

Using VMware Lab Manager for the Support Organization at SAP Business Intelligence



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1.0 Introduction

This paper describes a VMware® Lab Manager solution for a software product support environment and its large group of support engineers at SAP®, one of the world's largest software companies. The support engineers work within the new Lab Manager environment in parallel with other support personnel who oversee the technical needs of the department. The solution allows the support engineers and managers at SAP® BusinessObjects™ to perform their support tasks more effectively, thus reducing the costs of solving problems and enhancing customer satisfaction with the company's end user products.

VMware Lab Manager brings the following advantages to the support function at SAP:

- Allows the support teams to construct complex test configurations of SAP products rapidly so they can re-create customer scenarios and issues.
- Reduces the time it takes to resolve customer support calls by a significant factor.
- Simplifies the migration of customer data from one version of the application to another by allowing the SAP support engineers to test that migration in a contained environment.
- Allows engineers to work on replicas of premium customers' systems in-house, thereby giving a higher level of service to those customers.
- Improves security by centralizing the storage of customer data rather than having it dispersed to engineers' workstations.
- Allows engineers to work on software versions that are internationalized and localized to many different languages.
- Facilitates the testing and repair of defects across many different operating systems.
- Reduces time to market for new products by decreasing the time to implement new product training for the support engineers.

These advantages are explored more fully in the remainder of this document. SAP BusinessObjects set a goal to improve the effectiveness of its support engineering in the area of reproduction testing. The objective was best accomplished when the company deployed VMware Lab Manager.

2.0 Business Challenges

SAP is the leader in enterprise software solutions used by the largest institutions in the world, the best known of which is the Enterprise Resource Planning (ERP) suite, but which also include a comprehensive business intelligence (BI) suite that came from its acquisition of Business Objects® in 2008. The customer support function within the business intelligence unit is the main subject of this paper. The BI support department forms the user community for the VMware Lab Manager implementation at SAP.

In order to provide technical support for the complex multi-tiered applications and datasets that make up the business intelligence software suite, SAP support engineers need to reproduce customer problems rapidly at their own site, very often remotely from the original customer reporting the problem. Problem reproduction can be a very complicated endeavor because these applications have inter-dependent parts that can be run on different operating systems, with many variations in versions and patches. Prior to the adoption of Lab Manager SAP attempted to solve this problem with very limited success. These attempts involved using multiple desktop-based virtual machines, with hand-crafted links between them, and ad-hoc customer setups by

the engineers on request. While this configuration was better than the equivalent older physical system, it did not fully meet the needs of the organization. Customer support calls were taking too long to resolve. The main bottleneck to effective operation was the time it took to set up the required test systems in order to reproduce the problem.

VMware Lab Manager allows the support engineers to check out a fully-fledged configuration from a pre-existing library containing known valid configurations of the company's product. Some of these configurations are replicas of important customer installations, often with the different parts of the BI application installed in multiple virtual machines. After checkout, Lab Manager allows the engineers to deploy (i.e. boot up and run) the configuration of virtual machines on to a pool of ESX host servers and test it for a problem at the application level, without being concerned about which ESX host machine the system occupies. This removes a large burden from the shoulders of the customer support (CS) engineers and from the IT setup staff who help them to get their job done. It also lowers the company's costs by reducing the time to resolve issues and generates higher customer satisfaction scores.

3.0 High Level Use-Case Summary

In the SAP application support world, many engineers can work on similar but slightly different configurations of their products at one time – each with some customer-specific data of their own. The contents of the underlying databases in the business intelligence solutions will vary for each customer. Doing this type of work means that the same application may operate independently but concurrently in several isolated customer contexts. Lab Manager is the only product available on the market that allowed the SAP support engineers to isolate the copies of each application image type from each other.

This was crucial for other technical reasons also. Certain older SAP software components will not work correctly if the server name, IP address or MAC Address for the host operating system changes from one invocation of the application to another. SAP eliminated this problem by exploiting the network fencing capability in Lab Manager. The network fencing feature allows engineers to keep the internal network structure (including the network addressing) consistent within a configuration of virtual machines, even if the same configuration is deployed multiple times on the same set of ESX host servers.

The company's pre-existing knowledge of the VMware ESX and VMware Workstation products made for an easier learning curve for the support engineers with VMware Lab Manager. This background knowledge decreased the time needed for the engineers to become effective using the new testing infrastructure. As well, the engineers liked being able to share multi-virtual machine configurations quickly among themselves, as this ability reduced the need for different engineers to recreate systems multiple times. Sharing configurations enables a more efficient problem escalation process and reduces time to resolution for the customer.

Each support engineer at SAP handles several support calls during each working day. These support calls often require complex configurations made up of multiple tiers of application software and database products. These tiers must be connected together; for instance, the application or business analysis logic needs to retrieve data from a database tier. This scenario can prove to be complex to set up – especially at short notice, when a problem is holding up customer business. Before adopting the VMware Lab Manager solution, engineers built these multi-tier systems out of component parts, each of which was itself a virtual machine running in the VMware Workstation desktop environment. This approach required significant effort to get the entire system working correctly – and often the resulting configurations were not retained for re-use – so they had to be reconstructed many times over.

The support organization decided to move to a shared image configuration library environment, Lab Manager, which utilizes a pool of multiple ESX host systems at its back end for virtual machine deployment. This environment frees the IT support team from having to allocate physical and virtual machines to the support engineers on an ad-hoc basis. By using Lab Manager to control the transient technical environment that is a support engineer's daily working set, they increased the productivity of the engineers and reduced the costs of maintaining all the instances and servers that were needed in the previous system.

Key Decisions in the Lab Manager Adoption Process

SAP's support engineering organization wanted a system that was easy to manage and fit their specialized software needs. The system also had to be quick to train on so that the engineers could rapidly get to work supporting the customer base, and it had to be robust enough to support their most challenging deployments.

One of the additional benefits for SAP is that a global roll out of VMware Lab Manager reduced the need for individual storage on separate workstations. Instead the organization wanted to move towards a common secured storage for all customer-related testing files. SAP is also looking at reducing the need for desktop test engineering machines, replacing them for the most part with browser access to ESX-based servers hosting VMware Lab Manager. SAP expects the move to a browser-based user interface to reduce costs further and improve the company's environmental footprint by lowering the need for server cooling and power.

4.0 Technology Overview

This section describes the VMware Infrastructure environment and the Lab Manager solution. It also outlines the types of product configurations with which the SAP support engineers work.

VMware Infrastructure

VMware Infrastructure is the most widely deployed software suite for optimizing and managing IT environments through virtualization, from the desktop to the datacenter. VMware Infrastructure has delivered results at more than 120,000 customers of all sizes and is used in a wide variety of environments and applications. The VMware Infrastructure suite is fully optimized, rigorously tested and certified for a wide range of hardware, operating systems and software applications. This enables enterprise-wide standardization independent of operating systems and hardware. VMware Infrastructure provides built-in management, resource optimization, application availability and operations automation capabilities that deliver cost savings as well as increased operational efficiency, flexibility and IT service levels.

VMware Infrastructure virtualizes and aggregates the underlying physical hardware resources (such as CPU bandwidth and RAM) across multiple physical systems and provides pools of computing resources to optimize datacenter management in the virtual environment. These resource pools can be shared in a variety of ways depending on the importance of the applications within the different virtual machines – and their relative “shares” of that pool's resources.

In addition, VMware Infrastructure provides a set of distributed services that enables fine-grained, policy-driven resource allocation, high availability, and consolidated backup of the entire virtual data center. These distributed services empower an IT organization to establish and meet production service level agreements (SLAs) with its customers in a cost-effective manner.

Figure 1 shows the relationships among the components of VMware Infrastructure.

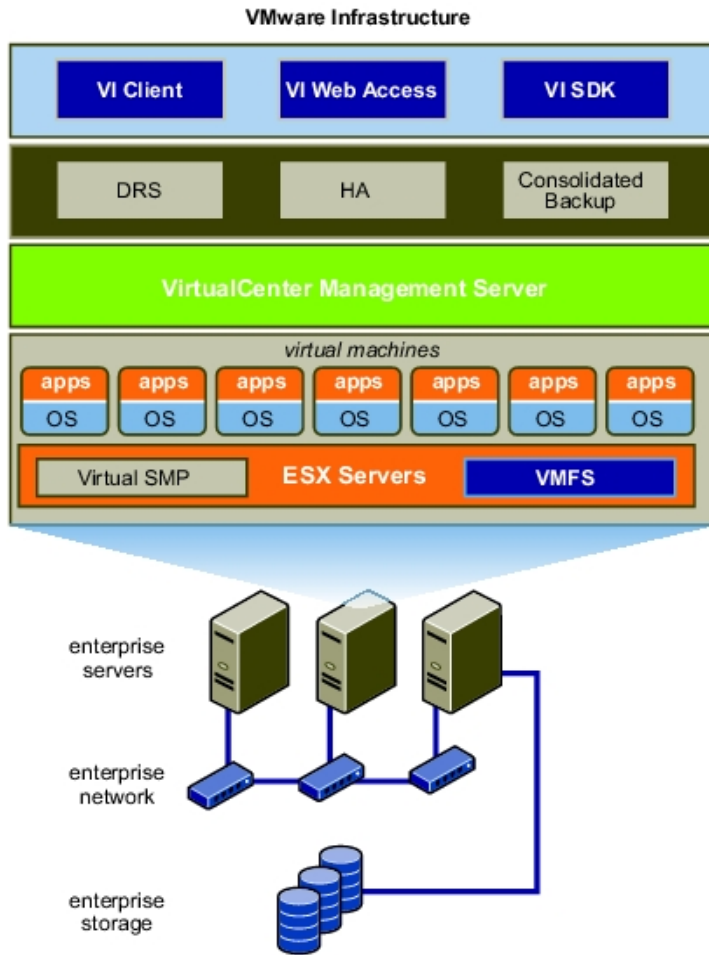


Figure 1. VMware Infrastructure Components

VMware Infrastructure includes the following components:

- **VMware ESX (ESX):** A robust, production-proven virtualization layer, run on physical servers, that abstracts processor, memory, storage, and networking resources into multiple virtual machines.
- **VMware VirtualCenter™ Management Server (VirtualCenter):** A central point for configuring, provisioning, and managing virtualized IT environments.
- **VMware Virtual Infrastructure Client (VI Client):** A graphical interface that allows users to connect remotely to VirtualCenter Server or to individual ESX instances from any Windows PC.
- **VMware Virtual Infrastructure Web Access (VI Web Access):** A Web interface that allows virtual machine management and access to remote consoles.
- **VMware Virtual Machine File System (VMFS):** A high-performance clustered file system for ESX virtual machines.
- **VMware Virtual Symmetric Multi-Processing (SMP):** Allows a single virtual machine to use multiple physical processors simultaneously.

- **VMware Vmotion™ (VMotion):** Enables the live migration of running virtual machines from one physical server to another with zero down time, continuous service availability, and complete transaction integrity.
- **VMware High Availability (HA):** Provides easy-to-use, cost-effective high availability for applications running in virtual machines. In the event of server failure, HA automatically restarts affected virtual machines on other production servers that have spare capacity.
- **VMware Distributed Resource Scheduler (DRS):** Allocates and balances computing capacity dynamically across collections of hardware resources for virtual machines.
- **VMware Consolidated Backup (Consolidated Backup):** Provides a centralized facility for agent-free backup of virtual machines. It simplifies backup administration and reduces the load on ESX host servers.
- **VMware Infrastructure SDK (SDK):** supports a standard programming interface for VMware and third-party solutions that want to access VMware Infrastructure.

Figure 2 illustrates the basic components of virtualization infrastructure that are covered in this document.

A single VirtualCenter Management Server instance manages multiple ESX hosts, as shown in Figure 2 below. The Virtual Infrastructure (VI) clients connect to VirtualCenter in order to create resource pools and clusters within which the virtual machines reside. The VI Client instances provide a management view of the pool of ESX host machines and resources that Lab Manager uses to host configurations made up of multiple virtual machines.

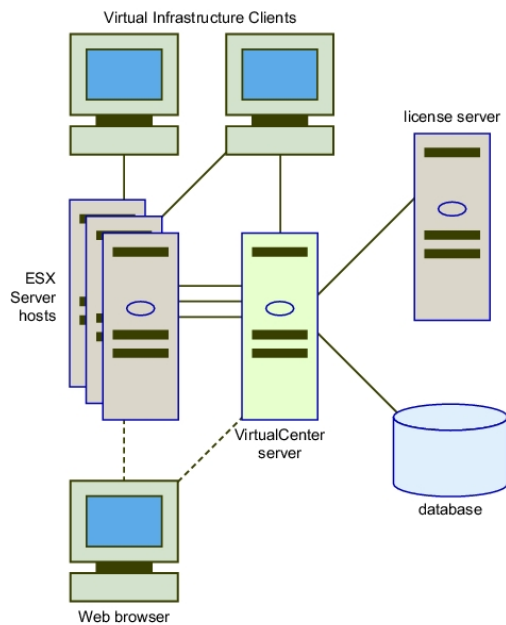


Figure 2. VMware VirtualCenter Server Outline architecture

VMware Lab Manager

VMware Lab Manager is a lab automation, management and rapid provisioning tool for collections of virtual machines that use the VMware Infrastructure environment. It automates the process of provisioning sets of one or more virtual machines (called “configurations”) and enables the management of the lifecycle of these configurations from creation to final archiving and retirement. It simplifies and automates the tasks of the support engineer, the systems tester or quality assurance person, as well as the tasks of the IT systems support person who provides services and templates to the engineers, when dealing with the multiple tiers of a distributed application. The IT support team can set up VMware Lab Manager so that the engineers can self-provision the configurations that they need, with little or no intervention required from other engineering staff. This self-service provisioning environment saves a great deal of time and effort for everyone in the development, QA, support and the IT support organizations.

VMware Lab Manager allows SAP’s support teams to construct complex configurations of several related, inter-connected virtual machines and treat them as a single deployment unit. Any configuration composed of multiple virtual machines can be checked out from the Lab Manager configuration library to an engineer’s private workspace. The entire checked-out configuration can then be deployed (i.e. started up) by the engineer on a shared pool of ESX host servers. The application within the virtual machines can then be tested and any problems can more easily be diagnosed. That same configuration can be shared with other engineers and then later undeployed (i.e., the constituent virtual machines are stopped) if need be. Shared configurations can include the current state of the virtual machines, so that others may see exactly what the symptom of a problem test case was, at the time it occurred.

In the undeployed state, the virtual machines within a configuration are no longer occupying ESX server resources, saving the computing resources in the ESX host server pool for others to use. With Lab Manager, the deployment (booting) and undeployment (shutdown) of complex configurations are simple one-click operations that can be used by suitably-entitled engineers at will. Lab Manager then decides on which ESX server to place each virtual machine, saving the engineers the trouble of making that decision.

The lifecycle of these connected virtual machines can therefore be controlled as one unit. When a support or testing engineer needs to use a particular configuration (and to get hold of it in a hurry), VMware Lab Manager can re-create that multiple-machine configuration from the library within minutes and then deploy it to a pre-allocated pool of ESX host servers that make up the virtual infrastructure platform. This capability dramatically reduces the time spent on systems provisioning by either the technical support person (who would have to find and provision the appropriate physical machines) or the development person (who would have to check that the configuration is exactly what he or she wants) and therefore it saves valuable engineers’ time, costs and effort.

Figure 3 in section 6 depicts the architecture for the systems that support the engineers at SAP. Section 5 defines the use cases for the Lab Manager system.

5.0 Lab Manager Solution Use Cases

The use cases described here pertain to three types of Lab Manager Users within SAP's Business Intelligence software support organization:

- the support engineers (referred to as "engineers").
- the advanced configuration setup managers (called "super-users").
- The system administrators (who manage the Lab Manager installation itself and create templates for virtual machines).

The system supports 100 people in the North American and Asia Pacific offices and 25 people in the European offices. Most of these users are support engineers. The total number of users is expected to grow to 500 people over the next phase of deployment in 2009 and 2010.

Support Engineer Use Cases

Support engineers have the least amount of rights to the Lab Manager environment but they make the most use of the environment and receive the most benefit from it. The Lab Manager setup is designed to boost the productivity of their testing and troubleshooting activities. They use Lab Manager to duplicate customer environments, to identify and resolve software defects, and to migrate data between two environments at different version levels.

Duplicating a Customer Environment to Identify and Resolve a Software Defect

This use case starts when a support engineer receives a new customer support case. The engineer studies the details of the customer's environment, and often contacts the customer directly to confirm some of those details and review the case itself. During this time the engineer logs in to Lab Manager and browses its library looking for a configuration or a template virtual machine that matches the customer's environment as closely as possible. This library has been populated with known configurations of SAP software products, some of which are even tailored for particular customers. After finding the closest match in the Lab Manager configuration library, the engineer clones the matching configuration to his own workspace and then deploys it.

A Lab Manager "workspace" is a unique environment within which each user can carry out private tasks independently of others and customize a private copy of a configuration. The deployment step (a one-click operation) causes the virtual machines within the new configuration to be started on the pool of ESX host servers that are dedicated to supporting the Lab Manager environment. Lab Manager automatically assigns the various virtual machines to the individual ESX host servers, without operator intervention. Once deployed, the configuration may need some customization before the engineer can work on duplicating the issue itself in order to find a resolution.

Working on a resolution can take place in different ways:

- **Option 1:** The engineer sees the defect and knows how to resolve the issue. Usually this is in the form of a configuration issue; for example an end user may have set a switch improperly or written a configuration file with the wrong setting. With Lab Manager, the engineer can compare different systems and resolve the issue right away, typically while the customer is still on the phone.
- **Option 2:** The engineer sees the defect but has insufficient knowledge to resolve the problem. The engineer escalates the case to a more senior support engineer. At this point the original case engineer saves the configuration in the Lab Manager library with a new name and shares it with the escalation engineer simply by passing a URL for the captured configuration. The escalation engineer then clones the configuration to his/her own

workspace and compares it with the original if need be. The engineers then work together with the customer to resolve the issue, knowing that they have the same setup for the application in their separate work areas.

- Option 3:** The case engineer identifies a software defect and recognizes that the application code will have to be changed in order to resolve the customer's issue. The engineer escalates the case to a more senior engineer because of seniority rules and raises the case to a separate group named "Customer Intelligence and Escalations," (CI&E). In the escalation notes, the engineer documents the existence of the configuration that exhibits the defect. The engineer also captures the configuration with the reproducible defect in the Lab Manager library. When CI&E picks up the escalation, the CI&E engineer takes note of the configuration information and asks the case engineer for access. The case engineer deploys a copy of the configuration containing the problem image and a second copy for CI&E to use for investigation. CI&E can use both systems for comparison and development of the defect fix. When the investigation is completed, the CI&E engineer contacts the case engineer who can validate the fix against the defect prior to sending the fix along to the customer. This helps to reduce the amount of regression testing and improves the overall escalation process, thus saving costs.

Migrating Data Between Two Environments at Different Version Levels

Assisting customers with application migration issues is one of the support organization's more frequently occurring and challenging tasks, greatly simplified by VMware Lab Manager. First, the engineer works with the customer to identify the details of the source and destination environments for the proposed migration. Then, using the customer specifications the engineer builds a custom configuration internally from two or more existing templates in the Lab Manager library by cloning each one to a single configuration and then adjusting each one as necessary to mirror the customer's situation.

After completing the deployment and customization phase, the customer and engineer can work together to provide sample data or real data to the engineer for testing purposes. The sample data may be placed into virtual machines that are within the control of Lab Manager, or it may be in other virtual machines on external ESX host systems that are manually connected into the new configuration. At this point the engineer can test and validate the migration steps prior to the customer doing so in their own environment. This testing reduces the likelihood that the customer will experience problems when performing the actual migration. In the worst case scenario the customer may attempt to execute the migration prior to engaging with SAP's Customer Assurance department and may have issues with it. By using Lab Manager, engineers can engage faster than in the past to find the cause of a failed migration.

Failed migrations are a big concern for sales efforts and for SAP Global Services personnel. When such migrations come to the customer assurance engineers they are usually highly sensitive situations that need immediate attention and care. Lab Manager helps expedite the quick resolution of these cases and shortens the sales process and project cycles for the services organization.

Super User Use Cases

Super-users have more power in the Lab Manager environment than do the support engineers. Although their main task is the building of configurations, super-users can also create a template (a single standalone virtual machine with a specific operating system loaded into it) and customize it with specific application software. Template construction is usually but not exclusively the domain of the administrators (described in a later section). The super-user stores any newly-created template in the Lab Manager template library for use in constructing configurations later

on. These configurations are normally made up of several virtual machines, although they can contain just one.

Building Library Configurations

Building library configurations is the main task of the super-user group. This group receives direction from the program board, which submits a request to build a new library configuration for a certain product or technology as requested by Customer Support management or staff. The super-users examine the request to ensure that they have access to the correct templates on which to build the library configuration. If they do, they research the software availability for the product build and any licensing issues that may need to be met to fulfill the build requirement. After all the preconditions are met the super-user creates a new configuration from one or more templates and builds the configuration with the specified application software.

After completing the build, the super-user captures the configuration in the Lab Manager configuration library and shares it with the others in the super-user group. One or more super-users clones the new configuration to their own workspace and validates the configuration build. Once the configuration has passed the validation phase it is shared with everyone and the super-user notifies the program board of the configuration's availability. The program board publicizes the information to the Customer Support engineering staff.

Building Environments for New Products

Assuring product readiness for customer support personnel is a major task that can take months while staff goes through training on the newly-released product. This process includes a large portion of time spent teaching the support staff about the product and perfecting the installation procedures. With Lab Manager the company can help perfect the installation process more quickly than ever before.

Super-users work with Product Generation (PG) personnel to ensure that the Lab Manager systems have the new product installed and configured in virtual machines according to PG's specifications. These new systems are used as a basis for training all staff on the installation and configuration of the new software and the installed configurations are further used as the support platform for all of CS.

The process works as follows. A super-user engages with PG to obtain their installation guidance prior to the product release-to-market (RTM) process. During this time, the super-user learns the installation and configuration procedures for the new software product. Within Lab Manager, the super-user clones a template (a sample virtual machine with a known operating system already set up in it) from the template library to his or her private workspace. The super-user installs and configures the new SAP software into the template. PG can then validate or certify that the installation has been done correctly. The super-user captures the validated template to the library and shares it with the training resources. The super-user uses the templates (some of which may be created by the administrators) to create configurations to match the business needs of the engineers. Training personnel subsequently use the configurations to teach the support staff. After training has been completed, support staff can clone the template or configuration to their own workspaces for use in support case work.

Building a Platinum-Level Customer Environment

"Platinum Level" customers are those considered most strategically important to the continued success of the SAP organization. For these customers the SAP business intelligence unit designs and pre-provisions a set of known configurations within the support organization that match the customer's production environment. In that way CS engineers can clone a particular configuration and work on copies of environments that mirror what the customer has. Super-users facilitate this

process by supplying templates and configurations in the template and configuration library areas of Lab Manager.

The working scenario for this use case is as follows. A Technical Account Manager or Strategic Relationship Manager working with the CS management recognizes a Platinum Level customer that could benefit from a Lab Manager environment build. A designated lead super-user arranges to meet with the manager and the customer to gather details on the customer's environment. The lead super-user architects a system specification and creates a build document which is provided to the account manager to get customer approval. The lead super-user then builds the environment within Lab Manager, working in conjunction with others where needed. After the environment is built, they validate the build with the manager and with the customer. The environment is then captured to the configuration library so that it can be cloned by the engineers for support case work.

This process is a significant enhancement and value-add to customers and to engineers who in the past struggled to understand, build and maintain proper environments for these customers. The customers' environments are typically very complicated and consist of multiple server installations with different technologies.

Before Lab Manager was introduced, if the engineers collaborated closely, they might have been able to build a larger environment amongst a few of them. But these ad-hoc customer setups were impossible to maintain and hard to put together and deploy for longer periods of time. Lab Manager eliminates these challenges by allowing a team of experts to build the system once for others to use it multiple times thereafter.

Administrator Use Cases

Administrators manage the Lab Manager installation itself, including the ESX servers and the storage mechanisms that support it. Administrators set the Lab Manager quotas for users, limiting the number of configurations they can have deployed at any one time. An administrator may also place limits on the amount of disk space occupied by a certain user. Administrators also install the operating systems into the base templates that are used by other users to build configurations from.

Creating Operating System Templates

Creating sample template virtual machines (called "templates") for different operating systems can be a tedious and time consuming task. Without virtualization, it can lead to a unique build no matter how many times the build steps are documented and repeatedly used. With Lab Manager this problem is eliminated.

In this use case, an administrator builds an operating system template in Lab Manager that is utilized several times over its lifetime in multiple configurations. A template is a basic building block in Lab Manager used as a pattern for virtual machine creation. Templates from the template library may be used to build configurations whether those new configurations are eventually considered valuable enough to be captured to the configuration library or not. In some cases, a configuration may be disposed of when it is no longer needed by the engineer.

The administrator receives a request for a new operating system type, where the types consist of either Windows or Linux builds, possibly at different version levels. The requesters from the support community also specify what additional software needs to be installed on the templates, such as applications like Microsoft Office, Adobe Acrobat or others. The administrator takes the request and loads the appropriate product media into the Lab Manager media storage. The medium may take the form of an ISO file for a product, for example. The administrator then creates the template shell and sets the template properties such as the number of virtual CPUs, the

memory size and the hard disk size. The administrator deploys the new template and mounts the operating system medium (e.g. CDRom). The administrator installs the operating system, any operating system patches, anti-virus software, the third party software that was requested and the VMware tools. The administrator then powers off the template, undeploys it, publishes it for use within Lab Manager and shares it with the super-users. The super-users review the template build for any errors or omissions and validate it. After the template is validated, the administrator shares the template with everyone and notifies the program board of the new template publication. The program board releases the publication information to the super-users who may then build configurations from the existing templates in the template library.

Managing Users, Groups, Storage and Leasing Issues

The administrators and some of the super-users are tasked with managing the Lab Manager infrastructure itself. One of the most common tasks here is managing the system availability and resources by making sure users and groups have appropriate access to resources and that they have the correct roles assigned to them.

Administrators further ensure proper allocation and balance of the data storage consumption. Lab Manager has the ability to manage multiple types of data storage, from high-speed access mechanisms to less performing solutions. Lab Manager optimizes the support department's use of its storage space using a technique in VMware Infrastructure called "linked clones." This technique means that a base image of any virtual machine's file system contents are stored along with just the deltas for any changes that are made to it subsequently, rather than storing the entire virtual machine each time a change is made. This linked clones technique avoids copying and storing huge amounts of data as virtual machines are changed.

Configurations and templates, as well as installation media, need to be balanced amongst all this storage so that there is consistent performance and free space for the user community. The administrators also need to be able to take storage offline for maintenance and bring new storage online. These tasks are conducted on a regular basis.

Another task, more rarely done, requires the administrators and lead super-users to assist other super-users and engineers in retrieving configurations that have been marked for deletion. Only administrators can ultimately see which configurations have been flagged for deletion by the quota handling and aging system of Lab Manager. A particular template or configuration may be specified to be valid for a period of six months, for example. The administrator can send those configurations back to an engineer's workspace for continued use or for proper deletion by the engineer. Deletion of redundant templates and configurations from Lab Manager's library areas helps to conserve storage and optimize use of the overall system. Administrators also set quotas on the amount of Lab Manager resources that may be consumed by any one user. They can do this by limiting the number of configurations that the user may deploy at any one time, or limiting the number of templates the user may control. This housekeeping activity helps the whole community to get the best use out of the Lab Manager system.

6.0 Technical System Architecture

This section provides a description of the systems supporting the Lab Manager users at the SAP support center. Figure 3 depicts the entire system, with detailed ESX host machine configurations shown in Figures 4 and 5.

As shown in Figure 3, the system consists of two parts:

- The Lab Manager-controlled ESX host systems (green shading).
- The ESX-only host systems (blue shading).

VMware VirtualCenter, shown at the top of Figure 3, jointly manages both parts. The Lab Manager-controlled infrastructure shown on the left side is used for the configurations of virtual machines that are built daily in an ad-hoc, self-provisioned fashion by the support engineers. These configurations can either be removed when a support case is resolved or they can be stored in the Lab Manager configuration library. These are entirely self-provisioned systems.

The “ESX Infrastructure Static Content” side of the picture shows systems that are not under the control of the Lab Manager environment. These virtual systems are not self-provisioned but are set up by the super users for the support engineers to use in constructing their temporary configurations. These ESX-based systems are used for longer term storage of virtual machines and static data sets that are required for longer periods of time such as for several months. They may contain large customer databases that are required for longer term testing, for example.

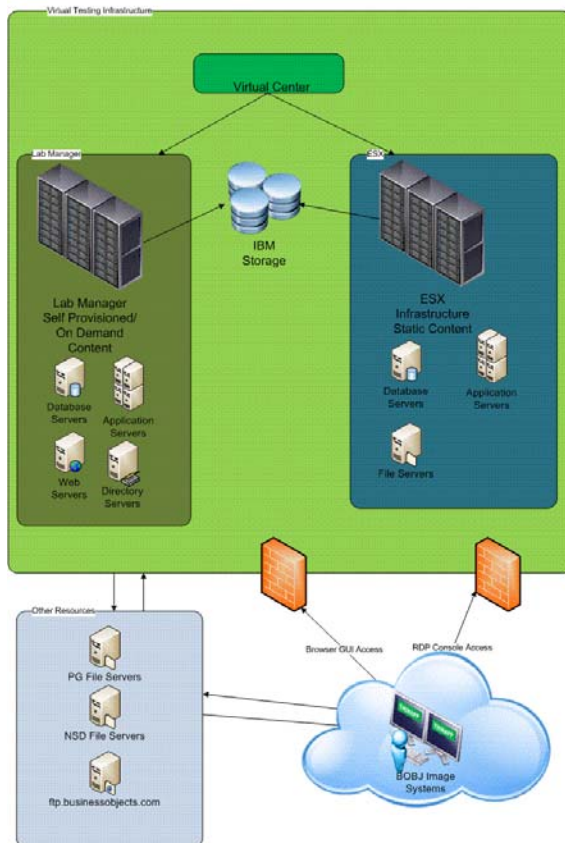


Figure 3. Outline of the whole virtual testing system architecture

The three dark-shaded machine “racks” at the top on each side of the architecture represent the ESX hosts that are either under the control of Lab Manager or are controlled only by VirtualCenter Server. The lower brighter colored machine icons represent the virtual machines that run on those ESX hosts. The entire virtual testing infrastructure is based on VMware ESX, but the more dynamic parts of it (i.e. those parts that are self-provisioned by the support engineers) are also under the control of Lab Manager.

The Lab Manager Server management process itself is housed in a virtual machine on an ESX host server (shown on the Static side of the figure). Eventually the support department plans to provide the Web Interface to end users on a Shared Services Infrastructure and the virtual machines will reside within a firewalled, isolated network to protect the integrity of the corporate network and to enhance flexibility to engineers building environments that don't meet the SAP corporate standard.

A separate set of file servers, shown on the lower left side of Figure 3, are used for Product Generation and other uses – and they also may be connected to other systems from time to time as needed. These file servers are for receipt of customer data that is used in the long-lived, ESX-controlled side of the infrastructure. The file server virtual machines shown on the lower part of the “ESX Infrastructure Static Content” area get their customer data originally from these external file server resources. The file servers are also contained in virtual machines running on ESX.

File Servers for data such as customer-related test data and files, engineer tools and third party software, and the SAP software will all be housed on the infrastructure. These are provided for easy and rapid deployment of data to either the ESX Static or the Lab Manager Self Provisioned infrastructure. The organization plans to make FTP Services available to facilitate the transfer of data to and from the infrastructure for customers and for other departments within SAP. These FTP services will also be hosted on VMware Infrastructure. The FTP services will be contained within the DMZ and will either feed or be fed by Shared Services Zone File Servers.

Support engineers and other users access the two types of systems from desktops on the SAP network, as shown in the bottom right-hand side of Figure 3. At the time of writing, the Business Objects network was in the process of being integrated into the SAP network, so the support users may for the time being make use of their own segment of the overall company network. Internal firewalls based on F5 technology help with load balancing the connections to the Lab Manager-based systems.

Any one of the support engineers' virtual machines, under the control of Lab Manager, may be connected to a database instance that resides in another virtual machine. That second database virtual machine may be contained within the Lab Manager images (if it is transient in the sense that it is not needed beyond a week's time) or it may be under the ESX-controlled static side, external to Lab Manager. Any databases that are contained within the Lab Manager system are not persistent. The connections between the two virtual machines are done in exactly the same way as they would be done in the physical world, using TCP/IP connections. The bulk of the shared storage across the Lab Manager and ESX-managed systems is dedicated to Lab Manager.

If an engineer is working on an area that is considered technically risky, such as altering a database schema or dropping a table that supports a business application, then that change is carried out on a database virtual machine under Lab Manager's control. Such data may be discarded at the end of the work period and the next time it is needed a new copy is made from a virtual machine on the “Static” side of the architecture. This procedure allows engineers to work safely on new innovations or customizations of products without the risk of losing important data.

Disk Storage

The IBM shared storage system contains a total of 19 Terabytes of data. Of this total space, 14TB are allocated to the Lab Manager system. On the Lab Manager system, many copies of the same image may be required over and over for various reasons; the linked clone technology helps to optimize the disk space consumed. In most cases, the test case data for a support call is inserted into the Lab Manager-controlled virtual machines, for the purposes of conducting tests on it.

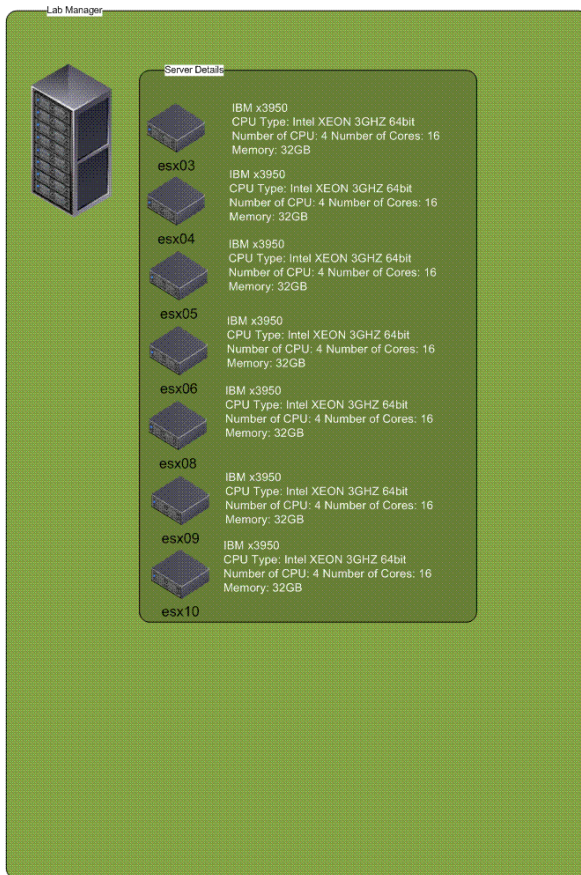


Figure 4. Details of ESX server hosts controlled by Lab Manager

Figure 4 shows the machine characteristics for the ESX hosts that are placed under Lab Manager’s control. These ESX host servers are registered with the VMware Lab Manager server, which uses their computing resources for deployment of virtual machines. Each ESX host machine is an IBM x3950 rack-mounted server with four sockets each containing four cores. There are seven such ESX server hosts in the Lab Manager-controlled setup.

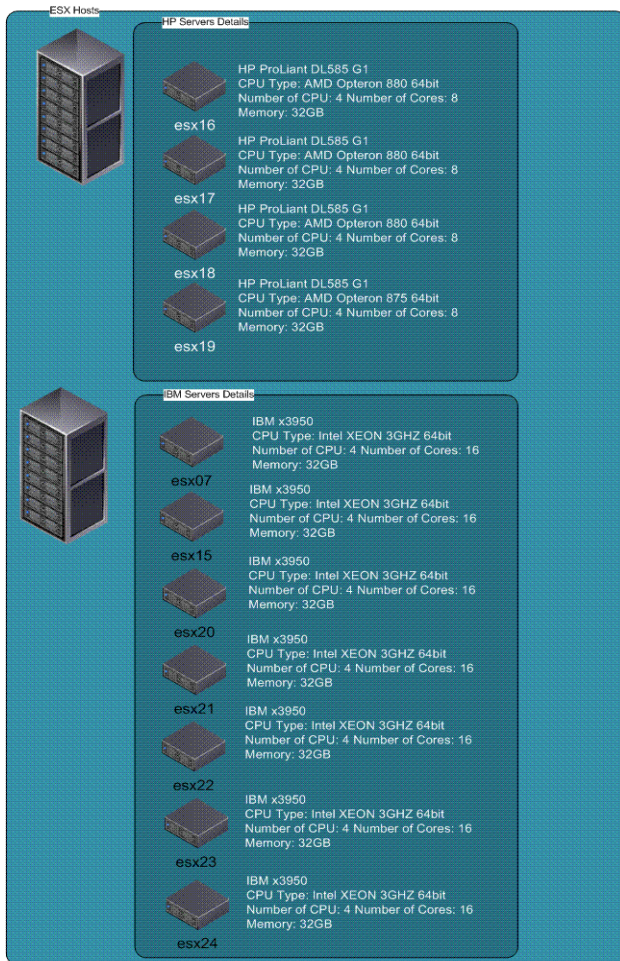


Figure 5. Details of ESX server hosts outside of Lab Manager control

Figure 5 shows the layout of the ESX host servers that are complementary to the Lab Manager environment, but are not under its control. These systems are used to host virtual machines that are required over the longer term (typically more than a month's time) because the data within them is important for use in several different situations. The ESX server hosts here are composed of a set of machines similar to those controlled by Lab Manager (the IBM hosts), along with a set of HP ProLiant DL585 G1 machines. A larger ESX infrastructure is allocated to the long term storage side of the architecture than is allowed for the Lab Manager controlled side. However the opposite is true of the disk storage allocation, which proved to be the higher priority item in the construction of the system architecture.

7.0 Conclusions

The SAP business intelligence technical support area is a high pressure environment where engineers work hard to diagnose and fix SAP customers' technical problems as well as assisting with migrations to new software products. As is the case in all customer support organizations, the time to resolution for support cases and migrations is a key measure of the performance of the department. The support engineers at SAP needed automation tools to help them recreate their customers' environment very quickly; home-grown efforts to implement this level of automation proved too difficult to get right.

The VMware Lab Manager implementation, along with the process steps that were developed for its use, solved this set of pressing support challenges and increased the ease with which the support engineers, systems administrators and other support staff can do their jobs. As an additional benefit, the staging of premium customer example environments on virtual machines under Lab Manager allows the support team to give a high level of service to those important customers. Since the user community inside SAP had some earlier exposure to virtualization technology in the form of the VMware Workstation product, it proved remarkably easy for them to adjust their working style to an ESX-based automation tool like VMware Lab Manager, while at the same time increasing their productivity. Customer satisfaction and time to problem resolution were greatly improved as a direct result of the ease with which problems could be recreated in the Lab Manager environment.