Oracle Solaris Guide for Linux Users

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Fujitsu Limited

Contents

- Preface
- 1. Starting and Stopping the OS Environment
- 2. Package Management
- 3. User Management
- 4. Network Management
- 5. Service Management
- 6. File System and Storage Management
- 7. Monitoring
- 8. Virtual Environment

Preface 1/2

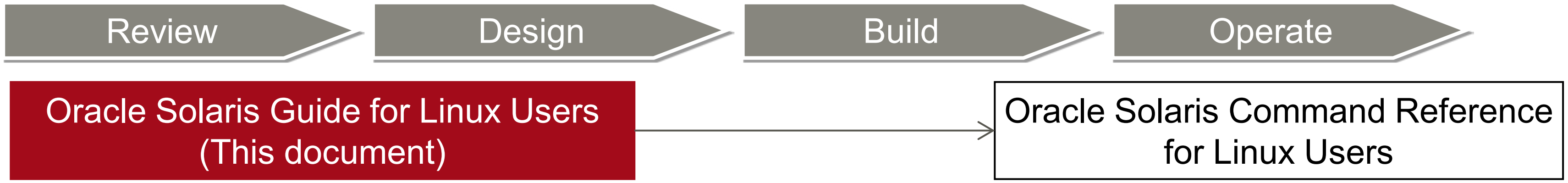
Purpose

- 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

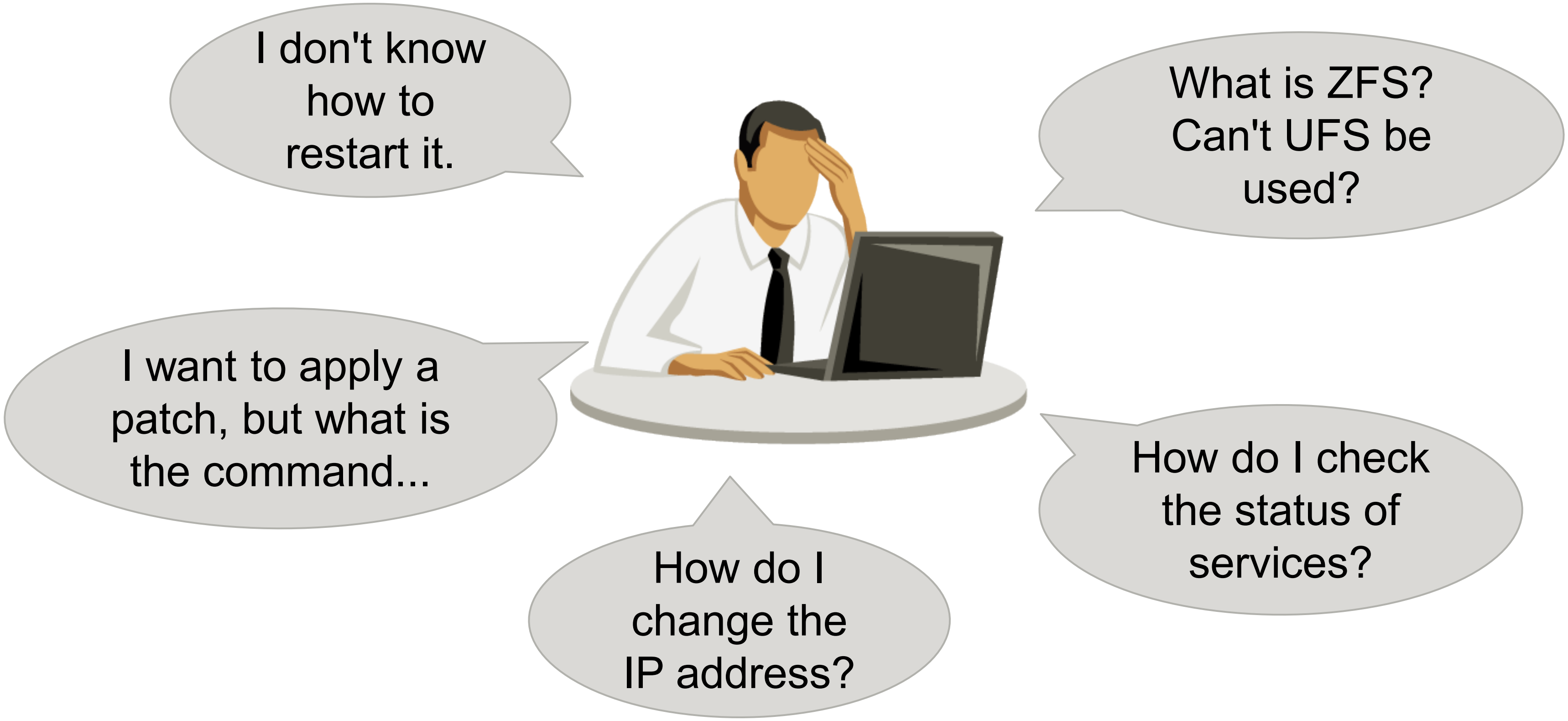
Preface 2/2

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. Solaris
- 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 check the status of services?

How do I change the IP address?

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 processer 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

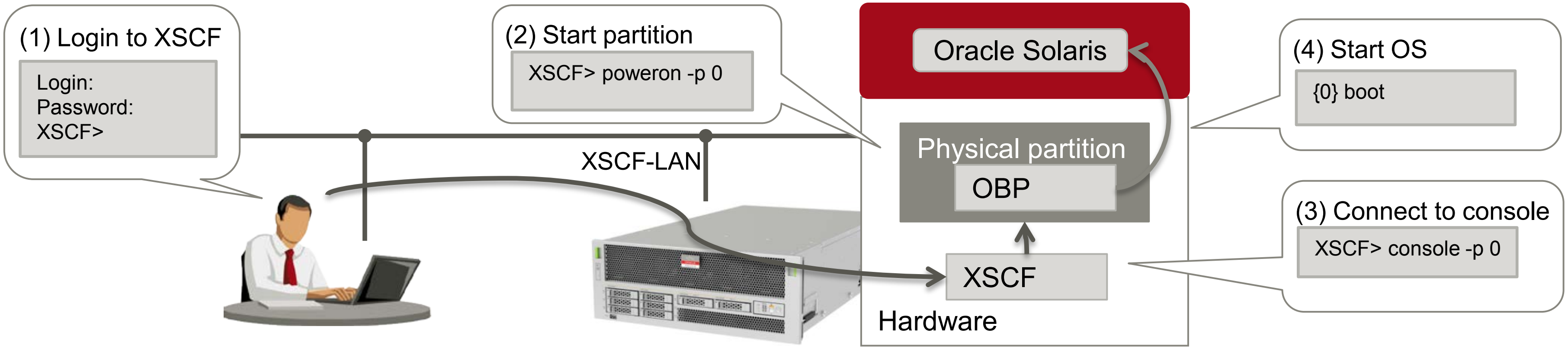
(1) Use terminal software to log in to the XSCF.

(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.



(1) Login to XSCF

```
Login:
Password:
XSCF>
```

(2) Start partition

```
XSCF> poweron -p 0
```

(3) Connect to console

```
XSCF> console -p 0
```

(4) Start OS

```
{0} boot
```

Linux and Solaris Runlevels

FUJITSU

Runlevel comparison

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

Runlevel/Target		Meaning		Notes
RHEL 6 Solaris	RHEL 7	Red Hat Enterprise Linux	Oracle Solaris	
0	poweroff.target	Power-off state	OS-stopped state (*1)	*1 OBP is running.
s (or S)		-	Single user	
1	rescue.target	Single user	System management state	
2		Not used	Multi-user (no NFS)	
3	multi-user.target	Multi-user	Multi-user (*2)	*2 Solaris default
4		Not used	Multi-user (*3)	*3 Can be used as required
5	graphical.target	X window (*4)	Power-off state	*4 Linux default
6	reboot.target	OS restart	OS restart	

- 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

FUJITSU

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

Solaris

Starting the Solaris GUI desktop

GUI connection using VNC (* VNC is freeware.)

Execution example

1. Install the solaris-desktop package.

```
# pkg install solaris-desktop
```

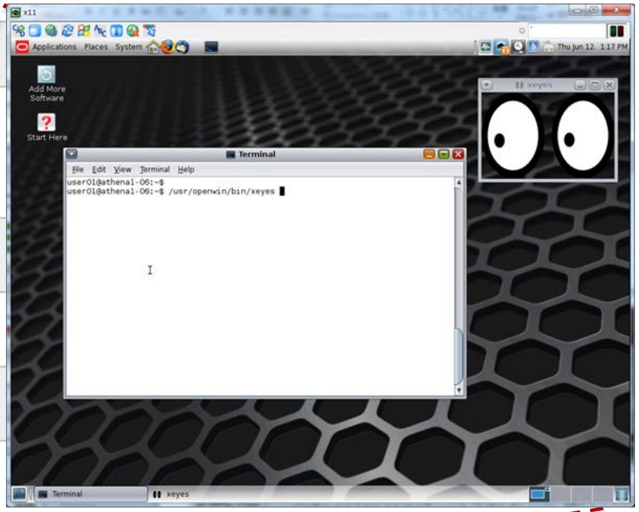
2. Edit the /etc/gdm/custom.conf file.
3. Restart the system.

```
# shutdown -y -g0 -i6
```

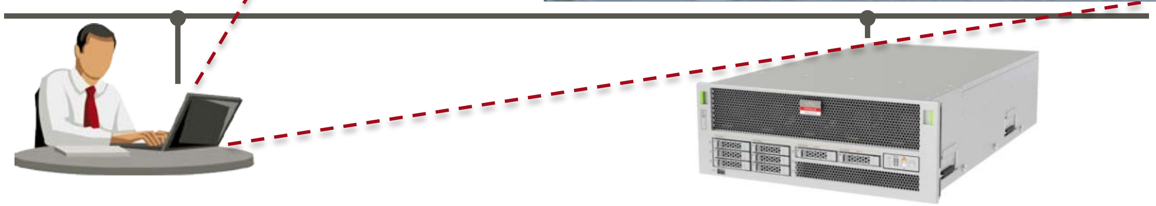
4. Enable the xvnc inetd service.

```
# inetadm -e xvnc-inetd
```

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



```
user01@athenal-06:~$
user01@athenal-06:~$ /usr/openwin/bin/xeyes
```



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

Stopping the OS Environment 1/2

OS shutdown in Linux and Solaris

Linux

- RHEL 6

Execution example

✓ Stop the Linux OS.

```
# shutdown –h now
```

✓ Restart the Linux OS.

```
# shutdown –r now
```

- RHEL 7

Execution example

✓ 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
```

Linux and Solaris Command Comparison (1)

OS boot/stop commands to keep in mind

Basic Operation	Red Hat Enterprise Linux		Oracle Solaris
	RHEL 6	RHEL 7	
Start OS	Start from the GRUB menu.	Start from the GRUB 2 menu.	Execute the start command from the OBP (OpenBoot PROM) environment. {0} ok boot
Start in single user mode	Add a runlevel. kernel /vmlinuz-... root=... 1	Add a runlevel. systemd.unit=rescue.target	Start in single user mode from the OBP (OpenBoot PROM) environment. {0} ok boot –s
Stop OS	Specify the stop option (-h) in the shutdown command. # shutdown -h now	Specify the stop option (poweroff) in the systemctl command. # systemctl poweroff	Execute the shutdown command. Specify the stop option (-i5). # shutdown -y -g0 –i5
Restart OS	Specify the restart option (-r) in the shutdown command. # shutdown -r now	Specify the restart option (reboot) in the systemctl command. # systemctl reboot	Execute the shutdown command. Specify the restart option (-i6). # shutdown -y -g0 -i6
Other execution examples	- Stop at 10 o'clock. # shutdown -h 10:00 - Stop after 5 minutes. # shutdown -h +5	- Suspend the OS. # systemctl suspend - Hibernate the OS. # systemctl hibernate	- Start via a network. {0} ok boot net:dhcp - Restart after 30 seconds. # shutdown -y -g30 -i6

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

Reference: Solaris System Locale

Solaris

- Solaris standard locale (character code) is UTF-8
  - System locale is set in the following service property:

    svc:/system/environment:init

Main Locale (Character Code)	Setting Value
English	C
Japanese (EUC)	ja_JP.eucJP, ja
Japanese (Shit-JIS)	ja_JP.PCK
Japanese (UTF-8)	ja_JP.UTF-8

  - Changing the system locale

Execution example

1. Install the system/locale/extra package.
   * Only when using a locale other than the standard locale

```
# pkg install system/locale/extra
```

2. Change the locale with the svccfg command (set LANG=C).

```
# svccfg -s system/environment:init setprop environment/LANG = astring: C
```

3. Reread the service property.

```
# svcadm refresh system/environment:init
```

4. Confirm that the setting has been reflected.

```
# svcprop system/environment:init | grep environment/LANG
environment/LANG astring C
```

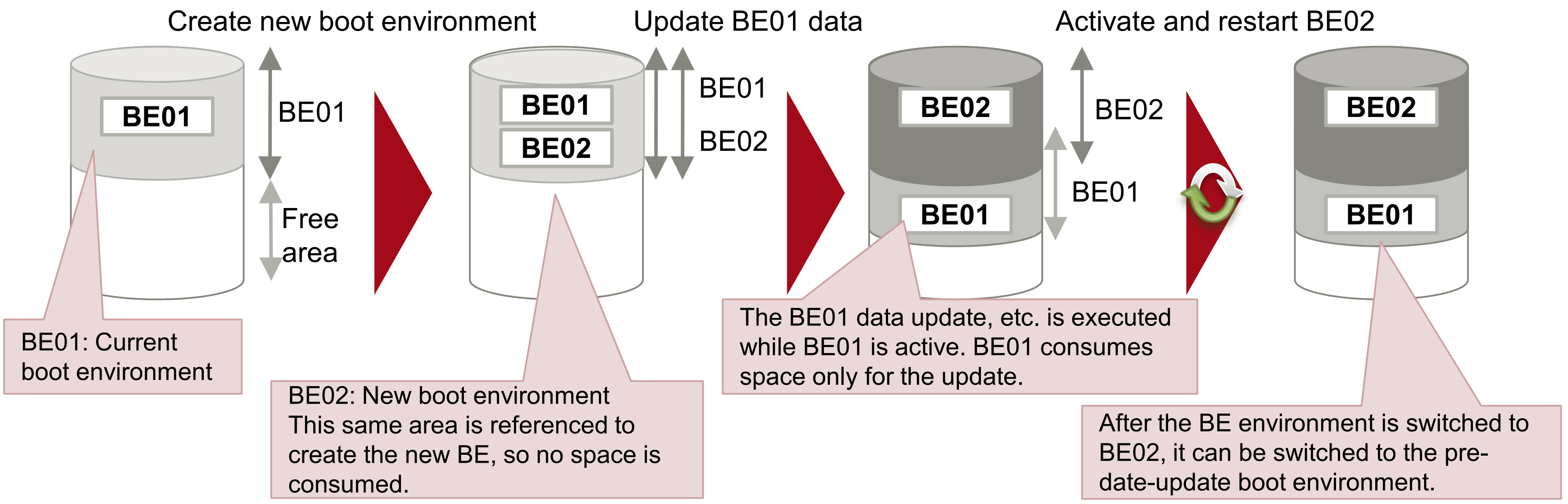
- The locale –a command can check for the locales that can be set.

Reference: Boot Environment (BE)

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



BE01: Current boot environment

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

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

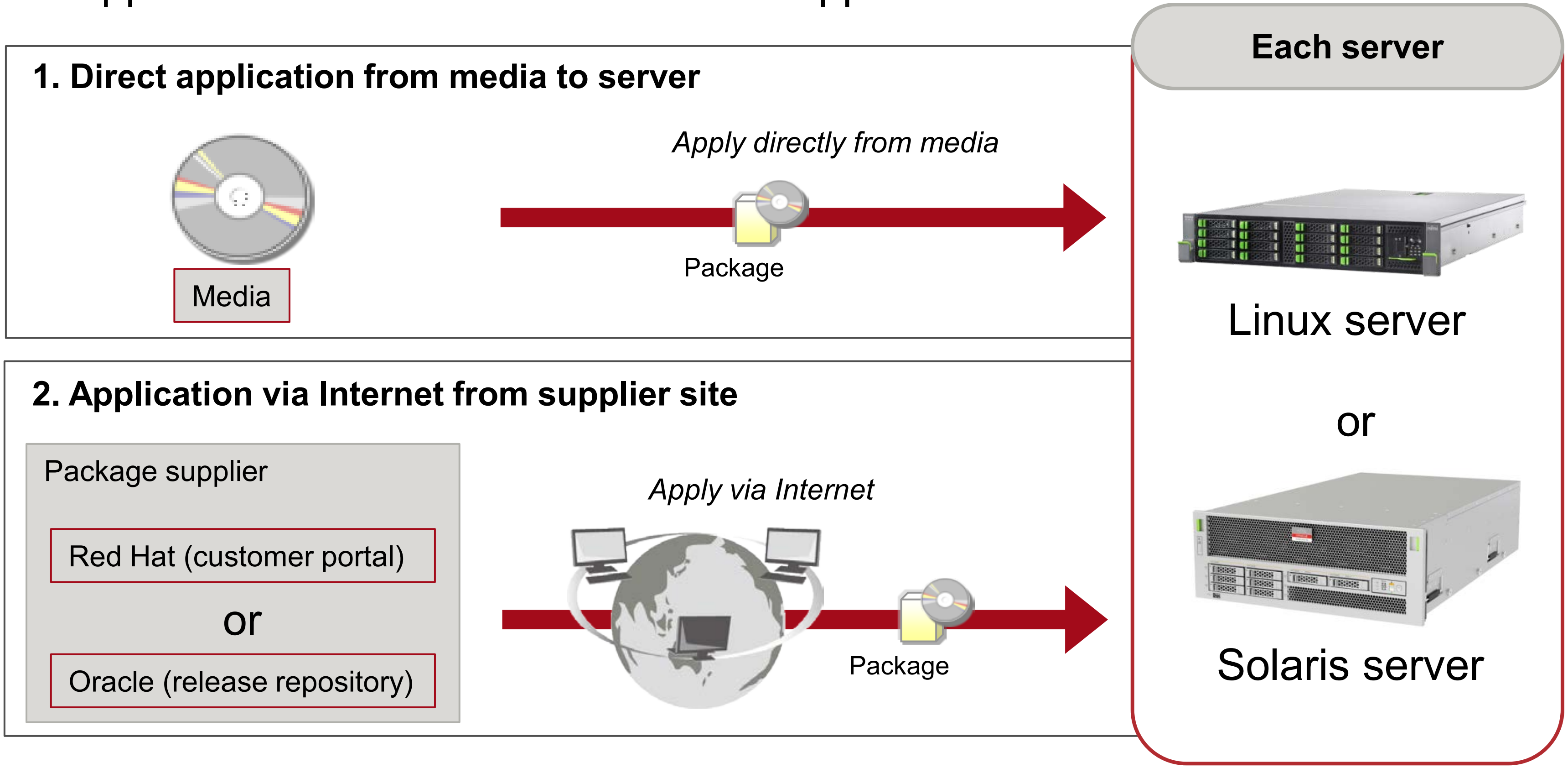
After the BE environment is switched to BE02, it can be switched to the pre-date-update boot environment.

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

Media

Apply directly from media

Package

2. Application via Internet from supplier site

Package supplier

Red Hat (customer portal)

or

Oracle (release repository)

Apply via Internet

Package

Each server

Linux server

or

Solaris server

Application of a Solaris Package

Solaris

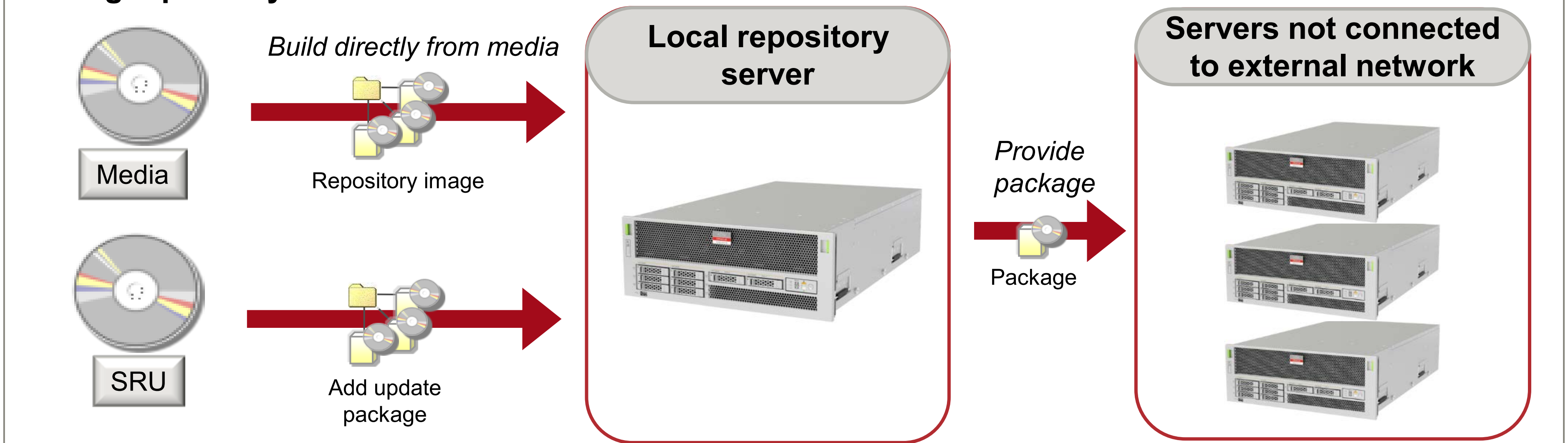
Server providing packages in the local environment (local repository server)

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.

Linux and Solaris Command Comparison (2)

Package management commands to keep in mind

Basic Operation	Red Hat Enterprise Linux		Oracle Solaris
	RHEL 6	RHEL 7	
Check update	yum check-update		pkg update -nv
Update package	yum update *package_name*		pkg update *package_name*
Update all packages	yum update		pkg update
Install	yum install *package_name*		pkg install *package_name*
Search	yum search *search-character-string*		pkg search *search-character-string*
List installed packages	yum list all		pkg list
Display package information	yum info *package_name*		pkg info *package_name*

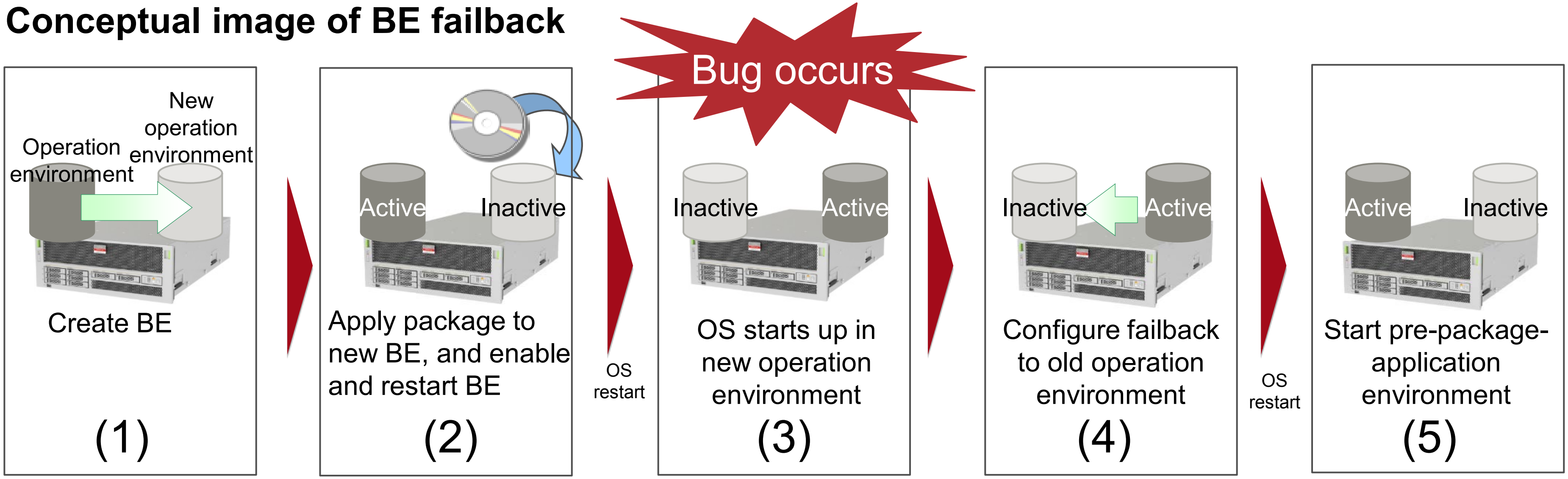
For details, see the *Oracle Solaris Command Reference for Linux Users*.

Reference: Environment Recovery to Before Package Application 1/2

Environment recovery using Boot Environment (BE)

- By using a BE in Solaris, you can failback to the environment from a time before 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


Bug occurs
New operation environment
Operation environment
Create BE
(1)
Active
Inactive
Apply package to new BE, and enable and restart BE
(2)
OS restart
Inactive
Active
OS starts up in new operation environment
(3)
Inactive
Active
Configure failback to old operation environment
(4)
OS restart
Active
Inactive
Start pre-package-application environment
(5)

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

Reference: Environment Recovery to Before Package Application 2/2

Solaris

OS environment recovery operation using a BE

Execution example (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
```

Active status
N: Current boot environment
R: Next boot environment

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

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

Execution example (To specify a BE on the OBP environment)

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

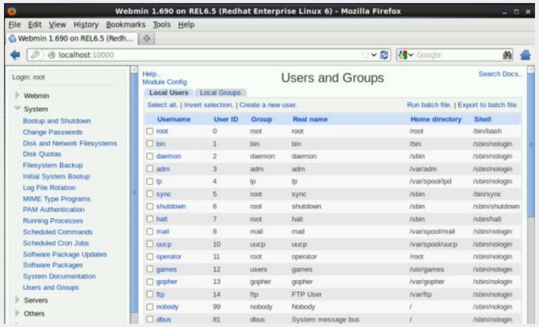
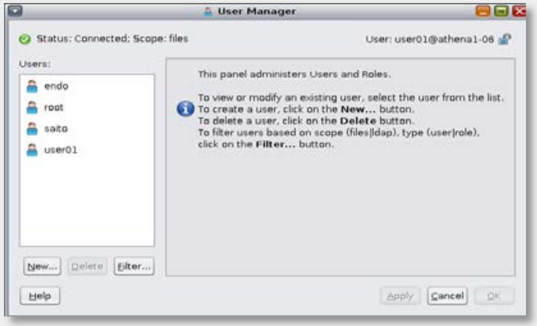
```
{0} ok boot -L
Boot device: /virtual-devices@100/channel-devices@200/disk@1  File and args: -L
1 solaris-1
2 solaris-2
Select environment to boot: [ 1 - 2 ]:1
```

2. Execute the start command as shown.

```
{0} ok boot -Z rpool/ROOT/solaris-1
```

3. User Management

Overview of User Management

Basic Operation	Red Hat Enterprise Linux	Oracle Solaris
Operation	Generally managed from command line * GUI management also possible 	Generally managed from command line * GUI management also possible 
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(*).

Webmin 1.690 on REL6.5 (Redhat Enterprise Linux 6) - Mozilla Firefox

File Edit View History Bookmarks Tools Help
Webmin 1.690 on REL6.5 (Redh...
localhost:10000
Google

Login: root

Webmin
System
Bootup and Shutdown
Change Passwords
Disk and Network Filesystems
Disk Quotas
Filesystem Backup
Initial System Bootup
Log File Rotation
MIME Type Programs
PAM Authentication
Running Processes
Scheduled Commands
Scheduled Cron Jobs
Software Package Updates
Software Packages
System Documentation
Users and Groups
Servers
Others

Help..
Module Config

Users and Groups

Search Docs..

Local Users | Local Groups

Select all. | Invert selection. | Create a new user.   Run batch file. | Export to batch file.

	Username	User ID	Group	Real name	Home directory	Shell
□	root	0	root	root	/root	/bin/bash
□	bin	1	bin	bin	/bin	/sbin/nologin
□	daemon	2	daemon	daemon	/sbin	/sbin/nologin
□	adm	3	adm	adm	/var/adm	/sbin/nologin
□	lp	4	lp	lp	/var/spool/lpd	/sbin/nologin
□	sync	5	root	sync	/sbin	/bin/sync
□	shutdown	6	root	shutdown	/sbin	/sbin/shutdown
□	halt	7	root	halt	/sbin	/sbin/halt
□	mail	8	mail	mail	/var/spool/mail	/sbin/nologin
□	uucp	10	uucp	uucp	/var/spool/uucp	/sbin/nologin
□	operator	11	root	operator	/root	/sbin/nologin
□	games	12	users	games	/usr/games	/sbin/nologin
□	gopher	13	gopher	gopher	/var/gopher	/sbin/nologin
□	ftp	14	ftp	FTP User	/var/ftp	/sbin/nologin
□	nobody	99	nobody	Nobody	/	/sbin/nologin
□	dbus	81	dbus	System message bus	/	/sbin/nologin

User Manager

Status: Connected; Scope: files   User: user01@athena1-06

Users:
endo
root
saito
user01

This panel administers Users and Roles.

To view or modify an existing user, select the user from the list.
To create a user, click on the **New...** button.
To delete a user, click on the **Delete** button.
To filter users based on scope (files|ldap), type (user|role), click on the **Filter...** button.

* 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

Solaris

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.

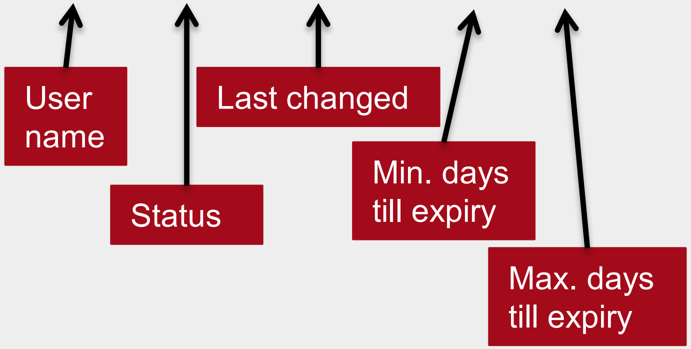
Variable	Description
CONSOLE	When set, allows login only by a superuser on that device
PATH	PATH variable of the initial shell
SUPATH	PATH variable of the initial shell for a superuser
TIMEOUT	Wait time (seconds) until the login session ends
SLEEPTIME	Number of seconds before displaying a login failure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

- 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.

Basic Operation	Red Hat Enterprise Linux	Oracle Solaris
Set maximum number of days	# chage -M 90 *user_name*	# passwd -x 90 *user_name*
Set minimum number of days	# chage -m 30 *user_name*	# passwd -n 30 *user_name*
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  User name Status Last changed Min. days till expiry Max. days till expiry

- 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.

Linux and Solaris Command Comparison (3)

User management commands to keep in mind

Basic Operation	Red Hat Enterprise Linux		Oracle Solaris
	RHEL 6	RHEL 7	
Add user	useradd *user_name*		useradd *user_name*
Update user ID	usermod -u *new_UID user_name*		usermod -u *new_UID user_name*
Delete user	userdel *user_name*		userdel *user_name*
Display password expiration date	chage -l *user_name*		passwd -s *user_name*
Set password expiration date	chage -m 60 *user_name*		passwd -x 60 *user_name*
Change account information (full name, etc.)	chfn		passwd -g

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

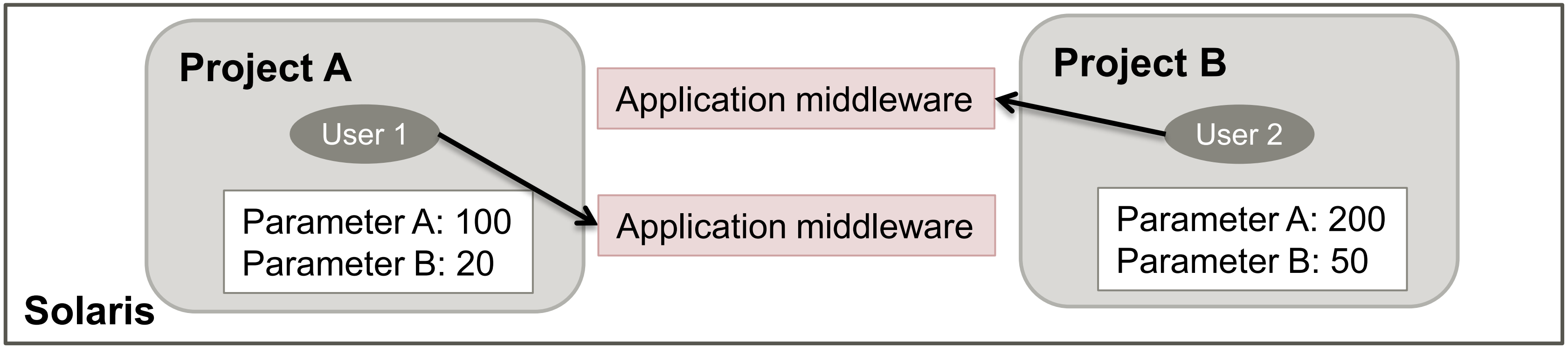
1. Change the default shell of the user (user01).

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

Reference: Solaris Project

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

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

- 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

Solaris

Configuring Solaris network settings

Execution example

Checking the interface status

```
# dladm show-link
LINK        CLASS    MTU    STATE    OVER
net0        phys     1500   up        --
net1        phys     1500   up        --
```

STATE status
up: Link up
down: Link down

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
```

Linux and Solaris Command Comparison (4)

Network management commands to keep in mind

Basic Operation	Red Hat Enterprise Linux		Oracle Solaris
	RHEL 6	RHEL 7	

Set IP address	# vi /etc/sysconfig/network-scripts/ifcfg-*device*
	IPADDR=*IP_address*
	# service network restart
		# nmcli con mod *device* ipv4.method manual ipv4.addresses "*IP_address/mask_gateway*"	# ipadm create-addr -T static -a local=*IP_address/mask_device*

Configure DHCP	# vi /etc/sysconfig/network-scripts/ifcfg-*device*
	BOOTPROTO=dhcp
	# service network restart
		# nmcli con mod *device* ipv4.method auto	# ipadm create-addr -T dhcp *device*

Check IP address	# ifconfig	# ip address	# ipadm show-addr

Configure gateway	# vi /etc/sysconfig/network
	GATEWAY=*IP_address*
	# service network restart
		# nmcli con mod *device* ipv4.gateway *IP_address*	# route -p add *network_address IP_address*

Check gateway information	# netstat -rn	# ip route	# netstat -rn
Display network device status	# ethtool eth0	# nmcli device status	# dladm show-link # dladm show-phys (Physical NICs)

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

Reference: Network Redundancy

Solaris

FUJITSU

IPMP configuration procedure

Execution example

Example of configuring IPMP (probe based)

1. Create an interface.

```
# ipadm create-ip net0
# ipadm create-ip net1
```

Create interface (net0, net1) for redundant configuration

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
```

Create IPMP interface with ipadm command

3. Specify a standby interface.

```
# ipadm set-ifprop -p standby=on -m ip net1
```

Make setting for operation standby configuration

- 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.

Linux and Solaris Command Comparison (5)

- Service management commands to keep in mind

Basic Operation	Red Hat Enterprise Linux		Oracle Solaris
	RHEL 6	RHEL 7	
Start service	service *service_name* start	systemctl start *service_name*	svcadm enable -t *service_name* (FMRI)
Start service and enable automatic start	service *service_name* start chkconfig *service_name* on	systemctl start *service_name* systemctl enable *service_name*	svcadm enable *service_name* (FMRI)
Stop service	service *service_name* stop	systemctl stop *service_name*	svcadm disable -t *service_name* (FMRI)
Stop service and disable automatic start	service *service_name* stop chkconfig *service_name* off	systemctl stop *service_name* systemctl disable *service_name*	svcadm disable *service_name* (FMRI)
Display list of services	chkconfig --list	systemctl list-unit-files --type service	svcs -a
Display service status	service *service_name* status	systemctl status *service_name*	svcs *service_name* (FMRI)

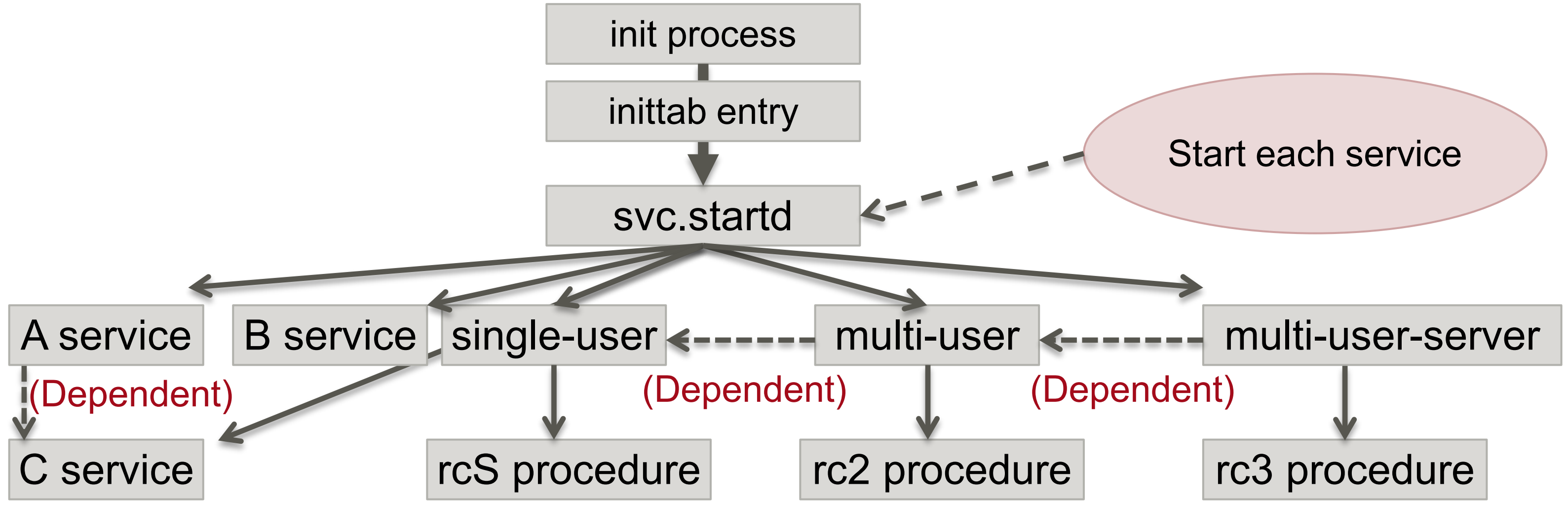
* FMRI (Fault Managed Resource Identifier)

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

Reference: Solaris Service Management

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

	Red Hat Enterprise Linux		Oracle Solaris
	RHEL 6	RHEL 7	
Storage (volume) management	- LVM (Logical Volume Manager)		- ZFS (Zettabyte File System) - zpool command
File system	- ext3 (Recommended), ext4	- XFS	- ZFS - zfs command
Maximum file system size	- 16 TB	- 500 TB	- 256 quadrillion ZB
Maximum file size	- 2 TB (ext3), 16 TB (ext4)	- 500 TB	- 256 quadrillion ZB
Redundant configuration	- Basically use a hardware RAID with server internal or external storage devices.		- Use a software RAID using ZFS or a hardware RAID with an external storage device. * 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.

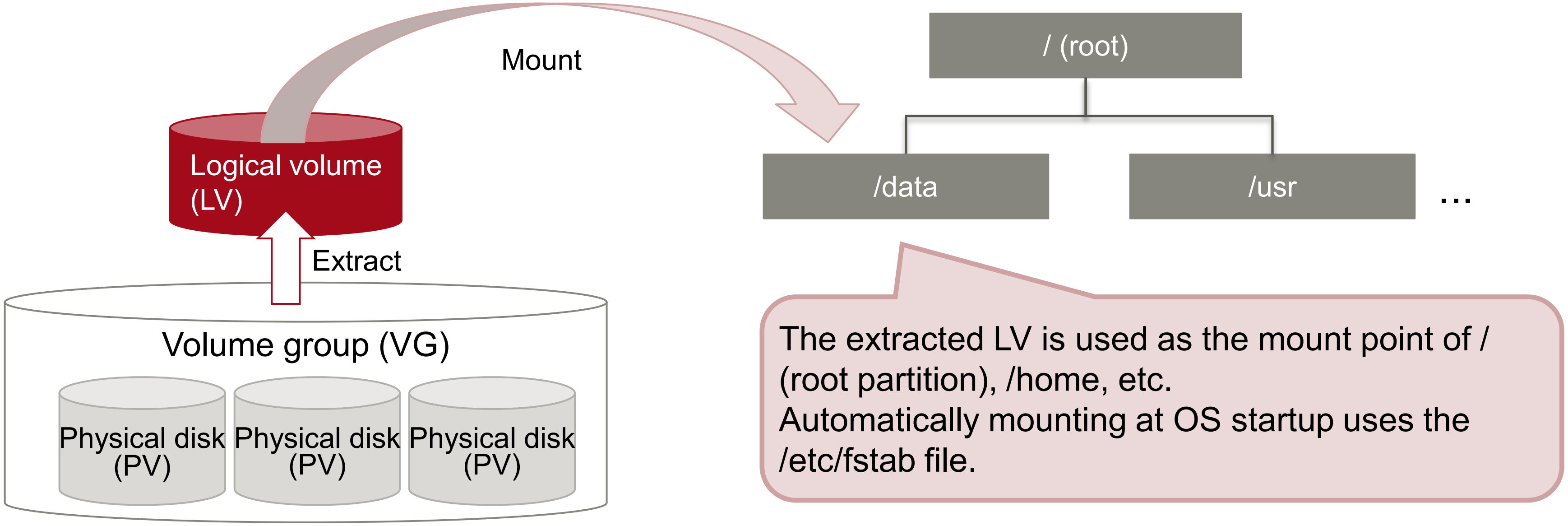
Linux Storage Management

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.

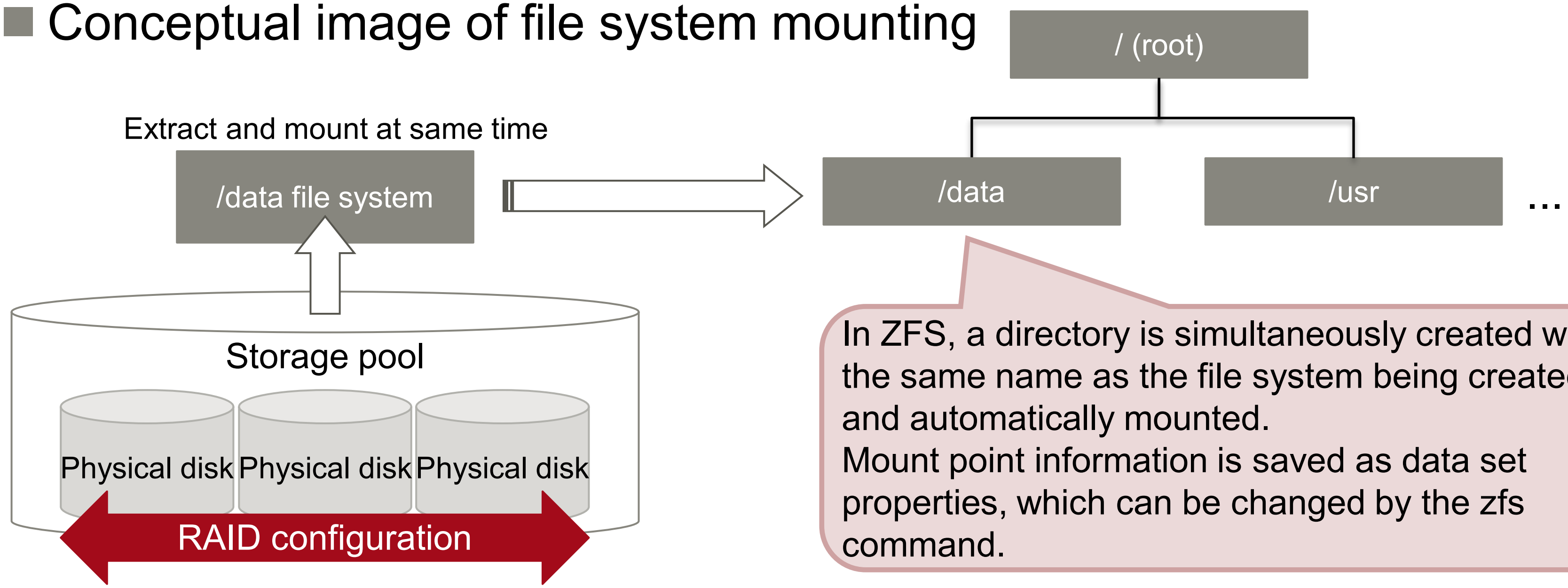
Solaris Storage Management

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.

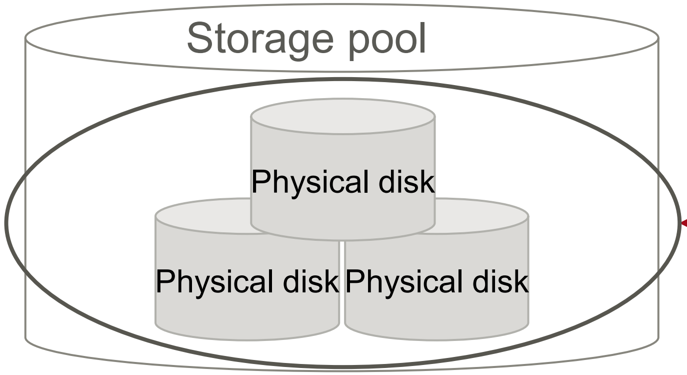
Conceptual image of file system mounting



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)

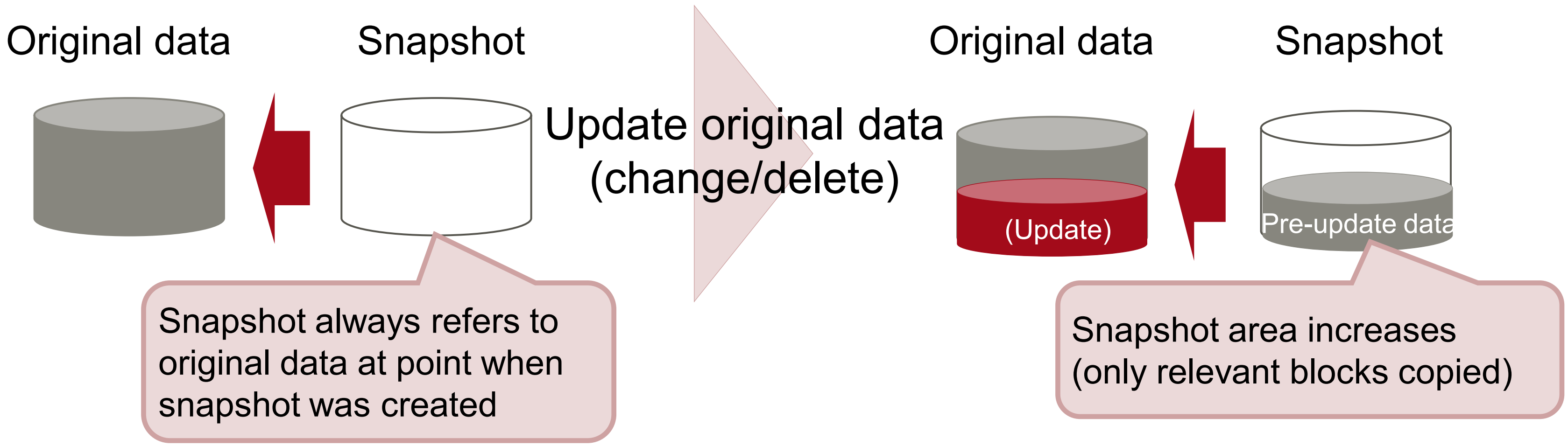
RAID-Z3

◆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

Snapshot always refers to original data at point when snapshot was created

Update original data (change/delete)

Original data

Snapshot

(Update)

Pre-update data

Snapshot area increases (only relevant blocks copied)

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

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]

Solaris Backup/Restore

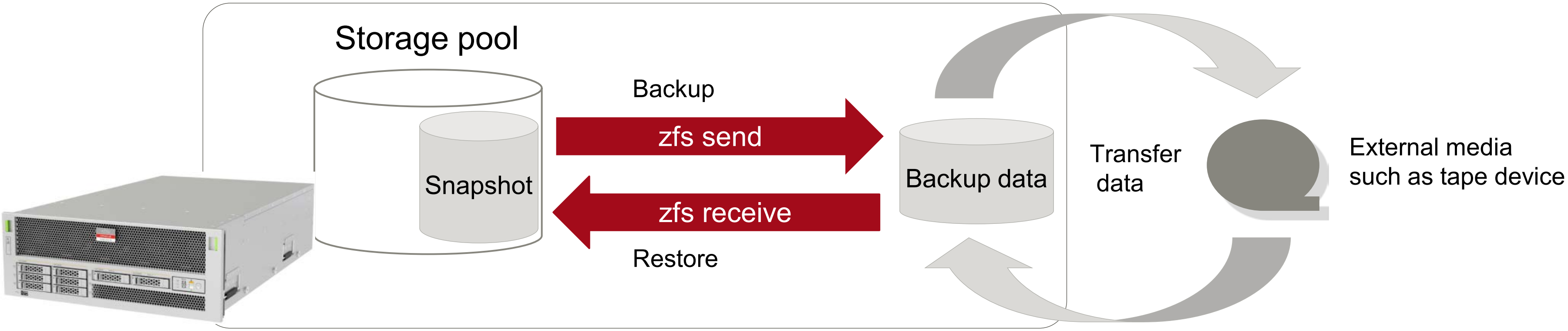
Backup/Restore with a ZFS command

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.*
  http://www.fujitsu.com/global/products/computing/servers/unix/sparc/downloads/documents/

Linux and Solaris Command Comparison (6)

- File system and storage management commands to keep in mind

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

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

Reference: Disk Label and Device Path

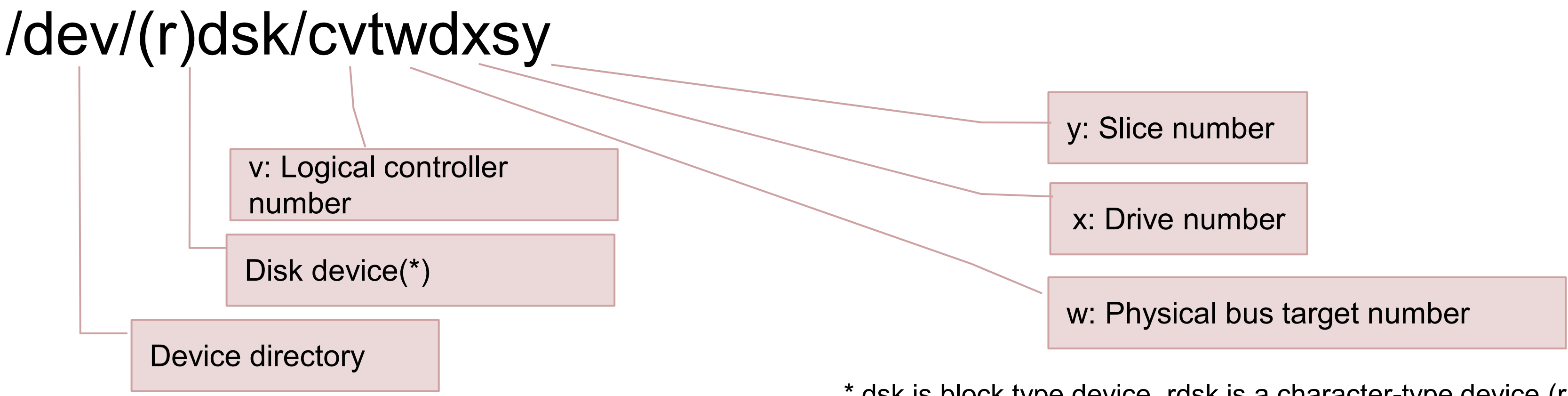
Solaris

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

y: Slice number

x: Drive number

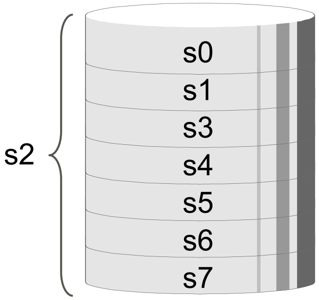
w: Physical bus target number

* dsk is block type device. rdsk is a character-type device (raw device).

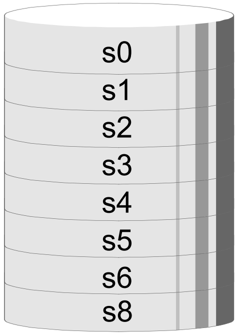
Reference: Disk Partition

- 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.

Disk with SMI label



Disk with EFI label



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
```

Reference: File System Configuration

Solaris file system configuration

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

- Main directories

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

- 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

System 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

Log	Red Hat Enterprise Linux	Oracle Solaris
Log output by system	/var/log/messages	/var/adm/messages
Log recording sent/received e-mail	/var/log/maillog	/var/log/syslog
Log when cron is executed	/var/log/cron	/var/cron/log

Log rotation

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

Red Hat Enterprise Linux	Oracle Solaris

- The /etc/logrotate.conf file defines the following:
weekly --- Every week
rotate 4 --- 4 generations
compress --- Compress
/var/log/messages {
sharedscripts
postrotate
/bin/kill -HUP `cat /var/run/syslogd.pid 2> /dev/null` 2> /dev/null || true
endscript
}
	- The /etc/logadm.conf file defines the settings for each log file that is rotated.
	
	/var/adm/messages -C 4 -a '/usr/sbin/svccfg -s svc:/system/system-log refresh'
	
	-C: Number of saved generations
	-a: Executes the command in single quotation marks (' ') after changing the log file name.

System Monitoring Commands

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Example of commands for checking mounted resources

Check Item	Red Hat Enterprise Linux	Oracle Solaris
Check CPU, memory, and expansion card	cat /proc/cpuinfo cat /proc/meminfo lspci	prtdiag

Example of commands for checking for failures

Check Item	Red Hat Enterprise Linux	Oracle Solaris
Network status	ethtool, ping	dladm, ping
Service status	service (RHEL 6) systemctl (RHEL 7)	svcs
Process status	pstree, ps	ptree, ps
Process trace	strace	truss

Example of commands for checking resource usage

Check Item	Red Hat Enterprise Linux	Oracle Solaris
System uptime	uptime	uptime
CPU, memory, and I/O load	mpstat, vmstat iostat, iotop, netstat	mpstat, pgstat, vmstat, iostat, fsstat, netstat, flowstat, dlstat, ipmpstat
Load per process	top, pidstat	top, prstat

Linux and Solaris Command Comparison (7)

Monitoring commands to keep in mind

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

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

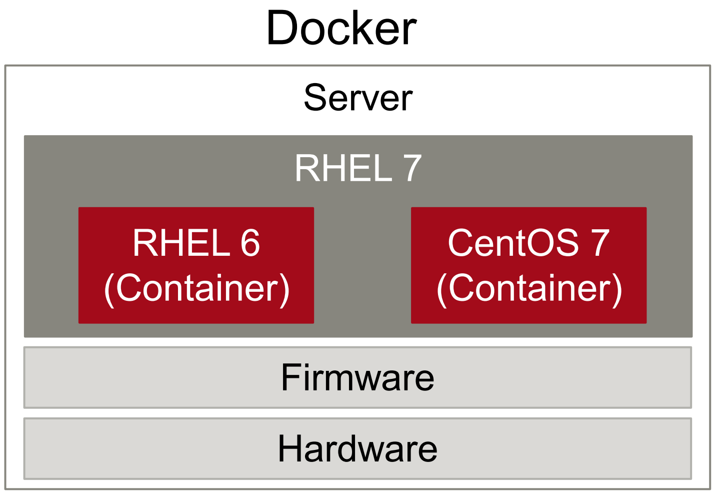
- Hypervisor-type virtualization software creates a virtual environment called a guest OS.
- Since hardware is virtualized using the CPU virtualization support function, various OSs (Windows, etc.) other than Linux can be used as a guest OS.
- KVM does not have its own hypervisor, and it controls the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

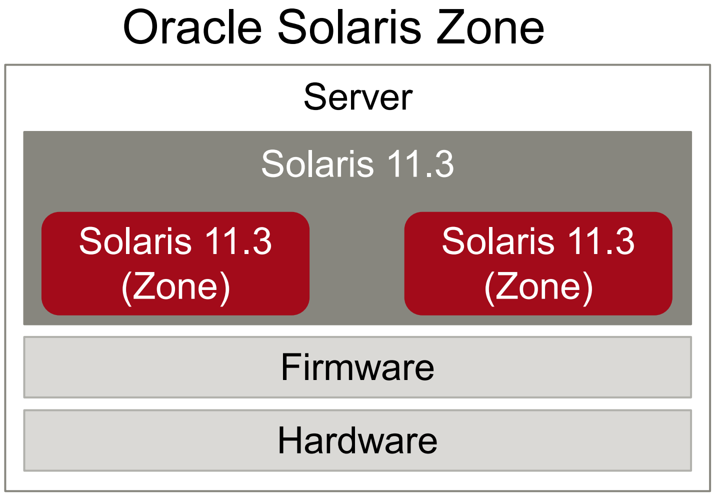
Solaris Virtualization Technology Solaris Zone - (1)

Solaris

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.

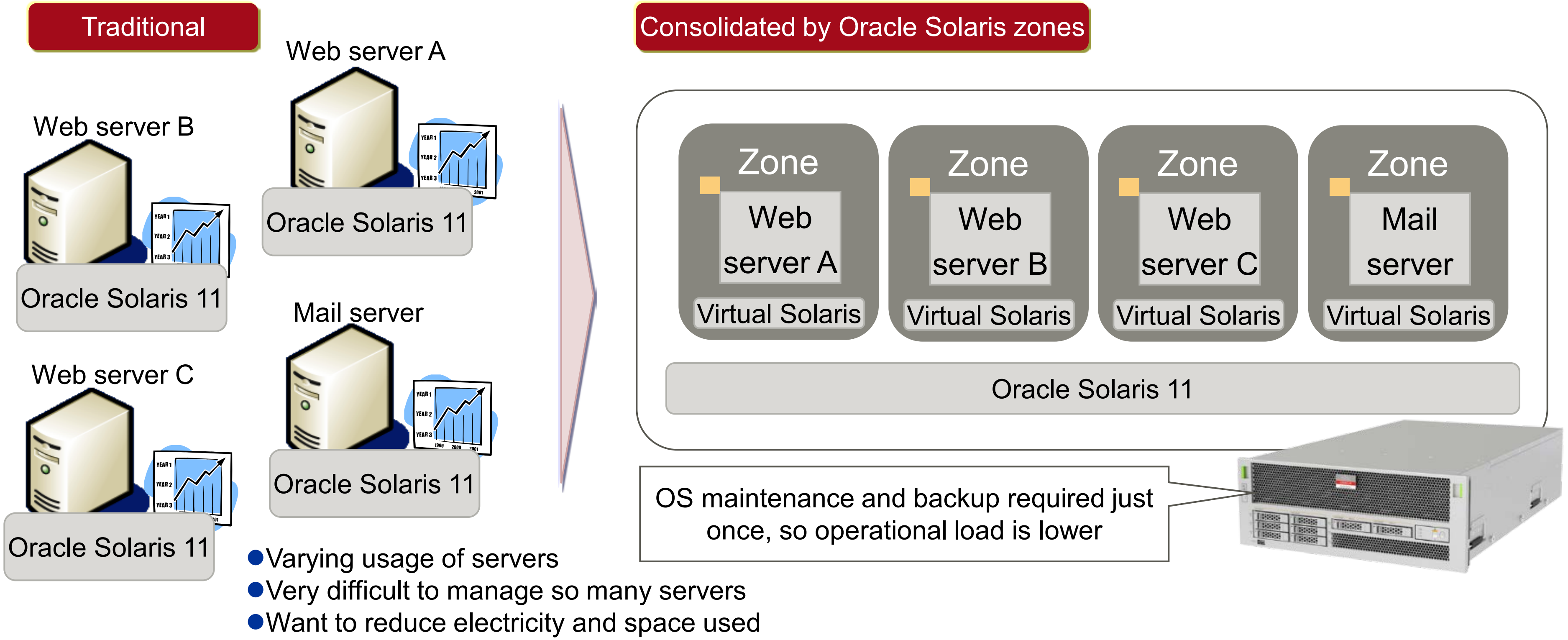




Solaris Virtualization Technology Solaris Zone - (2)

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.



OS maintenance and backup required just once, so operational load is lower

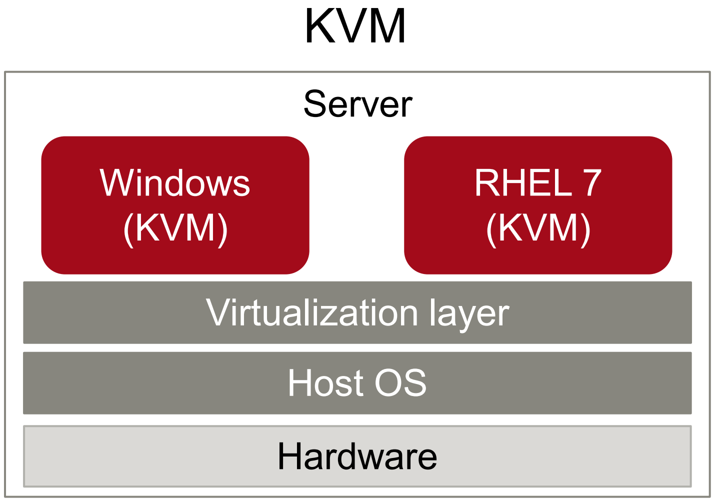
- ●Varying usage of servers
- ●Very difficult to manage so many servers
- ●Want to reduce electricity and space used

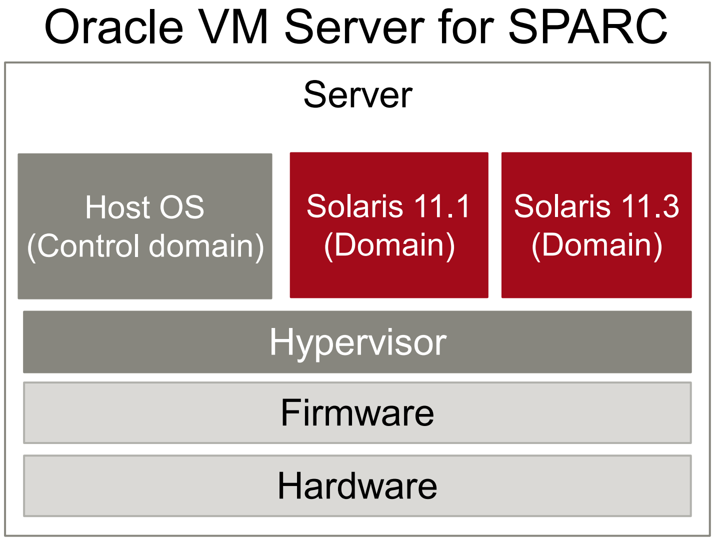
Solaris Virtualization Technology - Oracle VM - (1)

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.

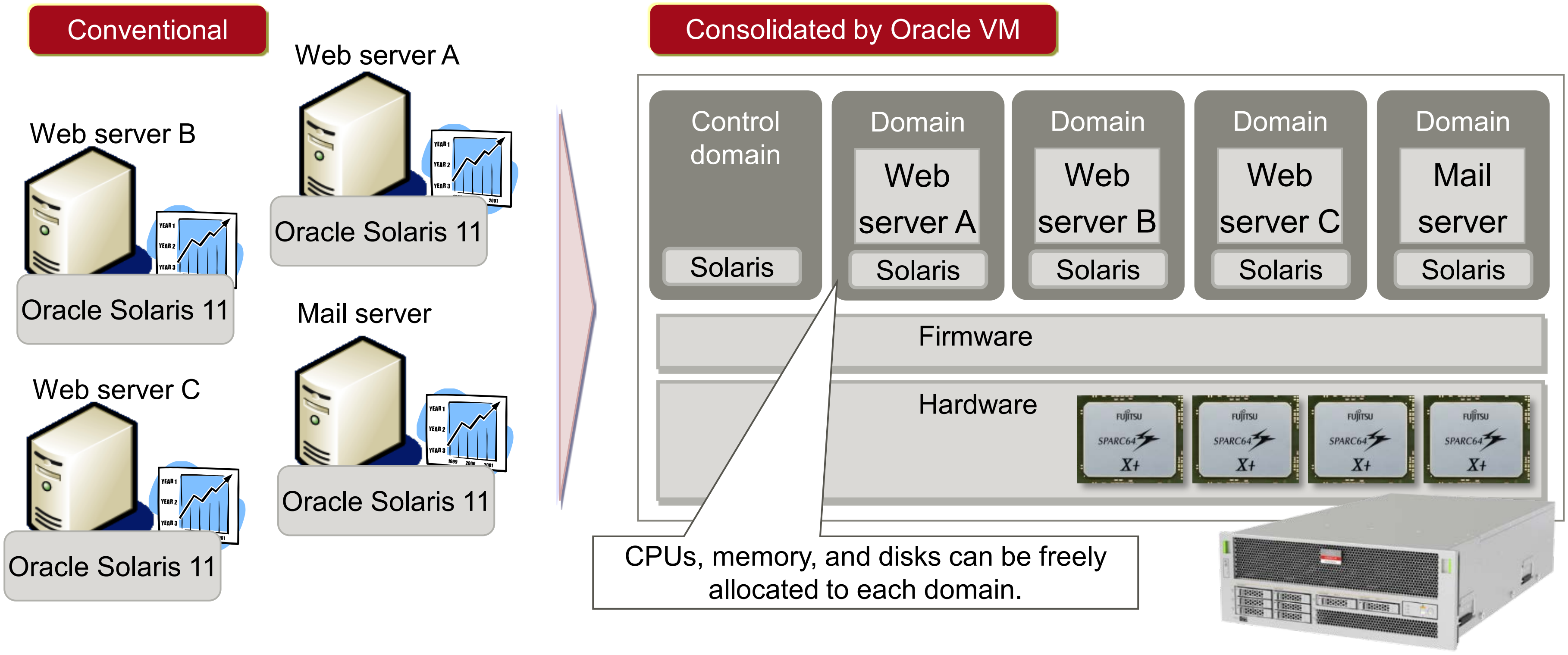




Solaris Virtualization Technology - Oracle VM - (2)

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.



CPUs, memory, and disks can be freely allocated to each domain.

Linux and Solaris Virtualization Comparison

Docker and Oracle Solaris zones

	Docker	Oracle Solaris Zone
OS running on virtual environment	Various Linux distributions (RHEL, Cent OS, etc.)	Solaris 10, Solaris 11 * When host OS is 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

	KVM	Oracle VM Server for SPARC
OS running on virtual environment	Can select from various OSs such as Windows, Linux, and IA Solaris	Solaris 10, Solaris 11 * When host OS is 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

Execution example

```
# 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

Execution example

```
# 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/
→ 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
http://www.fujitsu.com/global/products/computing/servers/unix/sparc/downloads/manuals/m10-1/en/index.html
→ Describes the basic operations required for system operation and administration.

Technical Park: Technical information

UNIX Server SPARC M10 Documentation
http://www.fujitsu.com/global/products/computing/servers/unix/sparc/downloads/documents/
→ Introduces various functions and presents guides.

Linux-related information

Product Documentation for Red Hat Enterprise Linux
https://access.redhat.com/documentation/en/red-hat-enterprise-linux/

Revision History

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