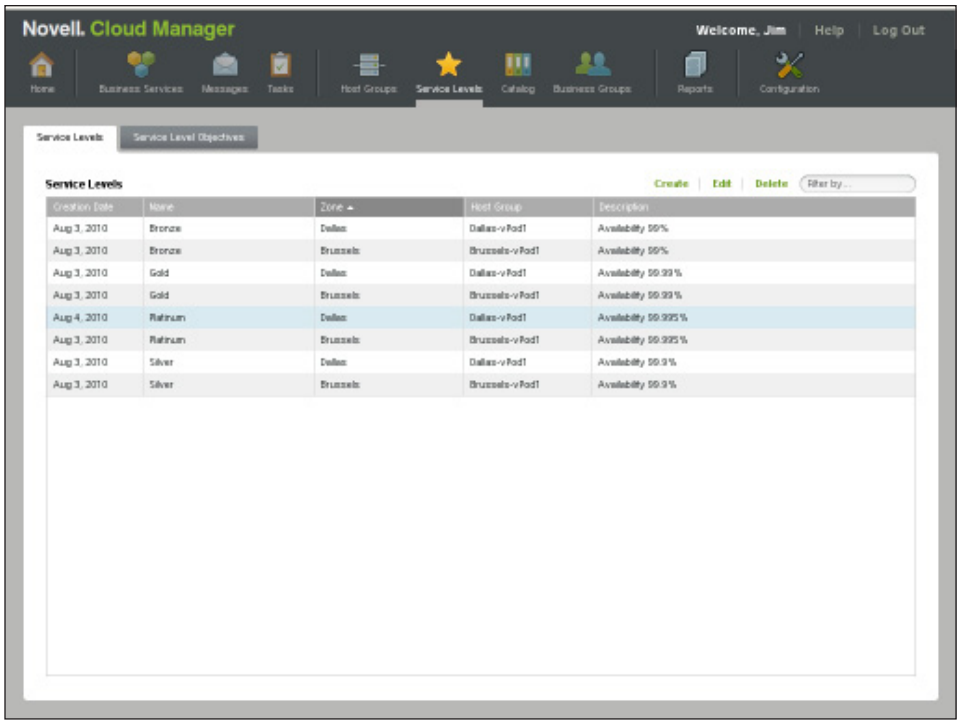

Figure 13: Jim adding service levels to the catalog

Use Case 3: Jim Manages Users and Business Groups

Different users require different applications. Hence Jim (cloud administrator) does not want to expose all workload templates to all internal IT customers. Rather, Jim scopes the catalog on a per business group basis. This increases simplicity for the internal IT customer, and allows Jim to better manage his cloud.

The steps to achieve this are as follows:

1. Jim creates the business group "ERP Application Administrators Team," and adds Kelly, Diana, Bob, and Ron (internal IT customers) to it. He assigns Ron to be the sponsor for the group. Ron will now have to approve all business service requests for this business group.

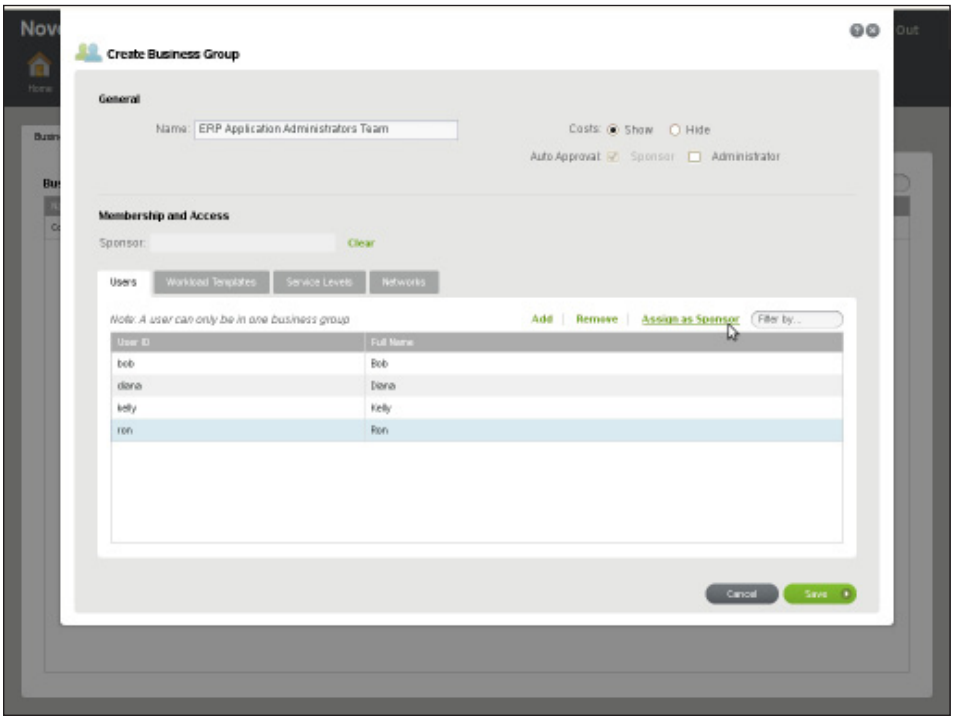

Figure 14: Jim creates a new Business Group

2. In another tab, Jim can select the workload templates that are visible to this business group. As the ERP Application Architects only need to see SAP* related workload templates, Jim only exposes SAP and Oracle*. Jim can also select the service levels and the networks (VLANs) that he wants to expose to this business group.
3. Jim also creates a business group called "Corporate IT Service Administrators Team," adds Fred, Lee, Tom, and Jenny (internal IT customers), and assigns Jenny as the sponsor of the business group. Jim exposes workload templates for Oracle, Microsoft SQL Server*, Microsoft Exchange*, and base operating systems.

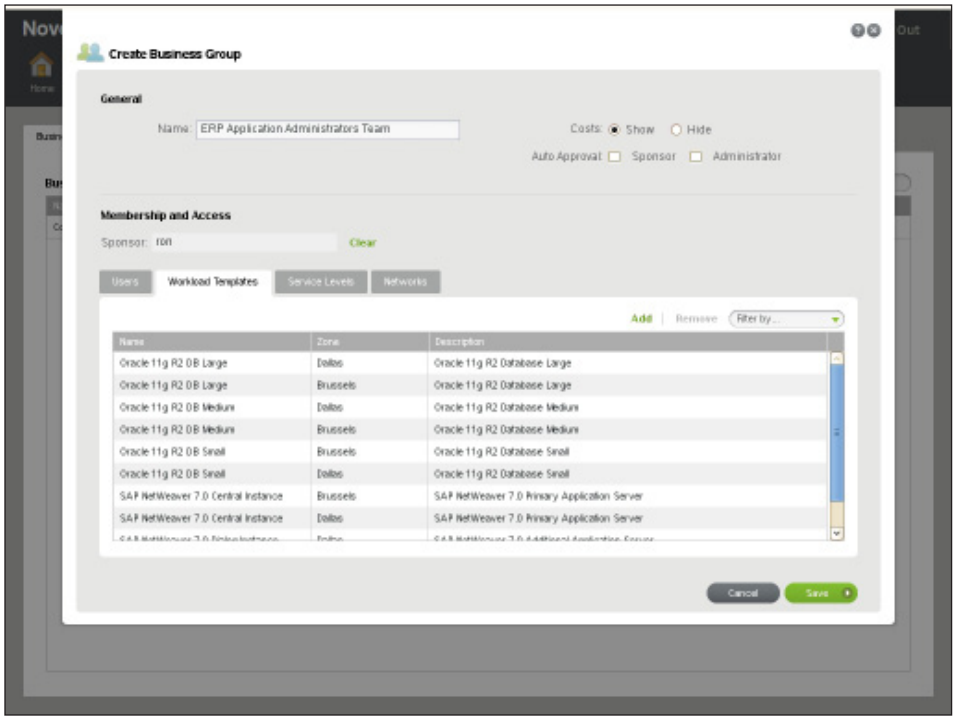

Figure 15: Jim selects the workload templates for the ERP Administrator Business Group

Use Case 4: Diana and Tom Provision New Business Services in the Cloud

Novell Cloud Manager dramatically speeds up the provisioning process of requested business services using a built-in workflow and automated virtual resource provisioning. Rapid service delivery means satisfied internal IT customers. Automation means a decrease in manual interactions in the datacenter, which leads to increased transparency and repeatability, lower TCO, and the elimination of human errors.

The steps to achieve this are as follows:

1. Diana (internal IT customer – ERP Application Architects Team) creates a business service request called "SAP* ERP Operations." This new service will run in the Dallas data center. She opens the catalog and picks the "SAP NetWeaver 7.0 Central Instance" workload template from the list of workload templates that is exposed to her through her business group.

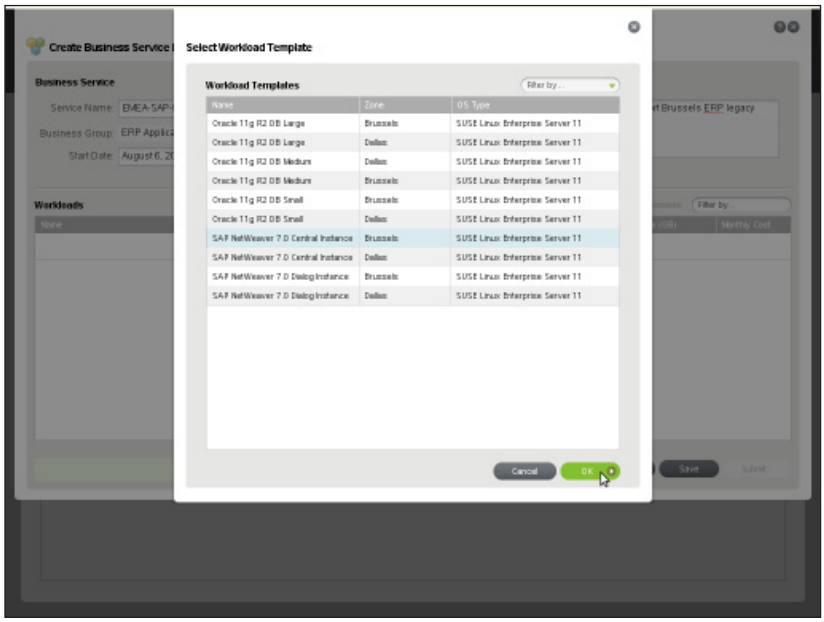

Figure 16: Diana selects a workload template from the catalog

2. Diana can select a service level, and add additional virtual resources to her workload template if needed. As she tunes her workload template, the Total Monthly Cost field shows her what this workload will cost her business unit per month, once provisioned.

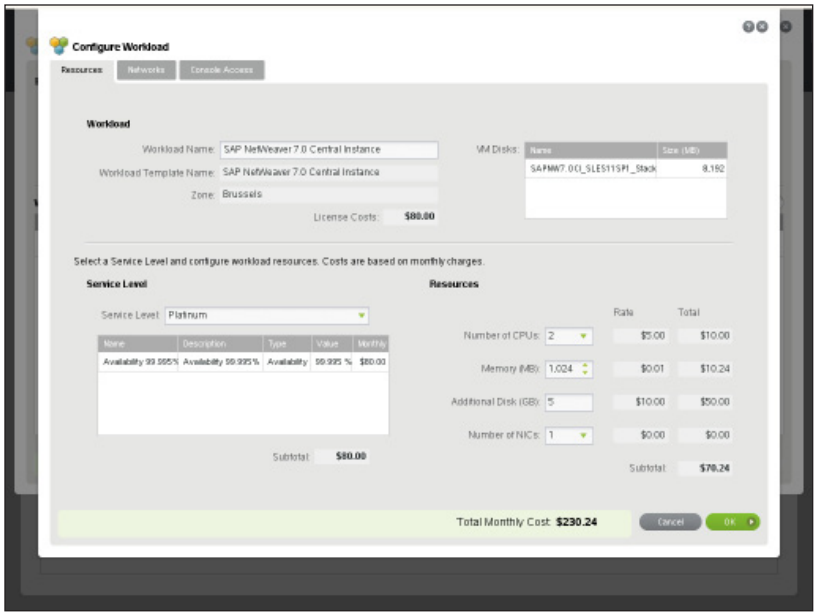

Figure 17: Diana configures the workload template to her specifications

3. As the SAP application server needs a database, Diana adds and configures the workload template "Oracle* 11g R2 DB Medium" to her business service request. This time she can select a service level, but cannot edit the available resources. The database administrator (DBA) team at ACME wants to limit the number of Oracle configurations in the enterprise, so Jim (cloud administrator) has locked down the virtual resource settings. Diana is now ready to submit her business service request.

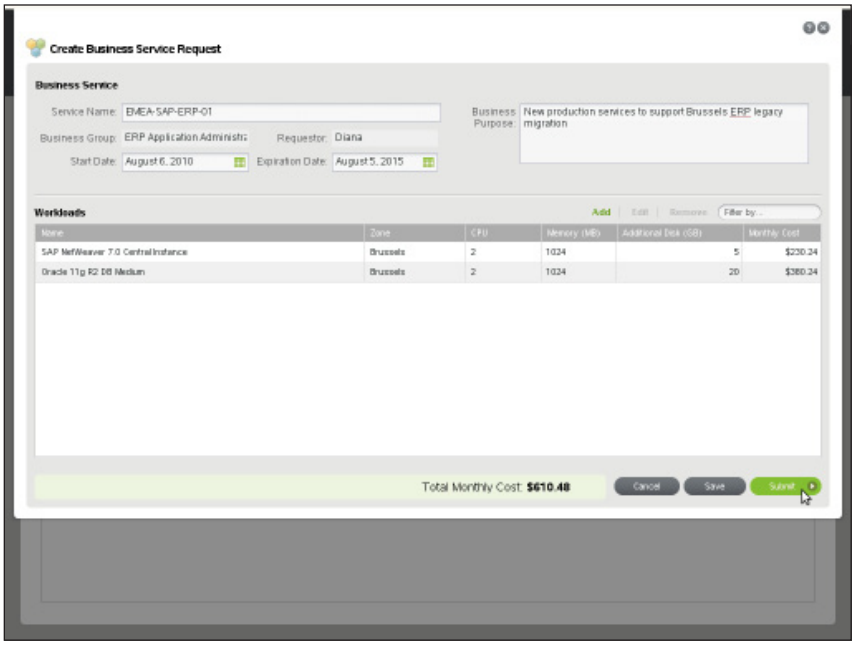

Figure 18: Diana is ready to submit her service request

4. Once Jim has approved the business service request, Ron (the sponsor for the group to which Diana belongs) is invited to log in to Novell Cloud Manager. He can review the cost of the business service and approve or reject Diana's request.

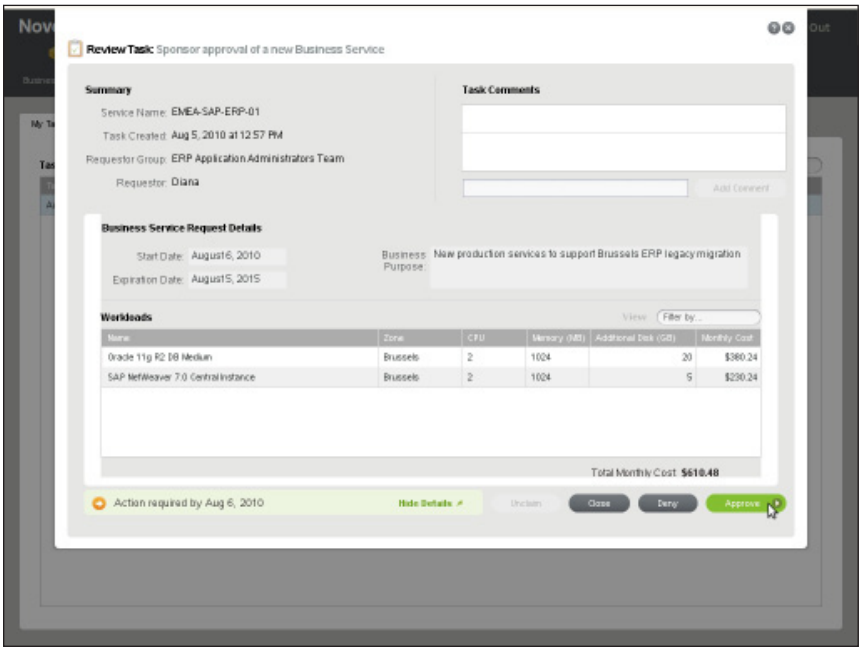

Figure 19: Ron reviews Diana's service request.

5. Once all approvals are in, Novell Cloud Manager automatically builds the business service. Technical teams have the ability to perform tasks before and after the building step. The whole process is streamlined by the Novell Cloud Manager workflow engine. Once all steps are performed, Diana receives an email confirming that her business service is ready. When she logs in, she finds her new service in the "Deployed" state, and up and running.

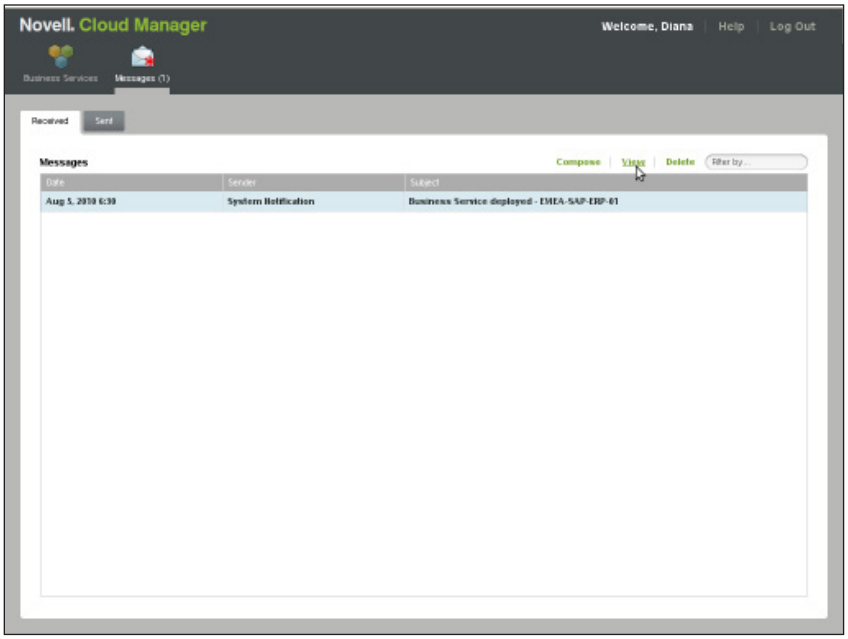

Figure 20: Diana's Business Service is now deployed

6. Diana can now view her business service and log in to the consoles of the individual workloads (as shown in later use cases).

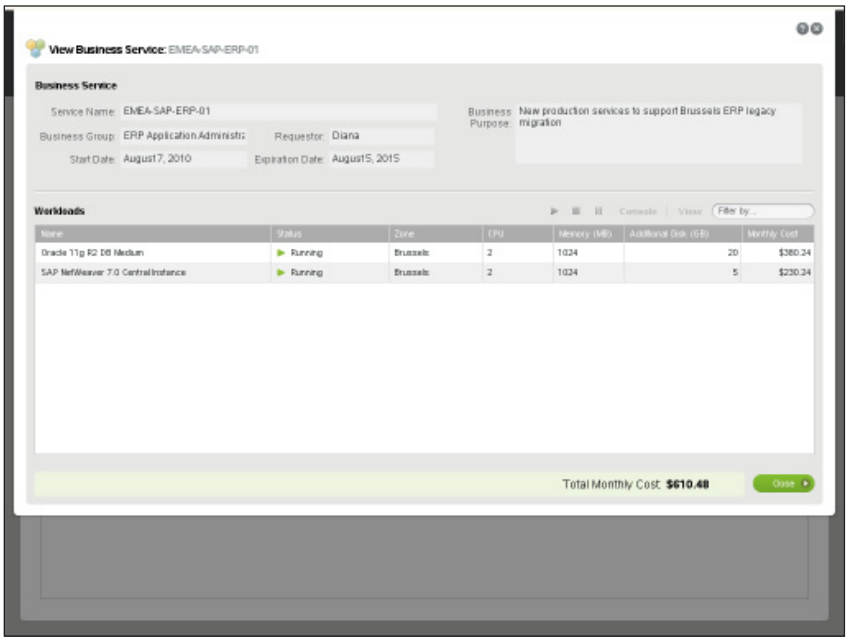

Figure 21: Diana checking the status of her workloads

7. Much in the same way, Tom (internal IT customer – Corporate IT Services Team) orders a Microsoft* Exchange 2008 business service to be provisioned in Dallas. A little while later, his service is ready for use too.

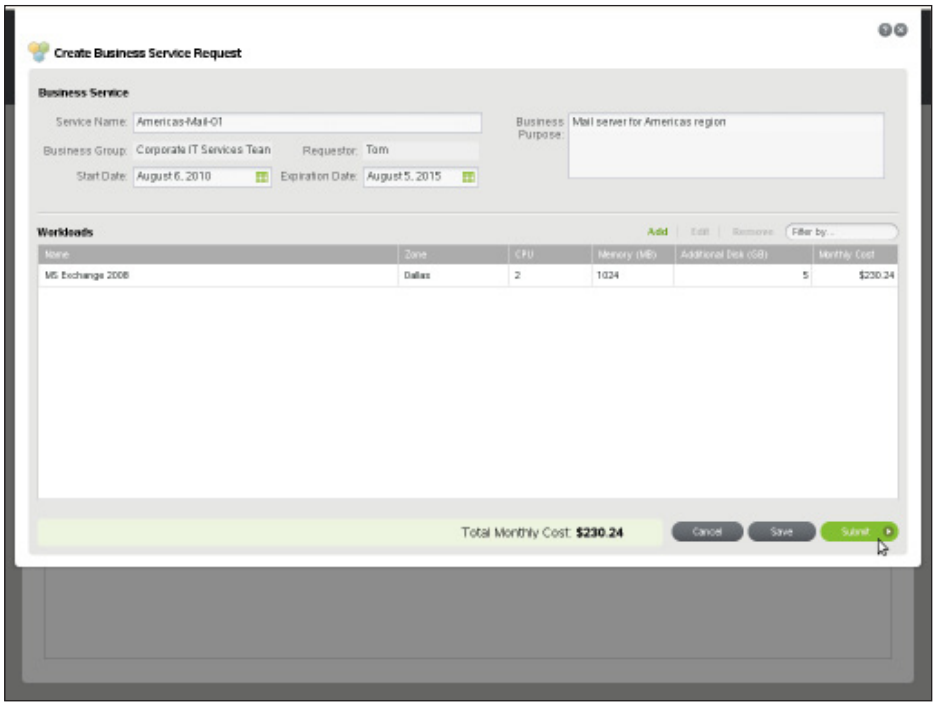

Figure 22: Tom's Business Service deployed in Dallas

Use Case 5: Diana and Tom Check Their Received Services when They Log in to the Workloads

With Novell Cloud Manager, internal IT customers can access their business services over any web-enabled device. Whether or not their service runs in a virtual machine, and regardless of what hypervisor the VM is running on, it's completely transparent to them. This allows Jim (cloud administrator) to mix and match different hypervisors and hardware in the data center, which leads to an overall lower TCO.

The steps to achieve this are as follows:

1. Diana (internal IT customer – ERP Application Architects Team) opens her business service, selects the workload she wants to log in to, and hits the "Console" link.

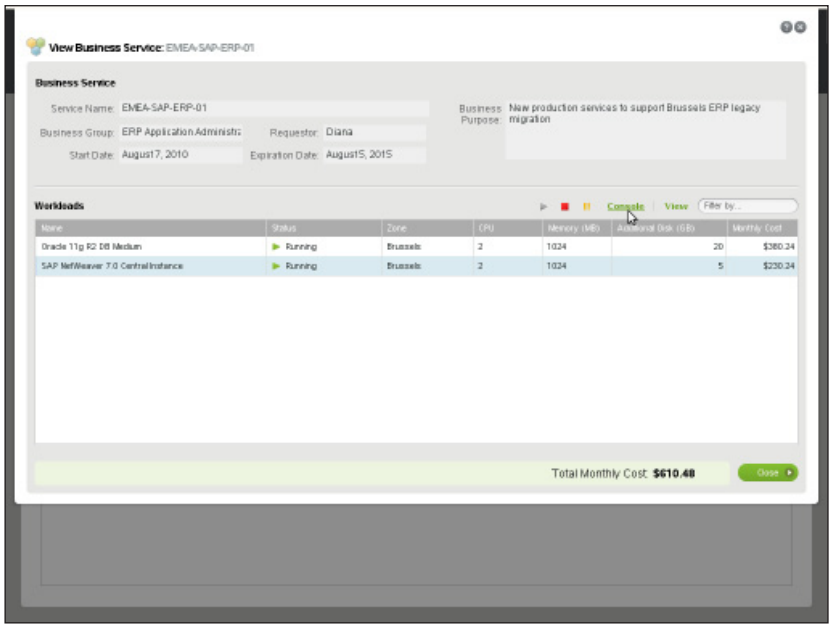

Figure 23: Diana getting ready to view her workload console

2. Cloud Manager asks Diana to provide a password to authenticate the remote connection.

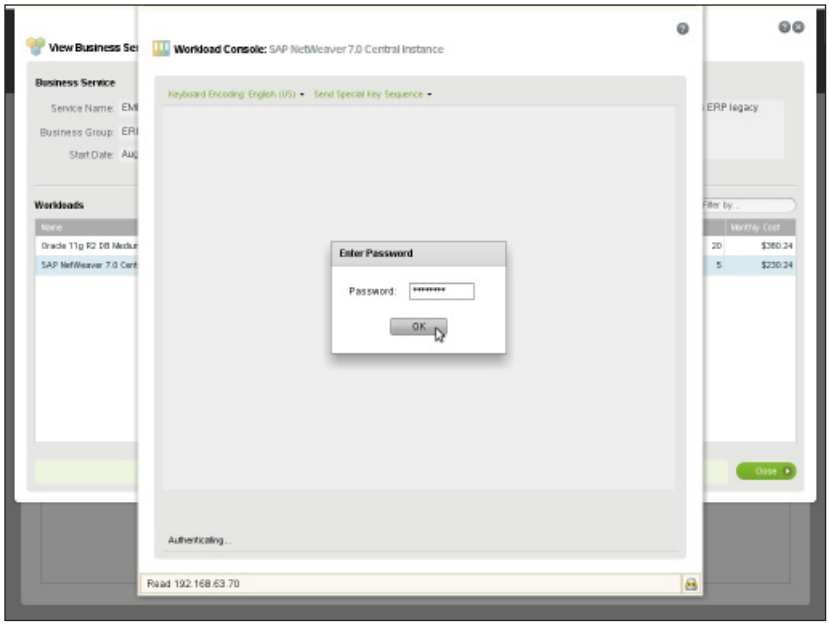

Figure 24: Diana logging on to her workload console

3. After she logs in, Diana can verify that she received the resources she asked for: two cores, two disks, and one network card. She can now start to manage her SAP application.

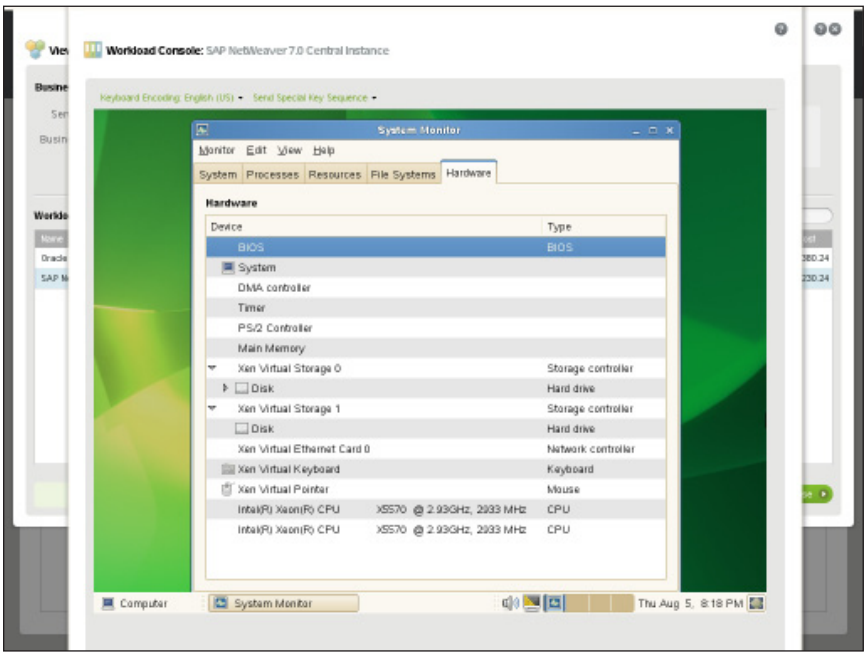

Figure 25: Diana verifies the resources available to her workload

4. Similarly, Tom (internal IT customer – Corporate IT Services Team) opens up the console to his Microsoft Windows-based Exchange 2008 business service, and checks the resources for this workload.

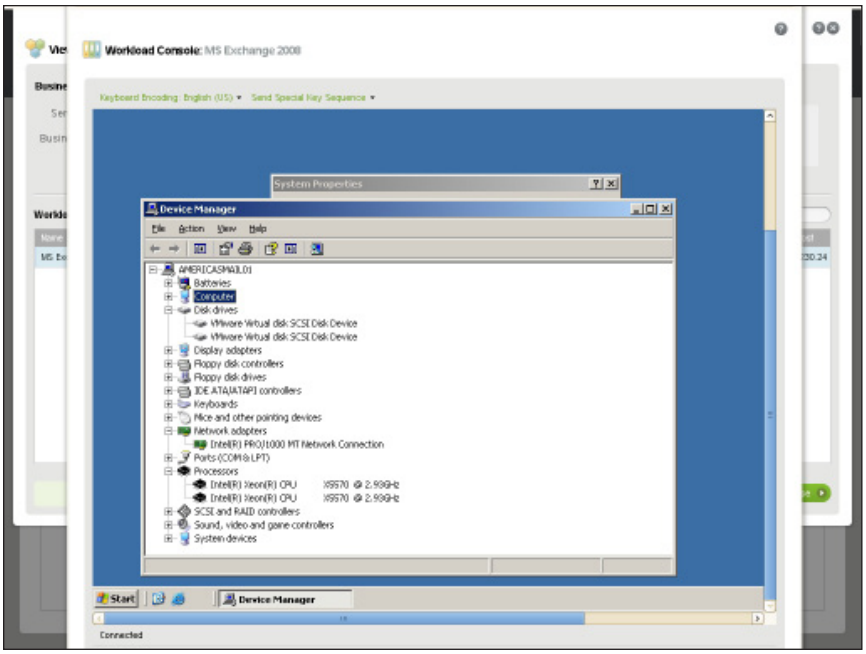

Figure 26: Tom verifies the resources available to his workload

Use Case 6: Diana Scales out an Existing Business Service

As ACME grows, Diana (internal IT customer) needs to provide her business service with more resources to keep up with increasing demand. Cloud computing groups data center resources into pools, so that new workloads can be easily and rapidly provisioned and added to business services.

The steps to achieve this are as follows:

1. To cope with the increasing load on the SAP system, Diana wants to add an SAP Dialog Instance to her business service. She can easily select the new workload template from the catalog, and configure it, just like she configured the first two workloads.

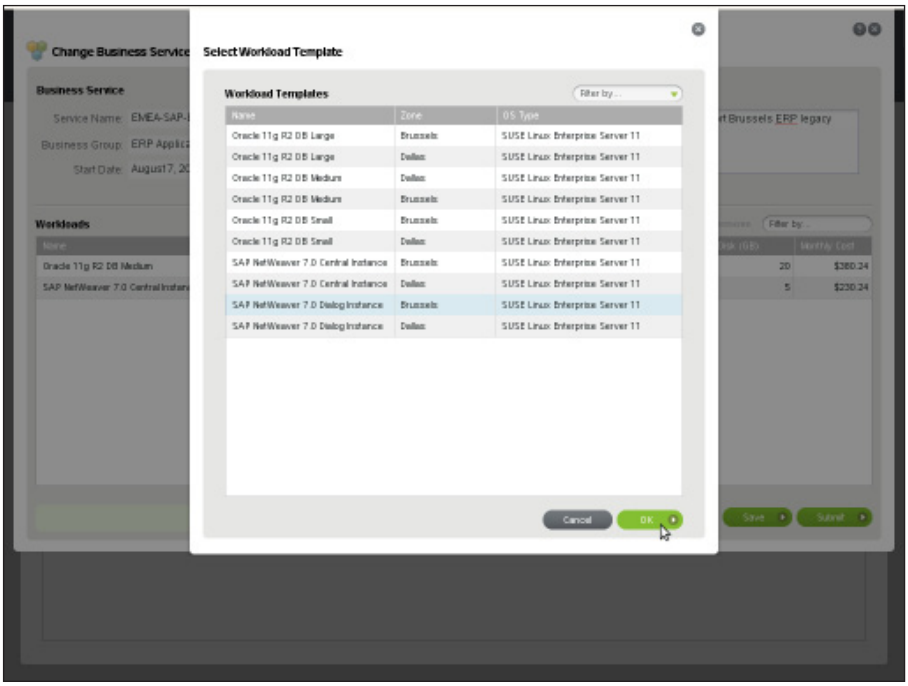

Figure 27: Diana selecting a new workload template to add to her business service

2. Diana is now ready to submit the change request. Once approved by Jim (cloud administrator), Diana's sponsor, Ron, also approves the change. The change in cost is visible to all players.

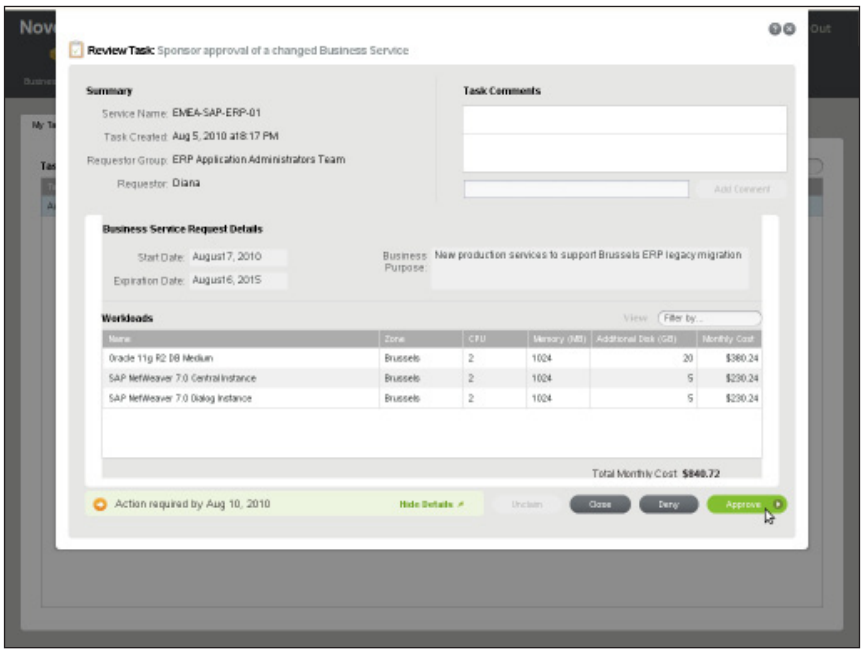

Figure 28: Diana's account page displays her deployed services and the costs associated with them

3. Now that all approvals are in, Novell Cloud Manager provisions the new workload in the cloud. Diana receives an email, inviting her to check up on her changed business service, which now contains three workloads.

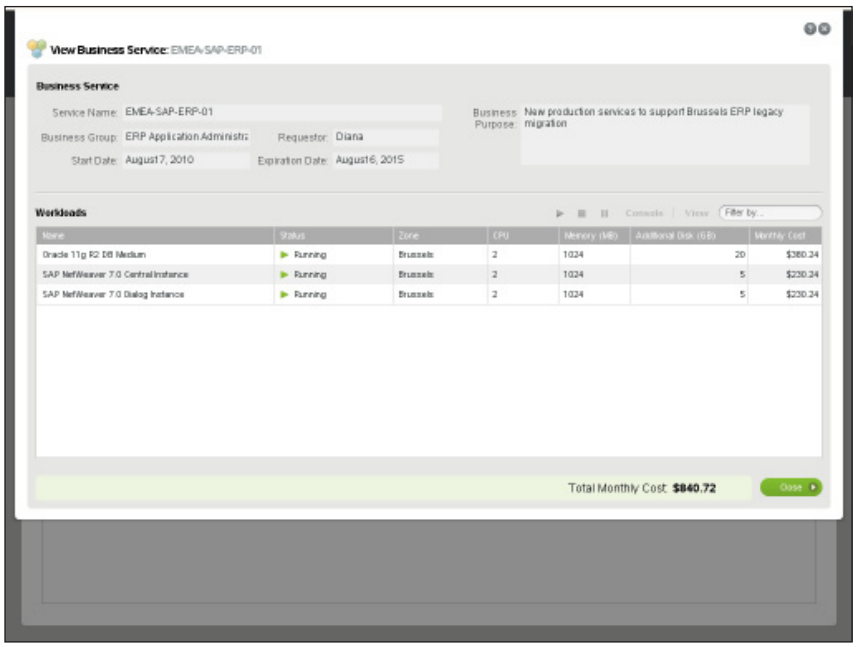

Figure 29: Diana's new workload is now running

Use Case 7: Diana Delegates Business Service Rights to Bob and Kelly

Flexible and efficient business service management guarantees an overall good usability experience for internal IT customers. This does not end when the business service has been provisioned. As an example, when employees from a business group go on holiday, they must be able to delegate certain levels of control over their business services to other employees in their business group.

The steps to achieve this are as follows:

1. Diana delegates "Read Only" rights to Bob, and "Full Control" rights to Kelly (all internal IT customers from the "ERP Application Architects Team" business group).

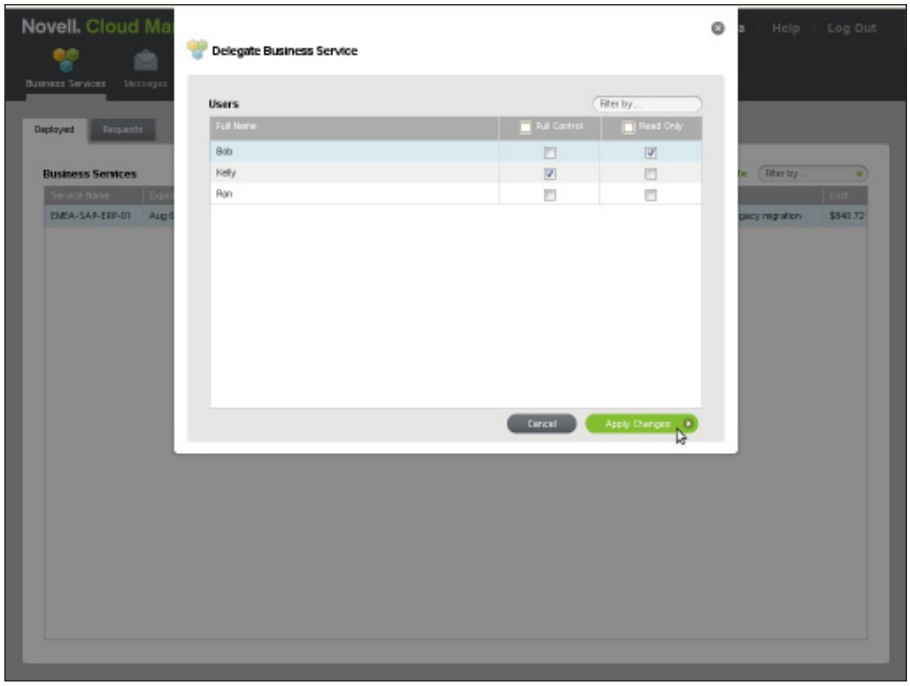

Figure 30: Diana's delegation screen

2. When Bob logs in to Novell Cloud Manager, he sees Diana's SAP service, but he can only check up on the workloads, to see if they are up and running.

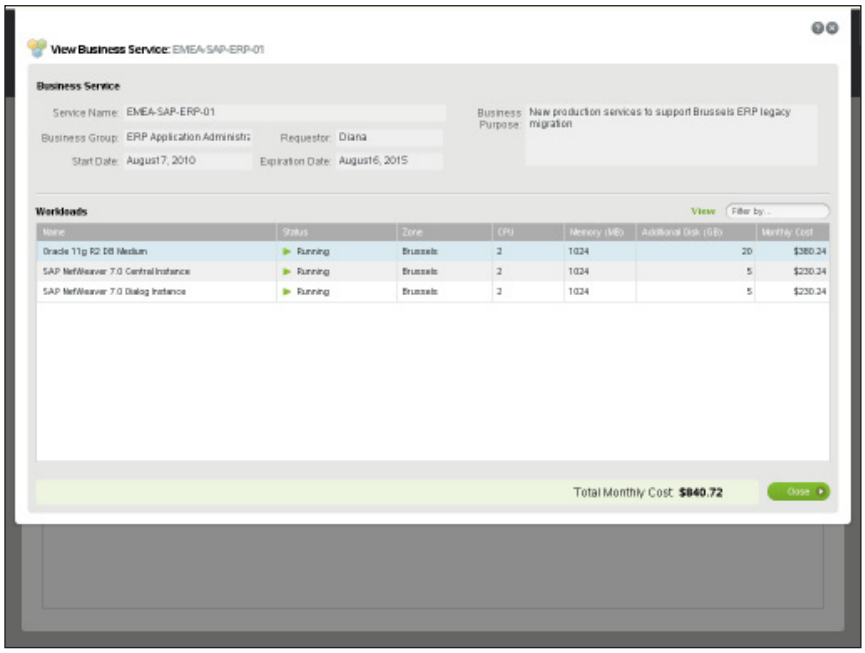

Figure 31: Bob viewing the status of Diana's workloads

3. Kelly however, has the same control over Diana's SAP business service as Diana herself.

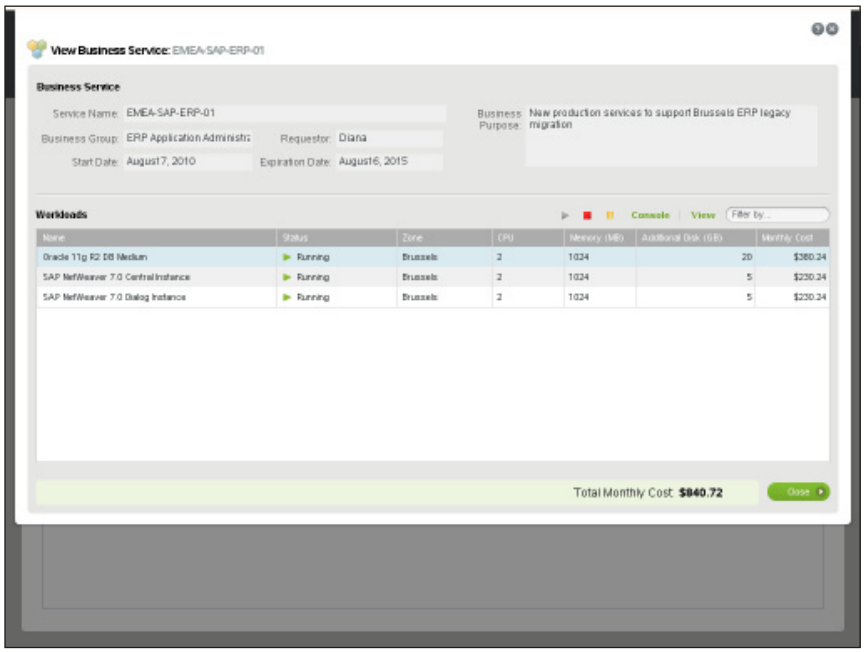

Figure 32: Kelly viewing Diana's workloads

Use Case 8: Jim Generates Detailed Cost Reports

Novell Cloud Manager restores transparency to the real cost of virtualization. Costs can be linked to workload templates, virtual resources, and service levels. Jim (cloud administrator) can generate reports of these costs, so that sponsors and other stake holders can make intelligent business decisions.

The steps to achieve this are as follows:

1. Novell Cloud Manager ships with several out-of-the-box reports that can be run per business group, or for all business groups. In our example, Jim generates a cost details report for all business groups.

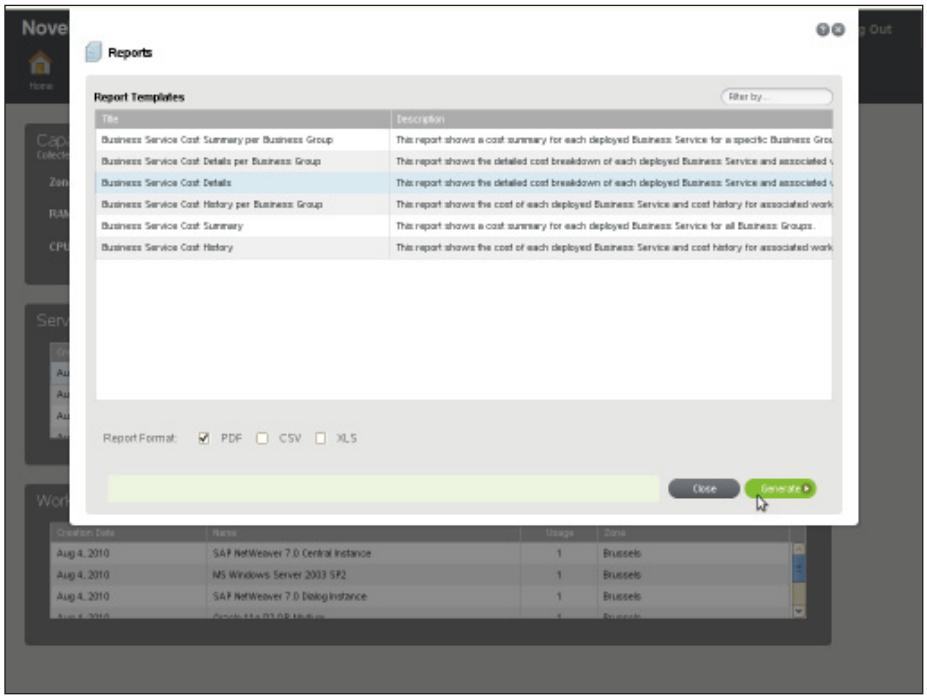

Figure 33: Jim's report screen

2. The report can be exported as pdf, Microsoft* Excel spreadsheet, or CSV.

Novell® Cloud Manager

Business Service Cost Details

All Business Groups

Business Group: Corporate IT Services Team

Business Service:	EMEA-Mail-01	Start Date: 06-Aug-2010	Expiration Date: 04-Aug-2015	
Workloads		Service Level	Zone	Workload Cost
MS Exchange 2008		Platinum	Brussels	$ 230.24
			Monthly Business Service Costs:	$ 230.24

Business Service:	Americas-Mail-01	Start Date: 06-Aug-2010	Expiration Date: 04-Aug-2015	
Workloads		Service Level	Zone	Workload Cost
MS Exchange 2008		Platinum	Dallas	$ 230.24
			Monthly Business Service Costs:	$ 230.24

Business Group: ERP Application Administrators Team

Business Service:	EMEA-SAP-ERP-01	Start Date: 06-Aug-2010	Expiration Date: 05-Aug-2015	
Workloads		Service Level	Zone	Workload Cost
Oracle 11g R2 DB Medium		Platinum	Brussels	$ 380.24
SAP NetWeaver 7.0 Central Instance		Platinum	Brussels	$ 230.24
SAP NetWeaver 7.0 Dialog Instance		Platinum	Brussels	$ 230.24
			Monthly Business Service Costs:	$ 840.72

Page 1 of 2

Figure 34: Detailed business service report

Use Case 9: Jim Seamlessly Manages Different Hypervisor Types in the ACME Cloud

Novell Cloud Manager allows Jim (cloud administrator) to mix and match several industry-leading hypervisors in ACME's private internal cloud: VMware vSphere 4, SUSE Linux Enterprise Server, Xen, and the Microsoft Windows Server 2008 (Hyper-V) hypervisor. Being able to use best-in-class hypervisors for various purposes reduces vendor lock-in and drives down TCO.

The steps to achieve this are as follows:

1. For the purpose of this reference architecture, we tested various combinations of VM operating systems and hypervisors, provisioned with Novell Cloud Manager. Some examples are: Microsoft Windows Server 2003 SP2 on Xen, SUSE Linux Enterprise Server 11 SP1 on Xen, and Microsoft Windows Server 2003 SP2 on VMware vSphere 4. For a complete list of supported platforms and hypervisors, consult the Novell Cloud Manager product documentation.[4]

Use Case 10: Jim Scales out the Cloud by Adding More Compute Resources

As the success of the ACME corporation grows, so do the needs of its internal private cloud. Jim (cloud administrator) must be able to easily add new physical resources to the cloud to accommodate this growing need.

The steps to achieve this are as follows:

1. Initially, the cloud consists of six hypervisors: three VMware ESX 4.0 VM Hosts, and three SUSE Linux Enterprise Server 11 SP1 Xen VM Hosts.

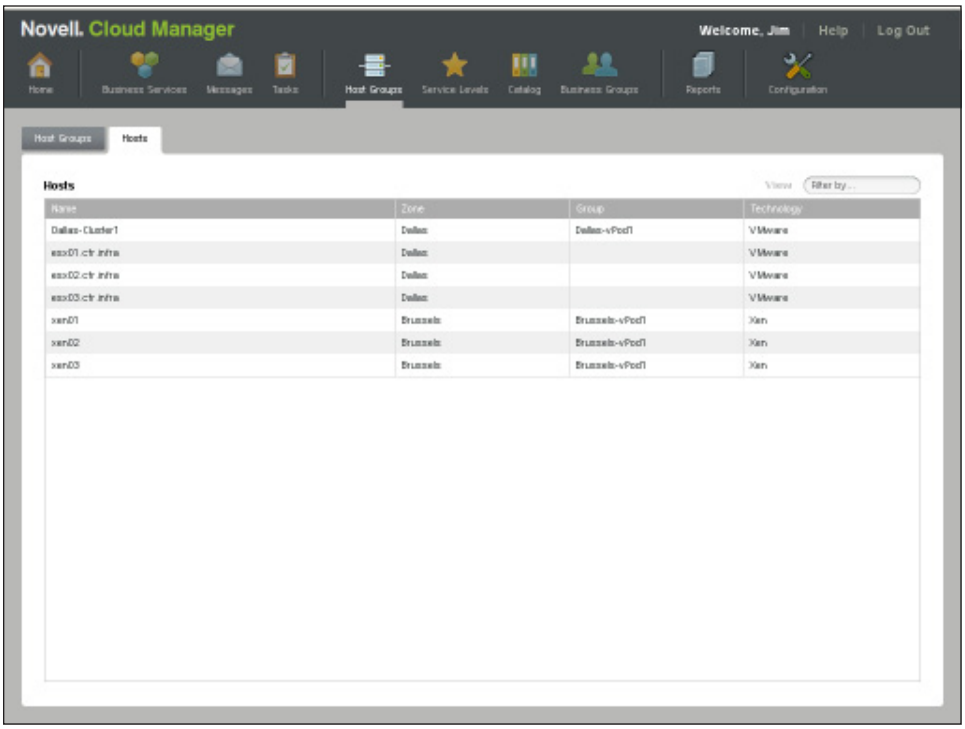

Figure 35: Jim views all the resources available in his cloud

2. Jim now adds an additional ESX 4.0 VM Host to the existing VMware cluster. Alternatively, he could add a complete new cluster. He also adds an additional SUSE Linux Enterprise Server 11 SP1 Xen VM Host, and installs the Novell Cloud Manager agent on it.

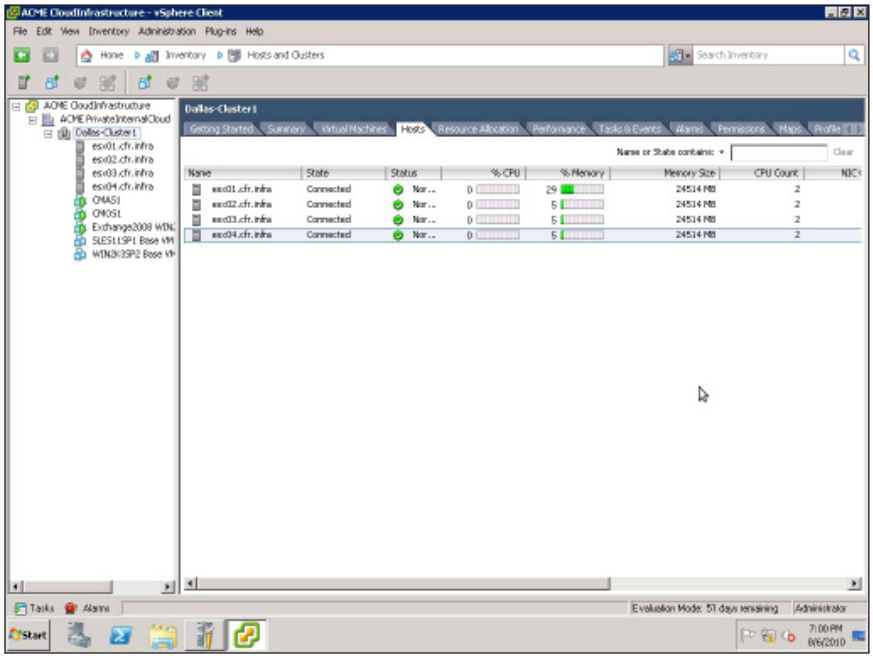

Figure 36: Jim adds a new host to his cluster

3. After being discovered in their respective zones, the new VM Hosts automatically show up in the Novell Cloud Manager Hosts section, and can now be added to existing or new host groups.

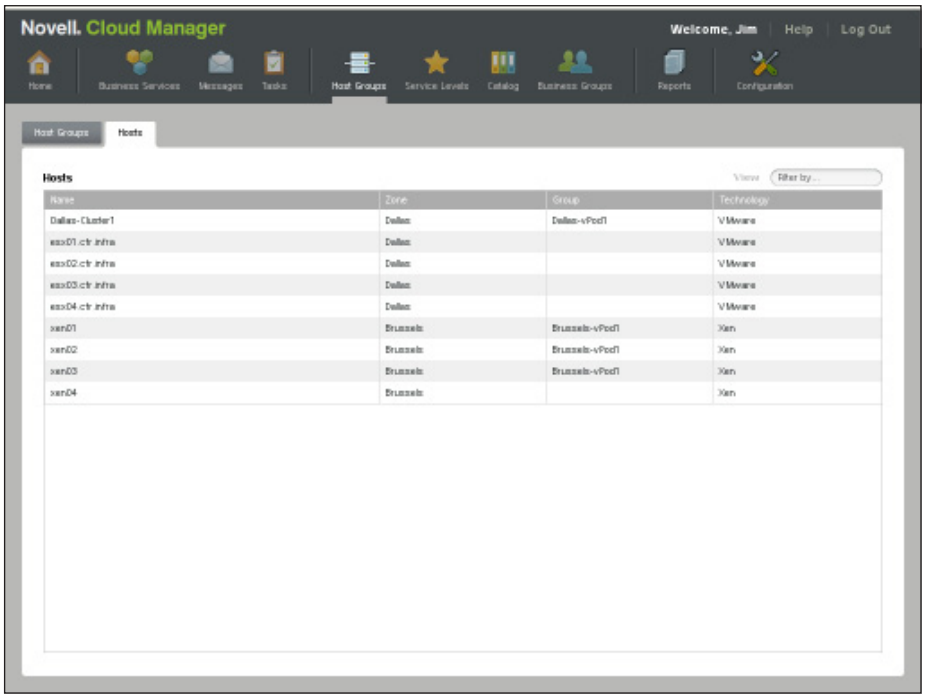

Figure 37: The newly added server is available

Use Case 11: Jim Tests a Physical Server Failure Scenario

In order to deliver the promised service levels for availability, Jim (cloud administrator) needs to make sure that cloud workloads are protected from physical hardware failure, and that recovery is handled transparently.

The steps to achieve this are as follows:

1. In Dallas, the VMs are provisioned in a VMware vSphere 4 cluster with High Availability enabled. The VMware HA technology ensures that a VM is reprovisioned when an ESX VM 4.0 VM Host crashes. For the Brussels zone, the Cloud Manager Orchestration Service is responsible for the high availability of the workloads that run on the Xen VM Hosts. To test this, Jim performs a hard reset on xen01.cfr.infra, to see what happens with the SAP VM that's running there. He uses the Orchestration Service's console to monitor the low-level VM operations.

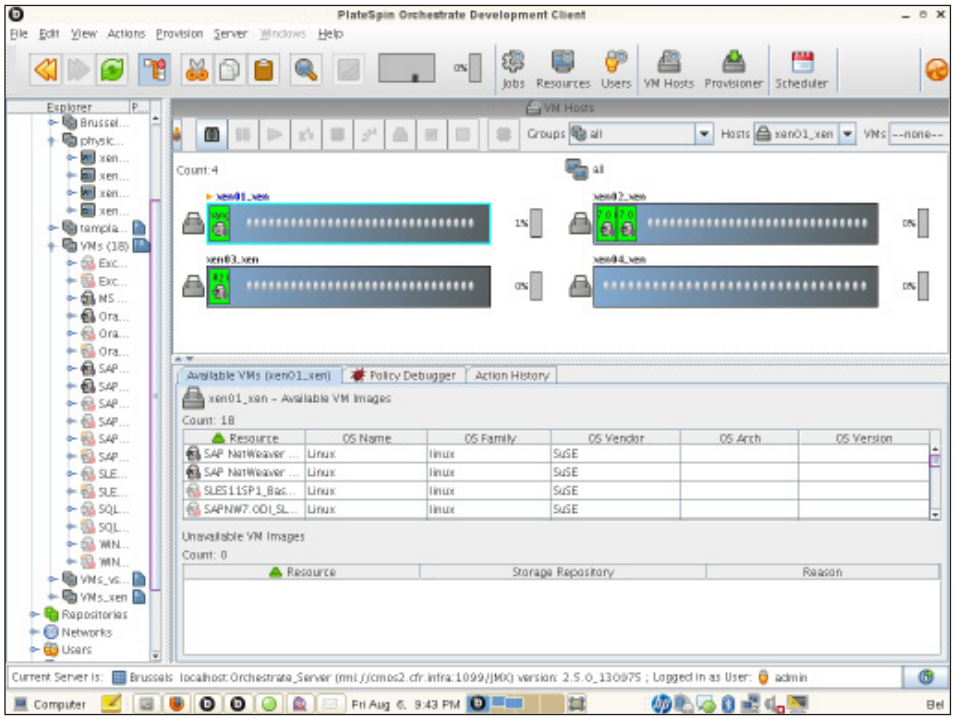

Figure 38: Using the Orchestration Service to monitor the VMs

2. As seen in the console, the Orchestration Service picks up the failure of the VM Host, and automatically re-provisions the SAP VM to esx02.cfr.infra. This operation is completely transparent to the Cloud Manager Application Service.

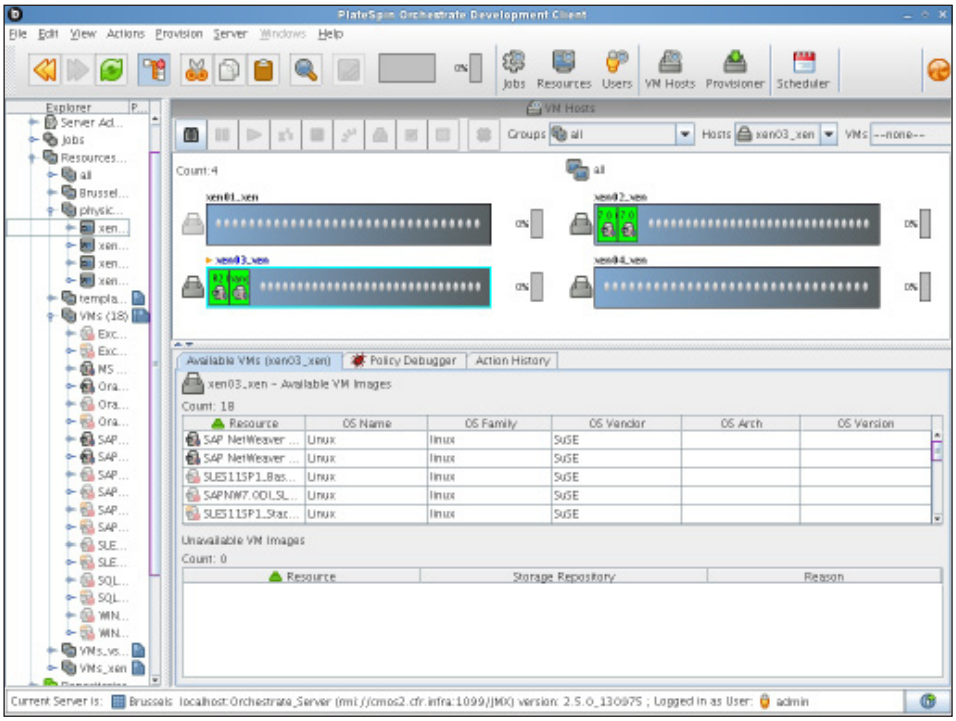

Figure 39: The Orchestration Service shows the re-provisioned VM

Use Case 12: Tom Is Able to Isolate His Network from Other Cloud Users (Vlan)

In order to achieve an environment that's ready for multi-tenancy, with hard isolation between applications, internal IT customers must be able to provision business services into isolated networks (VLANs). This ensures that internal IT customers in one business group cannot tamper with or even see services that belong to other business groups.

The steps to achieve this are as follows:

1. Jim (cloud administrator) sets up additional virtual networks in the respective virtual infrastructures in Dallas and Brussels. In Dallas, this is done by adding two new virtual networks (called "ERP" and "ITServices") to each VMware ESX 4.0 virtual switch.

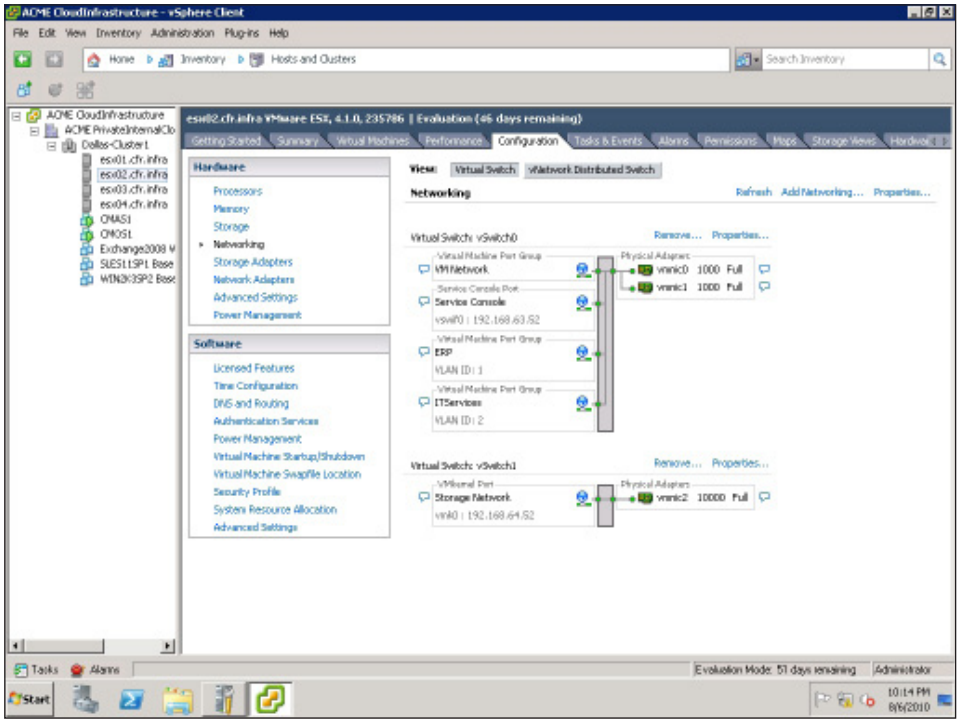

Figure 40: Jim adds two new virtual networks

2. In Brussels, Jim simply adds two VLAN-based bridges (called "ERP" and "ITServices") to his Xen VM Hosts.

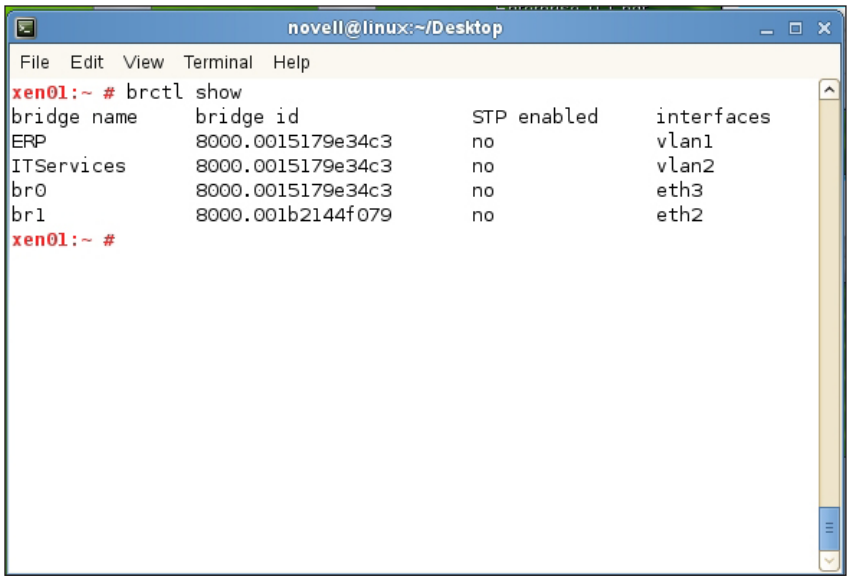

Figure 41: Jim adds two VLAN bridges

3. After discovering the networks in Novell Cloud Manager, Jim assigns the "ERP" network in Dallas and Brussels to the business group "ERP Application Administrators Team," to which Tom (internal IT customer) belongs. Similarly, he adds the "ITServices" network in both zones to Tom's (internal IT customer) group, called "Corporate IT Services Team."

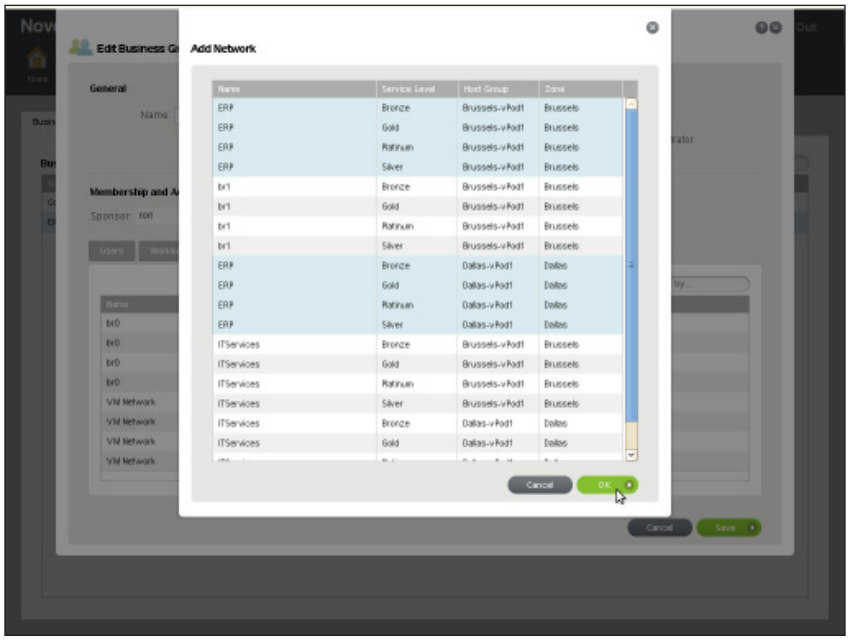

Figure 42: Jim assigns the new networks to the respective Business Groups

4. When Tom wants to order a new Microsoft SQL Server 2008 business service for Dallas, he can now select the "ITServices" network, to indicate that this business service needs to go on a dedicated, isolated network.

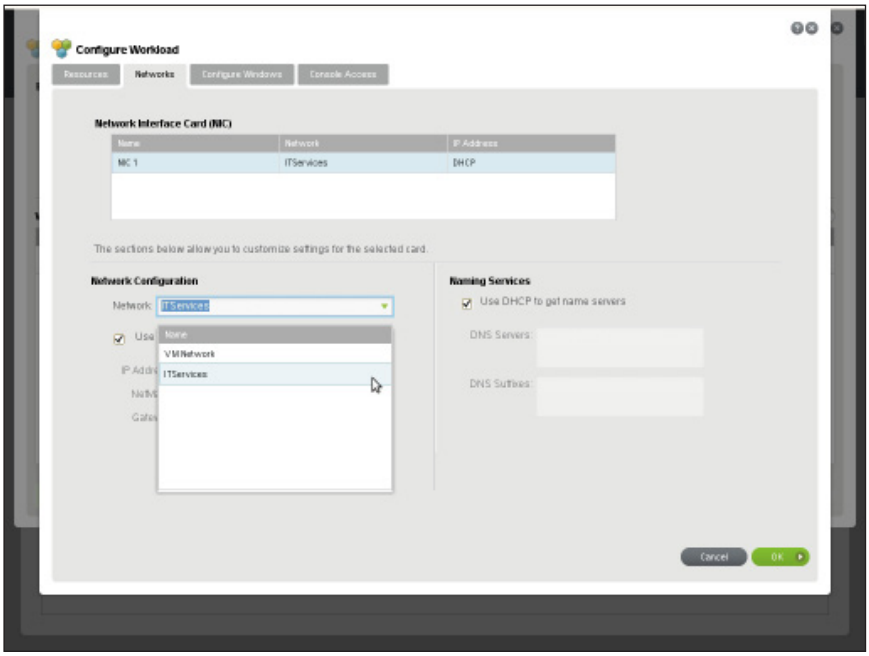

Figure 43: Jim configures a Business Service to go on an isolated network

5. Tom does the same thing when ordering a new Microsoft SQL Server 2008 business service for Brussels.

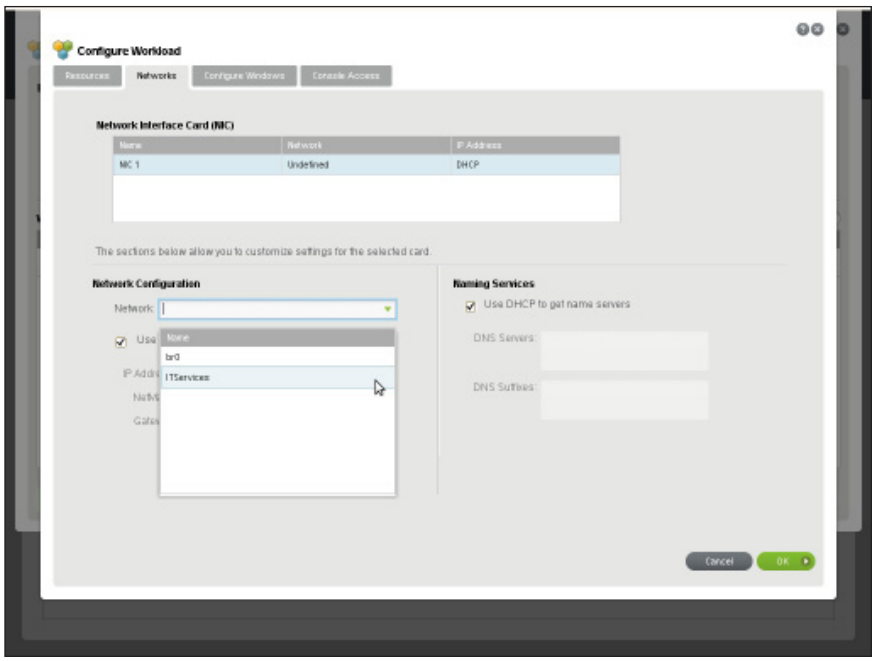

Figure 44: Tom configures his Business Service to go on a different network

6. Once provisioned, the Microsoft SQL Server 2008 workload running in Dallas on VMware vSphere 4 cannot see the Cloud Manager Application Server (which sits on the default "VM Network"), but it can see the other Microsoft SQL Server 2008 workload running in Brussels on SUSE Linux Enterprise Server 11 SP1 Xen.

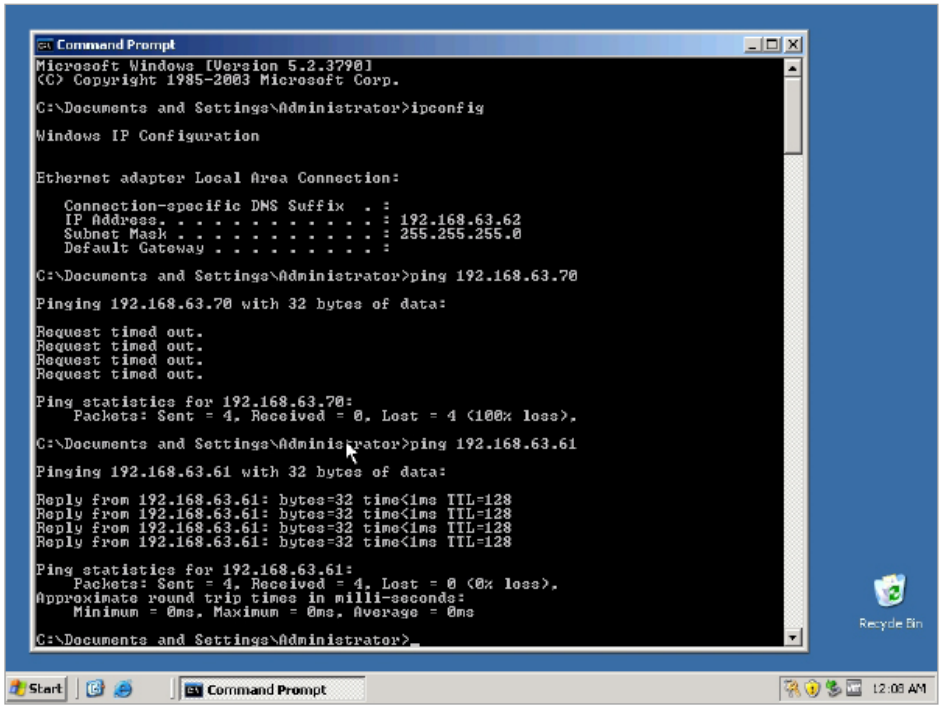

Figure 45: Services on different virtual LANs cannot access each other's resources

Next Steps

The previous design implements a multi-tenant internal private cloud. However, this design has only limited means to ensure that the software and BIOS on each node are in fact the exact versions that are approved. With Intel Xeon processor 5600 series, the trusted multi-tenancy technology is in place to be able to measure the key components of the BIOS and the hypervisor prior to allowing the server to join a pool of resources in the cloud. Some of the features in the new Intel Xeon processor 5600 series include:

1. Intel® Trusted Execution Technology (Intel® TXT) [5]: Using capabilities in the processor, chipset, BIOS, and a Trusted Platform Module (TPM), Intel TXT provides a mechanism for enabling a very small atomic level of "assumed trust" while allowing a robust basis for verification of platform components such as BIOS, option ROMs, etc. to a hypervisor or operating system. With Intel TXT, the assumed trust (root of trust) is pushed down into the processor itself — perhaps the best-protected component of any platform.
2. Intel® Advanced Encryption Standard New Instructions (AES-NI) [6]: Intel AES-NI are a new set of instructions available on Intel Xeon processor 5600 series based on the 32nm Intel® micro-architecture. These instructions enable fast and secure data encryption and decryption, using the Advanced Encryption Standard (AES) which is defined by FIPS Publication number 197.[7] Since AES is currently the dominant block cipher, and it is used in various protocols, the new instructions are valuable for a wide range of applications.
3. Intel® Intelligent Power Node Manager [8] and Intel® Data Center Manager [9] are used for power management and coordinate with policies to optimize power usage. These tools can allow for power capping, which avoids circuit breaker trips or hot spots in the data center. For more information, please refer to Baidu's case study using the Intel Intelligent Power Node Manager.[10]

Things to Consider

- **Network Technology Architecture**
  Novell Cloud Manager supports several network technology architectures. For this test bed, we selected a very simple network topology. The selection made for this test bed performed well for our purposes, but more advanced technologies and architectures (channel bonding technologies, highly segmented network architectures, etc.) may be more suitable for production deployments.
- **Storage Architecture (NFS vs. non-NFS / SAN or non-SAN)**
  Novell Cloud Manager supports several storage architectures. For our test bed, we selected the simplest option, a single NFS. This performed acceptably for our purposes, but more advanced architectures are recommended for production deployments.
- **Hardware Considerations**
  A full discussion of processor and overall server performance considerations is beyond the scope of this paper. However, it is important to note that the performance of virtual machines running on the cloud platform is heavily influenced by factors of processor architecture, and specific feature sets available in the processor such as Intel® Virtualization Technology for Directed I/O (VT-d). The use of high-performance server processors equipped with virtualization and I/O support feature sets, such as the Intel Xeon processor 5600 series, is strongly recommended. For more details on Intel Virtualization technologies please refer to http://www.intel.com/technology/virtualization/technology.htm?iid=tech_vt+tech.
- **Solid-State Drives (SSDs)**
  The performance of storage nodes (and compute nodes when local storage is utilized), as well as the overall power consumption of the cloud, may be favorably impacted by the use of SSDs. This was not specifically tested within our exercise.
- **Security Considerations**
  Security is a key consideration in the selection and management of IaaS. A complete discussion of best practices for cloud security, from the perspective of both the Enterprise and Service Provider, is beyond the scope of this document. However, the following points should be considered:
  - Established best practices for host security in a conventional physical host context (e.g., password management, patch management, server hardening, anti-malware, etc.) should be applied equally to virtual hosts operating on an IaaS platform.
  - IaaS platforms such as Novell Cloud Manager provide full isolation between virtual servers by employing full hardware-assisted virtualization. This provides each virtual server with its own virtual hardware, its own private operating system instance, etc. This contrasts with cloud platforms based on "domains" or "containers," in which some virtual hardware and some operating system components are shared between virtual hosts, which creates additional avenues of attack.
  - Novell Cloud Manager can further segregate the virtual hosts belonging to different customers at the level of the network, isolating the network traffic of each customer into one or more private VLANs.

- **Software Appliance Considerations**
  - SUSE Appliance Toolkit, with the award-winning SUSE Studio*, enables infrastructure managers and cloud administrators to create appliance based templates of in-house applications and software. This means they only have to maintain a single operating system and support a single set of software versions. This increases application security, while reducing troubleshooting, support and maintenance costs, compliance issues, and application outages related to software updates. With the SUSE Appliance Toolkit, building a new software appliance can be done with just a few mouse clicks in a couple of minutes. An integrated Support Assessment module ensures that new appliances are fully supported. Combining Novell Cloud Manager with the SUSE Appliance Toolkit results in a reliable, high quality and predictable software delivery process that saves you time and money.

Glossary

Infrastructure as a Service (IaaS): is the delivery mechanism of the use of computing resources (such as network, storage, and CPU cycles) as a service, typically through virtualization

Hypervisor: is a layer of software that allows multiple operating systems to run concurrently on a host computer

HA: High Availability

Node/Host: is a single physical server that can host the various operating systems and hypervisors

VM: Virtual Machine

RDP: Remote Desktop Protocol, a proprietary protocol developed by Microsoft that provides a user with a graphical interface to a remote computer

VNC: Virtual Network Computing, a platform independent graphical desktop sharing system similar to RDP

VT-d: Intel Virtualization for Directed I/O, an Intel technology that assists in I/O virtualization

VT: Intel Virtualization technology, an Intel technology that assists in CPU and memory virtualization

Endnotes

1. Intel Xeon processor 5600 series: http://www.intel.com/itcenter/products/xeon/5600/index.htm or http://ark.intel.com/ProductCollection.aspx?series=47915
2. Novell Cloud Manager: http://www.novell.com/cloudmanager
3. VMware vCenter: http://www.vmware.com/products/vcenter/
4. Novell Cloud Manager Product Data Sheet: http://www.novell.com/docrep/2010/08/novell_cloud_manager_data_sheet.pdf
5. Intel Trusted Execution Technology: http://www.intel.com/technology/security/downloads/TrustedExec_Overview.pdf
6. FIPS Publication 197 (AES): http://csrc.nist.gov/publications/fips/fips197/fips-197.pdf
7. Intel Advanced Encryption Standard New Instructions: http://software.intel.com/en-us/articles/intel-advanced-encryption-standard-aes-instructions-set/
8. Intel Intelligent Power Node Manager: http://communities.intel.com/docs/DOC-4765
9. Intel Data Center Manager: http://software.intel.com/sites/datacentermanager/
10. Baidu Case Study with Intel Intelligent Power Technology: http://software.intel.com/sites/datacentermanager/intel_node_manager_v2e.pdf

To learn more about deployment of cloud solutions,
visit www.intel.com/software/cloudbuilder

Disclaimers

[Δ]Intel processor numbers are not a measure of performance. Processor numbers differentiate features within each processor family, not across different processor families. See www.intel.com/products/processor_number for details.

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