In this excerpt, you’ll learn how to build your own cloud using converged infrastructures. Discover the technical requirements, implementation steps, and extensibility options that come with building your own cloud. Then, learn how to adapt your current service portfolio and associated operating processes to the new cloud.
Chapter 3

SAP Landscape Virtualization Management (LVM) is a tool for operating an SAP system landscape in a private cloud. This chapter explains how you can use SAP LVM operations for standardization and automation.

3 SAP LVM: Automating Your Cloud

SAP LVM has been available for more than ten years and was originally a part of SAP NetWeaver Adaptive Computing Controller (ACC), which was released in 2004. SAP LVM is a Java-based application that runs on an SAP NetWeaver Application Server (AS).

In the early 2000s, SAP created SAP NetWeaver ACC, a new tool for the administration of large SAP landscapes. The concept was that SAP NetWeaver ACC allowed users to easily manage very large SAP landscapes, both virtualized and physical. Back then, three critical trends played a major role in data centers:

- Due to the low costs of x86-based hardware, this hardware type was increasingly used in data centers and for SAP hosting. Commodity x86 hardware can be purchased and used at lower costs.
- Since 2000, virtualization manufacturers have gradually established themselves in data centers. VMware has successfully acquired a leading position in this area, closely followed by technologies that are based on OpenSource, such as Xen and KVM.
- Finally, the number of SAP systems and, as a result, SAP customers, has grown significantly. Here, a decisive factor was the hype about Service-Oriented Architectures (SOAs or Enterprise SOA).

Particularly in large enterprises with different units, these trends often result in higher IT operating costs. So enterprises were looking for a tool that enabled them to manage SAP landscapes easily and efficiently.
Consequently, SAP developed SAP NetWeaver ACC to facilitate the administration of large SAP landscapes, for example, by using SAP NetWeaver ACC for SAP hosting. In addition, SAP NetWeaver ACC was supposed to enable customers to dynamically respond to new performance and workload requirements. SAP NetWeaver ACC allowed users to add and remove dialog instances dynamically. This enabled customers to add new dialog instances to respond to the increasing workloads on the SAP system and thus to reduce the overall load on the system. SAP NetWeaver ACC made this adaptive computing concept possible, but it was rarely used. The primary goal of SAP NetWeaver ACC was to facilitate the administration.

SAP NetWeaver ACC was continuously extended, and new features were added up to 2010 and version 7.3. In June 2012, its successor, SAP LVM 1.0, was published. Essentially, SAP LVM is an enhancement of SAP NetWeaver ACC and uses its basic structure. SAP LVM adopted all functions of SAP NetWeaver ACC and added a completely new function—the automated provisioning of SAP systems. In the latest version, version 2.1, SAP LVM is now a highly functional and sophisticated tool for the configuration, provisioning, implementation, monitoring, and administration of SAP systems in physical, virtualized, and cloud-based environments.

The beginning of this chapter will provide you with an overview of SAP LVM and its scope. Then, the structure of SAP landscapes with SAP LVM is explained. The third section deals with the various options for adding customized functions to SAP LVM and using it as a kind of SAP administration framework. Finally, this chapter explains how you can integrate SAP LVM into the virtualized infrastructure of data centers and use public cloud services.

### 3.1 SAP LVM Overview

SAP LVM provides a broad range of functions that you can use immediately. This section first provides you with an overview of the basic SAP LVM functions and then describes SAP LVM use cases in the SAP environment and with other applications. Finally, you will learn about the two versions of SAP LVM and their main differences.

#### 3.1.1 Features and Functions

SAP LVM has adopted all the basic functions of SAP NetWeaver ACC. Consequently, there are no major functional differences in system administration between SAP NetWeaver ACC and SAP LVM. However, SAP LVM provides many more functions that are critical for efficient SAP operations.

**Basic Functions**

First, we will introduce you to the basic functions. SAP LVM provides the following functions for the administration of your landscape:

- **Centralization**
  Instead of using different tools to manage your SAP landscape, you use only one tool, SAP LVM, which enables you to monitor and manage the entire landscape.

- **Mass operations**
  Mass operations allow you to start, stop, or relocate numerous SAP systems or a large landscape with just a few clicks.

- **Landscape monitoring**
  SAP LVM monitors the entire SAP and non-SAP landscape and can map the most important key figures of the landscape in a dashboard. In addition to the dashboard, SAP LVM also enables you to visualize landscapes.

- **Tasks**
  SAP LVM allows you to schedule critical tasks and execute them. These tasks can affect the entire landscape and thus have to be controlled centrally. However, these tasks can also be system-specific.

- **Integration**
  SAP LVM enables you to manage all SAP and non-SAP systems. Naturally, the functions to administer non-SAP systems are not as extensive as the specific tools for SAP systems.

SAP LVM provides these critical, basic functions in an optimal way so that you can easily manage your large SAP system landscape. However, SAP LVM gets really interesting when you take a look at two other...
important functions: the integrated management of virtualization and storage and the automation of SAP activities. The following sections introduce these two functions.

**Integration of Virtualization and Storage**

The wide prevalence of virtualization often results in two administration solutions being used in data centers and for SAP operations. Usually, one tool is used to manage the SAP systems, and one tool is used to manage the virtual infrastructure. This leads to additional effort because two tools need to be maintained and operated. SAP LVM addressed this problem and can integrate your virtualization solutions. Consequently, SAP LVM can be a comprehensive solution in reducing the complexity of your data center operations.

**Adapters for virtualization**

The manufacturers of virtualization solutions currently provide the following critical adapters. Each adapter may have various restrictions, which are described in the respective SAP Notes:

- Microsoft Hyper-V with Windows operating system in the virtual machine (SAP Note 1843134)
- IBM PowerVM with AIX and IBM i (SAP Note 1833980)
- VMware vCenter with Red Hat Enterprise Linux, SUSE Linux Enterprise Server, and Windows (SAP Note 1259069)
- Amazon Elastic Compute Cloud (EC2) (SAP Note 1861561)

By integrating virtualization solutions, you can control virtual machines. Controls includes common actions, such as starting and stopping a virtual machine, but also more advanced actions like cloning. You will find a more detailed description of this in Section 3.4.1.

In addition to the tools for administering virtualizations and SAP systems, many storage manufacturers also provide management tools. You can use them, for example, to clone storage areas or to link storage to another server. To enable SAP LVM to operate as dynamically as possible, you can also control storage operations via SAP LVM. For this purpose, you can integrate the storage solutions of different manufacturers using adapters.

In addition to integrating virtualization solutions, storage systems also form the backbone of SAP operations. You can integrate the following solutions with SAP LVM:

- EMC storage via NFS with Windows, HP-UX, RHEL, SLES, and Solaris
- EMC storage via a storage area network or fiber channel with AIX, RHEL, SLES, or Windows
- Hitachi/HDS with AIX, RHEL, SLES, and Windows (only on a project-by-project basis)
- HP with Windows, RHEL, SLES, and HP-UX
- IBM via storage area network or fiber channel with AIX and Linux
- NetApp via NFS with AIX, HP-UX, RHEL, SLES, and Solaris
- NetApp via storage area network or iSCSI with Windows, RHEL, and SLES (not validated by NetApp)
- NetApp via storage area network or fiber channel with Windows, SLES, and RHEL (not validated by NetApp)

For storage adapters, there are various restrictions, which you should check before using SAP LVM and your storage system. These restrictions can affect the functionality, usable operating systems, or the databases. Thus, it is critical to verify any restrictions before you use adapters. The respective storage manufacturers should provide you with all the important news and updates.

**Integrating Orchestration Software**

In addition to controlling virtualization and storage, SAP LVM also enables you to use SAP LVM functions through orchestration software, and vice versa. SAP LVM’s capabilities also enable you to control other software products. You can use custom hooks or custom operations in SAP LVM to execute critical external functions. This allows you to control external tools and have them execute critical functions.

In total, SAP LVM provides a broad range of functions that can simplify SAP operations a great deal. Performing mass operations alone can save you a lot of time. However, the most interesting functions are evident when SAP LVM is used for virtualization. This leads to interesting use cases, such as the cloning of SAP systems.
Advanced Functions

Thanks to integrating the functionalities of both virtualization solutions and storage solutions, you can also use SAP LVM for advanced functions in the context of SAP systems. The most important functions are as follows:

- **Cloning, copying, and refreshing SAP systems**
  SAP LVM allows you to clone SAP systems (that is, make an exact image). You can also make system copies and refresh data. These operations are also available for SAP HANA-based SAP systems.

- **Automating post-copy actions**
  After copying SAP systems with a new SID, for example, from the production system (PRD) to the quality assurance system (QAS), you usually have to perform post-copy actions. SAP LVM enables you to automate these actions.

- **Providing application servers and diagnostic agents**
  To accommodate adaptive computing, you can deploy additional application servers with SAP LVM and activate them during high system loads. You can also have SAP LVM install diagnostic agents on the hosts.

- **Automatic capacity management**
  Server and landscape capacity management is a basic requirement for the successful operation of your environment. You can outsource this function to SAP LVM. In this case, SAP LVM coordinates the automatic starting and stopping of additional application servers.

- **Creating and using templates**
  Templates allow you to create your provisioning process generically and use it for mass deployments. This way, you can customize your clone, copy, and refresh actions.

- **Starting, stopping, and relocating**
  These operations have been available since SAP NetWeaver ACC. To use them, however, you had to implement a specific SAP NetWeaver ACC architecture. Due to the integration with virtualization and storage solutions, SAP LVM provides functions that are more generic so that you can use virtualization features for starting, stopping, and relocating.

Based on the above functions, not only can you use SAP LVM to simply manage your SAP landscape but also in a much broader context. The following section introduces the most critical use cases.

### 3.1.2 Use Cases

SAP LVM can support various use cases. This includes use cases for SAP but also for more general SAP and infrastructure operations.

#### Use Cases for SAP

SAP LVM provides a broad range of use cases, which you can implement in your SAP landscape. Perhaps the most interesting use cases involve automating SAP operations, particularly in the context of cloning and refreshing.

Figure 3.1 shows a use case for the creation of a system clone of an SAP PRD system.

![Figure 3.1 Cloning an SAP System](image)

The goal is to have an isolated clone of the PRD system for testing, training, demonstration, or other purposes. Here, the clone needs to be isolated because it is an exact image of the SAP system and because no post-processing has taken place. This means that all remote function call (RFC) connections are still available in the cloned systems and would access the other PRD systems. To avoid this and other inconsistencies,
the clones need to be isolated. Also, these clones cannot and must not be operated forever but only for a limited time.

The best way to create this kind of isolated environment is to use secure network segments, for example, specific VLANs. You need to configure firewalls and routing in such a way that no communication to other SAP PRD systems can take place. You can also operate clones in virtual machines without any network communication at all. This enables you to still access the SAP system via a console without having to deal with network issues.

Another use case involves the copying of SAP systems. Here, the goal is to be able to immediately use the created copies of the SAP system. Furthermore, usage is not restricted, and the copied systems can be used in the long term. This use case is illustrated in Figure 3.2.

If you copy a system (for example, the PRD system), you make an exact copy. This means that the entire dataset and all other settings of the SAP system, including SID, are copied. First, it is a clone of the PRD system. To turn the clone into an independent system, you must change all of the system settings.

These postprocessing tasks make copying an SAP system a very complex process. You can automate a lot of the postprocessing tasks with SAP LVM, including all standard SAP postprocessing tasks. However, there are also tasks that you need to define specifically for your systems. However, SAP LVM can be of great help here as well through custom hooks.

After all the postprocessing work is completed, you have (in our example) two separate copies of the PRD system: the test system (TST) and the QAS system. Both have the same dataset as the PRD system. But both systems also have their own identities and can be operated in parallel to the original PRD system. Isolation is not necessary.

Another SAP use case is the system refresh, that is, refreshing the data. Usually, this involves monthly or otherwise regular copying of the data from the PRD system to the QAS system. Because this task has to be performed regularly, it makes sense to automate it.

Figure 3.3 shows the scenario. You can see the typical system landscape consisting of a development system (DEV), QAS system, and PRD system. Usually, your system landscape is configured in such a way that you perform the developments in the DEV system first. Then, the developments or changes are transferred to the QAS system, where they are checked against a dataset that is similar to that in the PRD system.

Only after the quality has been assured in the QAS system, the new developments are released for the PRD system, and the changes can be transferred to the PRD system.
Staying up to date

To evaluate the new developments against a dataset that is similar to that of the PRD system, you must refresh the data. You can perform these refreshes either manually or automatically using SAP LVM. To refresh the data, SAP LVM uses the system copy function again and copies the PRD system to the QAS system. After copying, the identity of the QAS system is restored. Finally, the configuration of the QAS system, as it was before the copying process, is reimported, and you now have a QAS system that is up to date.

Considering the Change Level

The copying and cloning of SAP systems generally works well and is surprisingly easy. As long as you use a standard SAP system with only a few changes, such as additional programs, it should work well. However, the copying effort increases with the number of linked systems and the number of business processes that are executed across system boundaries. You will encounter situations in which SAP LVM is no longer able to perform all the postprocessing tasks after the copy process, and then you would have to perform them manually or using custom hooks with external tools.

Relocating

Another critical use case originates from SAP NetWeaver ACC: relocating SAP systems. Relocation means that SAP instances are moved from one physical host to another physical host. This use case is illustrated in Figure 3.4. In addition to changing physical hosts, you can also relocate instances between virtual machines. The decisive factor here is that the two hosts or the two virtual machines can access the same storage and thus the same SAP system.

Using SAP host agents

The entire process is managed via SAP LVM and involves SAP host agents, which should be basically available on each of your SAP servers. These SAP host agents perform tasks, while SAP LVM monitors the entire process. Relocation comprises the stopping and detaching of the SAP instance of the first host and attaching and starting the SAP instance on the second host. Because both hosts access the storage, the SAP instance can simply be reassigned.

Relocating does not mean moving an SAP system, but rather “reassigning” the SAP system. Relocation does not involve a transfer of data but a change of the SAP system between two hosts. If you performed this task using a virtualization solution, a lot of data would have to be copied. SAP LVM accelerates this process.

Use Cases for Other Administration Tasks

In addition to SAP-specific use cases, SAP LVM provides further functions that are also ideal for advanced administration tasks. This includes, for example, the visualization of the landscape that is monitored and managed by SAP LVM. Figure 3.5 shows a dashboard from SAP LVM for a landscape with 376 managed instances, 184 systems, and 22 hosts. The standard dashboard in SAP LVM provides a rough overview of the status of your landscape.
However, SAP LVM not only provides a dashboard for the entire landscape, but also dashboards for specific layers of the IT infrastructure. You can customize these dashboards to your requirements to focus on specific details. Consequently, SAP LVM enables a comprehensive and detailed overview of your landscape.

Capacity management

We already mentioned Automatic Capacity Management (ACM) as an essential function. ACM allows you to implement various use cases for day-to-day operations. ACM enables you to add new servers dynamically if the need for resources increases. With SAP, this can be done using additional dialog instances. However, your data center probably works, not only with SAP systems, but also with non-SAP systems. The extensibility of SAP LVM and using custom hooks allow you to also control other software products.

If demand decreases, SAP LVM can also ensure dialog instances or virtual machines no longer required are dynamically stopped by other applications. Figure 3.6 shows the system landscape of SAP LVM with a PRD system and an additional non-SAP application (labeled Application ABC). In an SAP system, SAP LVM can easily start and stop additional dialog instances. For Application ABC, SAP LVM cannot do this. Here, additional orchestration is required, which controls the operations for Application ABC in these cases. SAP LVM can control the orchestration software and start the specific operations for Application ABC.

In addition to ACM, you can also use SAP LVM generally to automate IT processes. Numerous templates, the option to generate templates, the high level of automation, and central management can make your daily work considerably easier. In particular, the integration of external non-SAP applications facilitates administrative tasks. This enables you to also control non-SAP systems in addition to SAP systems. To do this, you use the central SAP host agent, which needs to be installed on the servers. The central SAP host agent can access previously defined scripts and thus control non-SAP systems.
### Host agent actions

The most critical actions of the host agent are as follows:

- **List**
  This function enables you to identify services (e.g., the active Apache server).

- **Start**
  This function is used to start the non-SAP system and has to be specifically created for your application.

- **Stop**
  This function is used to stop the non-SAP system and—just like the start function—depends on your application.

- **Monitor**
  This function allows you to identify the current status of the application. The different statuses are "running," "stopped," "crashed," and so on.

All activities are defined in a definition file. The respective function is then executed via an executable script. The SAP host agent requires that scripts exist in their corresponding environments. This means that both the scripts and the definitions should ideally be kept on a shared storage that both hosts, for example, can access in the case of relocation. In addition to defining scripts, you can also define external applications for large and complex workflows.

### Rapid deployment

Another use case is the rapid deployment of new SAP systems on the basis of copies or templates. Especially if SAP systems are used temporarily only, you can benefit from the functions of SAP LVM. You can use SAP LVM to rapidly deploy new systems for demonstration, testing, or training purposes. The focus is on systems that are supposed to be operated for a short time only rather than on systems with a long usage time. So these systems do not have to pass through all phases of the lifecycle, the deployment and deletion steps are sufficient.

### Easy to manage

The management of all resources in a landscape can be very time consuming. If you use SAP LVM, you take great strides towards simplification. SAP LVM provides a consolidated view of SAP, hardware (computing and storage), and cloud resources. Figure 3.7, for example, shows a list of the existing network resources, including two network segments: 38 net and 39.

As you can see, SAP LVM can play a central role in your SAP and non-SAP landscape. However, some requirements must be met, which will be explained in detail in Section 3.2. Another aspect is the variant used by SAP LVM and the corresponding licensing. This is discussed in the next section.

### 3.1.3 Editions

SAP offers SAP LVM as a Standard edition and as an Enterprise edition. Only the Enterprise edition provides full access to all of SAP LVM’s functions. From a technical perspective, these two editions do not differ. In both scenarios, SAP LVM is based on WebAS Java and is installed and operated. The licenses do, however, differ functionally.

The Standard edition allows you to implement the most essential SAP LVM use cases and usage scenarios. Basically, the Standard edition is SAP NetWeaver ACC with a new name. You can perform the following actions:

- **Starting, stopping, and relocating SAP systems**
  These basic functions from SAP NetWeaver ACC are still available in SAP LVM.
Performing mass operations for systems and servers
Mass operations enable you to use SAP LVM to perform basic functions, such as starting, stopping, and so on, for numerous systems and servers in a controlled manner.

Performing validations
Through SAP host agents, SAP LVM can validate the configuration and overall status of an SAP system and server.

Task scheduler
This function allows you to schedule actions on systems and servers (e.g., controlled shut downs) and have SAP LVM perform them.

Adding new servers
This function enables you to easily add new servers and import the configuration automatically to SAP LVM via the SAP host agents.

Adding new services
This function enables you to easily add new SAP systems and import configurations automatically to SAP LVM via the SAP host agents.

Creating simple dashboards (without customizing)
SAP LVM provides a dashboard with the most critical key figures but without customizing options.

Integrating virtualization solutions
You can use this function to integrate common and released virtualization solutions (e.g., vSphere) with SAP LVM.

Defining custom hooks
These are the user exits in SAP LVM through which you can add further functions.

Creating custom operations
Custom operations enable you to define new buttons in the SAP LVM interface.

Adding custom services
Custom services allow you to integrate non-SAP systems using defined scripts.

Controlling access through AccessControl
AccessControl is a basic function through which you can define access based on roles.

Analyzing dependencies between systems
This function enables you to create relationships between systems and make them known to SAP LVM. For example, you can specify that the SAP Process Integration (PI) system is to be started first before the SAP ERP system is started.

Providing application servers
SAP LVM can deploy application servers for SAP systems.

SAP LVM’s broad range of functions forms the basic module for the automation and central administration of the SAP landscape.

Enterprise edition
The Enterprise edition provides many more options than the Standard edition. Basically, all the automation functions that you previously had to purchase via additional software products are now included in the Enterprise edition of SAP LVM. Of course, the Enterprise edition also includes all functions of the Standard edition. The Enterprise edition provides the following additional functions:

Enhanced and customizable dashboards
The Enterprise edition allows you to create your own dashboards.

Landscape visualization
This helps you visualize the landscape that is currently managed in SAP LVM and determine hierarchies.

Managed landscape reporting
You can have SAP LVM create reporting that contains the most important key performance indicators (KPI).

Take-over of replicated SAP HANA databases
SAP LVM can trigger the take-over process for SAP HANA databases if they are replicated, moving changes from the primary to the secondary data center.

Rolling kernel switch
SAP LVM helps you prepare and perform rolling kernel switches. Here, the application server kernels of an SAP system are replaced by a new kernel version. The application servers are restarted in succession (thus “rolling”).

ACM
Already described in detail, this feature helps you deploy additional resources for SAP systems dynamically.
Performance monitoring
SAP LVM can assist you in monitoring performance by consolidating data from the SAP systems and mapping it in dashboards in an aggregated form.

Cloning, copying, and refreshing through virtual machines
SAP LVM uses the features of the virtualization solution to clone, copy, and refresh the systems (e.g., by copying the virtual machine).

Cloning, copying, and refreshing through storage functions
SAP LVM uses the features of the storage components to, for example, make a copy of an SAP system.

Cloning, copying, and refreshing through templates
For custom cloning, SAP LVM uses the methods that you defined to copy an SAP system, for example.

Capturing multinode databases
SAP LVM can capture and manage database instances with several nodes.

Authorizations for content and views
You can implement granular settings for content and view authorizations and consequently customize existing concepts according to your requirements.

Custom notifications and validations
You can check and validate non-SAP services using your own scripts and methods. This is equivalent to validation on the basis of SAP host agent information.

Custom tabs
Within the SAP LVM GUI, you can create your own menus to contain your required functions.

Custom provisioning
SAP LVM supports integrating replication methods for non-SAP systems. You can then use these methods to integrate all the systems.

Integration via near Zero Downtime Maintenance (nZDM)
SAP LVM supports performing nZDM tasks. If you need to create a shadow system as a copy of the PRD system, this is an ideal use case for SAP LVM.

Integration via SAP Solution Manager
SAP LVM manages the systems that are available in the landscape and can access information from SAP Solution Manager about the IT calendars of the systems. Consequently, you can access the operating modes of the configured SAP systems from SAP LVM.

As you can see, the Standard edition of SAP LVM already provides a broad range of functions, which enables SAP LVM to carry out actions in your landscape in an automated manner. However, you can only leverage the whole range of SAP automation if you use and license the Enterprise edition. This edition offers full automation and all the available functions. SAP LVM can then form an integral part of your daily IT operations, and you no longer have to perform tasks manually.

3.2 SAP LVM Landscape

The structure of the SAP LVM landscape mainly depends on your requirements; however, you can integrate SAP LVM into your landscape in only a few steps. The following sections describe the initial setup of the landscape and the structure of SAP LVM. Then, you get to know how to configure your future SAP LVM landscape and integrate your first systems.

3.2.1 Initial Setup

After installing SAP LVM in your environment, you should first configure the system so that SAP LVM can be used. This happens in the initial setup.

For the initial setup, log on to SAP NetWeaver Administrator first. There, you can perform the required steps. You only need to do this setup once to make SAP LVM ready for usage. Follow these steps to configure the new system to use SAP LVM:

1. Connect to SAP NetWeaver Administrator via a web browser. The respective URL is http://<host>.<domain>:<port>/nwa.
2. Log on as the administration user.
3. Select **Configuration Management** • **Scenarios** • **Configuration Wizard** in the menu.
4. Now, select **Initial Setup for Landscape Virtualization Management**, and click on the **Start** button to start the setup.
5. Use the **Default** configuration mode to apply default settings.
6. Start the configuration, and wait until the process is completed.

Now you can call and use SAP LVM through the web browser and the respective URL. The following sections provide further details on how to do this.

### 3.2.2 Structure

The following sections explain how to access SAP LVM and describes the basic operational concepts. Beyond this, you obtain information on how to make settings.

#### Access

As an application, you can find SAP LVM on WebAS Java, which means that you operate SAP LVM completely in the browser without interacting with the SAP GUI. The URL through which you access SAP LVM is rather simple and depends on your installation. The general URL is `http://<host>.<domain>:<port>/lvm`. In this example, we assumed the following parameters:

- Host: saplvm
- Domain: company.com
- Port: 50000

So the full URL would be `http://saplvm.company.com:50000/lvm` in this case.

After you’ve called the URL, the initial WebAS Java website is displayed where you have to enter your user name and password. If the specifications are entered correctly and if your user authorizations match, the system takes you to the SAP LVM landing page. Figure 3.8 shows a sample landing page. As with SAP NetWeaver ACC, the landing page first displays the most important dashboards, which provide you with a status overview of the landscape managed by SAP LVM.

**Figure 3.8 Sample SAP LVM Landing Page**

Of course, you can customize the dashboards and create your own effective landing page. This enables you to have the system directly display the current status of all instances, for example, or all diagnostic messages.

#### Operation

SAP LVM is easy to operate and is based on three large areas, which differ by menu entries in the upper part of the landing page. Figure 3.9 shows these areas. The menu changes depending on what area is selected.

**Figure 3.9 SAP LVM Ribbon**
The respective menus include the following entries:

- **Overview**
  The **Overview** menu provides information on the SAP LVM landscape and contains dashboards, all visualizations, and reports.

- **Operations**
  The **Operations** menu enables you to perform critical operations (individual or mass operations) on the servers and instances. Here, all hosts, instances, and pools are displayed allowing you to perform the basic operations (e.g., start, stop, and so on).

- **Provisioning**
  The **Provisioning** entry allows you to provide new systems. To provide new systems, you first have to create and maintain templates.

- **Automation**
  Contrary to the perception that the **Automation** entry enables you to perform a comprehensive automation of your landscape, this entry only includes the automated execution of tasks.

- **Monitoring**
  The **Monitoring** menu is the central menu to monitor running, scheduled, or completed tasks. From here, you can access all logs and performance values of the individual SAP systems and hosts.

- **Configuration**
  The **Configuration** menu contains the central menu for managing system landscapes and resources. Here, you can configure pools, systems, and hosts.

- **Infrastructure**
  The **Infrastructure** menu includes the configurations of all network segments, access to virtualization solutions, and access to storage. You can also configure the most important processes for Java post-copy automation and the provisioning of systems.

- **Setup**
  The **Setup** menu is located on the right-hand side of the ribbon. Here, you can, for example, change the look of SAP LVM, adapt custom hooks and save and load the SAP LVM configuration.

When you click on one of the menus, the system displays the respective submenu items that provide access to further information and tasks. After installing SAP LVM, at first you will not find any data in SAP LVM, and the first task is the configuration. For more information on configuring SAP LVM, see Section 3.2.3.

### Configuring Settings

In SAP LVM, you can modify various settings affecting the user interface. This includes common aspects, such as the size of tables, as well as email notifications.

To modify the user interface, proceed as follows:

1. Click **Setup** in the menu.
2. Navigate to the **Settings** tab and then to the **User Interface** sub-tab.
3. The system should now display the settings shown in Figure 3.10.

![Figure 3.10 Modifying the User Interface](image)

To edit these options, you must first enter edit mode. To do this, simply click on the **Edit** button. You can then change and save the values accordingly. Normally, you don’t need to modify the values.
Email notifications

In addition to the user interface, you can also use and configure notifications, including various email templates. To navigate to the notification settings, go to the Notification tab. The system should now display a screen similar to the one shown in Figure 3.11.

Figure 3.11 Notification Options

Email templates

The email settings also provide the option to create templates and adapt them according to your requirements. This enables you to have the system notify you of specific events. By default, SAP LVM provides the following email templates:

- Notification for validations
- Notification for planned tasks
- Notification for activities
- Notification for ACM

You can also define further templates in addition to these default templates. This enables you to have SAP LVM notify you of specific events. Therefore, you don’t have to wait for a notification from a monitoring system, but can instead receive these notifications directly through SAP LVM. You can easily adapt the templates using the editor (see Figure 3.12).

Figure 3.12 Editing an Email Template

However, you first have to enable the sending of emails. To do so, the system displays a checkbox next to the respective notifications (see Figure 3.11). You must enable the send process for the following areas:

- Enable email notification for validations
- Enable email notification for activities
- Enable email notification for task planner
- Enable email notification for ACM
- Enable custom notifications for validations
- Enable custom notifications for activities
- Enable custom notifications for task planner
Different levels

For each category, you can define whether you want to receive emails for errors, as warnings, and for information. You can set notifications for errors only or for a whole range of information.

3.2.3 Architecture

The following sections describe the common architecture of an SAP LVM landscape and introduce the most important configuration tasks.

Overall Architecture

The overall architecture of an SAP LVM landscape not only comprises SAP LVM but also includes the SAP systems that are managed by SAP LVM and corresponding resources. An overview of this is provided in Figure 3.13.

Figure 3.13 Overall Architecture of SAP LVM

An SAP LVM landscape basically consists of the following essential components:

- **SAP LVM management server**
  This is the central server on which SAP LVM is operated. This is usually an SAP NetWeaver Java server.

- **Virtualization and storage adapters**
  Manufacturers have created adapters to provide SAP LVM access to or control of specific functions. Section 3.4 provides more information on this.

- **SAP host agent**
  The SAP host agent is installed on the servers where SAP systems run. Each server or host with an SAP host agent can be managed by SAP LVM.

- **SAPACOSprep**
  This is a library that enables the SAP host agent to manage host names and storage. The SAP standard version can manage host names under Windows and Linux. In addition, the standard version of SAP can manage the storage based on NFS in Linux. If other technologies (i.e., operating systems or storage) are supposed to be used, you must request the corresponding libraries from your technology partner.

- **Platform and storage libraries**
  By means of the platform and storage libraries, the SAP host agent can communicate with your storage and platform via SAPACOSprep. These libraries are provided by the technology manufacturers.

- **Virtualization solution**
  SAP LVM can directly integrate virtualization solutions, including solutions from VMware and IBM.

- **Cloud**
  SAP LVM can also integrate the cloud as another possible solution to host servers. In this case, SAP LVM can integrate the Amazon Web Services (AWS) cloud.

- **Network**
  Probably the most essential component in the entire architecture is the network, which is required for all operations between SAP LVM and the managed servers. Of course, you also need the network to integrate cloud resources.
You can see that the overall architecture is basically transparent. Based on the overall architecture, you can use various resources, which must initially be maintained in SAP LVM.

**Configuring the Landscape**

After installing and configuring SAP LVM, next you must configure the resources. This is necessary to enable SAP LVM to access and manage resources. You can implement the basic configuration via the Configuration menu item. The most important aspects include the following:

- **Pools**
  Pools comprise the resources in your environment. Usually, the resources of a data center or of a landscape are combined in a pool.

- **Network**
  Here, you configure all network segments that are available to SAP LVM. For each network, you can configure the usual parameters, such as subnet mask and broadcast address. You can also adapt advanced parameters for a network. This includes, for example, the gateway server or the DNS zone.

- **Systems**
  After configuring a pool and the networks, you can now maintain the first systems. System maintenance is described in greater detail in the following sections.

- **Hosts**
  You can also add physical and virtual servers to your landscape.

- **Characteristics**
  Characteristics enable you to define and use different hosts, systems, or instances. This way, you can differentiate between the systems of a department or of a business area, for example.

For basic configuration, you don’t have to specify all the resources immediately or configure the entire landscape. For testing purposes, it is sufficient to select only the resources.

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### Configuring the System

Before you can configure a new system in SAP LVM, at least one pool and one network must be configured. This is the basic prerequisite for configuring the system. The configuration of a pool and a network is described in the previous section.

There are several ways to configure a new system. You can find the Configuration menu item under the Systems tab. Click the Retrieve button to add a new system (see Figure 3.14).

![Figure 3.14 Adding a New System via vCenter](image)

The following methods are available:

- **Detect via Host and Instance Agents**
  This is from the former SAP NetWeaver ACC solution. When a system is installed, the corresponding installed SAP host agent is used to configure the system in SAP LVM.
Detect on Managed Hosts
This option enables you to find a newly installed system on an already configured host and then configure this system in SAP LVM.

SAP LVM Landscape Scanner
The SAP LVM landscape scanner helps you find new systems.

Virtualization Manager
Here, you can retrieve the data of the virtual landscape directly from the manager of a virtualization solution (e.g., VMware vCenter) and add new hosts. Of course, the virtualization manager has to be configured in SAP LVM first.

Local System Landscape Directory
This option enables you to use the local SLD to add new systems and hosts to the SAP LVM configuration.

Remote System Landscape Directory
This option enables you to use a remote SLD to access information on new systems and hosts. Afterwards, you can add new hosts to the SAP LVM configuration.

Detect Appliances
The last option is the detection of appliances. Here, SAP LVM uses host names virtually, and then the respective SAP host agent accesses the hosts and systems. Afterwards, they are added to the SAP LVM configuration.

Depending on the method of data determination, you can also specify more details. This includes, for example, settings regarding the instance agent or settings regarding access to newly detected database instances.

Configuring a Virtualization Solution
In addition to configuring new hosts and systems, you can also add a virtualization solution. This is a common use case, because most of the SAP landscapes are currently operated in a virtualized way. To configure virtualization solutions, navigate to Infrastructure → Virtualization Manager.

You can configure the following virtualization solutions:

AWS
This is the access point to the AWS cloud.

IBM Hardware Management Console for IBM Power Adapter
This hardware management console manages a power-based infrastructure.

IBM PowerVC Adapter
This virtualization center adapter works with a power-based infrastructure.

IBM Systems Director/Flex System Manager Adapter
This solution establishes connections to the instances of Systems Director or Flex System Manager.

VMware vCloud
This SAP LVM link to vSphere via the VMware adapter allows you to fully control the virtual landscape.

VMware VIM
You can control the VMware-based landscape through VIM (Virtual Infrastructure Management). VIM enables you to generally control the virtual machines and ESX servers using a command line interface. SAP LVM is also able to do this.

After configuring the virtualization solution in SAP LVM, you can use data from the virtual landscape and the functions of the management solution correspondingly. Regarding functions in particular, you can benefit from the integration of management solutions with SAP LVM. You can use the functions of the virtualization solutions, such as simplified cloning. This is not possible if the virtualization solutions are not integrated.

Configuring Storage Solutions
The overall architecture (see Figure 3.13) shows that you can also—in addition to the usual infrastructure—integrate with a cloud. Explicitly integrating storage solutions is also an option. Figure 3.15 presents various options for integrating storage solutions.
Figure 3.15 Configuring Storage Solutions

IBM and NetApp

As you can see, you can also integrate IBM and NetApp. SAP LVM provides the adapters for these manufacturers by default. Because configuring and integrating adapters depend on the respective manufacturer, they are not described in detail here:

- **IBM Storage Adapter**
  This adapter enables you to establish a connection to an IBM Tivoli Storage FlashCopy Manager.

- **IBM System z DPS Storage Adapter**
  This connection for System z with the Database Provisioning System (DPS) enables you to refresh the system but only at the database level and not for the entire system.

- **NetApp Storage Instances Connector for SAP**
  This option allows you to use the functions of the NetApp storage systems. To do so, you must connect SAP LVM to the NetApp Operations Manager.

The benefit of integrating with storage solutions are that the features of the solutions are provided out of the box.

NetApp SSC and SAP LVM

For example, the NetApp Storage Service Connector (SSC) is used by SAP LVM to implement the following use cases through storage:

- **Starting, stopping, and relocating an SAP system**
- **Cloning, copying, and refreshing an SAP system**

NetApp SSC can manage various operating systems and storage connections. This includes the common operating systems, including versions of UNIX derivatives (AIX, Solaris, or HP-UX) to Linux (SLES, RHEL) up to Windows (2008/R2). The NFS, iSCSI, and FCP storage protocols can be used in various combinations.

If you integrate NetApp SSC into an SAP landscape with SAP LVM, the landscape and the function of SAP LVM change. Figure 3.16 shows an overview of the new landscape.

Thanks to SAP LVM’s integration with the NetApp SSC, SAP LVM no longer has to manage storage operations. Instead, SAP LVM transfers all operations to the NetApp SSC via the storage adapter. NetApp SSC then performs all the operations directly on the NetApp storage systems. NetApp storage systems use typical storage technologies, such as SAS, SSD, FC, and SATA drives in the backend. In the virtual machines, however, virtual storage devices, not individual drives, are mapped. Virtual machines or hosts can use different protocols to access the storage (NFS, FC, iSCSI). Storage layouts depend on the NetApp specifications.

NetApp SSC only forwards SAP LVM’s requests; the actual operations are performed on the storage systems. The most important operations are the following:

- **Clone**
  NetApp systems can clone storage areas and thus make exact images at...
the storage level. Cloning at the storage level is completed within seconds and is consequently considerably faster than at the virtualization solution level, for example.

**Copy**

NetApp systems can clone storage areas and thus make an exact image of an SAP system. SAP LVM can then provide this copy with a new SID and create a standalone SAP system.

**Backup and recovery**

Another benefit of the NetApp solution is the fast backup and recovery process for SAP systems, because snapshots are used at the storage level. In this case, *application-aware snapshots* are created, which allow for backups and recoveries within seconds.

As you can see, using a storage adapter enables you to better utilize the specific functions of the storage solution rather than using default SAP LVM operations only. Furthermore, you can integrate solutions from the hardware manufacturers with SAP LVM even more deeply. This enables you to implement further use cases. Using storage features plays a central role for faster SAP system operations.

**System copy**

If you use storage adapters and specific storage technologies, you can significantly reduce the time for cloning and copying SAP systems. Figure 3.17 illustrates the time savings for a system copy.

By using NetApp technology at the storage level, you can achieve considerable time savings. To copy systems fully and automatically, you need to perform the following three main steps:

1. **Tape Restore/Disk Restore**
   Here, the database (plus operating system) is reimported via tape restore or disk restore processes.

2. **Postprocessing of the database and operating system**
   After the restore, postprocessing must be implemented for the operating system and database (e.g., the database SID).

3. **Postprocessing SAP**
   When the restore process is completed and the operating system and database have been adapted, postprocessing in SAP starts. Here, the new SID is implemented and adaptations are made in the SAP system.

If you follow the traditional approach, it may take up to twenty-four hours to perform these three steps. Of course, this always depends on your system environment, the size of the database, and so on. However, the entire process involves manual tasks and a great deal of interaction. If SAP LVM and NetApp are integrated, you can achieve a time savings of up to 75% and create a copy of an SAP system in less than six hours. One of the most decisive factors here is that you no longer have to implement the tape or disk restore process. Instead, you can use the storage technology and copy the storage area of the original SAP system on the basis of a snapshot. Then, postprocessing tasks in the operating system and SAP system have to be performed, which can be done automatically. This results in significant time savings.

The overall structure of SAP LVM is designed in such a way that you can easily integrate the necessary automation tasks through other products. We illustrated this using virtualization solutions and storage solutions as examples. Furthermore, you can also customize other processes according to your needs. To do this, you can use custom hooks, which are described in Section 3.3.3.
3.3 SAP LVM as an Administration Framework

The previous sections introduced and described the functions of SAP LVM in detail. As you could see, SAP LVM functions as an administration tool with a high level of integration with its technical environment at the interface between SAP Basis and the IT infrastructure. The most important adapters that are essential for the functioning of SAP LVM are provided by SAP and the hardware partners, as described in Section 3.1.1.

Wide range of IT architectures

Despite these integration options, implementing SAP LVM in an existing SAP landscape always comprises open issues, which cannot be directly supported by SAP LVM. This is not very surprising if you consider the complex combinations of IT components at SAP customers. The different combinations of servers, storage systems and storage technologies, network components, operating systems, and databases are numerous. But there are also software components, such as backup systems, monitoring systems, and cluster software in PRD systems. No software can support everything out of the box as requested by customers.

SAP LVM vs. IT organizations

Another fact is that the functions of SAP LVM often push the envelope in the departments of IT organizations. In particular, large IT departments in correspondingly large enterprises and IT service providers are often organized in accordance with the technology stack (network, server, storage, operating system, database, and so on). In this case, SAP LVM also poses an organizational challenge when being implemented.

To meet all requirements, the development of SAP LVM has focused on increasing adaptability. Thus, today there are numerous ways you can customize SAP LVM and integrate it into IT environments and IT organizations. One could almost refer to SAP LVM as an SAP admin framework with a GUI. We will examine SAP LVM’s adaptability in more detail in the following sections.

Customizing SAP LVM

You can customize SAP LVM via LVM SETUP EXTENSIBILITY (see Figure 3.18).

3.3.1 Custom Tabs and Links

You have various options to customize SAP LVM’s interface to your needs. The easiest adaptations are simple and based on SAP Web Dynpro technology. You can customize the sizes of the displayed tables, for example, or enable each SAP LVM user to personalize the SAP LVM interface. To personalize the interface, users can define, for example, which main tabs and lower-level tabs should be displayed and which tab should be on the initial screen. You can implement personalization by clicking on the name of the currently logged in user at the top right in the SAP LVM interface (e.g., ADMINISTRATOR in Figure 3.18).

You can enhance the SAP LVM interface using custom tabs. Here, you can integrate each URL in an individual tab and define at which level it is displayed: either directly as a tab under the main functions or as a menu item within these tabs. By integrating URLs into the SAP LVM interface, you can establish it as the central access point to the management of the IT infrastructure, for example, by providing browser-based management tools.

Figure 3.19 shows an example in which the access to the interface of a storage manager (HP Command View EVA) was integrated into the main Infrastructure function.

The integration of external HTTP(S)-based tools, however, does not provide a single sign-on option, that is, every user requires corresponding access details and has to log on.
Another option for providing the SAP LVM user with new functions is to use custom links, specific functions or call URLs for a selected instance or host. SAP LVM Standard edition includes custom links, for example, for calling an RDP connection for Windows hosts or calling the SAP GUI. Furthermore, you can add the very useful SSH call function for a specific host or instance (see also SAP Note 1527599).

When defining custom links, it is important that you determine when the system is supposed to display them for users. For each custom link, you specify whether it is supposed to be used for instances or for hosts. In addition, each custom link is provided with constraints, which define the conditions when custom links are used. SAP LVM defines more than sixty constraints (e.g., OS type, database type, host status). You can then use these constraints to define corresponding statuses. For example, for a custom link for the SAP logon, the constraint instance status specifies that the instance must have the "running" status and the constraint instance type determines that the instance must be an AS ABAP instance.
Custom services are not defined directly via SAP LVM GUI but via configuration files. To enable SAP LVM to use custom services, the following three operations need to be defined:

- **LIST (acc_<custom_service>_list.conf file)** identifies the custom service(s) on the managed host.
- **MONITOR (acc_<custom_service>_monitor file)** monitors the custom service(s).
- **START & STOP (acc_<custom_service>_start/stop file)** starts or stops the custom service(s).

Further operations can be integrated through configuration files, for example, ATTACH/DETACH for custom services that are enabled for adaptive computing, that is, have virtual host names and shared storage. In addition to various parameters, the configuration files also specify the scripts, which perform the actual tasks.

The configuration files for custom services need to be in the following directory of the SAP host agent: `<Path_to_HostAgent>/exe/operations.d`.

### SAP LVM as an Administration Framework

You will find a more detailed description about how to implement custom services in SAP Note 1396981.

To use custom services, you only need an installed SAP host agent, which allows you to also use SAP LVM to manage custom services on hosts on which no SAP instance is installed.

#### 3.3.3 Custom Operations and Hooks

SAP LVM is like a Swiss Army Knife for SAP system administration, especially through enhancing or adapting default functions. You can even add custom functions. Custom operations enable custom functions in the SAP LVM interface, which you can then execute via buttons. Custom hooks can enhance or replace default functions or a feature of SAP LVM.

To enhance functions, you first must define provider implementations to determine which operations are executed in a new function. SAP LVM supports four different provider types:

- **SAP host agent scripts**
  - Script that is registered with and executed by the SAP host agent.
- **HTTP post service**
  - Servlet or similar that is directly called by SAP LVM.
- **Web service**
  - Server-side web service that implements the WSDL defined by SAP LVM.
- **Remote function call**
  - ABAP function module that is called and executed by SAP LVM.
- **Confirmation action**
  - Text that the system displays to the user to confirm successful operation.

You can customize the settings for provider implementations as well as for custom operations and custom hooks under LVM • SETUP • EXTENSIBILITY • CUSTOM OPERATIONS, HOOKS, AND NOTIFICATIONS • PROVIDER IMPLEMENTATION DEFINITIONS. Figure 3.22 illustrates a provider implementation for the "Trigger Log Switch for a DB2 Instance" function.
When and where are custom functions used?

As you can see in Figure 3.22, to define the provider implementation, you determine what type of provider should be used (in this case, a script registered with host agent). In addition, you specify where and when the provider is used, in this example, as an operation for an instance. Providers can also be used for operations and hooks. Furthermore, you can also define individual parameters for the provider if required, although custom parameters cannot be defined for custom hooks. The provider is then queried by the user when a custom operation is actually executed to have the parameters forwarded to the executing script, web service, or similar.

Creating individual types of providers is not described in detail here because this is beyond the scope of this chapter. However, you can find more information on SAP Help for SAP LVM.

Custom operations

After you have defined and implemented the corresponding providers (that is, created new functions), you create the actual operation via LVM • SETUP • EXTENSIBILITY • CUSTOM OPERATIONS, HOOKS, AND NOTIFICATIONS • CUSTOM OPERATIONS by assigning a name and establishing the link to the provider. Here, you also define when and where the operation is available by using constraints. For our sample operation TRIGGER LOG SWITCH, you would define the following constraints: DATABASE TYPE (STATIC) = DB2 and INSTANCE PROCESS IS RUNNING (STATE ‘GREEN’) (DYNAMIC) = TRUE (see Figure 3.23).

Now, if an operation is executed in SAP LVM and an instance meets the requirements for custom operations, the system displays the DB OPERA-

TION list box and the TRIGGER LOG SWITCH function next to the list box (see Figure 3.24).

Similarly, custom hooks follow the same principle as custom operations and are also based on provider implementations. In contrast to custom operations, however, they are always integrated into the specified SAP LVM work steps. Figure 3.25 maps a custom hook that is always exe-

cuted when a DB2 instance is stopped.

SAP LVM as an Administration Framework 3.3
You can integrate these custom hooks into the operation (Log Switch DB2) without any problems. You can find custom hooks under LVM • SETUP • EXTENSIBILITY • CUSTOM OPERATIONS, HOOKS, AND NOTIFICATIONS • CUSTOM HOOKS.

The selection of the Operation is important here. SAP LVM offers 61 default operations. For example, UNBIND IP ADDRESS and UNMOUNT FILESYSTEM can be enhanced with custom hooks. Finally, you can determine whether the custom hook is executed before or after the default operation or when the default operation has an error. Here, you also define constraints to specify when and where the custom hook applies. When a custom hook is integrated, it will always be executed without any interaction if the default operation runs and the constraints are met.

### 3.3.4 Replication for Custom Provisioning

Automatic provisioning (cloning and copying) of SAP systems is a vital feature of SAP LVM, as already described in this chapter. An integral process within this function is the replication of the source system in order to establish the target system afterwards. Because the need for SAP system copies is as old as SAP itself, there is a wide range of options and tools used in practically all cases.

By default, SAP LVM supports two types of replication. One is the virtual machine-based copy in which case the source system is installed on a virtual machine. Through integration with a corresponding virtualization solution (see Section 3.4.1), SAP LVM triggers the cloning of the respective virtual machine, which is then performed by the virtualization solution itself. SAP LVM then uses the virtual machine clone. The second type is a storage-based copy. For this purpose, the respective manufacturer needs to provide an SAP LVM storage integration (see Section 3.1.1). Here as well, SAP LVM triggers the creation of the clone, and the storage system then performs the actual work.

If the SAP environment lacks a virtualization integration or storage integration for SAP LVM, or if other established copying technologies, such as backup and recovery, are supposed to be used, you can use the custom provisioning function.

Technically, the custom provisioning function works in a similar way as custom hooks. The function is also based on a provider implementation in SAP LVM, which addresses a script, a web service, and so on. There, the function is implemented on the source or target system respectively. In addition, in the case of custom provisioning, you can use a proxy host. In other words, you don’t have to execute the script or web service directly on the source system, which is not possible on a PRD system for compliance reasons.

You can access custom provisioning via LVM • SETUP • EXTENSIBILITY • CUSTOM PROVISIONING PROCESS. A custom provisioning process includes various substeps. If you implement custom provisioning, you can define each of the substeps in one or more provider implementations. Figure 3.26 shows an example.

This example illustrates how the RESTORE BACKUP step was defined using the RESTORE WITH HP DATA PROTECTOR provider implementation. Following this approach, you can replace all other steps, for example, CLONE VOLUMES, with custom functions.

To have an SAP system use your custom provisioning function when copying or cloning a system, you must configure the system. The following Figure 3.27 shows SAP System R80, which uses custom provisioning for cloning.
In addition to adding functions to SAP LVM, custom notifications can also be created to send or display information in the case of specific events.

For custom notifications, you initially create a provider implementation again, which you then assign to a notification via LVM • SETUP • EXTENSIBILITY • CUSTOM OPERATIONS, HOOKS, AND NOTIFICATIONS • CUSTOM NOTIFICATIONS. For provider implementations for notifications, you can choose between scripts, HTTP posts, and web services.

**Email Notification**

Email is certainly the most important notification type. SAP LVM supports this type by default and also allows for numerous email notification options, for example, for tasks, validations, and so on.

When you create the actual custom notification, you specify when it is used. Notifications can be set for three processes: validations, activities, and tasks. Figure 3.28 shows a provider implementation for a custom notification and its definition.

Notifications can be used multiple times.

**3.3.5 Custom Notifications**

In addition to adding functions to SAP LVM, custom notifications can also be created to send or display information in the case of specific events.
The example lists a provider that sends an SMS via a web service. The definition of the custom notification determines that an SMS is sent for all process types (validations, activities, and tasks). This custom notification enables SAP administrators to schedule overnight tasks in SAP LVM, for example, restarting an SAP system and ensuring that the system sends an SMS if an error occurs (or in any other defined case).

As mentioned in previous sections, SAP LVM with its various enhancement options is a comprehensive and universal tool. You can virtually integrate any externally provided function (scripts, web services, RFC, etc.) with SAP LVM and thus create your own SAP administration platform. This flexibility and the appropriate authorization management will enable the inclusion of different groups in the SAP administration (e.g., first-level support, database administrators, SAP Basis administrators, and so on). For large IT organizations with a strong focus on SAP, SAP LVM is a great opportunity to enhance the effectiveness of processes.

3.4 Integration with Virtual Environments and the Public Cloud

When the predecessor of SAP LVM—SAP NetWeaver ACC—was developed, x86 host virtualization in the data centers where SAP systems operated was not a subject, and the cloud concept wasn’t defined yet.

When SAP LVM was introduced in 2012, the world had changed. Because SAP LVM functions as an interface between SAP system administration and its corresponding infrastructure, virtualization technologies and public cloud services must also be integrated into the SAP LVM architecture.

3.4.1 Integration with Virtualization Solutions

For SAP LVM, supporting virtualized environments is a prerequisite for supporting private and hybrid cloud scenarios because using virtualization solutions is the technical basis for cloud environments.

By default, SAP LVM supports three different virtualization solutions: VMware, Hyper-V, and IBM Power. All integration options can be used free of charge on the SAP LVM side. Of course, the software of the respective provider of the virtualization solution has to be licensed appropriately.

Basically, all integration options support the essential functions for managed resources (i.e., virtual machines):

- **Enable**
  - Activating or continuing the virtual machine.
- **Disable**
  - Deactivating the virtual machine; you usually differentiate between regular OS shutdowns or "hard" power offs.
- **Pause**
  - Switching the virtual machine to a suspend mode.
- **Migrate**
  - Relocating the virtual machine from a physical host to another host.
- **Provide**
  - Providing a new virtual machine using a template or by creating a new virtual machine from scratch.

If you have the corresponding authorizations, you can start all of these operations from SAP LVM. This, again, demonstrates the integrated role of SAP LVM: If you utilize virtualization integration, SAP Basis administrators become virtual machine administrators. Consequently, the required organizational and technical regulations must be provided in the IT organization.

In addition to the execution of operations, integration also includes monitoring functions, that is, SAP LVM monitors the essential entities of the virtualization environment, such as:

- **Virtualization manager**
  - Central management components of the virtualization solution (e.g., VMware vCenter or the Microsoft System Center virtualization manager server).
- **Resource pool**
  - For VMware, this is the resource pool defined in vCenter.
- **Virtual resource**
  - Every virtual machine in the environment.
Virtual resource template
Template for the creation of resources.

Hyper-V
Integration with Hyper-V is possible as of SAP LVM version 2.0 and uses the System Center Virtual Machine Manager 2012 SP1 connector for SAP Landscape Virtualization Management. Microsoft Hyper-V 3.0 with Windows Server 2012 or higher is required.

Comprehensive IBM integration
The SAP LVM integration for IBM Power goes beyond the actual virtualization solution of IBM, PowerVM. SAP LVM 2.0 for IBM Power includes the following adapters for storage and virtualization:

- SAP LVM storage integration:
  - IBM Storage Adapter
- SAP LVM virtualization integration:
  - IBM Hardware Management Console for IBM Power Adapter
  - IBM Systems Director / IBM Flex System Manager Adapter
  - IBM PowerVC Adapter

All adapters are directly provided with SAP LVM. Because IBM provides comprehensive support for SAP LVM, various application scenarios run in a homogeneous IBM hardware landscape. For example, integration may also include the management of logical partitions (LPARs) and, thus, of IBM hardware components.

VMware
The first virtualization integration that was available for SAP LVM was the adapter for VMware, which could be used as early as SAP NetWeaver ACC 7.2 and VMware vCenter 2.5. Thus, this integration has become rather sophisticated today. The following sections briefly introduce virtualization integration with SAP LVM. For the VMware integration, there are three different adapters:

- VMware VIM
  This adapter uses the VIM API to connect to VMware vCenter and to control or monitor the virtual environment. VMware VIM is included with SAP LVM.

- VMware vCloud
  This adapter was developed for establishing a link to VMware vCloud Director. Although this adapter is included with SAP LVM, it is not being further developed because vCloud Director has established itself in other VMware products.

VMware Adapter for SAP LVM
This adapter is completely new and based on a VMware software appliance that must be installed as well. The adapter itself is installed on SAP LVM from the appliance; it is not provided by SAP.

You can configure the adapters via LVM • INFRASTRUCTURE • VIRTUALIZATION MANAGERS. If you select Add, the system displays a selection of the available adapters (see Figure 3.29).

Figure 3.29 Selecting a Virtualization Adapter

After you have selected the VMware VIM adapter, the system queries the connection data for the vCenter server. Figure 3.30 shows an example of this.

Defined in the USER NAME field, the technical user plays a central role in creating the connection. The technical user must be created in vCenter’s user configuration and have specific authorizations to be able to use all VMware VIM adapter options via SAP LVM. Details on how to do this are described in SAP Note 1259069. You can also restrict the SAP Basis administrator’s options as an SAP LVM user using or managing the VMware environment according to specific specifications here.
After filling all the fields, you can test the connection using the Test Configuration button. After configuring the adapter, you can view and manage all vCenter hosts or clusters and all the available virtual machines under LVM • OPERATIONS • VIRTUALIZATION (see Figure 3.31).

VMware integration via VIM allows all these operations with the virtual machines and thus enables the SAP Basis administrator to manage and use the virtualized environment through SAP LVM.
As you can see, the VMware Adapter for SAP LVM (vLA) is a standalone software appliance that runs as a dedicated virtual machine and is directly linked to a central VMware Orchestrator (vCO). In turn, you can link numerous vCenter servers to this appliance, for example, to use different virtualized landscapes in SAP LVM. The actual adapter for SAP LVM is deployed through the vLA appliance in the SAP LVM system during installation. For this new integration, SAP LVM no longer directly communicates with a vCenter server but with the vLA. The vLA, in turn, forwards all tasks and workflows to the vCO, which then executes everything through the vCenter servers.

Of course, the new VMware integration process for SAP LVM takes more time to implement than before and creates a larger footprint in the system landscape due to its additional components. However, the advanced options unlocked by building a VMware-based infrastructure for SAP LVM are clear benefits.

Currently, SAP LVM does not support the integration of other hypervisor technologies, such as KVM and Xen. This will hopefully change as these open-source-based and cost-efficient technologies become increasingly important.

### 3.4.2 Integration with Public Cloud Offerings

With the success of virtualization, due in part to its standardization and automation capabilities, the development of IT infrastructures has since moved towards the cloud, particularly the IaaS cloud. SAP LVM as a tool for the interface between SAP Basis and IT infrastructure plays a major role here as well.

If an enterprise uses SAP LVM to manage SAP Basis in its IT department, it would be part of a private cloud. So SAP LVM leverages (physical and virtualized) resources that belong to the enterprise. For flexibility and cost reasons, customers may want to be able to purchase external resources if required, that is, use public cloud services. SAP LVM enables you to build an infrastructure bridge from your private cloud to a public cloud.

Building bridges here means using resources, that is, virtual machines in a public IaaS cloud for SAP systems. This way, SAP LVM allows for hybrid cloud scenarios, which are viewed as the most probable use of the cloud. SAP also thinks that hybrid scenarios are the preferred usage models for their customers.

Two important prerequisites for integrating SAP LVM with a public cloud (always an IaaS) are an appropriate API on the provider side and the corresponding adapter for SAP LVM. As of this writing, only the SAP LVM integration for AWS cloud was available, but more options are forthcoming. The required adapter is delivered with the SAP LVM version 2.0, Enterprise edition.

Adapters for virtualization technologies can be configured via LVM • INFRASTRUCTURE • HYBRIDORIZATON MANAGERS (see Figure 3.29). If you select Amazon AWS here, the system queries the connection data for access via the AWS API. Figure 3.33 shows an example of this.

![AWS Adapter Configuration](image-url)

**Figure 3.33 AWS Adapter Configuration**

Authentication is implemented via an access key and a secret key, which must be created for each AWS user in the AWS console. Please consider...
that an AWS adapter can access only one AWS region. So, if resources in different regions are used, the corresponding number of AWS adapters must be configured.

Another important aspect to use the AWS cloud is the communication between SAP LVM and AWS. You can configure elastic IPs for your resources in AWS, or you can use the Virtual Private Cloud (VPC) connection provided by Amazon. To ensure that SAP LVM does not have to communicate with the AWS cloud directly—for security reasons—you can also use a proxy host for the configuration.

After configuring SAP LVM and AWS, you can view and manage AWS instances via LVM • OPERATIONS •VIRTUALIZATION, for example, to start and stop the instances as shown in Figure 3.34.

Figure 3.34 Overview and Operations with AWS Instances

As you can see, SAP LVM always identifies AWS regions as resource pools. When the AWS instances are available in SAP LVM, you can then configure and use them like "normal" hosts.

For quite some time now, SAP LVM users have asked for more public cloud providers to be supported by SAP LVM. SAP is currently developing additional adapters, and the SAP LVM roadmap already includes integration with the Microsoft Azure cloud. However, even more exciting is the plan to develop an adapter for OpenStack-based cloud environments (both public and private). With this adapter, SAP LVM would provide support for a widely accepted cloud standard, which would considerably increase the number of potentially usable IaaS offers.

Costs for Public Clouds

One critical aspect when using public IaaS in the cloud is cost. In this area, SAP LVM does not provide any support (understandably, considering the complex pricing of the cloud market) so you must ensure that the pay-per-use concept does not lead to a cost explosion in your enterprise due to carelessness or poor organization.
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First-hand knowledge.

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