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Introduction

Today’s SAP administrators face many challenges in a world of steadily growing and increasingly complex SAP landscapes. How do you run systems on different hardware systems depending on demand and load? How do you migrate and clone systems if necessary, preferably on a 24/7 basis, with the least amount of resources? In addition, administrators must find solutions and resources for the additional requirements of different departments, such as creating new training landscapes and development systems.

Consequently, flexible architectures based on virtualization technologies are becoming more relevant to help address these complex challenges.

Figure 1. Architectures based on virtual technologies help SAP administrators find solutions.
This white paper uses concrete examples to describe the architecture of a system landscape based on Oracle Solaris Containers and Oracle Solaris ZFS technologies. This architecture allows enterprises running Oracle Solaris to operate an SAP environment at lower cost, in a more flexible way, while retaining high availability. It is the objective of this architecture to minimize operating expenditures pertaining to administration, complexity, and downtime.
How to Get There

In current SAP system environments, approximately 70 to 80 percent of systems are nonproduction systems. However, these systems require the highest maintenance and administration expenditures and incur the highest costs of all systems. For that reason, this white paper primarily deals with this group of systems. However, the architectures and tools discussed here can also be used as a blueprint for virtualization of production SAP systems.

It is important to make new SAP systems available to users in a fast and flexible way, particularly for test, training, and development environments, where schedules are more fluid than in production environments. In addition, modern SAP datacenters need the ability to implement versioning and freezing of a complete SAP environment after an upgrade. These tasks can be performed by implementing Oracle Solaris Containers configured with Oracle Solaris ZFS file systems.

Implementation with Oracle Solaris 10

This procedure is performed by Oracle Professional services and Oracle partners who ensure that the architecture is customized to specific requirements and is made operational quickly. Each SAP instance is implemented in a single Oracle Solaris Container of Oracle Solaris 10—in other words, one container per application. A container is a zone using the Oracle Solaris Resource Manager to administer resource requirements. As such, the terms container and zone are used as synonyms in this white paper.

A zone is an isolated process environment within Oracle Solaris 10. Each instance of Oracle Solaris 10 has at least one zone, the global zone. This zone can be considered as the actual operating system (OS) where most administrative tasks are performed.

Within the global zone, any number of local zones can be set up. For security reasons, these zones are completely isolated from each other. A local zone can neither access nor manipulate data or objects in another local zone within the same Oracle Solaris 10 instance. All communication options between local zones and to outside systems must be configured in the global zone. The global zone can assign different resources to the local zones to effectively control resource requirements of the local zones.

In addition, a root user can be defined for each local zone. However, root privileges exclusively apply to this environment. This feature facilitates implementation of the delegated administration concept.

Different Types of Zones

In general, there is a distinction between sparse-root and whole-root zones, as shown in Figure 5. Sparse-root zones can be implemented effortlessly. The additional disk space requirements for installation are negligible because the zone inherits directories such as /usr, /lib, /sbin, and /platform as read-only file systems from the global zone. Another advantage of this type of zone is the fact that updates and patches are only installed once in the global zone and are then immediately available for all local zones.
Minimizing Downtime in SAP Environments

Figure 2. Sparse-root zones can be implemented effortlessly, while whole-root zones constitute independent systems.

In contrast to sparse-root zones, whole-root zones do not inherit root directories from the global zone. These zones have their own root environment and require additional disk space for an Oracle Solaris installation. Installation of updates and patches must be performed separately for each of these zones. Whole-root zones have a distinct advantage—because they are independent, they are mostly self-reliant and can be operated in a very flexible way. For the administrator, they constitute independent systems.

Figure 3 illustrates the different zone types in an example from the SAP sector.

Note: Prior to installation, the number of zones required must be defined. Space requirements for the zone, the application, and files to be installed within must also be defined, which helps provide the overall storage requirements for the system.
File System Setup

Data and configuration of all application layers should preferably be located on Oracle Solaris ZFS file systems. Using Oracle Solaris ZFS facilitates easy allocation of hard disk resources to the individual layers. For maintenance of the system, ZFS Snapshot is a very powerful tool.

Oracle Solaris ZFS is a very powerful and reliable file system. It is transaction oriented; that is, any operation in the file system either is successful as a whole or fails as a whole. Consequently, the file system is always consistent, and file system checks are no longer required. All changes in the file system are performed as copy-on-write, so the contents of valid files are never overwriten. Data is only written to free blocks, which are then integrated into the file system structure.

The copy-on-write paradigm also offers the option to maintain any number of snapshots in a file system (however, the actual number of snapshots is restricted by the overall capacity) and to open a snapshot (or clone) during writing. Oracle Solaris ZFS integrates a volume manager, so additional volume managers are not required. This reduces the complexity of the infrastructure as well as reducing operating costs.

Oracle Solaris ZFS has a hierarchical structure, as shown in Figure 4. In a zpool (a collection of virtual or physical devices), ZFS file systems are created, if needed with caps for minimum or maximum size. In this ZFS, other file systems can then be created, which might inherit these size settings. With scripts that are available from Oracle's Server Presales Architects, each zone is allocated a ZFS like the one described above. In addition, during allocation, administration of ZFS is delegated to the zone. This enables users to create additional ZFS file systems within the zone if needed and to assign the required features. However, the maximum size or quota cannot be modified from within the zone.

![Figure 4. Oracle Solaris ZFS has a hierarchical structure.](image)

Note: The initial size of the zpool is determined by the number and size of the zones. Initially, one zpool should be assigned per SAP system group. For example, a system group contains all nonproduction SAP Enterprise Portal systems. The size of the pool can easily be expanded later. Oracle Solaris ZFS supports RAID-1 and RAID-Z to safely store data in the pool.

Network Connection

Oracle recommends the network connection described in this section and illustrated in Figure 5. This recommendation is based on the assumption that the hardware system is equipped with two physical
network interfaces. One of these interfaces connects the local zones to the external user network, which, for example, gives all SAP users access (possibly through a load balancer). The other interface connects to the internal administration network, which gives OS and SAP basic administrators access to the zones, for example to perform SAP upgrades. This distinction is vital for implementation of the SAP upgrade scenario, where it is assumed that user access is controlled by switching on and off or switch-over of the I/O interfaces.

High Availability Out-of-the-Box

For each container, the zone root path is installed on shared storage and the global root file system is installed on the local disks of the system.

Oracle Solaris Containers and Oracle Solaris ZFS offer the ability to implement a form of manual high availability. As shown in Figure 6, in case of failure, the container with all of its installed applications can be started on another system.

Figure 5. A network connection with two physical interfaces is recommended.

Figure 6. A container from one system can be moved to another to facilitate high availability.
Moving a container is performed using the standard Oracle Solaris commands and is described in detail in the “Moving Containers to Another System” section.

The prerequisites for moving a container are

- There must be identical hardware/system architecture—for example, oracle4v and oracle4u.
- The new system where the container or the SAP application will run must have the same Oracle Solaris release and patch release as the originating system.
- The new system where the container or the SAP application will run must provide the same network interfaces. Alternatively, virtual network interface cards (VNICs) can be used.
- The shared storage used must be visible on all systems.

Architecture of the SAP Systems

Using Solaris and Solaris Zones and ZFS, is an ideal procedure for SAP development, test, and training systems. These systems can be installed, allocated, and automated easily. However, they can always be reset to a defined status. For example, they can reset if a logical fault occurs during implementation or testing of an upgrade.

An SAP system, such as a training system TP1, is implemented in a master zone as a standalone system and is allocated a dedicated server. This facilitates installation of such architectures and offers a better overview for administration of the SAP systems. Because zones can be moved, a consolidation or merger of the master zones is possible at any given time.

Due to the complexity involved, installation or migration of the SAP systems cannot be described in this white paper. Detailed information is available in the application-specific guidelines, which are provided for download in the SAP Service Marketplace at service.sap.com.

Central Instance and Database in an Oracle Solaris Container

Figure 7 shows an example of a standalone installation of an SAP NetWeaver Portal. All components (for example, the central instance and database) required for starting and running an SAP application are installed in one zone.

Figure 7. All components required for starting and running an SAP application are installed in one zone.
In the distributed installations of the past, the database was installed so that it was isolated from the central instance, and the database files were stored on different file systems, mainly to improve performance or to increase data security. The security aspect was mainly influenced by the option to be able to quickly and consistently reinstall the data of the database after a system crash.

However, the performance of advanced servers and their network components is steadily increasing. For most SAP development, test, and training systems, a standalone installation meets the current performance and user number requirements.

The data security aspect for these systems is negligible in most instances when using Oracle Solaris ZFS. For more-detailed information regarding data integrity with Oracle Solaris ZFS, such as applying different RAID methods and ZFS functions, refer to the ZFS administration guide at opensolaris.org/os/community/zfs/docs/.

**Configuration Steps**

The following sections address the initial steps, tasks, and scripts to set up the architecture and all processes required for operation.

*Note: The scripts below are only examples. There used to be specified scripts when Sun Microsystems still offered N1AA as a special offering to SAP-Sun customers. As N1 is EOL by now, those scripts are no longer available under this name. But it is no problem to find equivalent copy and clone shell scripts based on zone and zfs commands or to write them yourself. There are many examples to be found on SAP’s SDN or on various blogs and Wikis covering this topic.*

**Initial Tasks**

This section describes the steps to be performed and their sequence to configure the Oracle Solaris Zones and ZFS architecture.

Analyze and Define the System Landscape

The analysis consists of several steps and starts with a workshop where the project associates

- Present the business case—the economic assessment of the investment into the project.
- Discuss basic architecture and technologies.
- Define
  - The old and new SAP systems involved. New or differently used host and zone names.
  - Required network names/connections/information.
  - Storage requirements (the storage-area network, or SAN) and pool names.

Information gathered during the workshop is compiled in a configuration table and approved by the specialized departments. The configuration form in Appendix A provides a template.

Table 2 and Table 3 contain sample configuration descriptions referred to in later sections.
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### TABLE 2. STORAGE CONFIGURATION

<table>
<thead>
<tr>
<th>Zpool</th>
<th>Disks</th>
</tr>
</thead>
<tbody>
<tr>
<td>xpoold4</td>
<td>c0t252400015D22B300d4 &lt;SUN-SE6920-0202-80.00GB&gt; /pci@780/</td>
</tr>
<tr>
<td></td>
<td>SUNW_emlx@0.1/fp@0.0/ssd@w25400015d22b300,4</td>
</tr>
<tr>
<td></td>
<td>MIRRORED WITH: (optional)</td>
</tr>
<tr>
<td></td>
<td>c0t252400015D22B300d13....</td>
</tr>
<tr>
<td>xpoold5</td>
<td>c0t252400015D22B300d5 &lt;SUN-SE6920-0202-80.00GB&gt; /pci@780/</td>
</tr>
<tr>
<td></td>
<td>SUNW_emlx@0.1/fp@0.0/ssd@w25400015d22b300,5</td>
</tr>
<tr>
<td>xpoold6</td>
<td>c0t252400015D22B300d6 &lt;SUN-SE6920-0202-80.00GB&gt; /pci@780/</td>
</tr>
<tr>
<td></td>
<td>SUNW_emlx@0.1/fp@0.0/ssd@w25400015d22b300,6</td>
</tr>
<tr>
<td>xpoold7</td>
<td>c0t252400015D22B300d7 &lt;SUN-SE6920-0202-80.00GB&gt; /pci@780/</td>
</tr>
<tr>
<td></td>
<td>SUNW_emlx@0.1/fp@0.0/ssd@w25400015d22b300,7</td>
</tr>
</tbody>
</table>

Note: The disks allocated to the zpools must be visible on all systems to allow moving the containers. The OS command format can be used for verification.

### TABLE 3. ZONE AND NETWORK CONFIGURATION

<table>
<thead>
<tr>
<th>Physical host name/IP</th>
<th>Zone Name</th>
<th>Net</th>
<th>Virtual host name/IP</th>
<th>Sub net</th>
<th>Interface</th>
<th>FS Type</th>
<th>Master</th>
<th>Zpool</th>
<th>ZS</th>
<th>Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>ssc1apx1</td>
<td>zm1host5</td>
<td>A</td>
<td>n1host5 / 192.168.20.129</td>
<td>24</td>
<td>ngeo</td>
<td>ZFS</td>
<td>Yes</td>
<td>xpoold4</td>
<td>I</td>
<td><img src="image" alt="" /></td>
</tr>
<tr>
<td></td>
<td></td>
<td>U</td>
<td>192.168.30.129</td>
<td>24</td>
<td>bgeo</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>SAP Portal XE1 - Training system</td>
</tr>
<tr>
<td></td>
<td>zm1host7</td>
<td>A</td>
<td>n1host7/ 192.168.20.131</td>
<td>24</td>
<td>ngeo</td>
<td>ZFS</td>
<td>No</td>
<td>xpoold4</td>
<td>C</td>
<td><img src="image" alt="" /></td>
</tr>
<tr>
<td></td>
<td></td>
<td>U</td>
<td>192.168.30.131</td>
<td>24</td>
<td>bgeo</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>SAP Portal XE1 - Training system Clone of XE1 (zm1host5)</td>
</tr>
<tr>
<td></td>
<td>zm1host8</td>
<td>A</td>
<td>n1host8/ 192.168.20.132</td>
<td>24</td>
<td>ngeo</td>
<td>ZFS</td>
<td>No</td>
<td>xpoold5</td>
<td>C</td>
<td><img src="image" alt="" /></td>
</tr>
<tr>
<td></td>
<td></td>
<td>U</td>
<td>192.168.30.132</td>
<td>24</td>
<td>bgeo</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>SAP Portal XE2 - Training system Copy of XE1 (zm1host8)</td>
</tr>
<tr>
<td></td>
<td>zm1host6</td>
<td>A</td>
<td>n1host6/ 192.168.20.130</td>
<td>24</td>
<td>ngeo</td>
<td>ZFS</td>
<td>Yes</td>
<td>xpoold6</td>
<td>I</td>
<td><img src="image" alt="" /></td>
</tr>
<tr>
<td></td>
<td></td>
<td>U</td>
<td>192.168.30.130</td>
<td>24</td>
<td>bgeo</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>SAP NetWeaver 2004q Application Server TE4</td>
</tr>
<tr>
<td></td>
<td>zm1host14</td>
<td>A</td>
<td>n1host14/ 192.168.20.138</td>
<td>24</td>
<td>ngeo</td>
<td>ZFS</td>
<td>No</td>
<td>xpoold6</td>
<td>C</td>
<td><img src="image" alt="" /></td>
</tr>
<tr>
<td></td>
<td></td>
<td>U</td>
<td>192.168.30.138</td>
<td>24</td>
<td>bgeo</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>SAP NetWeaver 2004q Application Server TE5 Copy of TE4 (zm1host14)</td>
</tr>
<tr>
<td></td>
<td>zm1host9</td>
<td>A</td>
<td>n1host9/ 192.168.20.133</td>
<td>24</td>
<td>ngeo</td>
<td>ZFS</td>
<td>No</td>
<td>xpoold7</td>
<td>C</td>
<td><img src="image" alt="" /></td>
</tr>
<tr>
<td></td>
<td></td>
<td>U</td>
<td>192.168.30.133</td>
<td>24</td>
<td>bgeo</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>SAP Portal XE3 - Training system Copy of XE1 (zm1host9)</td>
</tr>
</tbody>
</table>

Legend
Net (network connection): U = user LAN, A = administration LAN
FS Type (file system type): ZFS or UFS
ZS (zone status): I = installed, C = configured
An XML file must be created for each system based on the Container Configuration Form (see Appendix A). This file defines the zones to be installed on the system (for example, sscsapx1) and all zones that can be moved from another system (for example, sscsapx2) to this system. An example is show below.

```xml
<?xml version='1.0' encoding='utf-8'?>
<!-- NIVTools Hostname IP List -->
<HostnameIPList>

  <zonename name="znlhost5">
    <Path>/zones/znlhost5</Path>
    <IPNetmask>192.168.20.129/24,nge0;192.168.30.129/24,Dge0</IPNetmask>
    <VirtualHost>nhost5</VirtualHost>
    <Type>ZFS</Type>
    <ZPool>xpoold4</ZPool>
    <Used>MASTER</Used>
    <Comment>SAP Portal XE1 - Trainingsystem</Comment>
  </zonename>

  <zonename name="znlhost7">
    <Path>/zones/znlhost7</Path>
    <IPNetmask>192.168.20.131/24,nge0</IPNetmask>
    <VirtualHost>nhost7</VirtualHost>
    <Type>ZFS</Type>
    <ZPool>xpoold4</ZPool>
    <Used></Used>
    <Comment>SAP Portal XE1 - Trainingsystem (Clone von znlhost5)</Comment>
  </zonename>

  <zonename name="znlhost8">
    <Path>/zones/znlhost8</Path>
    <IPNetmask>192.168.20.132/24,nge0</IPNetmask>
    <VirtualHost>nhost8</VirtualHost>
    <Type>ZFS</Type>
    <ZPool>xpoold5</ZPool>
    <Used></Used>
    <Comment>SAP Portal XE2 - Trainingsystem (Copy+rename of znlhost5)</Comment>
  </zonename>

</HostnameIPList>
```
Minimizing Downtime in SAP Environments

Legend:

• `<IPNetmask>`—In case several network interfaces exist, they must be separated from each other by `:`.

Note: The first IP of the file must always represent the user network—in other words, the network from which the application is accessed.

• `<Type>`—Enter UFS or ZFS as type.

• `<Used>`—Enter MASTER in case it is a master zone. In all other cases, no entry.

• `<Comment>`—General comments regarding applications in the zone—for example, SAP application.

```xml
<zone name="zn1host6">
    <Path>/zones/zn1host6</Path>
    <IPNetmask>192.168.20.130/24,nge0</IPNetmask>
    <VirtualHost>zn1host6</VirtualHost>
    <Type>ZFS</Type>
    <ZPool>xpool6</ZPool>
    <Used>MASTER</Used>
    <Comment>SAP Netweaver 2004s ApplServer TE4 - Trainingssystem </Comment>
</zone>

<zone name="zn1host9">
    <Path>/zones/zn1host9</Path>
    <IPNetmask>192.168.20.133/24,nge0</IPNetmask>
    <VirtualHost>zn1host9</VirtualHost>
    <Type>ZFS</Type>
    <ZPool>xpool7</ZPool>
    <Used>MASTER</Used>
    <Comment>SAP Netweaver 2004s ApplServer TE4 - Trainingssystem </Comment>
</zone>

<zone name="zn1host14">
    <Path>/zones/zn1host14</Path>
    <IPNetmask>192.168.20.138/24,nge0</IPNetmask>
    <VirtualHost>zn1host14</VirtualHost>
    <Type>ZFS</Type>
    <ZPool>xpool9</ZPool>
    <Used>MASTER</Used>
    <Comment>SAP Portal XE3 - Trainingssystem (Copy+Rename von zn1host5) </Comment>
</zone>
```

</HostnameIPList>
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Create a zpool and a ZFS File System for a Zone

Creating a zpool and allocating the ZFS file system to the zones based on the zone and network configurations must be performed for each system where zones are installed and where they are expected to be active. Following are the steps for creating a zpool, checking the zpools, and setting up the zone file systems:

1. Create a zpool.

```bash
sscsapx1# zpool create xoold4 c0t252400015D22B300d4
sscsapx1# zpool create xoold5 c0t252400015D22B300d5

sscsapx2# zpool create xoold6 c0t252400015D22B300d6
sscsapx2# zpool create xoold7 c0t252400015D22B300d7
```

2. Check the zpools.

```bash
sscsapx1# zpool list
sscsapx2# zpool list
```

3. Set up the zone file systems.

```bash
sscsapx1# zfs create -o mountpoint=/zones/zn1host5 xoold4/zn1host5
sscsapx1# chmod 700 /zones/ zn1host5
sscsapx1# zfs create -o mountpoint=/zones/zn1host7 xoold4/zn1host7
sscsapx1# chmod 700 /zones/ zn1host7
sscsapx1# zfs create -o mountpoint=/zones/zn1host8 xoold5/zn1host8
sscsapx1# chmod 700 /zones/ zn1host8

sscsapx2# zfs create -o mountpoint=/zones/zn1host6 xoold6/zn1host6
sscsapx2# chmod 700 /zones/ zn1host6
sscsapx2# zfs create -o mountpoint=/zones/zn1host14 xoold6/zn1host14
sscsapx2# chmod 700 /zones/ zn1host14
sscsapx2# zfs create -o mountpoint=/zones/zn1host9 xoold7/zn1host9
sscsapx2# chmod 700 /zones/ zn1host9
```

Note: This procedure should be part of an installation script. Use scripts example_install_sscsapx1.sh and example_install_sscsapx2.sh as a model. Also refer to the sample installation script in Appendix A.

Installing Zones

In the step described above, file systems are created for the zones. This section describes installation of a master zone for the SAP Portal System XE1 and configuration of movable zones. Should several master zones be installed on a system, the following steps must be performed for each of these zones.
A system is identified as a master when it serves as the basis for the creation of a clone or a copy. Initial SAP installations are performed on the master systems.

A zone is created with the zonecfg command or alternatively by using the zonemgr.sh script:

```bash
scsapxl# cd /opt/N1VTools
scsapxl# ./zonemgr.sh -a add -n znlhost5 -z "/zones" -P "sun123" -t w -R /root \
    -I "192.168.20.129|nghost|24|nghost5" \ 
    -C /etc/ssh/sshd_config -S ssh
```

In the example above, a new zone is created with a root user password of sun123 and is configured with ssh access. This step creates a new zone with a status of installed. It must be repeated for each master zone required.

Optional Tasks

The steps in the following sections are optional. They are application-specific and therefore not mandatory for installation and operation.

**Installing the Service Management Facility Script—Automatic Start of Oracle Listener**

Oracle Solaris service management facility scripts are required to automate the process of booting and shutting down a zone. Because the Oracle Listener process is not automatically started with the SAP system, it is recommended to automate this process when booting the zone using a service management facility script. The following steps contain the procedure for enabling a service management facility for this function:

1. Log in to the local zone zn1host5:
   ```bash
   sccsapxl# zlogin zn1host5
   ```

2. Copy the SMF file from N1VTools:
   ```bash
   zn1host5# mkdir /var/svc/manifest/application/sap
   zn1host5# cp /opt/N1VTools/SMF_OracleListenerStart/oracle-sap-portal.xml /var/svc/manifest/application/sap
   ```

3. Import and enable the SMF file:
   ```bash
   zn1host5# svccfg import /var/svc/manifest/application/sap/oracle-sap-portal.xml
   zn1host5# svcadm enable application/sap/oracle-sap-portal:default
   zn1host5# svcs -xv application/sap/oracle-sap-portal
   ```
4. Check the status of the service using the SMF `svcs` command:

```
zn1host5# svcs app*
```

<table>
<thead>
<tr>
<th>STATE</th>
<th>STIME</th>
<th>PMRI</th>
</tr>
</thead>
<tbody>
<tr>
<td>disabled</td>
<td>Oct_08</td>
<td>svc:/application/print/server:default</td>
</tr>
<tr>
<td>disabled</td>
<td>Oct_08</td>
<td>svc:/application/management/webmin:default</td>
</tr>
<tr>
<td>disabled</td>
<td>Oct_08</td>
<td>svc:/application/gdm2-login:default</td>
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<tr>
<td>disabled</td>
<td>Oct_08</td>
<td>svc:/application/sap/sap-portal_stop1:default</td>
</tr>
<tr>
<td>disabled</td>
<td>Oct_08</td>
<td>svc:/application/sappel:default</td>
</tr>
<tr>
<td>nline</td>
<td>Oct_08</td>
<td>svc:/application/management/sma:default</td>
</tr>
<tr>
<td>online</td>
<td>Oct_08</td>
<td>svc:/application/fcnt/stfsloader:default</td>
</tr>
<tr>
<td>online</td>
<td>Oct_08</td>
<td>svc:/application/x11/xfs:default</td>
</tr>
<tr>
<td>online</td>
<td>Oct_08</td>
<td>svc:/application/graphical-login/cde-login:default</td>
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<td>online</td>
<td>Oct_08</td>
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<tr>
<td>nline</td>
<td>Oct_08</td>
<td>svc:/application/sap/oracle-sap-portal:default</td>
</tr>
<tr>
<td>ffline</td>
<td>Oct_08</td>
<td>svc:/application/print/ipp-listener:default</td>
</tr>
<tr>
<td>offline</td>
<td>Oct_08</td>
<td>svc:/application/print/rfc1179:default</td>
</tr>
</tbody>
</table>

This set of steps is successful if the service `oracle-sap-portal` is online.

**Operation**

This section describes tasks that are required for day-to-day operation of this environment.

**Creating a New SAP System (Clone) Without Downtime**

An application in a zone (n1host5 in Figure 8) can be cloned in a zone (n1host7) with Oracle Solaris ZFS snapshot technology without downtime when both zones are allocated to the same zpool.

From a technical viewpoint, creating a clone signifies that a ZFS snapshot of the zone is performed. No data is copied when the zones are installed in one zpool. The actual cloning process takes only a few seconds.
Minimizing Downtime in SAP Environments

Figure 8. The Oracle Solaris ZFS snapshot technology clones zones without downtime.

Note: A zone that is installed on a ZFS file system, from which a snapshot clone originates, cannot be deleted as long as the clone exists.

The script zonecopy.sh enables cloning of a zone and has an online help function that describes the possible applications and parameters:

```
sscsapx1# cd /opt/N1VTools
sscsapx1# ./zonecopy.sh help
```

zonecopy.sh uses the file N1VToolsv1HostnameIPList.xml as the basis for configuration to create a new zone or overwrite existing zones. This relates to host name as well as network configuration.

For example, when an SAP portal is installed and booted in zone zn1host5 with <SID> XE1, a new zone zn1host7 can be created as a clone with the following command:

```
sscsapx1# cd /opt/N1VTools
sscsapx1# ./zonecopy.sh zone=recreate zn1host5 zn1host7
```

If zn1host7 already exists and is not to be recreated but the old configuration is to be used, use the value reuse rather than recreate.

After the clone is created, the administrator can log in to the new zone zn1host7 as <sidadm> and reboot the SAP Portal XE1 as follows:

```
sscsapx1# zlogin zn1host7
zn1host7# su - <sidadm>
zn1host7# startsap ALL n1host5
```

Note: Make sure to enter the virtual host name used during initial installation—in this example, n1host5.

If the HTTP port 50000 is used for the portal, the new application is immediately available under the following URL and can be used for production: http://n1host7:50000/irj.
Additional adapters and agents (for example, the SAP CCMS Agent) or other extensions or interfaces in the zone are available and operational immediately.

*Note: Depending on the type and function of the existing interfaces, they must be revised or shut down manually before start of the SAP application, if necessary.*

Copying a New SAP System

Copying implies that the data of a zone is physically copied to another zone on the current system. Processing time depends on the volume of data to be copied and on the hardware employed.

![Diagram showing system sscsapx1](image)

*Figure 9. New systems can be created by copying zones.*

A new zone can be recreated as a copy of another zone. Figure 9 illustrates an example where the *source zone* (*n1host5* (zpool=xpoold4)) is copied to the *target zone* (*n1host8* (zpool=xpoold5)).

The command to execute the copy in this example is below:

```
sscsapx1# cd /cpt/N1VTools
sscsapx1# ./zonecopy.sh zone=recreate zn1host5 zn1host8
```

When using the `zonecopy` script, the decision to copy or clone depends on the `zpool` definition in the xml control file. If different pools are allocated to the target zone and the source zone, the data is copied. In all other cases, a clone is created.

**SAP Application Server ABAP—Change SAP System ID and/or Host Name**

A clone or a copy of a zone signifies that the SAP installation installed in this zone has the same host name and the same system ID (SID) as the *source* SAP system.

If this is not desired or if for technical reasons a different ID and/or host name is required, perform the necessary adjustments as described below:

- ! Install the required N1VTools files in the zone that is to be renamed. This operation can be performed from the global zone:
Minimizing Downtime in SAP Environments

```bash
sscsapx1# mkdir /zones/zn1host8/root/opt/N1VTools
sscsapx1# cp /opt/N1VTools /zones/zn1host8/root/opt/N1VTools
```

Note: If the toolset is installed in the master zones, the scripts contained in the toolset are immediately available to the zone administrator after cloning or copying. For security reasons, all files that are not needed in the local zones should be deleted. This includes all .xml files with the exception of log.xml in directory /opt/N1VTools/config as well as the example files and files zonecopy.sh, zonemgr.sh, and ipmgr.sh.

- Rename the script—test call:
  ```bash
  n1host8# cd /opt/N1VTools
  n1host8# ./change_sapsid_ABAP.sh -?
  ```

- Rename the SID and the host name:
  ```bash
  n1host8# cd /opt/N1VTools
  n1host8# ./change_sapsid_ABAP.sh -s XE1,XE2 -h n1host5,n1host8
  ```

Note: The default script requires a standalone installation of the ABAP instance (ABAP Application Server Release: >= NW2004).

**SAP Application Server Java—Change SAP System ID and/or Host Name**

A clone or a copy of a zone signifies that the SAP installation installed in this zone has the same host name and the same SID as the source SAP system. If this is not desired of if for technical reasons a different SID and/or host name is required, perform the necessary adjustments as described below:

- ! Install the required N1VTools files in the zone that is to be renamed. This operation can be performed from the global zone:
  ```bash
  sscsapx1# mkdir /zones/zn1host8/root/opt/N1VTools
  sscsapx1# cp /opt/N1VTools /zones/zn1host8/root/opt/N1VTools
  ```

Note: If the toolset is installed in the master zones, the scripts contained in the toolset are immediately available to the zone administrator after cloning or copying. For security reasons, all files that are not needed in the local zones should be deleted. This includes all .xml files with the exception of log.xml in directory /opt/N1VTools/config as well as the example files and files zonecopy.sh, zonemgr.sh, and ipmgr.sh.

- ! Rename the script—test call:
  ```bash
  n1host8# cd /opt/N1VTools
  n1host8# ./change_sapsid_JAVA.sh -?
  ```

- Rename the SID and the host name:
  ```bash
  n1host8# cd /opt/N1VTools
  n1host8# ./change_sapsid_JAVA.sh -s XE1,XE2 -h n1host5,n1host8
  ```

Notes: After the script starts, it requires a number of interactions that are described in detail on the display. The default script requires a standalone installation of the Java instance (Java Application Server Release: >= NW2004).
Moving Containers to Another System

By installing Oracle Solaris Containers in a zpool on shared storage, one or several of these containers and the SAP applications installed in these zones can be switched to another system with only a few commands. Consequently, applications in these containers are not restricted to a physical system and can be moved. In the example in Figure 10, if the system sscsapx1 fails, the containers are manually moved to the system sscsapx2 and booted there.

Figure 10. Containers and the SAP applications installed in these zones can be moved to another system.

In the example, zpool xpoold4 has two containers: zn1host5 and zn1host7 with applications XE1 and XE1', respectively.

- ! Halt and detach the containers.
- ! Before any EXPORT of the zpool on the source system, each container must be shut down and then detached:

  sscsapx1# zoneadm -z zn1host5 halt
  sscsapx1# zoneadm -z zn1host5 detach
  sscsapx1# zoneadm -z zn1host7 halt
  sscsapx1# zoneadm -z zn1host7 detach

  sscsapx1# zpool export xpoold4

- ! Attach and boot the containers.
- ! After an import of the zpool, each container must first be attached and then booted on the target system:

  sscsapx2# zpool import xpoold4

  sscsapx2# zoneadm -z zn1host5 attach
  sscsapx2# zoneadm -z zn1host5 boot
  sscsapx2# zoneadm -z zn1host7 attach
  sscsapx2# zoneadm -z zn1host7 boot
Upgrading an Application

During an actual upgrade, the critical factor is the downtime of the application. The objective of the *minimizing downtime* concept, which is based on Oracle Solaris Containers and Oracle Solaris ZFS technology, is to minimize this downtime or to allow users to continue working with some restrictions.

At the core of this concept is the following problem: how to ensure database consistency—in other words, how to avoid loss of data during upgrade processes. The solution depends on the type (for example, SAP Portal) and the range of the application (for example, create reports) as well as on organizational flexibility.

In many projects, Oracle observes that upgrade downtimes can be avoided. Here are some examples:

- ! The application can be run in read-only mode (for example, SAP Portal).
- ! The Web or portal applications serve as a browser user interface (BUI) or navigation system—for example, for SAP back-end transactions or internal/external URLs.
- ! The application is used as a QA or training system—in other words, the database is always recreated or updated to ensure a defined information status at a time $x$.

To date, in order to avoid downtime for specialized departments, upgrades were mostly performed on weekends and holidays. If an update required more time or had to be performed on the spur of the moment, the system was unavailable for end users during this time.

The concept here is based on the assumption that, in many cases, it is essential to be able to at least access data in read mode (for example, business intelligence reports). In these instances, users must be informed of the limitations involved, either through system messages, entries in a universal worklist, through e-mail, or through automatic role modification.

It is also feasible to allow read-only access from the technical side. However, this depends on the application.

Figure 11 illustrates the upgrade process. First, a clone of the zone to be updated is created. The upgrade is then performed against the clone and tested. When the upgrade is confirmed as correct and functional, the network is shut down on the source zone and started on the target zone, which becomes the new user system.

Figure 11. The upgrade process minimizes downtime and allows users to continue working with some restrictions.
In the following sections, the process steps are described in detail:

- Create a new zone as a clone—in other words, within the same zpool. Shut down the interface of the user network of the new upgrade zone:

  ```
  scsapxl# cd /opt/N1VTools
  sscsapxl# ./zonecopy.sh zone=recreate zn1host5 zn1host7
  scsapxl# ./ipmgr.sh zn1host7 down
  ```

- Log in to update the zone through the administrator network and upgrade the application based on the upgrade guidelines.

- Shut down the user network of the original zone and start the network of the upgrade (clone) zone. Subsequently, the original zone can be shut down or archived/versioned:

  ```
  scsapxl# cd /opt/N1VTools
  sscsapxl# ./ipmgr.sh zn1host5 down
  sscsapxl# ./ipmgr.sh zn1host7 up
  ```

**Upgrading the Oracle Solaris Operating System**

Most companies perform an OS upgrade once a year. Consequently, a method must be defined to help ensure maximum availability of the applications during this process.

In this case, the core of the method is Oracle Solaris Live Upgrade functionality. Oracle Solaris Live Upgrade offers the option to perform system upgrades under operating conditions. A duplicate of the current boot environment is created, and the upgrade is then performed in this duplicate. Alternatively, instead of performing an upgrade, an Oracle Solaris flash archive can be installed in the boot environment. An upgrade or the installation of an archive has no effect on the original system configuration, which remains fully operational. Subsequent to the process, the new boot environment is started by rebooting the system. In case of a fault, the original boot environment can be restored through a simple reboot. This switch feature eliminates the regular downtime for the test and check process, because checks are performed parallel to regular operations.

With Oracle Solaris Live Upgrade, a boot environment is duplicated without affecting current operation. Subsequently, the following options are possible:

- Perform a system upgrade.
- Compare the disk configuration of the current boot environment to other file system types, sizes, and layouts in the new boot environment.
- Maintain multiple boot environments with different images. For example, it is possible to create a boot environment that contains current patches and another environment with an updated release.

Before using Oracle Solaris Live Upgrade, the structure of system administration must be clear.

Currently, this Oracle Solaris Live Upgrade functionality does not include ZFS-based zones; a direct upgrade is only possible with a future version of Oracle Solaris. Therefore, before starting the actual
live upgrade, an administrator must perform the following intermediate step. If all prerequisites described in previous sections are met and no more than a maximum of 10 containers are installed per server, upgrade time and downtime of the applications are only marginally extended by performing this step.

For each ZFS-based zone on a system for which an upgrade will be performed, an administrator should check to confirm if

- On principle, the zone is really required.
  - The zone can be deleted.
- The zone can be re-created based on another zone.
  - The zone can be deleted.
- The zone can/should be moved to another system where an upgrade is scheduled for a later date.
  - The zone can be moved.

For all zones to which the above items do not apply, a new UFS-based zone must be created before a live upgrade is performed. The ZFS zone must be copied there and then deleted. This can be done sequentially zone by zone, at preplanned times. The application can later be started directly in the new UFS-based zone.

Additional storage is temporarily required, for the duration of the upgrade. The required size is determined by adding the storage requirements per ZFS zone. Figure 12 illustrates this process sequence.
Figure 12. This is the process sequence using Oracle Solaris Live Upgrade to upgrade zones.

After a successful live upgrade, the ZFS zones are recreated based on the UFS zones.

Many of the steps to be performed can be automated with simple scripts. The following steps describe the commands to be executed:

- To create a UFS zone, first implement a new file system.
  - This example is based on an Oracle Solaris volume manager soft partition with ID d123:
    ```bash
    sscsapxl# mkdir -p /zones/<ufs zone>
    sscsapxl# chmod 700 /zones/<ufs zone>
    sscsapxl# newfs /dev/md/rdsk/d123
    ```
  - Create a new zone.
    - This example creates a new zone with root user password sun123 and configured ssh access:
Minimizing Downtime in SAP Environments

Copy all data from the ZFS zone with this command:

```
sscsapxl# cd /opt/N1VTools
sscsapxl#.zonemgr.sh -a add -n <ufs zone> -z "/zones" -P "sun123" -t w -R /root \
              -I "192.168.20.xxx|ngs0|24|<ufs zone>" \ 
              -C /etc/ssh/sshd_config -S ssh
```

Delete a zone:

```
sscsapxl# zoneadm -z <zfs zone> halt
sscsapxl# zoneadm -z <ufs zone> clone -m copy <zfs zone>
```

Perform live upgrade and reboot.

```
Oracle Solaris Live Upgrade reduces the downtime of applications on a system. The duration of the downtime is limited to a reboot of the system and the subsequent starting of the containers and applications.
```

Create a ZFS zone.

```
Steps for creating ZFS zones are detailed in the “Installing Zones” subsection of the “Configuration Steps” section.
```

Copy all data from the UFS zone, using the following command:

```
sscsapxl# zoneadm -z <ufs zone> halt
sscsapxl# zoneadm -z <zfs zone> clone -m copy <ufs zone>
```

Delete the UFS zone.

```
It is not always required to delete the UFS zone. Before performing this step, check the purpose of the zone. Also refer to “Versioning of Applications in Zones” subsection of the “Other Operating Requirements for Zones” section.
```

A zone can be deleted using this command:

```
sscsapxl# cd /opt/N1VTools
sscsapxl# zonemgr -F -a del -n <zfs zone>
```
Minimizing Downtime in SAP Environments

Other Operating Requirements for Zones

This section describes some other processes required for running applications. The script `zonemgr.sh` in particular offers additional basic commands for the administration of a server.

Renaming Zones

A zone can be renamed as follows (this does not affect the zone path):

```bash
sscsapxl# cd /opt/N1VTools
sscsapxl# ./zonemgr.sh -a modify -n <old zone name> -m "zonename:<new zone name>"
```

Versioning of Applications in Zones

The versioning concept operates on the assumption that not only the application itself but all settings relevant to run an application must be versioned or frozen. The steps to create a new version are as follows:

- ! Create a UFS zone with the name `<zfs zone>_<version>`.
- ! Copy the ZFS zone to the UFS zone (do not start the zone):

```bash
sscsapxl# zoneadm -z <zfs zone> halt
sscsapxl# zoneadm -z <ufs zone> clone -m copy <zfs zone>
```

Offline Backup of SAP Applications

A simple option to generate consistent offline backups without any downtime works as follows (this process assumes that only a portion the entire zone is backed up):

- ! Create a new ZFS zone as a clone of the zone to be backed up. See the “Creating a New SAP System (Clone) Without Downtime” section.
- ! Start the file system backup for the new zone in the global zone. Backup the directory `/zones/<zone name>/root`

The advantage of this method is that it is easy to perform file system backups. Adapter licenses for backup products such as Legato are more cost effective than online database adapters, for example, and only one file system adapter for the global zone is required.
Answers to Common Questions

Below are answers to some frequently asked questions on containers, zones, and upgrades.

**Does a container architecture require more hardware?**

Basically, it is essential to determine the medium-term requirements for storage, network, and server technology.

- Working with Oracle Solaris Containers offers flexibility, so it is not necessary to install a new server every time a new specialized requirement presents itself.
- The additional expenditure regarding the networks mainly consists in making available VLANs and in preparing Domain Name System, proxy server, and network switches (for example, load balancers). In most cases, this only involves organizational modifications.
- For the storage sector, definition of the required LUN size mainly depends on specific requirements. First try to define a minimum size depending on the number and type of SAP systems as well as required master and cloning zones. For most storage systems, upgrading disk space if this becomes necessary presents no problem.

Generally, the use of multiprocessor systems based on Sun’s chip multithreading (CMT) architecture should be considered when working with containers, because these systems are more powerful as far as distribution and (almost linear) processing of loads are concerned.

**Why use Oracle Solaris Containers?**

Oracle Solaris Containers provide consolidation, flexibility, operation, and security.

Oracle Solaris Containers are used to consolidate applications like the SAP Portal, which to date are running on different servers—sometimes even with different OSs. Containers enable flexible reaction to new specialized requirements. New hardware does not necessarily need to be installed to support new environments. Instead, new containers can be created and made operational within minutes.

The resource management of containers ensures that each application is allocated sufficient CPU capacity. Should this capacity become inadequate, containers can be moved to other hardware with free capacity, if needed, using the procedures in this white paper.

Moreover, using Oracle Solaris Containers also makes sense from an SAP operation and user point of view. At most installations, operation of an SAP landscape is performed by different groups or departments. One group is in charge of hardware and OS basic operation, another for the databases, and yet another for SAP applications. Each of these groups wants to have its own private environment and to manage it independently to the greatest extent. The reason is that, particularly in development and test environments, new application-specific functions or software products are frequently tested, applications are patched, and upgrades are performed. Operations can allocate containers with root access to these groups, enabling them to perform their tasks independently.
Especially in an SAP Portal environment, a container makes sense from a security viewpoint, because it helps to ensure—as with all Web servers—that an attack on the portal does not entail a crash of the hardware and possibly other applications.

Why use whole-root zones?

Flexibility is a core feature of the Oracle Solaris Containers technology. Whole-root zones should be installed when for operational and organizational reasons a simple “black box” approach seems favorable.

In contrast to sparse-root zones, whole-root zones guarantee that all file systems can be overwritten, and settings and extensions of an application installed in a local zone can be moved to other hardware systems as a unit. Consequently, whole-root zones are a simple and secure method to consolidate applications on one system.

Is a single sign-on possible?

Yes. SSO integration can be performed conventionally, as with installation of a new SAP system.

Are there limitations on integration?

Because a copied or cloned system can be renamed, there are no restrictions regarding integration or connection.

Does a server crash affect multiple applications simultaneously when using containers?

- Statistically, availability of an application remains unaffected.
- Fewer servers/OS instances (instead of many smaller servers/instances) are easier to protect against a potential crash.
- Containers can be restarted (moved) in the grid in case of a server crash.

Do containers increase the number of simultaneously affected users during maintenance?

- Overall, fewer maintenance windows are required, because fewer servers and OS instances need to be maintained.
- Possible conflicts can be avoided or diffused by targeted relocation of containers in the runup.
- Using Oracle Solaris Live Upgrade for patching and upgrades further reduce user impact.

What happens if an identical OS patch status is not feasible?

- Oracle Solaris 10 requires exactly one minimum recommended patch level for all SAP applications.
- Savings potential can only be realized by standardization.
- In all other cases, use physical or logical domains instead of or in addition to containers.
What about SAP systems that require defined and allocated hardware capacities?

- Capacities can be allocated to containers either statically or dynamically (that is, during ongoing operation).
  - Using the Oracle Solaris Resource Manager, the administrator can define guaranteed capacities
  - Define fixed capacities for CPU sets, memory sets, IP Quality of Service (IPQoS), and resource capping daemon (rcapd).
- Use SAP and Oracle memory management.

Can applications with specific security concerns be run on a separate server?

Oracle Solaris zones are EAL4+ certified. This means that

- None of the processes or their subprocesses running in a local zone can switch zones.
- Network services can run isolated in a local zone.
- Modifications in a local zone do not affect the global zone or other local zones.

How does SAP licensing work with this concept?

New SAP systems are created and therefore require additional licenses. Because licensing and costs involved depend on the type of usage, this needs to be addressed with SAP sales.

Conclusion

Oracle Solaris 10 offers users a multitude of cost-effective options for consolidating applications, as well as flexible and fast installation and easy administration.

Using Oracle Solaris Zones and ZFS optimizes or even avoids long installation, upgrades, or downtimes. Business requirements of specialized departments within enterprises can be implemented quickly and in a standardized way, resulting in considerable cost savings in the IT sector.

Operation and SAP basic administration are further supported by Oracle Solaris 10 and ZFS, and Oracle Solaris Cluster software. These solutions can be fully integrated into the specified architecture and processes and offer room for further automation.
Appendix A: Configuration Form

**Storage Configuration**

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**Container Configuration**

Zonepath: ________________________________

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<tr>
<th>Physical host name/IP</th>
<th>Zone Name</th>
<th>Net</th>
<th>Virtual host name/IP</th>
<th>Sub net</th>
<th>Interface</th>
<th>FS Type</th>
<th>Master</th>
<th>Zpool</th>
<th>ZS</th>
<th>Information</th>
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</tbody>
</table>
#!/bin/sh
#
===============================================
==
# This script is an example for zone handling
# It could be use for the first installation or system setup steps
#===============================================

# create zfs pools
zpool create xpoold4 c6t600015D00022B3000000000000006B5Cd0
zpool create xpoold5 c6t600015D00022B3000000000000006B56d0

# create filesystem & mount filesystem to path
zfs create -o mountpoint=/zones/zn1host5 xpoold4/zn1host5
zfs create -o mountpoint=/zones/zn1host7 xpoold4/zn1host7
zfs create -o mountpoint=/zones/zn1host8 xpoold5/zn1host8

# change rights of file systems
cd /zones/
chmod 700 /zones/*

cd /opt/N1VTools

# create / install "configured" zones to make moving zones possible
./zonecopy.sh zone=install all

#-----------------
# create MASTER zfs zone "zn1host5"; config interface and ssh;
#-----------------

# first step: delete the existing zone
./zonemgr.sh -a del -n zn1host5 -F
# second step: install new zone
./zonemgr.sh -a add -n zn1host5 -z "/zones" -P "sun123" -t w -R /root \-I "192.168.20.129"nge0|24|n1host5" \-C /etc/ssh/sshd_config -S ssh