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Preface 1/2

■ Purpose

This document explains how to use Oracle Solaris to users who have experience operating systems in a Linux environment.

■ Audience

People who have basic knowledge of Linux
People who are planning to operate an Oracle Solaris system

■ Positioning of documents

Review  Design  Build  Operate

Oracle Solaris Guide for Linux Users (This document)

Oracle Solaris Command Reference for Linux Users
Notes

 Oracle Solaris may be described as "Solaris" in this document.

 Oracle VM Server for SPARC may be described as "Oracle VM" in this document.

 The commands, etc. explained in this document are based on the following environments:
  - Linux: Red Hat Enterprise Linux 6.5, Red Hat Enterprise Linux 7.1
  - Solaris: Oracle Solaris 11.3, ESF 5.1

 The mark on the right appears on slides about Solaris functions.

 Fujitsu M10 is sold as SPARC M10 Systems by Fujitsu in Japan. Fujitsu M10 and SPARC M10 Systems are identical products.
For a Linux Administrator Who Will be Operating Solaris...

- You may be thinking there will be no big difference because Solaris can be operated with the same command base as Linux...

  I don't know how to restart it.

  What is ZFS? Can't UFS be used?

  I want to apply a patch, but what is the command...

  How do I change the IP address?

  How do I check the status of services?

Intended for Linux users, this document explains the operations and functions required in Solaris operation scenarios.
1. Starting and Stopping the OS Environment
From Server Power-On to OS Startup

SPARC M10 server operation from the XSCF

What is the XSCF (eXtended System Control Facility)?
- It runs with a dedicated processor independent from the main processor, and has hardware/OS state monitoring, notification, and other mechanisms.
- Connected remotely (XSCF-LAN), it can power on/off a physical partition.

Flow of OS startup via a network

1. Use terminal software to log in to the XSCF.
2. Start a physical partition with an XSCF command.
3. Log in to the console with an XSCF command.
4. Start the Solaris OS with an OBP command(*).

* Execute it when the OBP parameter (auto-boot?) is false. The OS starts up automatically after the poweron command when the parameter is true.
Linux and Solaris Runlevels

- Runlevel comparison

Like Linux RHEL 6, Solaris has runlevels 0 to 6. However, the meanings are somewhat different. (In RHEL 7, runlevel is target.)

<table>
<thead>
<tr>
<th>Runlevel/Target</th>
<th>Meaning</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>RHEL 6 Solaris</strong></td>
<td><strong>RHEL 7</strong></td>
<td><strong>Red Hat Enterprise Linux</strong></td>
</tr>
<tr>
<td>0</td>
<td>poweroff.target</td>
<td>Power-off state</td>
</tr>
<tr>
<td>s (or S)</td>
<td>-</td>
<td>Single user</td>
</tr>
<tr>
<td>1</td>
<td>rescue.target</td>
<td>Single user</td>
</tr>
<tr>
<td>2</td>
<td></td>
<td>Not used</td>
</tr>
<tr>
<td>3</td>
<td>multi-user.target</td>
<td>Multi-user</td>
</tr>
<tr>
<td>4</td>
<td></td>
<td>Not used</td>
</tr>
<tr>
<td>5</td>
<td>graphical.target</td>
<td>X window (*4)</td>
</tr>
<tr>
<td>6</td>
<td>reboot.target</td>
<td>OS restart</td>
</tr>
</tbody>
</table>

- The Solaris OS runlevels to keep in mind are 0 (OS stopped), s (single user), 3 (multi-user), 5 (power off), and 6 (OS restart).
- For details on service starts that differ by runlevel, see "5. Service Management."
Starting the OS Environment

**OS startup in Linux and Solaris**

**Linux**
- After powering on the hardware, select the boot kernel from the GRUB2 environment. (In RHEL 6, the environment is GRUB.)
- You can start the OS in single user mode by modifying an option from the GRUB2 environment.

**Solaris**
- After powering on the hardware, start from the OBP (OpenBoot PROM) environment.
- OBP is an environment including both the PC server BIOS and Linux GRUB.
- Use exclusive commands at the prompt shown as "ok" (commonly called the "ok prompt").

**Execution example**

✓ Start the Solaris OS.

```
{0} ok boot
```

- In the OBP environment, you can check the boot disk and start options (single user mode, etc.). Operations in addition to that include checking the connected devices and setting various OBP parameters.
Implementation of a GUI Environment

Starting the Solaris GUI desktop

GUI connection using VNC (* VNC is freeware.)

Execution example

1. Install the solaris-desktop package.
   
   # pkg install solaris-desktop

2. Edit the /etc/gdm/custom.conf file.

3. Restart the system.
   
   # shutdown -y -g0 -i6

4. Enable the xvnc inetd service.
   
   # inetadm -e xvnc-inetd

5. Log in from a PC using the VNC client.

- For details, see the Oracle Solaris 11.3 Desktop Administrator's Guide.
  http://docs.oracle.com/cd/E53394_01/html/E54808/gmdah.html#scrolltoc
OS shutdown in Linux and Solaris

**Linux**

- **RHEL 6**
  
  ✓ Stop the Linux OS.
  
  ```
  # shutdown -h now
  ```
  
  ✓ Restart the Linux OS.
  
  ```
  # shutdown -r now
  ```

- **RHEL 7**
  
  ✓ Stop the Linux OS.
  
  ```
  # systemctl poweroff
  ```
  
  ✓ Restart the Linux OS.
  
  ```
  # systemctl reboot
  ```

- You can continue using the shutdown command in RHEL 7 to maintain compatibility. However, we recommend using the systemctl command.
Stopping the OS Environment 2/2

- Solaris
  - Although Solaris uses the shutdown command in the same way as RHEL 6, the specification of options is different.
  - In the –g option, specify the time (in seconds) until the OS stops. In the –i option, specify an operation such as stopping or restarting the OS.

- Execution example
  - Stop the Solaris OS.
    ```
    # shutdown -y -g0 -i5
    ```
  - Restart the Solaris OS.
    ```
    # shutdown -y -g0 -i6
    ```
# OS boot/stop commands to keep in mind

<table>
<thead>
<tr>
<th>Basic Operation</th>
<th>Red Hat Enterprise Linux</th>
<th>Oracle Solaris</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>RHEL 6</td>
<td>RHEL 7</td>
</tr>
<tr>
<td>Start OS</td>
<td>Start from the GRUB menu.</td>
<td>Start from the GRUB 2 menu.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Execute the start command from the OBP (OpenBoot PROM) environment.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>{0} ok boot</td>
</tr>
<tr>
<td>Stop OS</td>
<td>Specify the stop option (-h) in the shutdown command.</td>
<td>Specify the stop option (poweroff) in the systemctl command.</td>
</tr>
<tr>
<td></td>
<td># shutdown -h now</td>
<td># systemctl poweroff</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Execute the shutdown command.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Specify the stop option (-i5).</td>
</tr>
<tr>
<td></td>
<td></td>
<td># shutdown -y -g0 -i5</td>
</tr>
<tr>
<td>Restart OS</td>
<td>Specify the restart option (-r) in the shutdown command.</td>
<td>Specify the restart option (reboot) in the systemctl command.</td>
</tr>
<tr>
<td></td>
<td># shutdown -r now</td>
<td># systemctl reboot</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Execute the shutdown command.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Specify the restart option (-i6).</td>
</tr>
<tr>
<td></td>
<td></td>
<td># shutdown -y -g0 -i6</td>
</tr>
<tr>
<td>Other execution examples</td>
<td>- Stop at 10 o'clock.</td>
<td>- Start via a network.</td>
</tr>
<tr>
<td></td>
<td># shutdown -h 10:00</td>
<td>{0} ok boot net:dhcp</td>
</tr>
<tr>
<td></td>
<td>- Stop after 5 minutes.</td>
<td>- Restart after 30 seconds.</td>
</tr>
<tr>
<td></td>
<td># shutdown -h +5</td>
<td># shutdown -y -g30 -i6</td>
</tr>
<tr>
<td></td>
<td>- Suspend the OS.</td>
<td></td>
</tr>
<tr>
<td></td>
<td># systemctl suspend</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Hibernate the OS.</td>
<td></td>
</tr>
<tr>
<td></td>
<td># systemctl hibernate</td>
<td></td>
</tr>
</tbody>
</table>

For details, see the *Oracle Solaris Command Reference for Linux Users.*
### Solaris standard locale (character code) is UTF-8

- System locale is set in the following service property:
  ```bash
  svc:/system/environment:init
  ```

### Changing the system locale

#### Execution example

1. Install the system/locale/extra package.
   ```bash
   # pkg install system/locale/extra
   ```
   * Only when using a locale other than the standard locale

2. Change the locale with the svccfg command (set LANG=C).
   ```bash
   # svccfg -s system/environment:init setprop environment/LANG = astring: C
   ```

3. Reread the service property.
   ```bash
   # svcadm refresh system/environment:init
   ```

4. Confirm that the setting has been reflected.
   ```bash
   # svcprop system/environment:init | grep environment/LANG
   ```

- The locale –a command can check for the locales that can be set.

<table>
<thead>
<tr>
<th>Main Locale (Character Code)</th>
<th>Setting Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>English</td>
<td>C</td>
</tr>
<tr>
<td>Japanese (EUC)</td>
<td>ja_JP.eucJP, ja</td>
</tr>
<tr>
<td>Japanese (Shit-JIS)</td>
<td>ja_JP.PCK</td>
</tr>
<tr>
<td>Japanese (UTF-8)</td>
<td>ja_JP.UTF-8</td>
</tr>
</tbody>
</table>
Boot environment management

The function of Boot Environment (BE) is to create, delete, and replicate boot environments.

- It creates a new BE based on the snapshot of an existing boot environment.
- You can switch the environment to a new boot environment by selecting the BE and restarting the OS.
- Since it uses a snapshot, only the updated data consumes the disk space.
- In Linux, the pre-update kernel can be selected and started in GRUB. In Solaris, this is executed by the BE function.

Conceptual image of BE

Create new boot environment

BE01: Current boot environment
BE02: New boot environment
This same area is referenced to create the new BE, so no space is consumed.

Update BE01 data

The BE01 data update, etc. is executed while BE01 is active. BE01 consumes space only for the update.

Activate and restart BE02

After the BE environment is switched to BE02, it can be switched to the pre-date-update boot environment.
2. Package Management
Package Application Methods

- Package application methods in Linux and Solaris

  - Basically, the package application methods are the same. Their two methods are as follows:
    - Direct application from media to a server
    - Application via the Internet from the supplier site

1. Direct application from media to server

   ![Image of media and package](image1)

   - Media
   - Package
   - Apply directly from media

2. Application via Internet from supplier site

   ![Image of internet and package](image2)

   - Package supplier
   - Red Hat (customer portal)
   - Oracle (release repository)
   - Apply via Internet

   Each server

   - Linux server
   - Solaris server

   or
Application of a Solaris Package

Server providing packages in the local environment (local repository server)

Using the local repository server
- It is used by servers that cannot connect to an external network (release repository).
- Media does not need to be used for each server, so packages can be centrally managed.
- Apply the SRU (Support Repository Update) to the local repository server to bring a provided package up to date.

* Release repository: Provides packages updated for every Oracle Solaris release
* SRU (Support Repository Update): Update package

Using repository server

* SRUs are received from My Oracle Support.
## Package management commands to keep in mind

<table>
<thead>
<tr>
<th>Basic Operation</th>
<th>Red Hat Enterprise Linux</th>
<th>Oracle Solaris</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>RHEL 6</td>
<td>RHEL 7</td>
</tr>
<tr>
<td>Check update</td>
<td>yum check-update</td>
<td>pkg update -nv</td>
</tr>
<tr>
<td>Update package</td>
<td>yum update <code>package_name</code></td>
<td>pkg update <code>package_name</code></td>
</tr>
<tr>
<td>Update all packages</td>
<td>yum update</td>
<td>pkg update</td>
</tr>
<tr>
<td>Install</td>
<td>yum install <code>package_name</code></td>
<td>pkg install <code>package_name</code></td>
</tr>
<tr>
<td>Search</td>
<td>yum search <code>search-character-string</code></td>
<td>pkg search <code>search-character-string</code></td>
</tr>
<tr>
<td>List installed packages</td>
<td>yum list all</td>
<td>pkg list</td>
</tr>
<tr>
<td>Display package information</td>
<td>yum info <code>package_name</code></td>
<td>pkg info <code>package_name</code></td>
</tr>
</tbody>
</table>

For details, see the *Oracle Solaris Command Reference for Linux Users.*
Environment recovery using Boot Environment (BE)

- By using a BE in Solaris, you can failback to the environment from a time before package application.
- If the OS does not start because a package was applied, you can select and start a pre-package-application BE from OBP.

Conceptual image of BE failback

1. Create BE
2. Apply package to new BE, and enable and restart BE
3. OS starts up in new operation environment
4. Configure failback to old operation environment
5. Start pre-package-application environment

- A BE environment is not a system backup. System backups must be obtained in case of disk error and other failures.
OS environment recovery operation using a BE

(To specify a BE on the OS environment)

1. From the BE list, confirm the name of the BE to start.

```
# beadm list
BE     Active  Mountpoint   Space     Policy    Created
----     -------  ----------------  ---------  --------   ----------
solaris-1  -       -                 9.67M   static   2012-11-06 15:08
solaris-2  NR      /                 3.82G   static   2012-11-06 15:30
```

2. Enable the old operation environment, and restart the OS.

```
# beadm activate solaris-1
# shutdown -y -g0 -i6
```

(To specify a BE on the OBP environment)

1. From the BE list, specify the number of the BE to start. (Execute boot -L.)

```
{0} ok boot -L
Boot device: /virtual-devices@100/channel-devices@200/disk@1  File and args: -L
1 solaris-1
2 solaris-2
Select environment to boot: [ 1 - 2 ]:1
```

2. Execute the start command as shown.

```
{0} ok boot -Z rpool/ROOT/solaris-1
```
3. User Management
# Overview of User Management

<table>
<thead>
<tr>
<th>Basic Operation</th>
<th>Red Hat Enterprise Linux</th>
<th>Oracle Solaris</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Operation</strong></td>
<td>Generally managed from command line * GUI management also possible</td>
<td>Generally managed from command line * GUI management also possible</td>
</tr>
</tbody>
</table>
| **root user/role** | - User  
- All general users can be changed to the root user. | - Role (can be assigned to a user)  
- The root role can be assigned only to specific general users. |
| **Group**       | - By default, the user belongs to the group with the same name as the user name. | - The user belongs to not only the group but also the category called project. It is a resource control unit such as an IPC parameter(*). |

* IPC (Inter Process Communication)

- The user management commands (useradd, usermod, userdel) have the same names in Linux and Solaris. However, you need to note that the meanings may differ depending on the option.
### User Authentication at Login

#### Local authentication files
- The `/etc/passwd` file stores account information.
- The `/etc/shadow` file stores encrypted password information.
  - Encryption method: Hash (Solaris: SHA-256, Linux: SHA-512)

#### Parameters at login
- The parameters at login are set in the `/etc/default/login` file.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>CONSOLE</td>
<td>When set, allows login only by a superuser on that device</td>
</tr>
<tr>
<td>PATH</td>
<td>PATH variable of the initial shell</td>
</tr>
<tr>
<td>SUPATH</td>
<td>PATH variable of the initial shell for a superuser</td>
</tr>
<tr>
<td>TIMEOUT</td>
<td>Wait time (seconds) until the login session ends</td>
</tr>
<tr>
<td>SLEEPTIME</td>
<td>Number of seconds before displaying a login failure message on the screen</td>
</tr>
<tr>
<td>RETRIES</td>
<td>Number of login retries</td>
</tr>
</tbody>
</table>

- When configuring/changing accounts and passwords, do not edit an authentication file (`/etc/passwd`, `/etc/shadow`) directly. Instead, configure/change them by using the respective commands (`usermod`, `passwd`, etc.).
- The encryption method has a default setting (Hash) and can be changed.
# User Password Expiration Time

## Password expiration time settings

- In Linux, use the `chage` command to set the user password expiration time. In Solaris, use the `passwd` command.

<table>
<thead>
<tr>
<th>Basic Operation</th>
<th>Red Hat Enterprise Linux</th>
<th>Oracle Solaris</th>
</tr>
</thead>
<tbody>
<tr>
<td>Set maximum number of days</td>
<td><code># chage -M 90 user_name</code></td>
<td><code># passwd -x 90 user_name</code></td>
</tr>
<tr>
<td>Set minimum number of days</td>
<td><code># chage -m 30 user_name</code></td>
<td><code># passwd -n 30 user_name</code></td>
</tr>
</tbody>
</table>
| Display password expiration information | `# chage -l user_name`  
Last password change: July 29, 2015  
Password expires : Never  
Password inactive : Never  
Account expires : Never  
Minimum number of days between password changes: 30  
Maximum number of days between password changes: 90  
Number of days of warning before expiry: 7 | `# passwd -s user_name`  
admin     PS    07/29/15     30   90 |

- Solaris also has user password expiration time settings. You can set the time in the same way, though the commands and options are both different.
## User management commands to keep in mind

<table>
<thead>
<tr>
<th>Basic Operation</th>
<th>Red Hat Enterprise Linux</th>
<th>Oracle Solaris</th>
</tr>
</thead>
<tbody>
<tr>
<td>Add user</td>
<td>useradd <em>user_name</em></td>
<td>useradd <em>user_name</em></td>
</tr>
<tr>
<td>Update user ID</td>
<td>usermod -u <em>new_UID</em> <em>user_name</em></td>
<td>usermod -u <em>new_UID</em> <em>user_name</em></td>
</tr>
<tr>
<td>Delete user</td>
<td>userdel <em>user_name</em></td>
<td>userdel <em>user_name</em></td>
</tr>
<tr>
<td>Display password expiration date</td>
<td>chage -l <em>user_name</em></td>
<td>passwd -s <em>user_name</em></td>
</tr>
<tr>
<td>Set password expiration date</td>
<td>chage -m 60 <em>user_name</em></td>
<td>passwd -x 60 <em>user_name</em></td>
</tr>
<tr>
<td>Change account information</td>
<td>chfn</td>
<td>passwd -g</td>
</tr>
<tr>
<td>(full name, etc.)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

For details, see the Oracle Solaris Command Reference for Linux Users.

- The basic add/modify/delete operation related to a user management command can be likewise executed in Solaris, even though an equivalent command may not exist.
Reference: Default Shell at Login

Changing the default shell

The default shell is bash for both Linux and Solaris.

In Linux, use the chsh command.

Execution example

1. Change the default shell of the user (user01).

```
# chsh user01
Changing shell for user01.
New shell [/bin/bash]: /bin/sh
Shell changed.
```

In Solaris, use the passwd command.

Execution example

1. Change the default shell of the user (user01).

```
# passwd -e user01
Old shell: /usr/bin/bash
New shell: /bin/sh
passwd: password information changed for user01
```
Resource control using projects

- **Project**
  - In Solaris, the concept called project is the unit for executing resource control.
  - A user belongs to any of the projects. To control the resources for an application or process executed by the user, execute the resource control configured for the project that the user belongs to.

- **Resource control unit**
  - Because of the configuration by project, resources can be controlled by users executing applications and middleware.

- Resources include the CPU usage time, core file size, maximum heap size, and IPC parameters for processes. You can configure/change project parameter settings while the OS is running.
4. Network Management
Overview of Network Management

<table>
<thead>
<tr>
<th>IP address setting</th>
<th>RHEL 6</th>
<th>RHEL 7</th>
<th>Oracle Solaris</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>- Edit the configuration file and restart the network service.</td>
<td>- nmcli command</td>
<td>- Set it with the ipadm command.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>- After it is set, the definition file is automatically updated.</td>
</tr>
<tr>
<td>Network interface name</td>
<td>- ethXX - Example: eth0, eth1</td>
<td>- Assigned based on the physical device connection information - Example: ens1p1, enp0s25</td>
<td>- Logical device name created based on the physical device name (netXX) - Example: net0, net1</td>
</tr>
<tr>
<td>Data link layer management</td>
<td>- ethtool command</td>
<td></td>
<td>- dladm command</td>
</tr>
<tr>
<td>IP layer management</td>
<td>- ifconfig command</td>
<td>- ip command</td>
<td>- ipadm command</td>
</tr>
<tr>
<td>Redundancy function</td>
<td>- Bonding</td>
<td></td>
<td>- IPMP</td>
</tr>
</tbody>
</table>

- The network management mechanism and command system in Solaris have changed greatly from Solaris 11. Network virtualization and network redundant configuration with the OS standard functions are possible.
Network Management Commands

■ Solaris

■ dladm command
  - The command manages the data link layer.
  - Use it to create virtual interfaces and configure network redundancy.

■ ipadm command
  - The command manages the IP layer.
  - Use it to manage IP addresses as the address objects of the "interface name/arbitrary character string" format, and to target an address object for configuration or deletion.

■ Linux

■ ifconfig command (RHEL 6)
  - The command configures a network and displays its status.

■ nmcli command (RHEL 7)
  - The command configures and manages a network.
  - Use it to set a host name or IP address, bring up/down a network, and create an interface.

■ ip command (RHEL 7)
  - The command consolidates RHEL 6 commands (ifconfig, route, netstat, arp).
Network Management Commands

- Comparison with Linux commands

1. Create an interface and set an IP address.

   (RHEL 6)
   ```
   # ifconfig <interface> <addr> netmask <netmask>
   ```

   (RHEL 7)
   ```
   # nmcli c add type eth ifname <interface>
   con-name <string>
   # nmcli c mod <interface> ipv4.method manual
   ipv4.addresses 
   "<addr>/<prefixlen> <gateway>"
   ```

   (Solaris)
   ```
   # ipadm create-ip <interface>
   # ipadm create-addr -T static -a
   local=<addr>/<prefixlen>
   <interface>/<string>
   ```

2. Check the IP address information.

   (RHEL 6)
   ```
   # ifconfig
   ```

   (RHEL 7)
   ```
   # ip address
   ```

   (Solaris)
   ```
   # ipadm show-addr
   ```

- Linux: Configuration by the nmcli command automatically updates the definition file.
- Solaris: Configuration by the ipadm command automatically updates the definition file.
IP Address Configuration Method

Configuring Solaris network settings

- Configuring Solaris network settings

  - Checking the interface status
    
    
    ```
    # dladm show-link
    LINK     CLASS  MTU  STATE OVER
    net0 phys  1500 up   --
    net1 phys  1500 up   --
    ```
    
    - Creating a network interface
      
        (Format: ipadm create-ip interface_name)
        
        ```
        # ipadm create-ip net1
        ```
    
    - Setting an IP address
      
        (Format: ipadm create-addr -T static -a local=IP_address/netmask_length interface_name/ arbitrary_character_string)
        
        ```
        # ipadm create-addr -T static -a local=192.168.1.10/24 net1/v4
        ```
    
    - Checking the IP address
      
      ```
      # ipadm show-addr
      ```
## Network management commands to keep in mind

<table>
<thead>
<tr>
<th>Basic Operation</th>
<th>Red Hat Enterprise Linux</th>
<th>Oracle Solaris</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>RHEL 6</strong></td>
<td><strong>RHEL 7</strong></td>
</tr>
<tr>
<td>Set IP address</td>
<td><code># vi /etc/sysconfig/network-scripts/ifcfg-device</code> IPADDR=<code>IP_address</code></td>
<td><code># nmcli con mod device ipv4.method manual ipv4.addresses &quot;IP_address/mask_gateway&quot;</code></td>
</tr>
<tr>
<td></td>
<td><code># service network restart</code></td>
<td></td>
</tr>
<tr>
<td></td>
<td><code># nmcli con mod device ipv4.method auto</code></td>
<td># ipadm create-addr -T static -a local=<code>IP_address/mask_device</code></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Configure DHCP</td>
<td><code># vi /etc/sysconfig/network-scripts/ifcfg-device BOOTPROTO=dhcp</code></td>
<td><code># nmcli con mod device ipv4.method auto</code></td>
</tr>
<tr>
<td></td>
<td><code># service network restart</code></td>
<td></td>
</tr>
<tr>
<td></td>
<td><code># ipadm create-addr -T dhcp device</code></td>
<td></td>
</tr>
<tr>
<td>Check IP address</td>
<td><code># ifconfig</code></td>
<td><code># ip address</code></td>
</tr>
<tr>
<td></td>
<td></td>
<td><code># ipadm show-addr</code></td>
</tr>
<tr>
<td>Configure gateway</td>
<td><code># vi /etc/sysconfig/network GATEWAY=</code>IP_address</td>
<td><code># route -p add network_address IP_address</code></td>
</tr>
<tr>
<td></td>
<td><code># service network restart</code></td>
<td></td>
</tr>
<tr>
<td></td>
<td><code># nmcli con mod device ipv4.gateway IP_address</code></td>
<td></td>
</tr>
<tr>
<td>Check gateway information</td>
<td><code># netstat -rn</code></td>
<td><code># netstat -rn</code></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Display network device</td>
<td><code># ethtool eth0</code></td>
<td><code># dladm show-link</code></td>
</tr>
<tr>
<td></td>
<td></td>
<td><code># dladm show-phys (Physical NICs)</code></td>
</tr>
<tr>
<td>device status</td>
<td><code># nmcli device status</code></td>
<td></td>
</tr>
</tbody>
</table>

For details, see the *Oracle Solaris Command Reference for Linux Users*. 
Reference: Network Redundancy

- **Solaris IP network multipathing (IPMP)**
  - Solaris standard function achieving a high-reliable network with redundant NICs
    - Equivalent to the Linux Bonding function
  - **IPMP features**
    - Failure detection
      - Detects NIC failure and automatically switches the network route.
    - Recovery detection
      - Detects that the failed NIC has recovered, and restores the network route automatically to the original state.
    - Outbound load spreading
      - By spreading outbound packets to multiple NICs, IPMP can improve overall data transmission throughput.

Oracle Solaris document
*Administration: Network Interfaces and Network Virtualization (For Oracle Solaris 11)*
[https://docs.oracle.com/cd/E23824_01/html/821-1458/gfkcy.html#scrolltoc](https://docs.oracle.com/cd/E23824_01/html/821-1458/gfkcy.html#scrolltoc)
Reference: Network Redundancy

- **IPMP configuration procedure**

  **Execution example**

  **Example of configuring IPMP (probe based)**

  1. Create an interface.
     
     ```
     # ipadm create-ip net0
     # ipadm create-ip net1
     ```

  2. Configure the IPMP interface.
     
     ```
     # ipadm create-ipmp ipmp0
     # ipadm add-ipmp -i net0 -i net1 ipmp0
     # ipadm create-addr -T static -a local=192.168.1.10/24 ipmp0/v4
     ```

  3. Specify a standby interface.
     
     ```
     # ipadm set-ifprop -p standby=on -m ip net1
     ```

  - As shown above, all of IPMP can be configured with the ipadm command. A combination of subcommands is used to make each setting.
5. Service Management
Service Management

- Service management mechanisms in Linux and Solaris

  RHEL 6
  - The service startup script (rc script) of the /etc/init.d directory is executed sequentially based on the runlevel at OS startup.
  - Dependency between services must be managed by services (controlled by the startup script).

  RHEL 7
  - The service manager called systemd provides the on-demand start of services, and improves the dependency management of transactions. This has greatly reduced the start times.
  - The start of important services can be given a higher priority than that of less important services.

- Service management in RHEL 6 is equivalent to the old service management in Solaris9 and earlier.
Service Management

Service management mechanisms in Linux and Solaris

- Solaris
  - The service management function called SMF (Service Management Facility) manages dependencies. It can thus start/stop in advance the services that are dependent on service start times or service stop times.
  - A service stopped by a failure, etc. can be automatically restarted (self healing).
  - You can check what caused a service to stop and other affected services.
  - The rc script is called a legacy script and is compatible with the old service management mechanism.

- Solaris SMF always monitors not only service starts but also the status of running services. Thus, a check for the investigation of a service stop due to a failure and a check of the affected range can be done immediately.
Automatic Service Start

Linux and Solaris differences in automatic service starts

- **RHEL 6**
  - Different commands configure the service start and automatic start settings.

  Execution example

  ```
  # service httpd start              --- Start service
  # service httpd stop              --- Stop service
  # chkconfig httpd on              --- Enable automatic service start
  # chkconfig httpd off             --- Disable automatic service start
  ```

- **RHEL 7**
  - Starts are managed by the systemctl command alone.
  - Different commands configure the service start and automatic start settings.

  Execution example

  ```
  # systemctl start postfix.service  --- Start service
  # systemctl stop postfix.service   --- Stop service
  # systemctl enable postfix.service--- Enable automatic service start
  # systemctl disable postfix.service--- Disable automatic service start
  ```

- In RHEL 7, processes equivalent to conventional services are managed as files with the .service extension. Specify such a name when executing a service-related process.
Automatic Service Start

### Linux and Solaris differences in automatic service starts

#### Solaris
- Starts are managed by the `svcadm` command alone.
- The started/stopped service states are inherited at the next OS startup.

**Execution example**

```
# svcadm enable -t httpd                         --- Start service
# svcadm disable -t httpd                        --- Stop service
# svcadm enable httpd                            --- Start service and enable automatic start
# svcadm disable httpd                           --- Stop service and disable automatic start
```

- In Solaris, service start/stop states are inherited at the next OS startup.
- If you do not want these states inherited at the next OS startup, use the `–t` option to temporarily start/stop the service.
### Service management commands to keep in mind

<table>
<thead>
<tr>
<th>Basic Operation</th>
<th>Red Hat Enterprise Linux</th>
<th>Oracle Solaris</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>RHEL 6</strong></td>
<td><strong>RHEL 7</strong></td>
</tr>
<tr>
<td>Start service</td>
<td><code>service service_name</code></td>
<td><code>systemctl start service_name</code></td>
</tr>
<tr>
<td></td>
<td><code>start</code></td>
<td></td>
</tr>
<tr>
<td>Start service and enable automatic start</td>
<td><code>service service_name</code></td>
<td><code>systemctl start service_name</code></td>
</tr>
<tr>
<td></td>
<td><code>start</code></td>
<td><code>service_name</code></td>
</tr>
<tr>
<td></td>
<td><code>chkconfig service_name</code></td>
<td><code>on</code></td>
</tr>
<tr>
<td>Stop service</td>
<td><code>service service_name</code></td>
<td><code>systemctl stop service_name</code></td>
</tr>
<tr>
<td></td>
<td><code>stop</code></td>
<td></td>
</tr>
<tr>
<td>Stop service and disable automatic start</td>
<td><code>service service_name</code></td>
<td><code>systemctl stop service_name</code></td>
</tr>
<tr>
<td></td>
<td><code>stop</code></td>
<td><code>service_name</code></td>
</tr>
<tr>
<td></td>
<td><code>chkconfig service_name</code></td>
<td><code>off</code></td>
</tr>
<tr>
<td>Display list of services</td>
<td><code>chkconfig --list</code></td>
<td><code>systemctl list-unit-files --type service</code></td>
</tr>
<tr>
<td>Display service status</td>
<td><code>service service_name</code></td>
<td><code>systemctl status service_name</code></td>
</tr>
<tr>
<td></td>
<td><code>status</code></td>
<td></td>
</tr>
</tbody>
</table>

* FMRI (Fault Managed Resource Identifier)

For details, see the *Oracle Solaris Command Reference for Linux Users*. 
SMF (Service Management Facility)

- The service start scripts managed by SMF are in the /lib/svc/method directory, and they are controlled by svc.startd (master restarter daemon).

- A manifest file defines the dependencies between services. The /var/svc/manifest directory for each group contain a manifest file, which is referenced/changed by svc.configd (repository daemon).

- The log of management from SMF is output under /var/svc/log by each service.

- Services without dependencies start in parallel.
- Services with dependencies start according to the dependency.
- The rc procedure starts the legacy script.
6. File System and Storage Management
## Overview of File System and Storage Management

<table>
<thead>
<tr>
<th>Storage (volume) management</th>
<th>Red Hat Enterprise Linux</th>
<th>Oracle Solaris</th>
</tr>
</thead>
<tbody>
<tr>
<td>RHEL 6</td>
<td>LVM (Logical Volume Manager)</td>
<td>ZFS (Zettabyte File System)</td>
</tr>
<tr>
<td>RHEL 7</td>
<td>Zpool command</td>
<td>zfs command</td>
</tr>
<tr>
<td>File system</td>
<td>ext3 (Recommended), ext4, ext4</td>
<td>XFS</td>
</tr>
<tr>
<td>Maximum file system size</td>
<td>16 TB</td>
<td>500 TB</td>
</tr>
<tr>
<td>Maximum file size</td>
<td>2 TB (ext3), 16 TB (ext4)</td>
<td>500 TB</td>
</tr>
<tr>
<td>Redundant configuration</td>
<td>Basically use a hardware RAID with server internal or external storage devices.</td>
<td>Use a software RAID using ZFS or a hardware RAID with an external storage device.</td>
</tr>
</tbody>
</table>

* The Fujitsu M10 from Fujitsu supports hardware RAID as a standard function.

- The system volume area of Solaris is configured with ZFS.
- UFS (UNIX File System) of Solaris 10 or earlier can be used only for user volume areas.
Linux Storage Management

- LVM (Logical Volume Manager)

  - Features
    - Consolidates multiple physical disks (PV) into one volume group (VG).
    - Extracts a logical volume (LV) from the volume group (VG).
      A logical volume (LV) can be added or expanded while the OS is running.
    - Creates and mounts a file system for a logical volume (LV).
    - Can obtain a backup by using the snapshot function while the OS is running.

  - Conceptual image of file system mounting

The extracted LV is used as the mount point of / (root partition), /home, etc. Automatically mounting at OS startup uses the /etc/fstab file.
Solaris Storage Management

**ZFS (Zettabyte File System)**

**Features**

- One storage pool consists of multiple physical disks. The storage pool can have a RAID configuration.
- An area is extracted as a data set from the storage pool.
- The data set, immediately after being extracted, is mounted as a file system with the ZFS format. The file system is automatically expanded within the range of the storage pool capacity.
- A backup can be obtained using the snapshot function while the OS is running.

**Conceptual image of file system mounting**

In ZFS, a directory is simultaneously created with the same name as the file system being created and automatically mounted. Mount point information is saved as data set properties, which can be changed by the zfs command.
RAID Configuration Using ZFS

- Disk redundancy possible with standard functions

Specify the RAID configuration when registering a disk in a storage pool.
* RAID 1+0 configuration also available

- RAID configuration supported by ZFS

- Non-redundant
  - Striping (RAID-0)

- Mirror (mirroring)
  - Multi-way mirroring supported (RAID-1)

- RAID-Z
  - Single parity (similar to RAID-5)

- RAID-Z2
  - Double parity (similar to RAID-6)

- RAID-Z3
  - Triple parity

- A Solaris storage pool can improve file system performance and reliability by configuring a RAID array and registering physical disks.
ZFS Snapshot

- **ZFS snapshot mechanism**
  - Original data
  - Snapshot
  - Update original data (change/delete)
  - Original data
  - Snapshot
  - Snapshot always refers to original data at point when snapshot was created
  - Snapshot area increases (only relevant blocks copied)

- **ZFS snapshot features**
  - Automatically uses an empty area, so it is not necessary to specify the snapshot area.
  - Copies only the relevant blocks when updating data, and thus consumes very little disk space.
  - Can restore data to the point when a snapshot was created. [Rollback function]
  - Can back up the file system based on a ZFS snapshot. [Backup function]
  - Can replicate the file system by using a snapshot. [Clone function]

*For a created snapshot, note that the total disk area does not decrease even when the original data is deleted.*
Solaris Backup/Restore

Backup/Restore with a ZFS command

- **Backup: zfs send**
  - The zfs send command writes a snapshot to the standard output as backup data.
  - The OS does not need to be stopped.

- **Restore: zfs receive**
  - The command reads backup data from the standard input and restores the file system.
  - The OS does not need to be stopped unless the restore target is the system volume (root pool).

- For details on ZFS, see the ZFS Overview and Design Guide.
### File system and storage management commands to keep in mind

<table>
<thead>
<tr>
<th>Basic Operation</th>
<th>Red Hat Enterprise Linux</th>
<th>Oracle Solaris</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>RHEL 6</strong></td>
<td><strong>RHEL 7</strong></td>
</tr>
<tr>
<td>Linux: Create volume group</td>
<td><code>vgcreate volume_group_name device_name</code></td>
<td>zpool create <code>pool_name</code> RAID <code>device_name</code></td>
</tr>
<tr>
<td>Solaris: Create storage pool</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Linux: Create logical volume</td>
<td>`lvcreate -L size -n logical_volume_name</td>
<td>zfs create <code>file_system_name</code></td>
</tr>
<tr>
<td>Solaris: Create ZFS file system</td>
<td><code>volume_group_name</code></td>
<td></td>
</tr>
<tr>
<td>Create snapshot</td>
<td>`lvcreate -s -L size -n snapshot_name</td>
<td>zfs snapshot <code>snapshot_name</code></td>
</tr>
<tr>
<td></td>
<td><code>original_device</code></td>
<td></td>
</tr>
<tr>
<td>Roll back from snapshot</td>
<td><code>lvconvert --merge snapshot_name</code></td>
<td>zfs rollback <code>snapshot_name</code></td>
</tr>
<tr>
<td>Back up file system</td>
<td><code>dump -0u -f backup_file partition</code></td>
<td>zfs send <code>snapshot_name</code></td>
</tr>
<tr>
<td></td>
<td><code>xfsdump -l level -f backup_file partition</code></td>
<td></td>
</tr>
<tr>
<td>Restore file system</td>
<td><code>restore -r -f backup_file</code></td>
<td>zfs receive <code>snapshot_stream</code></td>
</tr>
<tr>
<td></td>
<td>`xfsrestore -f backup_file -s session_ID</td>
<td></td>
</tr>
<tr>
<td></td>
<td><code>restore_destination</code></td>
<td></td>
</tr>
<tr>
<td>Operate partition</td>
<td>parted (Recommended), fdisk</td>
<td>format</td>
</tr>
</tbody>
</table>

For details, see the *Oracle Solaris Command Reference for Linux Users*. 
Solaris disk label

- Solaris supports the following two disk labels:
  - SMI (Sun Microsystems Inc.)
    - Disk label for the system volume. Disks with this label have a size of less than 2 TB.
  - EFI (GPT) (Extensible Firmware Interface GUID Partition Table)
    - Disk label for ZFS, excluding the system volume

Solaris device path

- Path for the character string that identifies a specific controller, disk, and slice, under the /dev/(r)dsk directory

```
/dev/(r)dsk/cvtwdxsy
```

- v: Logical controller number
- Disk device(*)
- Device directory
- x: Drive number
- y: Slice number
- w: Physical bus target number

* dsk is block type device. rdsk is a character-type device (raw device).
Reference: Disk Partition

- Differences between Linux and Solaris partitions

  - **Linux**
    - One disk is divided into multiple areas (partitions), which are used as the file system and raw device.
    - Use the fdisk command to configure the partitions.

  - **Solaris**
    - A Solaris partition is also called a "slice."
    - The number of created slices varies depending on the disk label.
    - A value from s0 to s7 is appended to the device name to represent the device path. (Example: /dev/rdsk/c2t0d1s0)
    - s2 of the SMI label is a special slice that represents the overall disk.
    - Use the format command to configure the slices.
Reference: Mounting an ISO Image File

- **File formats of Linux and Solaris ISO image files**

  - **Linux**
    - Specify iso9660 as the file system format and mount a file.

    **Execution example**

    Mount /ISO/media.iso to the /mnt directory.

    ```
    # mount -o loop -t iso9660 /ISO/media.iso /mnt
    --- Mount ISO file to /mnt
    ```

  - **Solaris**
    - Specify hsfs as the file system format and mount a file.

    **Execution example**

    Mount /ISO/media.iso to the /mnt directory.

    ```
    # mount -F hsfs /ISO/media.iso /mnt
    --- Mount ISO file to /mnt
    ```
Solaris file system configuration

File systems other than ZFS refer to the /etc/vfstab file at OS startup and are automatically mounted.

Main directories

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>/dev</td>
<td>Directory that contains special device files</td>
</tr>
<tr>
<td>/devices</td>
<td>Mount point directory of the devfs file system</td>
</tr>
<tr>
<td>/etc</td>
<td>Directory that contain system-specific management files and configuration files</td>
</tr>
<tr>
<td>/bin</td>
<td>Directory that contains executable files that general users can also use</td>
</tr>
<tr>
<td>/sbin</td>
<td>Directory that contains executable files used for system recovery by the boot process or manually</td>
</tr>
<tr>
<td>/usr/lib</td>
<td>Additional system library required by programs at runtimes</td>
</tr>
<tr>
<td>/proc</td>
<td>Mount point directory of the process file system</td>
</tr>
<tr>
<td>/tmp</td>
<td>Directory for temporary files. It uses tmpfs, the file system on memory.</td>
</tr>
</tbody>
</table>

- The ZFS volume has a configuration of swap and dump devices.
- Files allocated to /tmp use physical memory. Also, they are erased by a restart.
7. Monitoring
Log monitoring in Linux and Solaris

Linux
- The log output of system messages is defined in /etc/rsyslog.conf.

Solaris
- The log output of system messages is defined in /etc/syslog.conf.
- Like in Linux, system messages can be displayed to login users and administrators or sent to other servers.
- Like in Linux, you can check system performance information (CPU and memory usage, etc.) with an OS command.
- There are monitoring commands unique to Solaris.

- A popular implementation of on-site monitoring uses dedicated software and operation monitoring system.
System Monitoring Logs

- Linux and Solaris differences in log output

  - Log output destination

<table>
<thead>
<tr>
<th>Log</th>
<th>Red Hat Enterprise Linux</th>
<th>Oracle Solaris</th>
</tr>
</thead>
<tbody>
<tr>
<td>Log output by system</td>
<td>/var/log/messages</td>
<td>/var/adm/messages</td>
</tr>
<tr>
<td>Log recording sent/received e-mail</td>
<td>/var/log/maillog</td>
<td>/var/log/syslog</td>
</tr>
<tr>
<td>Log when cron is executed</td>
<td>/var/log/cron</td>
<td>/var/cron/log</td>
</tr>
</tbody>
</table>

- Log rotation
  - Like in Linux, Solaris also sets items in units of log files and periodically executes related jobs using cron.

<table>
<thead>
<tr>
<th>Red Hat Enterprise Linux</th>
<th>Oracle Solaris</th>
</tr>
</thead>
<tbody>
<tr>
<td>- The <code>/etc/logrotate.conf</code> file defines the following:</td>
<td>- The <code>/etc/logadm.conf</code> file defines the settings for each log file that is rotated.</td>
</tr>
<tr>
<td>weekly --- Every week</td>
<td>/var/adm/messages -C 4 -a '/usr/sbin/svccfg -s svc:/system/system-log refresh'</td>
</tr>
<tr>
<td>rotate 4 --- 4 generations</td>
<td>-C: Number of saved generations</td>
</tr>
<tr>
<td>compress --- Compress</td>
<td>-a: Executes the command in single quotation marks (&quot; &quot;) after changing the log file name.</td>
</tr>
<tr>
<td>/var/log/messages {</td>
<td></td>
</tr>
<tr>
<td>sharedscripts</td>
<td></td>
</tr>
<tr>
<td>postrotate</td>
<td></td>
</tr>
<tr>
<td>/bin/kill -HUP <code>cat /var/run/syslogd.pid 2&gt; /dev/null</code></td>
<td></td>
</tr>
<tr>
<td>2&gt; /dev/null</td>
<td></td>
</tr>
<tr>
<td>endscript</td>
<td></td>
</tr>
</tbody>
</table>
System Monitoring Commands

- **Example of commands for checking mounted resources**

<table>
<thead>
<tr>
<th>Check Item</th>
<th>Red Hat Enterprise Linux</th>
<th>Oracle Solaris</th>
</tr>
</thead>
<tbody>
<tr>
<td>Check CPU, memory, and expansion card</td>
<td>cat /proc/cpuinfo</td>
<td></td>
</tr>
<tr>
<td></td>
<td>cat /proc/meminfo</td>
<td></td>
</tr>
<tr>
<td></td>
<td>lspci</td>
<td>prtdiag</td>
</tr>
</tbody>
</table>

- **Example of commands for checking for failures**

<table>
<thead>
<tr>
<th>Check Item</th>
<th>Red Hat Enterprise Linux</th>
<th>Oracle Solaris</th>
</tr>
</thead>
<tbody>
<tr>
<td>Network status</td>
<td>ethtool, ping</td>
<td>dladm, ping</td>
</tr>
<tr>
<td>Service status</td>
<td>service (RHEL 6)</td>
<td>svcs</td>
</tr>
<tr>
<td></td>
<td>systemctl (RHEL 7)</td>
<td></td>
</tr>
<tr>
<td>Process status</td>
<td>pstree, ps</td>
<td>ptree, ps</td>
</tr>
<tr>
<td>Process trace</td>
<td>strace</td>
<td>truss</td>
</tr>
</tbody>
</table>

- **Example of commands for checking resource usage**

<table>
<thead>
<tr>
<th>Check Item</th>
<th>Red Hat Enterprise Linux</th>
<th>Oracle Solaris</th>
</tr>
</thead>
<tbody>
<tr>
<td>System uptime</td>
<td>uptime</td>
<td>uptime</td>
</tr>
<tr>
<td>CPU, memory, and I/O load</td>
<td>mpstat, vmstat</td>
<td>mpstat, pgstat, vmstat, iostat, fsstat, netstat, flowstat, dlstat, ipmpstat</td>
</tr>
<tr>
<td></td>
<td>iostat, iotop, netstat</td>
<td></td>
</tr>
<tr>
<td>Load per process</td>
<td>top, pidstat</td>
<td>top, prstat</td>
</tr>
</tbody>
</table>
## Monitoring commands to keep in mind

<table>
<thead>
<tr>
<th>Basic Operation</th>
<th>Red Hat Enterprise Linux</th>
<th>Oracle Solaris</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>RHEL 6</td>
<td>RHEL 7</td>
</tr>
<tr>
<td>Check CPU, memory, and I/O load</td>
<td>mpstat</td>
<td>mpstat</td>
</tr>
<tr>
<td></td>
<td>vmstat</td>
<td>vmstat</td>
</tr>
<tr>
<td></td>
<td>iostat</td>
<td>iostat</td>
</tr>
<tr>
<td>Check CPU, memory, and expansion card</td>
<td>cat /proc/cpuinfo</td>
<td>cat /proc/meminfo</td>
</tr>
<tr>
<td></td>
<td></td>
<td>lspci</td>
</tr>
<tr>
<td>Confirm network communication</td>
<td>ping</td>
<td>ping</td>
</tr>
<tr>
<td>Check process state</td>
<td>ps -ef</td>
<td>ps -ef</td>
</tr>
</tbody>
</table>

For details, see the *Oracle Solaris Command Reference for Linux Users*.

- You can use commands such as the top command for monitoring process states, in Solaris in the same way.
Reference: Solaris cron

- **cron**

  - **Editing cron**
    - Edit cron with the crontab command.
    
    ```
    # crontab -e
    10 3 * * * /usr/sbin/logadm
    # Format
    ^   ^   ^   ^   ^
    M  H  D Mon day   command
    ```

  - **Displaying registered contents**
    - Use the crontab command to display the contents registered in cron.
    
    ```
    # crontab -l
    10 3 * * * /usr/sbin/logadm
    ```

  - **Notifying about execution results**
    - Send the execution results from cron to the registered user by e-mail.
8. Virtual Environment
Linux Virtualization Technology

- **Docker**
  - Container-type virtualization software creates an isolated space (container) on the OS for an application to operate.
  - There is only a slight performance degradation due to server virtualization, and also less use of hardware resources.
  - By saving a container environment as an image, you can bring the image to Docker on other servers and operate the environment as is there.

- **KVM**
  - Hypervisor-type virtualization software creates a virtual environment called a guest OS.
  - Since hardware is virtualized using the CPU virtualization support function, various OSs (Windows, etc.) other than Linux can be used as a guest OS.
  - KVM does not have its own hypervisor, and it controls the guest OS by using Linux itself as the host OS.
Oracle Solaris Zone

Server virtualization function relevant to Linux Docker
- Divides and manages resources at the Solaris kernel layer.
- Implements container-type virtualization.
- Can batch apply patches and update packages to each zone because all zones use a common kernel.

<table>
<thead>
<tr>
<th>Docker</th>
<th>Oracle Solaris Zone</th>
</tr>
</thead>
<tbody>
<tr>
<td>Server</td>
<td>Server</td>
</tr>
<tr>
<td>RHEL 7</td>
<td>Solaris 11.3</td>
</tr>
<tr>
<td>RHEL 6 (Container)</td>
<td>Solaris 11.3 (Zone)</td>
</tr>
<tr>
<td>CentOS 7 (Container)</td>
<td>Solaris 11.3 (Zone)</td>
</tr>
<tr>
<td>Firmware</td>
<td>Firmware</td>
</tr>
<tr>
<td>Hardware</td>
<td>Hardware</td>
</tr>
</tbody>
</table>
Solaris Zone features

- Can build a maximum of 8,191 virtual OSs without being dependent on the hardware configuration.
- Can easily add or delete a virtual OS in a short time.
- Does not require OS installation for every virtual OS.
- Can flexibly assign hardware resources such as CPUs and memory.
- Can be used for free.

Traditional

Consolidated by Oracle Solaris zones

- Varying usage of servers
- Very difficult to manage so many servers
- Want to reduce electricity and space used

OS maintenance and backup required just once, so operational load is lower
Oracle VM Server for SPARC (Oracle VM)

Function relevant to Linux KVM

- Divides and manages resources at the firmware layer.
- Implements hypervisor-type virtualization.
- Can build environments with different Solaris update releases and patch levels because each domain uses a different kernel.
Oracle VM Server for SPARC features
- Can consolidate the OS environments of different revisions and update releases.
- Enables flexible allocation of resources (CPUs, memory, and I/O) per domain (virtual server).
- Establishes software failure isolation between domains.
- Can be used for free.
## Docker and Oracle Solaris zones

<table>
<thead>
<tr>
<th></th>
<th>Docker</th>
<th>Oracle Solaris Zone</th>
</tr>
</thead>
</table>
| OS running on virtual environment | Various Linux distributions (RHEL, Cent OS, etc.) | Solaris 10, Solaris 11 *
| Performance overhead  | Extremely small                       | Extremely small                          |
| Connection to virtual environment | Dedicated Docker client required      | Dedicated client not required (can connect via telnet, ssh, etc.) |

## KVM and Oracle VM Server for SPARC

<table>
<thead>
<tr>
<th></th>
<th>KVM</th>
<th>Oracle VM Server for SPARC</th>
</tr>
</thead>
</table>
| OS running on virtual environment | Can select from various OSs such as Windows, Linux, and IA Solaris | Solaris 10, Solaris 11 *
| Performance overhead  | Relatively large                      | Extremely small                          |
Docker/Solaris Zone Management Commands

**Docker: Container management**

- **Creating/Exiting a container**

  **Execution example**

```
# docker pull registry.access.redhat.com/rhel         --- Download image
# docker run -it -h container_name rhel /bin/bash  --- Start container named container_name
[container_name]#                                      --- Log in to container
[container_name]# exit                                 --- Exit container
# docker rm container_name                              --- Delete container
```

**Solaris zone: Zone management**

- **Creating/Exiting a zone**

  **Execution example**

```
# zonecfg -z zone_name create                          --- Create zone configuration file
# zoneadm -z zone_name install                         --- Install zone
# zoneadm -z zone_name boot                           --- Start zone
# zlogin -C zone_name                                  --- Log in to zone console
[zone_name]# ~.                                        --- Log out from zone
# zoneadm -z zone_name shutdown                       --- Stop zone
# zoneadm -z zone_name delete                         --- Delete zone
```
KVM/Oracle VM Management Commands

**KVM: Guest OS management**

- Creating/Exiting a guest OS

```
# virt-install --parameters --- Create and install guest configuration file
# virsh start guest_name --- Start guest named guest_name
# virsh console guest_name --- Log in to guest
[guest_name]# Press [Ctrl] key and [] key --- Log out from guest
# virsh shutdown guest_name --- Exit guest
```

**Oracle VM: Guest domain management**

- Creating/Exiting a guest domain

```
# ldm add-domain domain_name --- Create domain named domain_name
# ldm set-core 2 domain_name --- Specify core to use
# ldm set-memory 4096M domain_name --- Specify memory to use
# ldm bind domain_name --- Bind domain
# ldm start domain_name --- Start domain
# ldm stop domain_name --- Stop domain
# ldm unbind domain_name --- Unbind domain
```
Reference URLs

- **Oracle Solaris manuals**
  Oracle Solaris 11.3 Information Library
  [http://docs.oracle.com/cd/E53394_01/](http://docs.oracle.com/cd/E53394_01/)
  → Provides general documents for administrators and developers and a command reference.

- **SPARC M10 server manuals**
  Fujitsu M10/SPARC M10 Systems System Operation and Administration Guide
  → Describes the basic operations required for system operation and administration.

- **Technical Park: Technical information**
  UNIX Server SPARC M10 Documentation
  → Introduces various functions and presents guides.

- **Linux-related information**
  Product Documentation for Red Hat Enterprise Linux
<table>
<thead>
<tr>
<th>Edition</th>
<th>Date</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>First</td>
<td>December 2016</td>
<td>First edition created</td>
</tr>
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