Hewlett Packard Enterprise

Implementing Linux Software RAID1 on HPE ProLiant Servers with RHEL 7.3, RHEL 6.8 and SLES 12 SP2

Abstract

This document describes how to use HPE

LSRRB (Linux Software RAID - Redundant Boot), which uses in-distro open-source tools, to configure and build a two-disk RAID1 redundant boot volume in UEFI mode for major operating systems including: Red Hat Enterprise Linux 7.3 Red Hat Enterprise Linux 6.8 and SuSE Linux Enterprise Server 12.2.

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Introduction

LSRRB (Linux Software RAID - Redundant Boot) is a solution that uses in-distro open-source software to build and create a two-disk RAID1 redundant boot volume in UEFI mode.

This document describes how to create, manage, and recover the RAID system using the LSRRB value-added software provided by Hewlett Packard Enterprise.

Appendix A shows the manual steps to create a redundant boot system without our value-added software.

LSRRB provides:

- **Installation Scripts:** For deployment on a single or multiple servers including basic RAID1 configurations and system setup.
- **Boot Auto-Failover:** If the first drive fails, the system can boot to the second drive automatically
- **RAID Auto-Recovery:** When a faulty driver is replaced by the new one, the system will rebuild the RAID automatically.
- **Advanced Hard Drive Thermal information:** The system reports the thermal information of the hard drive on the RAID system.

Prerequisites

These tasks must be performed before moving to the OS installation procedures. In the included example, the services are installed on a CentOS 7.2 machine.

1. Prepare a PXE server.
2. Prepare a TFTP server.
3. Prepare a DHCP server.

PXE server information

The PXE server in this example is **xinetd v2.3.15**. You can use a different version or different software, but you must note the differences accordingly.

For instructions on how to install PXE/TFTP server on the server, see https://wiki.centos.org/HowTos/PXE/PXE_Setup.

For an example PXE server configuration, see “PXE server configuration.”

TFTP server information

In this example, **TFTP v5.2** is installed on the CentOS 7.2 system. You can use a different version of or different software, but you must note the differences accordingly.

Reference to https://wiki.centos.org/HowTos/PXE/PXE_Setup

For instructions on how to install PXE/TFTP server on the server, see https://wiki.centos.org/HowTos/PXE/PXE_Setup.

For example configuration, see “TFTP server configuration.”

DHCP server information

The DHCP server in this example uses **DHCPv v4.2.5**. You can use a different version of or different software, but you must note the differences accordingly.

For an example DHCP server configuration, see “DHCP server configuration.”

LSRRB Software

OS specific installation scripts

The BootScripts repository contains the boot scripts for KickStart, AutoYast, and Preseed. The boot scripts were designed to perform integrated installation for all steps described in this document.

They can be found at http://downloads.linux.hpe.com/SDR/project/lsrrb/current/.

File Name	Description
RHEL7_3_RAID1_ks.cfg	Installation script for RHEL 7.3 unattended mode
RHEL7_3_RAID1_ks_nvme.cfg	Installation script for RHEL 7.3 unattended mode (with NVMe disks)
SLES12SP2_RAID1_autoinst.xml	Installation script for SLES 12 SP2 unattended mode
SLES12SP2_RAID1_autoinst_nvme.xml	Installation script for SLES 12 SP2 unattended mode (with NVMe disks)

HPE Scripting Toolkit

The HPE Scripting Toolkit (STK) is used to perform a deployment on multiple servers. OS specific STK files can be obtained from the links below.

Linux Distro	**Download Link**
RHEL 7.3	http://downloads.linux.hpe.com/SDR/project/lsrrb/current/hpe-scripting-toolkit-linux-10.40-rhel7_3.tar.gz
SLES 12 SP2	http://downloads.linux.hpe.com/SDR/project/lsrrb/current/hpe-scripting-toolkit-linux-10.40-sle12sp2.tar.gz

LSRRB Value Added software

The automated scripts are packed in the rpm package for RHEL and SLES. Once installation is complete, the following files will be available on the system:

File Name	Location	Description
10-lsrrb.rules	/etc/udev/rules.d	The udev rule file that directs the udev subsystem to invoke LSRRB md_auto_resync.py script when a replacement disk is inserted.
lsrrb.service	/etc/systemd/system	LSRRB systemd service for RHEL 7.3 and SLES 12 SP2
lsrrbd	/etc/init.d	LSRRB init service for RHEL 6.8
HPEsdtemplog	/etc/logrotate.d	The logrotate config file for advanced thermal reporting
HPEtemp.sh	/opt/hpe/lsrrb/bin	Script for advanced thermal reporting
md_auto_resync.py	/opt/hpe/lsrrb/bin	The script that periodically checks the existence of the recovery key file. If there is a key file, the recovery process will be executed.
md_resync_trigger.py	/opt/hpe/lsrrb/bin	Invoked by udev when a new disk is inserted to the system, this script checks whether the conditions (e.g. disk size) satisfy the criteria for the RAID1 recover. If all conditions were met, a key file will be generated as a signal for the auto recovery script to take recovery process.
lsrrb.sh	/opt/hpe/lsrrb/bin	Script for executing LSRRB scripts

OS Deployment

Single machine deployment

This section describes the integrated workflow for the RAID1 Redundant Boot Strategy for Software RAID in Linux solution. The integrated flow starts with the pre-installation RAID setup, followed by the OS installation. It ends with the post-installation setup.

Existing installation facilities offered by the OS are leveraged to perform an unattended mode installation to deploy the solution

- KickStart in RHEL
- AutoYast in SLES

Figure 1 illustrates the single machine deployment scenario. In the system, we provide installation script for each OS we support: RHEL and SLES.

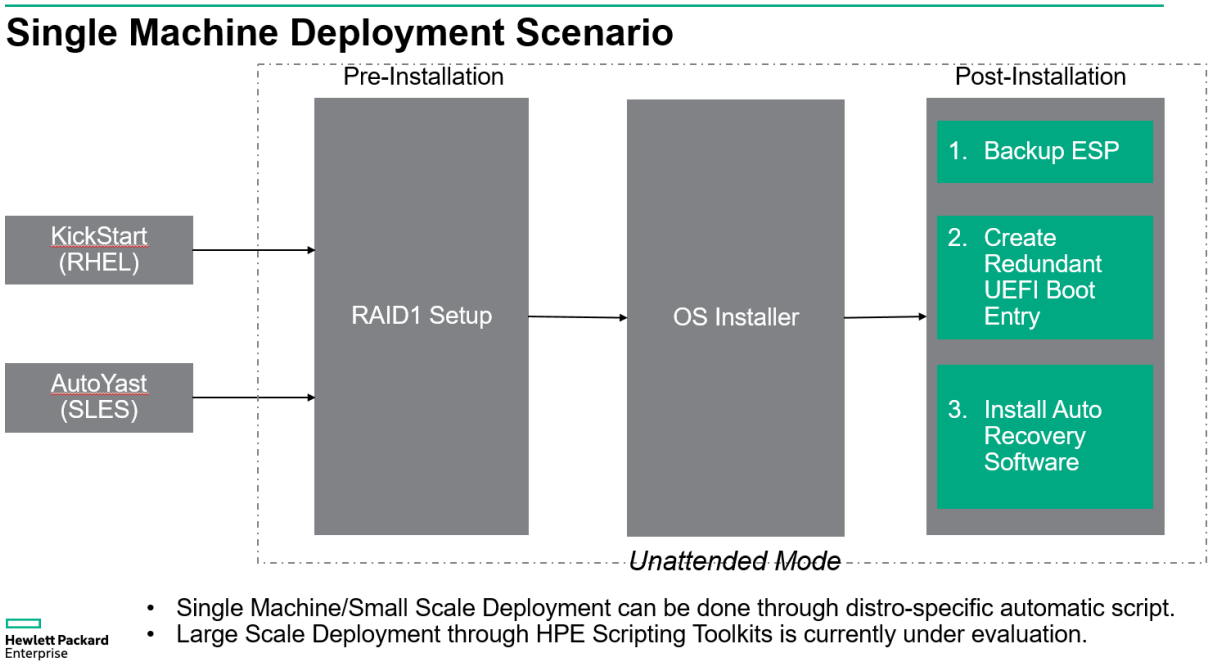


Figure 1 Single Machine Deployment Scenario

Before deploying LSRRB, enable the AHCI hard drive controller. For instructions, see "Setting AHCI mode" in Appendix A.

Single machine deployments for RHEL 7.3 and SUSE 12.2 are described below.

RHEL 7.3

To begin with the install, upload the KickStart file to the TFTP server and add an entry to the PXE server:

Example PXE entry:

```
# For RHEL7.3 single machine deploy
image=/RHEL/RHEL-7.3Server-x86_64/vmlinuz
label=RHEL-7.3Server-x86_64_ks
description = "RHEL 7.3 Server RAID1 kickstart"
initrd=/RHEL/RHEL-7.3Server-x86_64/initrd.img
append="ipv6.disable=1
inst.ks=http://172.1.1.100/answers/RHEL7_3_RAID1_ks.cfg" #The place to
change file path.
```

In the above example, the RHEL7_3_RAID1_ks.cfg file is placed on the TFTP server (172.1.1.100), in the folder ‘answer’.

The RHEL7.3 installation files are in the `mrepo/RHEL-7.3Server-x86_64` folder on the same server.

The installation begins when boot from the PXE entry. The detail of the KickStart script can be found in Appendix C-1.

RHEL 6.8

To begin with the install, upload the KickStart file to the TFTP server and add an entry to the PXE server:

Example PXE entry:

```
# For RHEL7.3 single machine deploy
image=/RHEL/RHEL-6.8Server-x86_64/vmlinuz
label=RHEL-6.8Server-x86_64_ks
description = "RHEL 6.8 Server RAID1 kickstart"
initrd=/RHEL/RHEL-6.8Server-x86_64/initrd.img
append="ipv6.disable=1
inst.ks=http://172.1.1.100/answers/RHEL6_8_RAID1_ks.cfg" #The place to
change file path.
```

In the above example, the RHEL6_8_RAID1_ks.cfg file is placed on the TFTP server (172.1.1.100), in the folder ‘answer’.

The RHEL6.8 installation files are in the `mrepo/RHEL-6.8Server-x86_64` folder on the same server.

The installation begins when boot from the PXE entry. The detail of the KickStart script can be found in Appendix C-2.

SLES 12 SP2

To begin the installation, upload the AutoYast file to the TFTP server and add an entry to the PXE server.

Example PXE entry:

```
# For SLES 12 SP2 single machine deploy
image=/SLE/SLE-12-SP2-Server-x86_64/linux
label=SLE-12-SP2-Server-x86_64_ks
description = "SLES 12 SP2 RAID1 ks"
initrd=/SLE/SLE-12-SP2-Server-x86_64/initrd
append="vga=normal netdev=eth1
autoyast=http://172.1.1.100/answers/SLES12SP2_RAID1_autoinst.xml instal
l2http://172.1.1.100/mrepo/SLE-12-SP2-Server-x86_64/disc1" #The place
to change file path.
```

In the above example, the SLES12SP2_RAID1_autoinst.xml file is placed on the TFTP server (172.1.1.100), in the folder 'answer'. The SLES12SP2 installation files are in the mrepo/SLE-12-SP2-Server_x86/disc1 folder on the same server.

The installation begins when boot from the PXE entry. The detail of the AutoYast script can be found in Appendix C-3.

Multiple machine OS deployment with the HPE Scripting Toolkit (STK)

The multiple machine OS deployment method may fit certain environments where there are hundreds or even thousands of machines that require deployment.

In this scenario, the hard disk controller settings in RBSU are changed from the default (B140i in Gen9 or B150i for Gen10) to AHCI for all machines under deployment. This should be done before proceeding to the network deployments described in "Single machine deployment." To do this, use the HPE Scripting ToolKit (STK). STK supports the `conrep` command that can modify the RBSU settings programmatically.

Figure 2 Illustrates the scenario for Multiple Machine Deployment. The HPE Scripting Toolkit (HPE STK) is use for enabling ACHI mode programmatically. After enabled AHCI mode, the installation proceeds with the same method as in the single machine deployment.

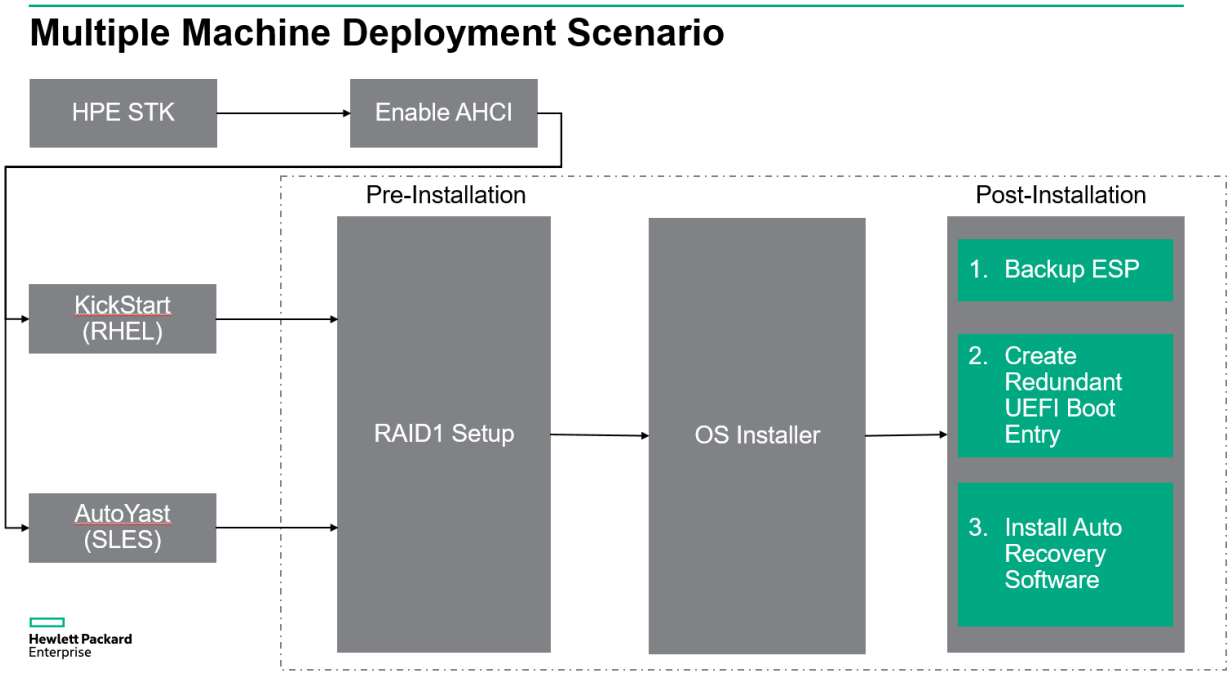


Figure 2 Multiple Machine Deployment Scenario

RHEL 7.3

To begin the installation, put the HPE STK on the TFTP server, and add an entry for it to the PXE server.

Example PXE entry:

```
image=/tools/toolkit10.40/vmlinuz

label=toolkit10.40

description = "HP Scripting Toolkit 10.40 nfs"

initrd=/tools/toolkit10.40/initrd.img

append="root=/dev/ram0 rw ramdisk_size=785612 quiet=1 sstk_nic=eth1
            :   ıet numa=off sstk_conf=toolkit.conf
            (   .oy.sh sstk_tgz=http://172.1.1.100/answers/STK/hpe-
scripting-toolkit-linux-10.40-rhel7_3.tar.gz"
```

The KickStart script can be specified in the grub.cfg in the install folder in the STK.

```
menuentry 'Install Red Hat Enterprise Linux 7.3' --class fedora --class
gnu-linux --class gnu --class os {

    linuxefi /efi/boot/vmlinuz
inst.ks=http://172.1.1.100/answers/RHEL7_3_RAID1_ks.cfg
```

```
    initrdefi /efi/boot/initrd.img
}
```

To modify the grub.cfg, unpack the tarball, modify the file, and the pack the tarball.

RHEL 6.8

To begin the installation, put the HPE STK on the TFTP server, and add an entry for it to the PXE server.

Example PXE entry:

```
image=/tools/toolkit10.40/vmlinuz
label=toolkit10.40
description = "HP Scripting Toolkit 10.40 nfs"
initrd=/tools/toolkit10.40/initrd.img
append="root=/dev/ram0 rw ramdisk_size=785612 quiet=1 sstk_nic=eth1
network=1 media=net numa=off sstk_conf=toolkit.conf
sstk_script=/deploy.sh sstk_tgz=http://172.1.1.100/answers/STK/hpe-
scripting-toolkit-linux-10.40-rhel6_8.tar.gz"
```

The KickStart script can be specified in the grub.cfg in the install folder in the STK.

```
menuentry 'Install Red Hat Enterprise Linux 6.8' --class fedora --class
gnu-linux --class gnu --class os {
    linuxefi /efi/boot/vmlinuz
inst.ks=http://172.1.1.100/answers/RHEL6_8_RAID1_ks.cfg
    initrdefi /efi/boot/initrd.img
}
```

To modify the grub.cfg, unpack the tarball, modify the file, and the pack the tarball.

SLES 12 SP2

To begin with the installation, put the HPE STK on the TFTP server and add an entry for it to the PXE server.

Example PXE entry:

```
image=/tools/toolkit10.40/vmlinuz
label=toolkit10.40
description = "HP Scripting Toolkit 10.40 nfs"
initrd=/tools/toolkit10.40/initrd.img
```

```
append="root=/dev/ram0 rw ramdisk_size=785612 quiet=1 sstk_nic=eth1
network=1 media=net numa=off sstk_conf=toolkit.conf
sstk_script=/deploy.sh sstk_tgz=http://172.1.1.100/answers/STK/hpe-
scripting-toolkit-linux-10.40-sle12sp2.tar.gz"
```

The AutoYast script can be specified in the grub.cfg in the install folder in the STK.

```
menuentry 'Install SUSE 12SP2' {

    linuxefi /efi/boot/linux vga=normal netdev=eth1
autoyast=http://172.1.1.100/answers/SLES12SP2_RAID1_autoinst.xml
install2http://172.1.1.100/mrepo/SLE-12-SP2-Server-x86_64/disc1

initrdefi /efi/boot/initrd

}
```

To modify the grub.cfg, unpack the tarball, modify the file, and the pack the tarball.

Checking system status

LSRRB Service Status

LSRRB is a systemd service on RHEL7.3 and SLES 12 SP2. Therefore, it can be used to check, start, stop, and restart the service. Any operations (except status) of the LSRRB service can only be done when the RAID status is clean. For more information, see "Known Issues and Limitations."

Checking system status

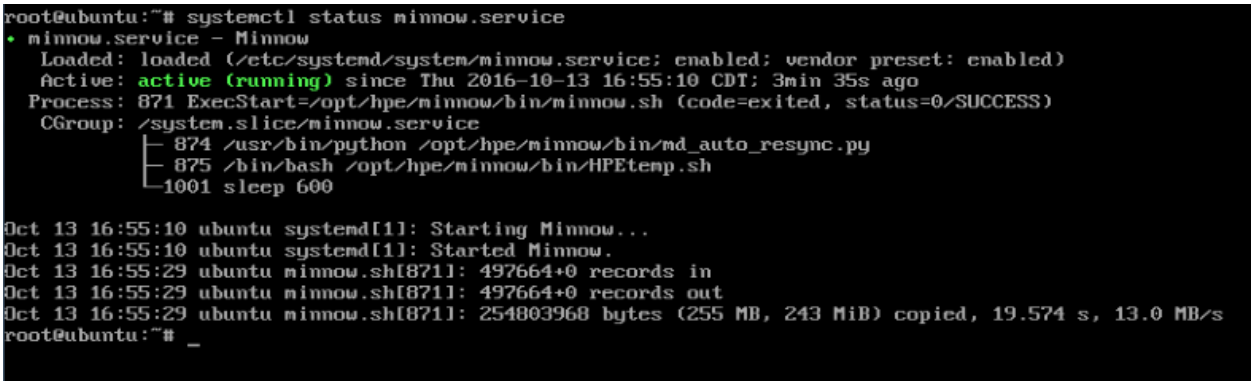
On RHEL 7.3 and SLES 12 SP2

Use the following command to check the LSRRB service status:

```
systemctl status lsrrb.service
```

Two processes will be running: one is the auto-resync process (md_auto_resync.py), and the other is the hard drive temperature reporting process (HPEtemp.sh).

Example service status:



On RHEL 6.8

Use to following command to check the LSRRB service status:

```
ps -ef | grep lsrrb
```

If you see both md_auto_resync.py and HPEtemp.sh running, the service works fine.

LSRRB service start, stop, and restart commands

On RHEL7.3 and SLES12.2

- Use the following command to start the service.

```
systemctl start lsrrb.service
```

- Use the following command to stop the service.

```
systemctl stop lsrrb.service
```

- Use the following command to restart the service.

```
systemctl restart lsrrb.service
```

On RHEL 6.8

- Use the following command to start the service.

```
/etc/init.d/lsrrbd start
```

- Use the following command to stop the service.

```
/etc/init.d/lsrrbd stop
```

Hard drive thermal information

The LSRRB service captures drive temperatures for all SATA disks on the system every 10 minutes and adds reported temperatures to the `/var/log/HPEsdtemp.log` file. It also reports **URGENT** messages in the same log if any disk temperature passes 60°C, which is considered critical point.

For log recycling, it uses the **Linux logrotate utility** set in **/etc/logrotate.d/HPEsdtemplog** config file on the system. This log (`/var/log/HPEsdtemp.log`) will rotate every 4 weeks, similar to other system logs to avoid filesystem becoming full.

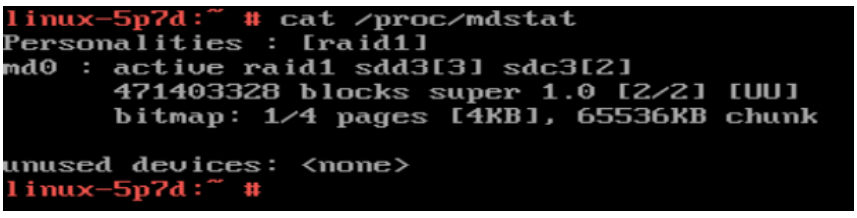
To find the drive thermal information, type the command:

```
cat /var/log/HPEsdtemp.log
```

Checking RAID status

To check the RAID device on the system, type the command:

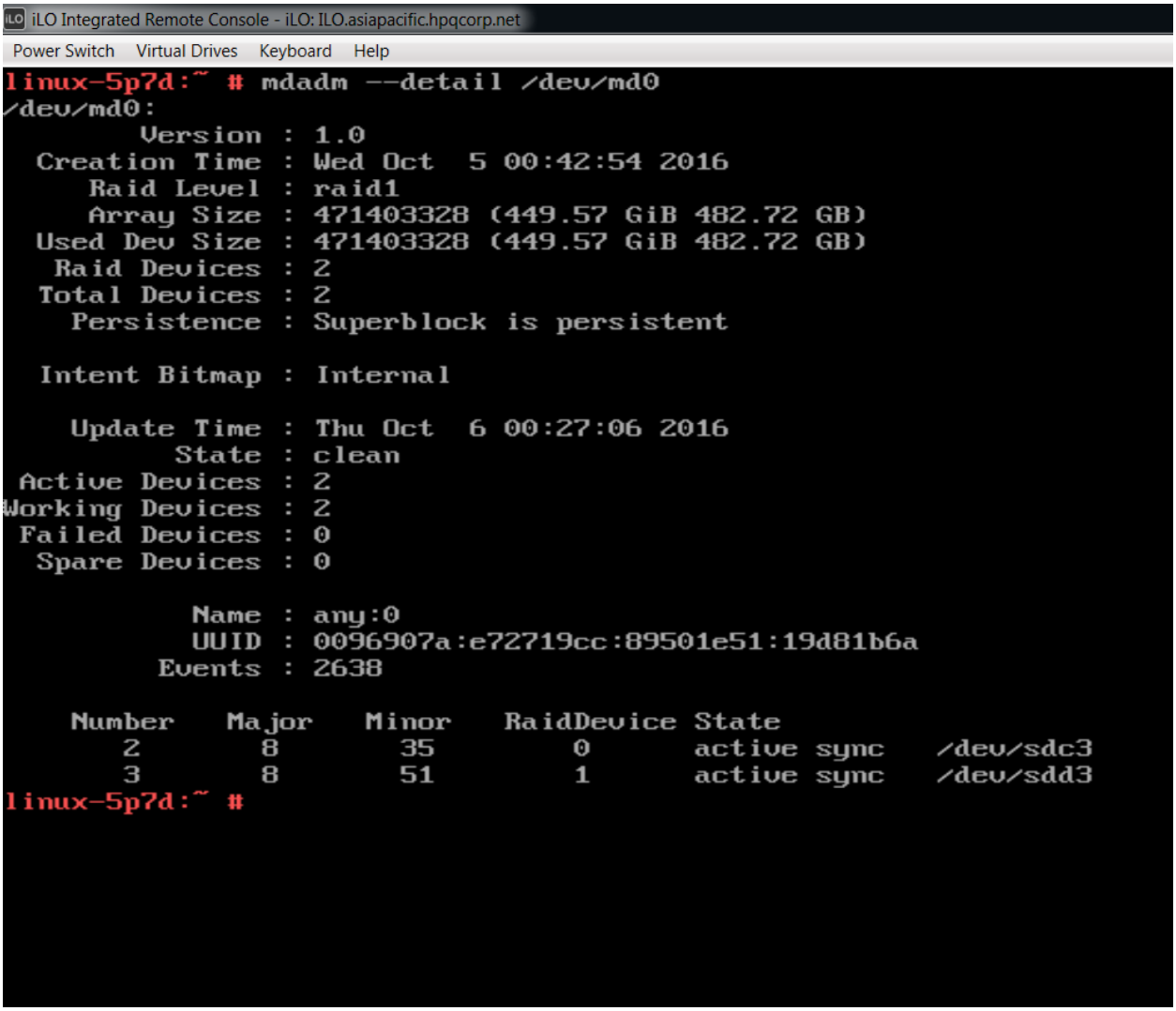
```
cat /proc/mdstat
```



The above screenshot indicates there is only one RAID device in the system. To check the RAID status for **md0**, type the command:

```
mdadm --detail /dev/md0
```

Here `/dev/md0` is the RAID device on the system.



The above screenshot reports the State as “clean”. This is the normal state of the RAID system. If State reports as “degraded”, the RAID system is degraded, and one of the disk became faulty.

Faulty disk replacement

To replace a faulty drive, use either the hot-swap method or the cold-swap method.

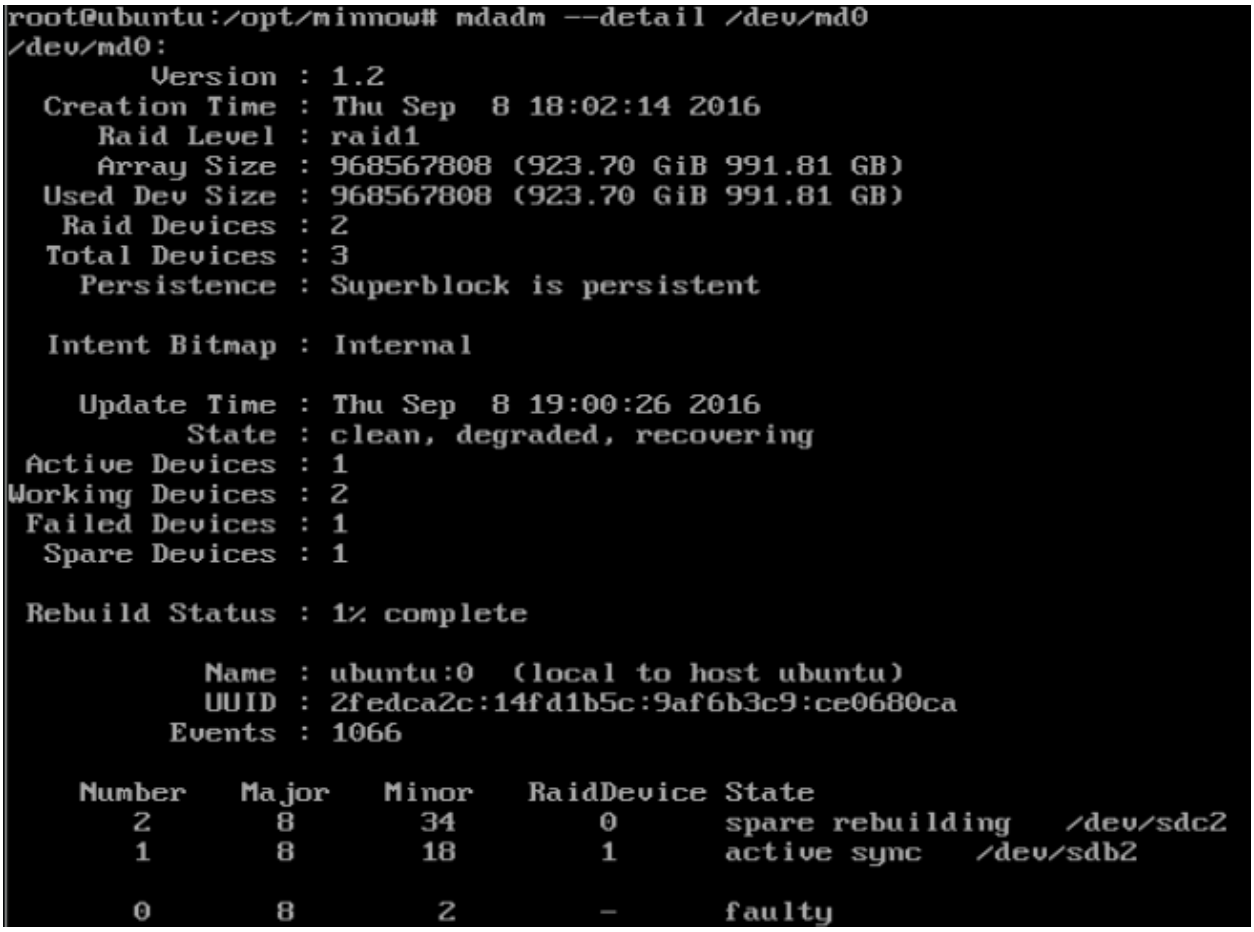
Replacing a faulty disk using the hot-swap method

In the hot-swap method, the system doesn’t need to shut down. Simply unplug the faulty drive and replace it with a new one. The system will automatically rebuild the RAID system with the new hard drive.

Type the following command to check the rebuild program.

```
mdadm –detail /dev/md0
```

Here `md0` is the RAID device on the system.



The screenshot indicates the progress of the rebuild, which is 1%. The time to complete a rebuild depends on the size of the hard drive. Once it reaches 100%, the rebuild process completes and the State indicates “clean”.

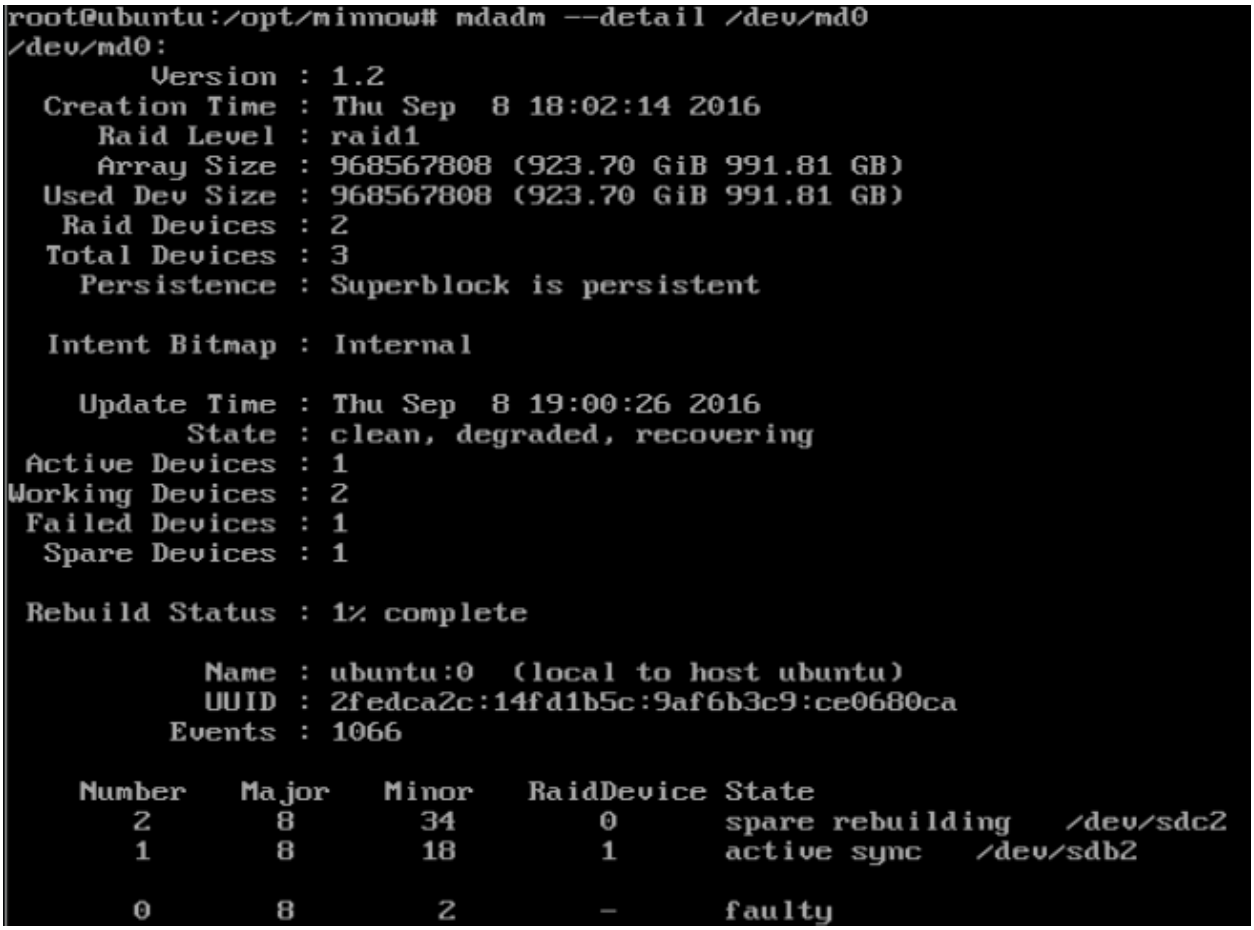
Replacing a faulty disk using the cold-swap method

In the cold-swap method, the system will be shut down. After the machine is completely shut down, replace the faulty drive with the new one. During the next boot, the RAID rebuild process is triggered.

Type the following command to check the rebuild progress:

```
mdadm –detail /dev/md0
```

Here **md0** is the RAID device on the system.



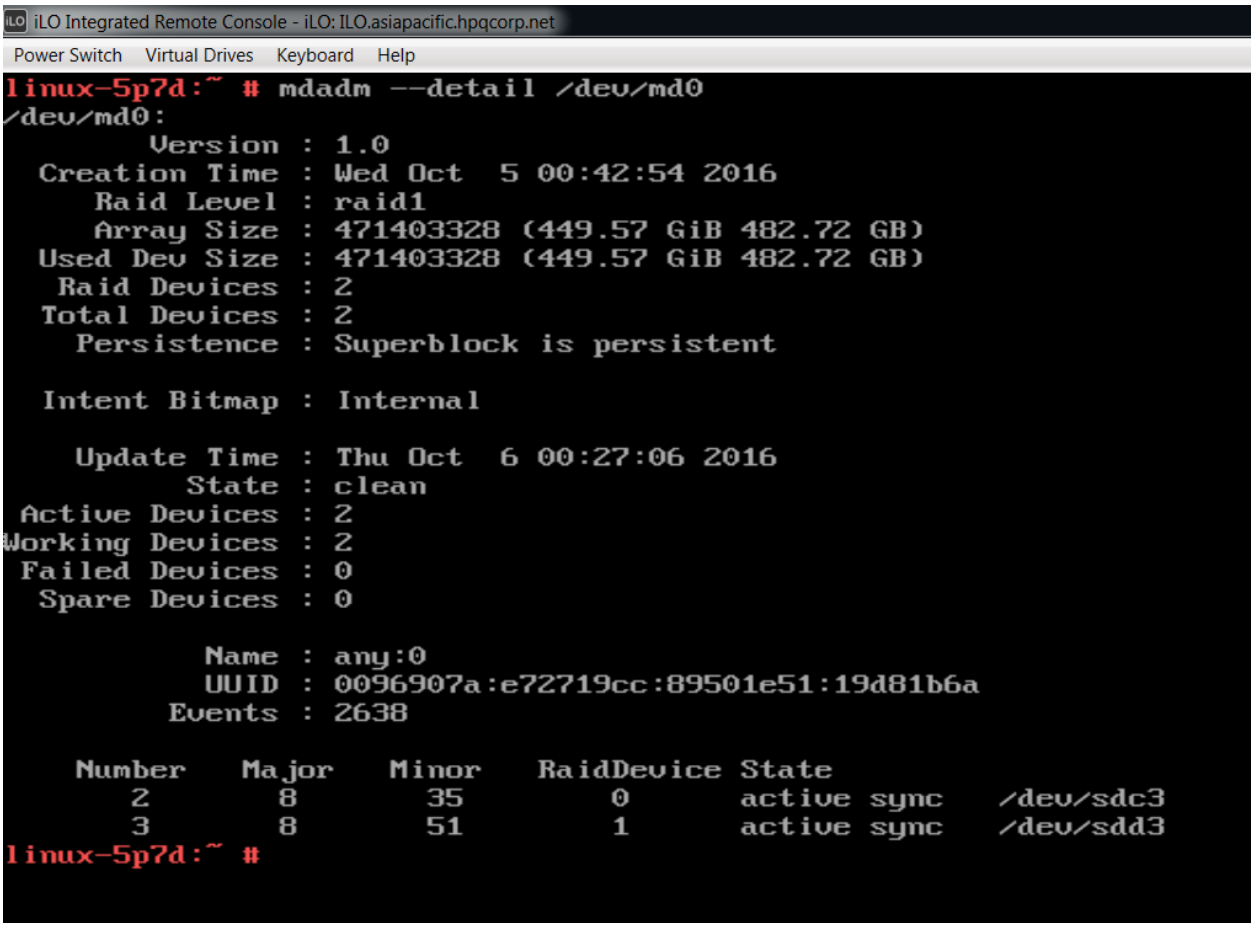
The screenshot indicates the progress of the rebuild, which is 1%. The time to complete a rebuild depends on the size of the hard drive. Once it reaches 100%, the rebuild process completes and the State indicates “clean”.

Verification

Type the following command to verify the RAID system:

```
mdadm -detail /dev/md0
```

Here **md0** is the RAID device on the system.



The above screenshot shows State reporting “clean”. It is the normal state of the RAID system.

Known Issues and Limitations

The LED on the hard drive tray doesn’t work

The LED on the hard driver tray doesn’t work in this version. The LED indicates the health state of the drive. To examine the health state of the hard drive, refer to “Checking RAID status” section.

Only RAID1 with two hard drives in the AHCI controller is supported, other AHCI/SATA ports cannot be used

Only two hard drive boot volumes are currently supported. Other AHCI/SATA ports cannot be used.

The replacement hard drive should not contain any MD metadata or partition information

The RAID metadata or partition information on the replacement hard drive should be wiped before inserting to the system.

LSRRB service should not be stopped or restarted before RAID is fully recovered and status is clean

When the RAID is degraded and the recovery is in progress, the LSRRB service should not be stopped or restarted.

For the RAID auto-recovery, the space of replacement disk must be the same as the faulty one; replacement disks with greater capacity are not supported

Only auto-recovery with same size hard drive replacement is supported for RAID recovery.

If the /boot/efi is empty after auto-recovery, reboot the system before making any changes to the ESP (such as upgrading kernel, modify grub settings, etc)

To check if the /boot/efi folder is empty, type the following command:

```
ls -la /boot/efi
```

With NVMe disks, the hot-swap feature is not supported

Hot-swap of failure NVMe disk is currently not supported.

Appendix A: Creating redundant boot strategy for software RAID1 in Linux

Introduction

The Redundant Boot Strategy for Software RAID1 in Linux operates with the UEFI mode only. This document describes the process to configure Software RAID in major Linux operating systems including:

- Red Hat Enterprise Linux
- SuSE Linux Enterprise Server

It covers the following topics:

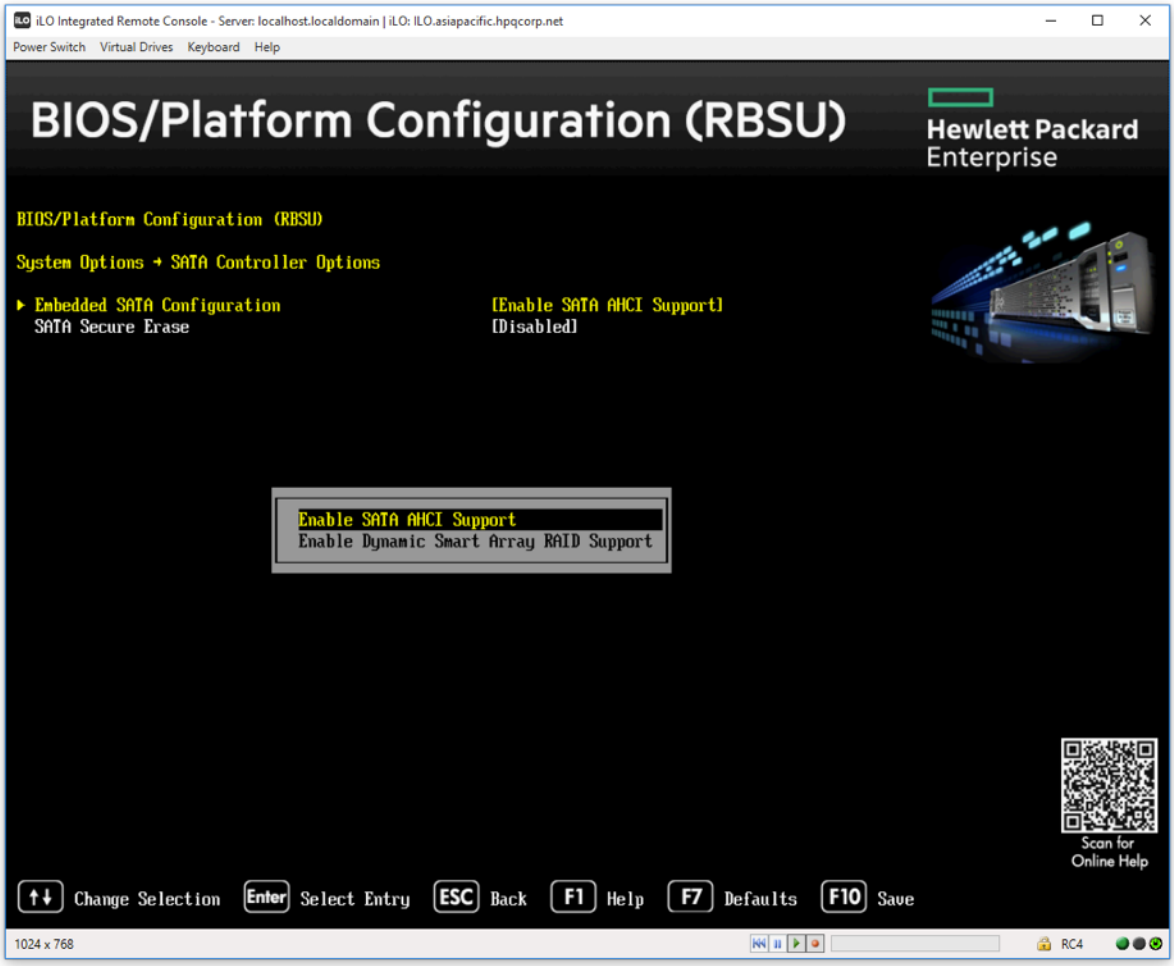
- Installation
- Configuration
- Recovery steps when a disk fails

Basic configuration

This procedure will be completed using HPE iLO. For more information, see the *HPE iLO 4 User Guide* in the Hewlett Packard Enterprise Information Library (www.hpe.com/info/docs),

Setting AHCI mode

1. In **RBSU** > **System Options** > **SATA Controller Options** > **Embedded SATA Configuration**.
2. Make sure that “Enable SATA AHCI Support” is enabled.



UEFI partitioning scheme

The following partition scheme is used throughout this document to describe the process.

Name	Size	File System Type	Mount Point
First disk			
/dev/sda1	200MB	FAT	/boot/efi
/dev/sda2	16GB	Swap	Swap
/dev/sda3	Rest of the disk	Ext4	None

Name	Size	File System Type	Mount Point
Second Disk			
/dev/sdb1	200MB	FAT	None
/dev/sdb2	16GB	Swap	None
/dev/sdb3	Rest of the disk	Ext4	None

* In the outlined configuration, the disk size is 500GB. The partition size for sda3 and sdb3 is roughly 460GB.

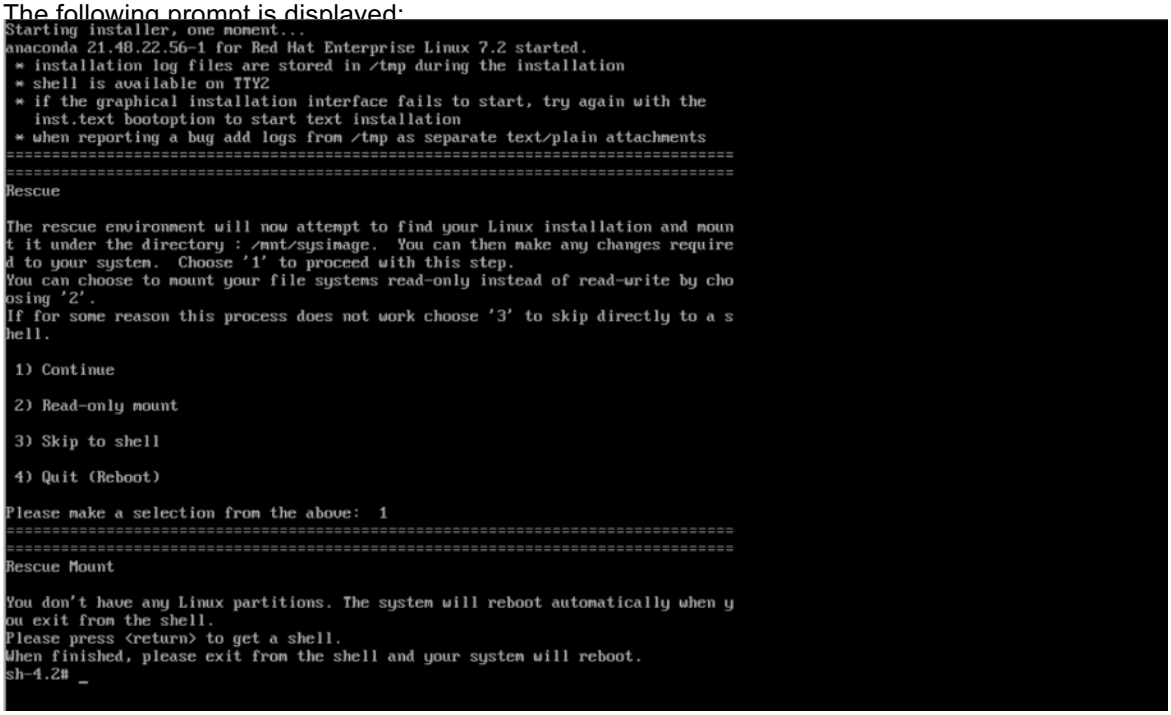
Red Hat Enterprise Linux (RHEL) 7.3

Manually Partitioning through Rescue mode

Partition the disk manually in Rescue mode before proceeding to the normal installation process. Do not use the RHEL GUI installer.

1. Boot from the RHEL 7.3 DVD image.
2. Select **Troubleshooting** > **Rescue a Red Hat Enterprise Linux system** from the GRUB boot menu.
3. Select **1) Continue**.

The following prompt is displayed:



4. To create partitions on the first disk (/dev/sda), type the following commands.

```
parted /dev/sda mklabel gpt
```

5. Type “Yes” to confirm changes are made to the existing disk label.

The following is displayed:

```
parted /dev/sda mkpart primary fat32 0 200MiB
```

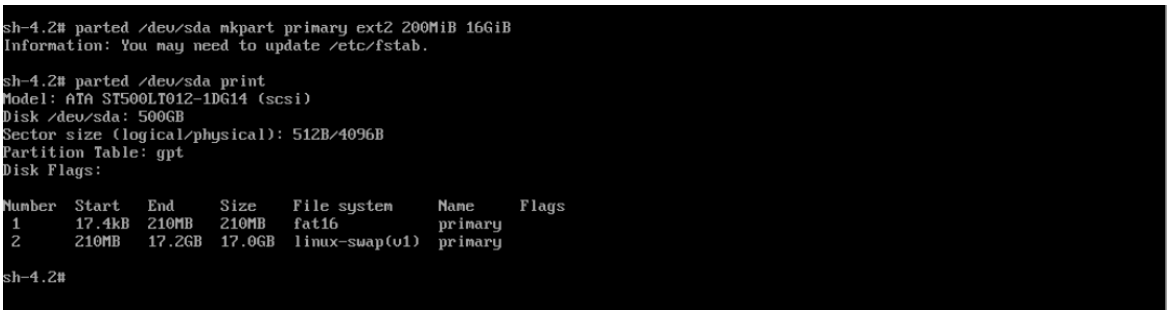
6. Type “Ignore” to ignore the size mismatch.

The following is displayed:

```
parted /dev/sda mkpart primary ext2 200MiB 16GiB
```

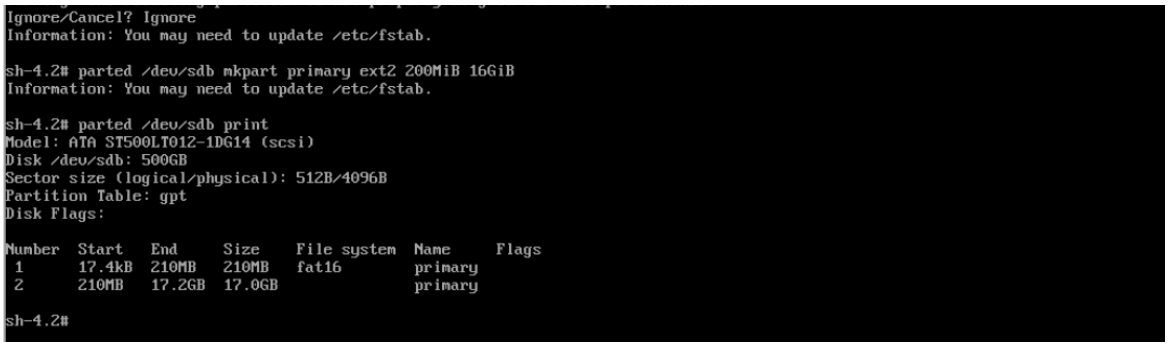
```
parted /dev/sda print
```

7. Refer to the screenshot for detail partitioning instruction and information for /dev/sda.



8. Repeat step 5 for the second disk (/dev/sdb).

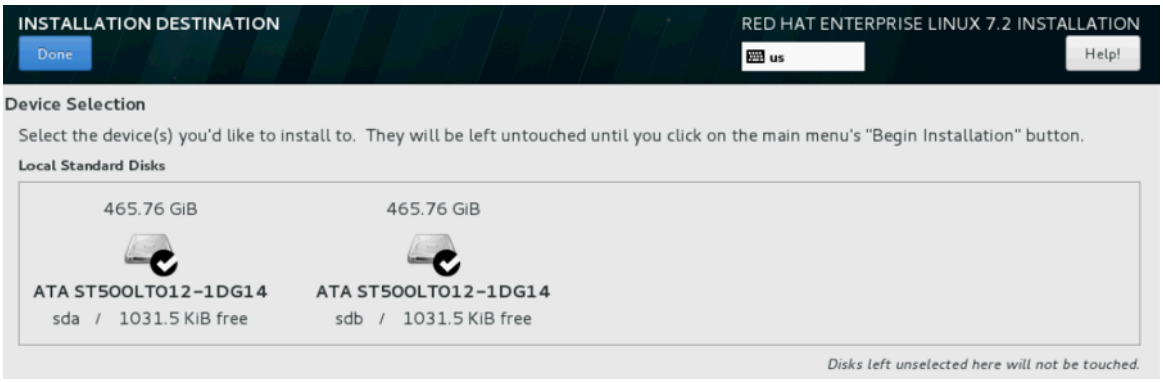
Refer to the screenshot for detail partitioning instruction and information for /dev/sdb.



9. Reboot to proceed with Red Hat installation.

Normal Installation Process

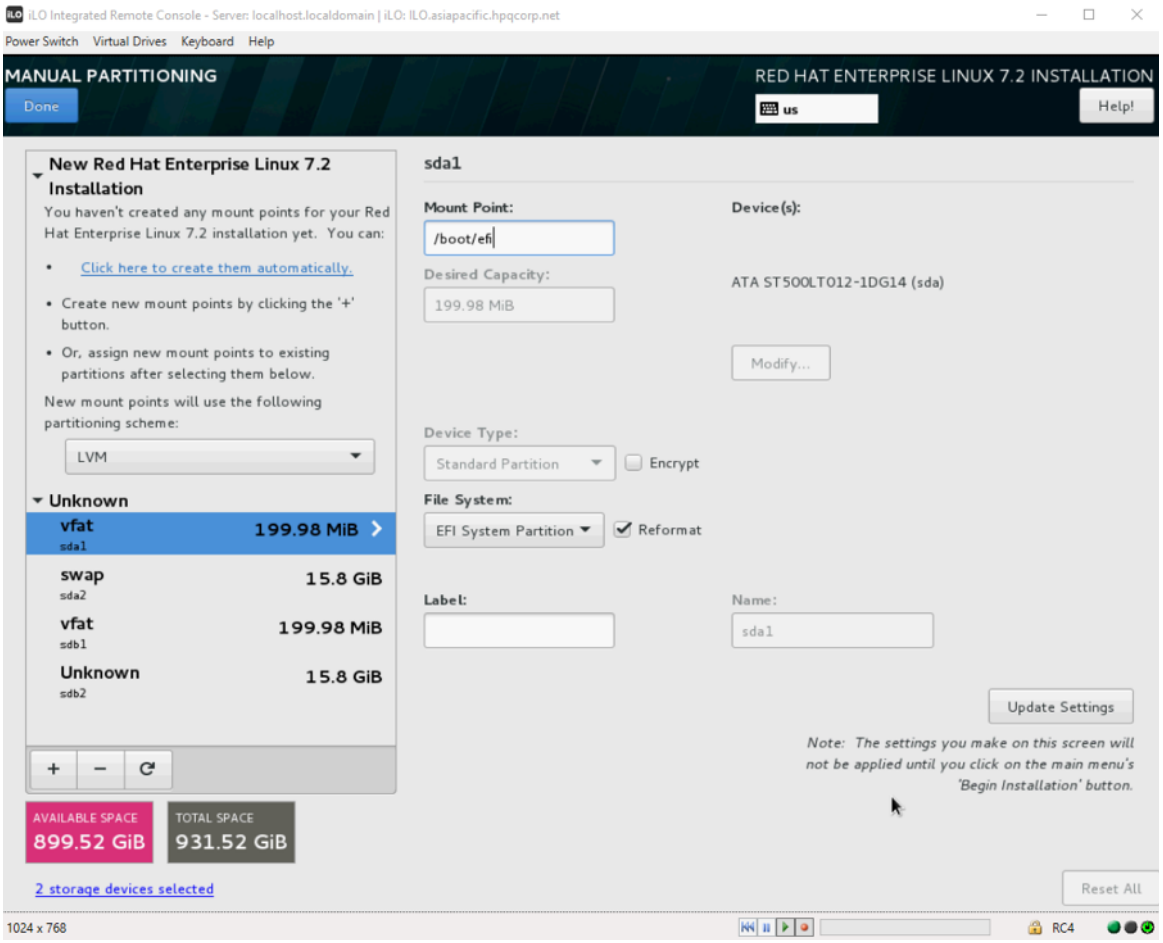
The software RAID installation differs from the normal installation process only in the “Installation Destination” step. In the “Installation Destination”, specify the ESP, swap, and root partition respectively. In the “Installation Destination” step, make sure both disks are selected, and “I will configure partitioning” is selected.



Specifying the ESP

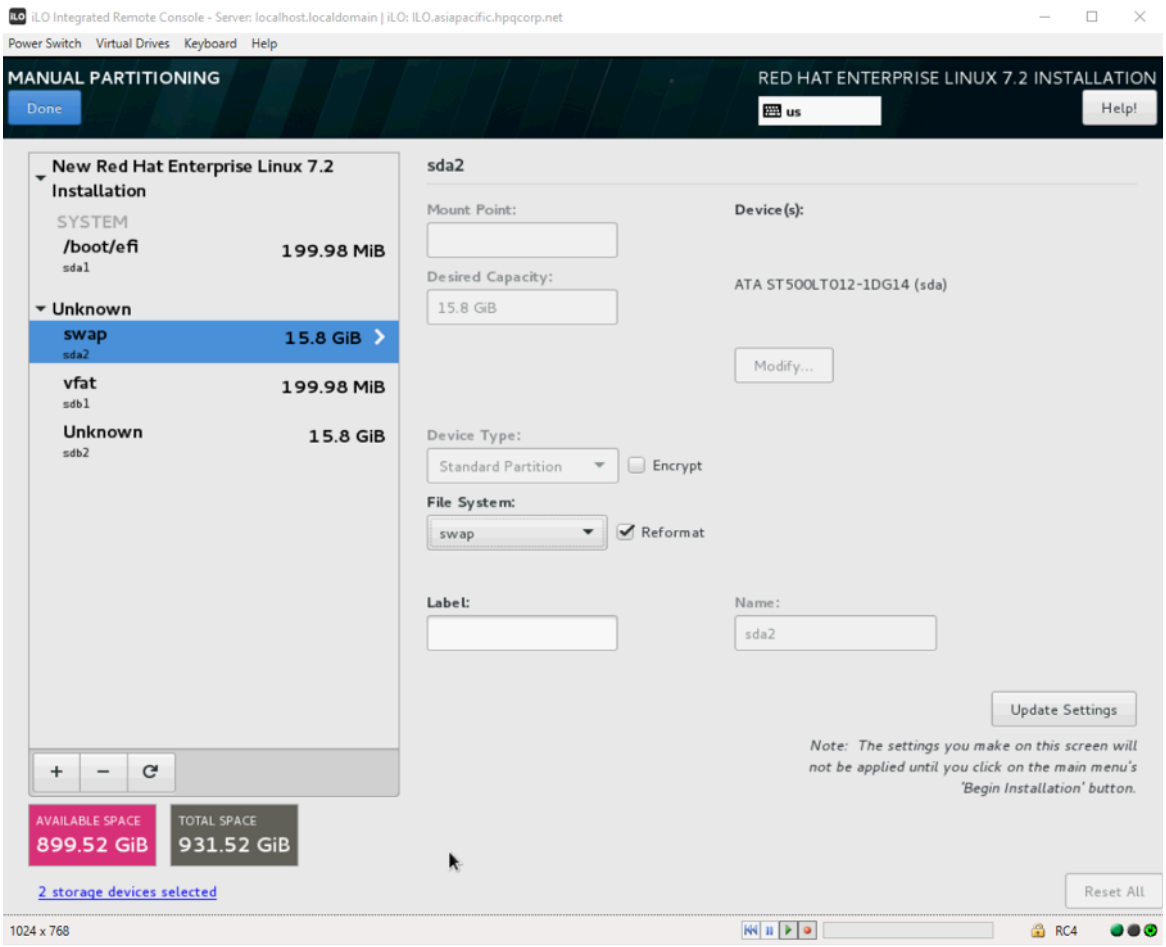
The ESP is the partition that contains the boot loaders used by the UEFI firmware.

1. Select **sda1** under Unknown in the left pane.
2. Under File System, select **EFI System Partition** and check **Reformat**.
3. In the Mount Point field, enter `/boot/efi`.
4. Click **Update Settings**.



Specifying the swap directory

1. Select **sda2** in the “Unknown” section.
2. In the File System dropdown, select **swap** and check **Reformat**.
3. Click **Update Settings**.

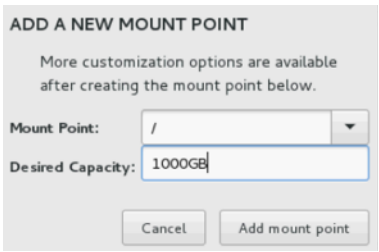


Creating root disk as RAID1

1. Click **+**.
2. To choose the root directory, enter “/” as mount point.
3. Enter “1000GB” in Desired Capacity.

The system will calculate the correct size.

4. Click **Add mount point**.

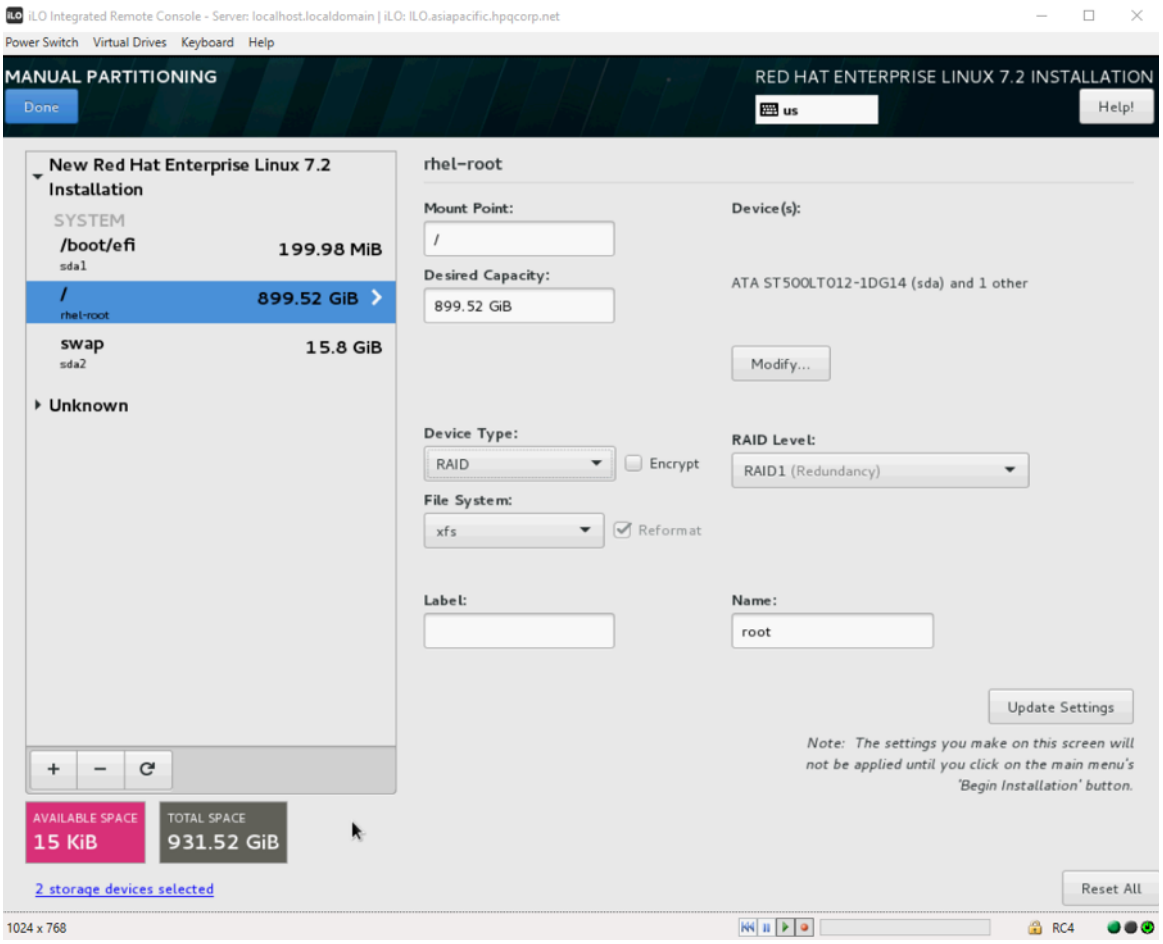


Create a RAID1 root partition

1. Select **/ rhel-root** in the left pane.
2. Select **RAID** in Device Type.
3. Choose **xfs** or other desired file system.
4. Make sure **RAID1 (Redundancy)** in RAID Level is selected.
5. Click **Update Settings**.

   The system will calculate the final size for the RAID partition.

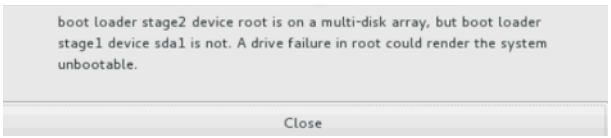
   The system will create a new md device in `/dev/md/root`.
6. In the Name field, type “root”.



7. Continue the installation by clicking **Done**.

   The system will show a warning message.

This message can be ignored.



Creating the Redundant ESP

1. Log in to Red Hat.
2. To clone the ESP partition from `/dev/sda1` to `/dev/sdb1`, enter the following command.

   ```
   dd if=/dev/sda1 of=/dev/sdb1
   ```

   “if” means the input and “of” is the output.

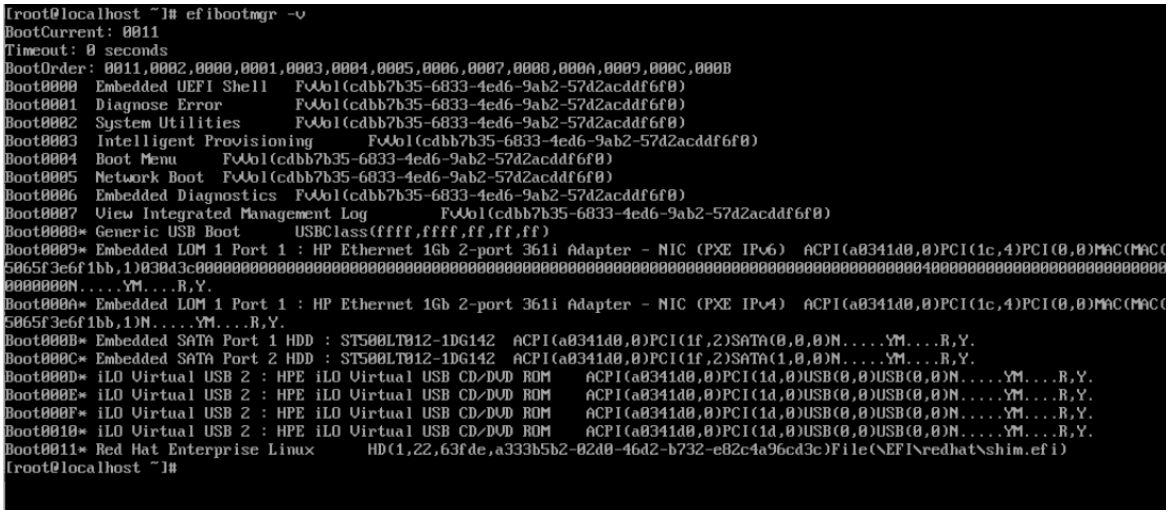
Creating a New Entry in UEFI Boot Manager

Before creating a new entry for the Redundant ESP for /dev/sdb1, examine the current EFI boot manager. Make sure the contents of the new entry match the existing entry for RHEL.

1. To list the entries in the EFI boot manager, type the following command.

   ```
   efibootmgr -v
   ```

The screenshot shows that entry Boot0011 is the RHEL entry created by the installer.



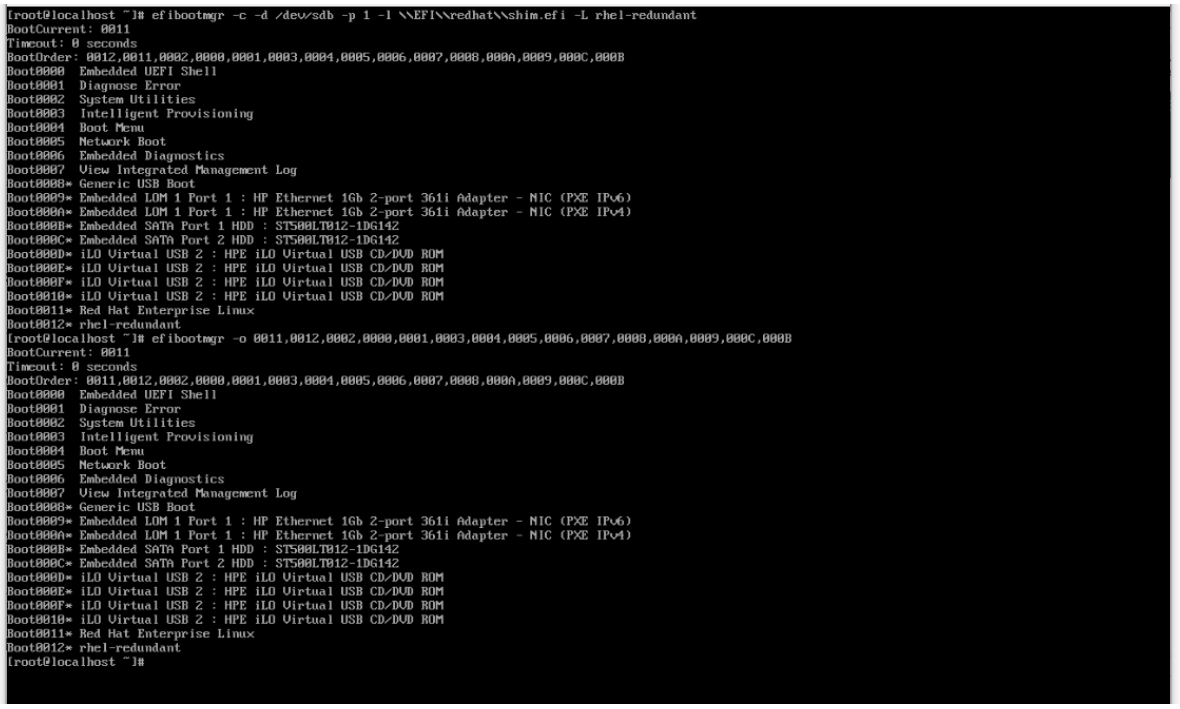
2. Create a new entry and name it “rhel-redundant” using the following command.

   ```
   efibootmgr -c -d /dev/sdb -p 1 -l \\EFI\\redhat\\shim.efi -L “rhel-redundant”
   ```

3. The “rhel-redundant” entry is created as Boot0012.

   It is selected as the first boot option. It should be moved to second boot option.

   ```
   efibootmgr -o
   0011,0012,0002,0000,0001,0003,0004,0005,0006,0007,0008,000A,0009,000C,000B
   ```

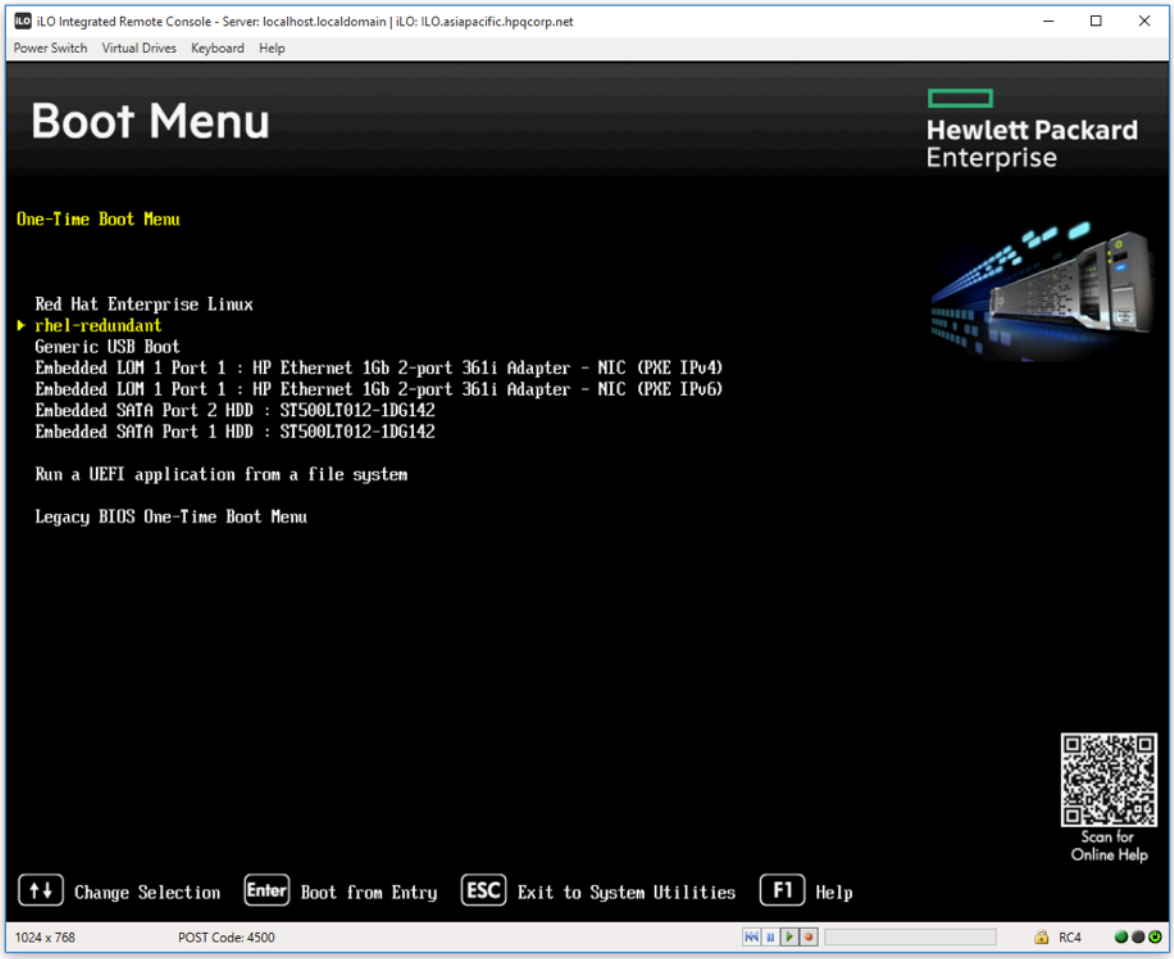


4. The actual number for entries depends on the system configuration.

   Check the system configuration by typing:

   ```
   efibootmgr -v
   ```

5. Verify the boot entry by rebooting the system.
   a. Press **F11** to go to the boot menu.
   b. Choose **rhel-redundant** from the boot menu.
6. Log in to the system.



Recovering a failed disk and repairing Software RAID

In the event of a failed disk, it is necessary to recover the failed partition and restore the software RAID. Logging in to the system through the second disk is possible when the EFI boot entries are set properly.

1. Examine the status of the RAID configuration using the following command.

   ```
   mdadm --detail /dev/md/root
   ```

   - Total Devices report “1”.
   - State reports as “clean, degraded”.
   - /dev/sdb3 has become /dev/sda3

   It is the only available disk.

Recover the RAID system

1. Prepare a new disk, partitioned as previously described.
2. From the boot menu, choose **rhel-redundant**.

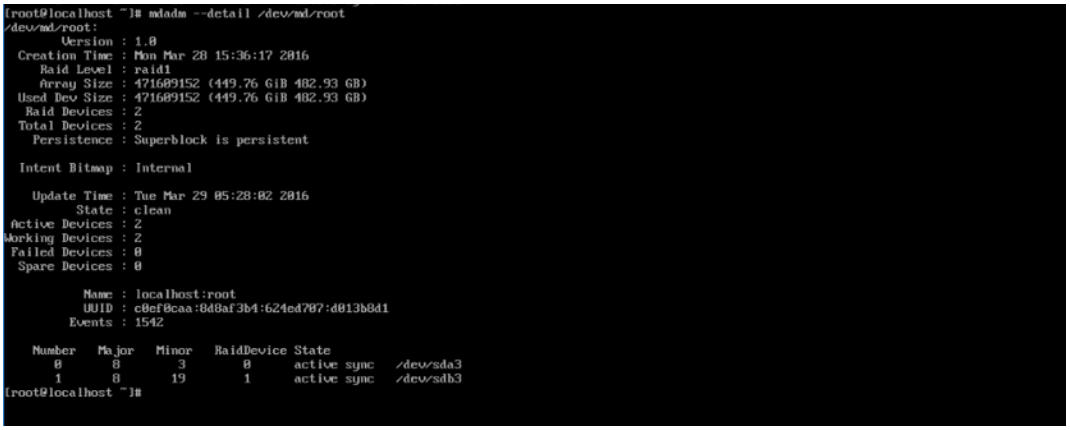
   The new disk is shown as `/dev/sda`.

   The original second disk will appear as `/dev/sdb`.
3. Type the following command to add the new /dev/sda3 to rebuild the RAID.

   ```
   mdadm --add /dev/md/root /dev/sda3
   ```
4. Enter the following command:

   ```
   mdadm --detail /dev/md/root
   ```

   The State will change to “clean, degraded, recovering” and the Rebuild Status will report “75% complete” (or other progress number).
5. Once the rebuild has completed, State will report as “clean”.
6. The recovery is complete.



Complete the recovery process

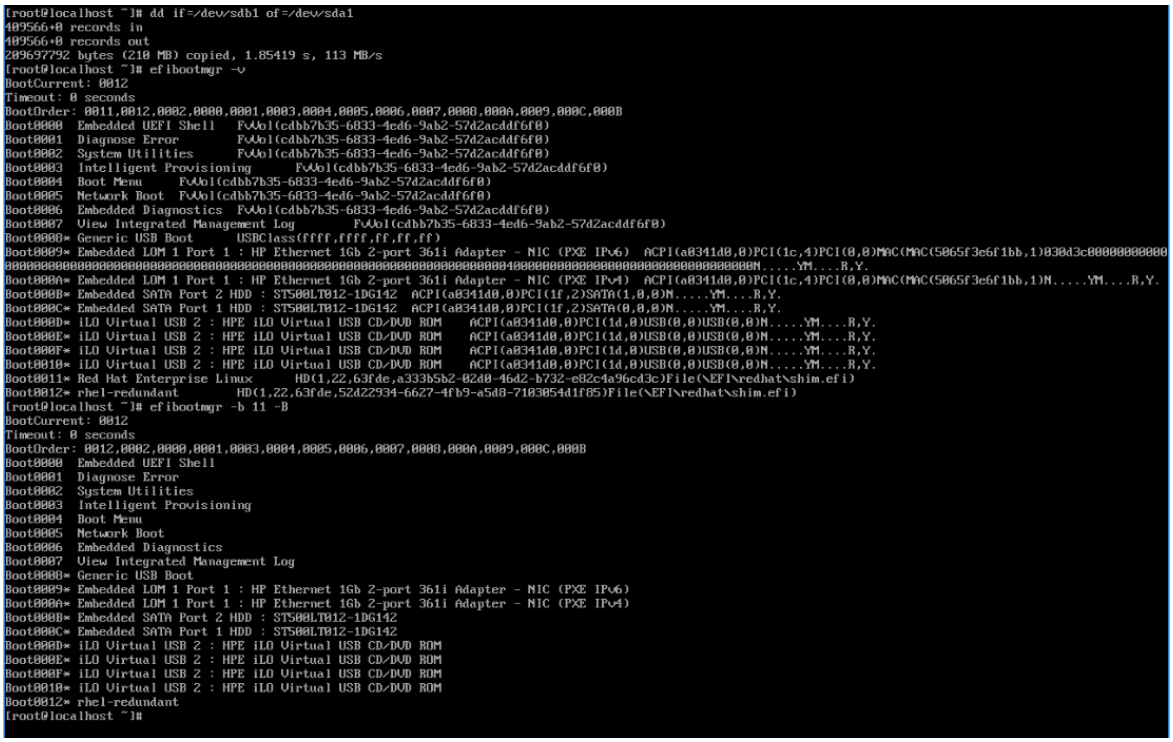
Repeat the process described in "Creating the Redundant ESP" to make a redundant copy of the ESP, and add a new entry to EFI Boot Manager to complete the recovery process.

1. To replicate the ESP from /dev/sdb1 back to /dev/sda1, enter the following command.

   ```
   dd -if=/dev/sdb1 -of=/dev/sda1
   ```

2. To remove the existing RHEL boot entry, enter the following command.

   ```
   efibootmgr -b 11 -B
   ```

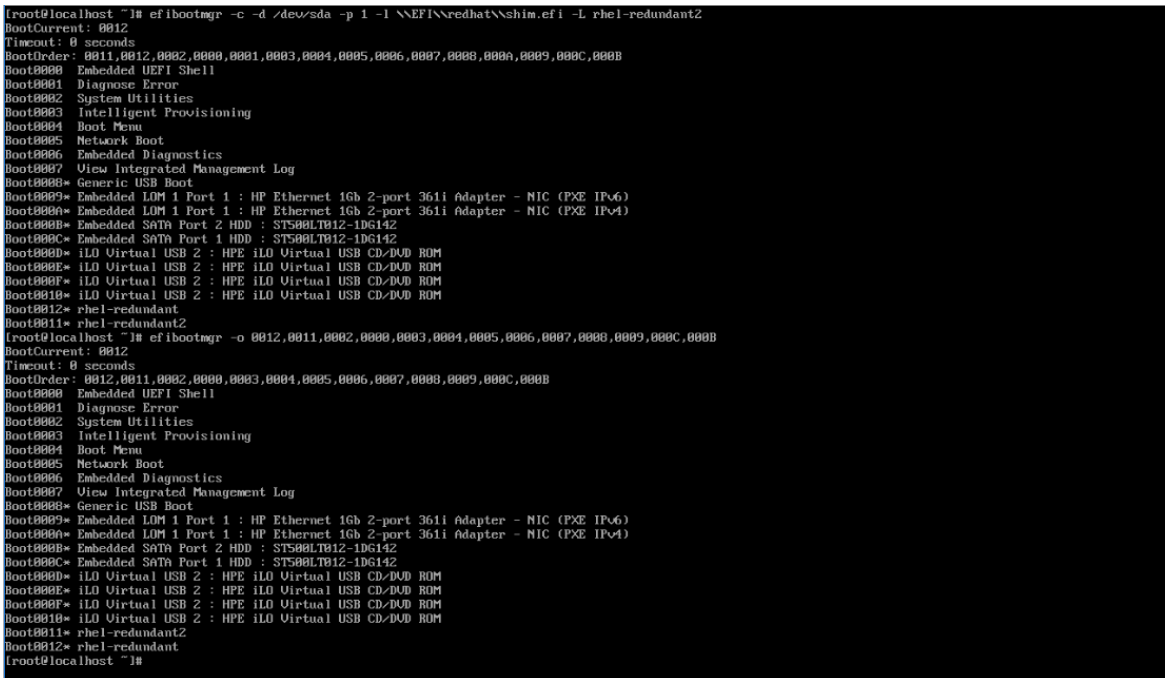


3. Create new entry for the replicated ESP by entering the following command:

   ```
   efibootmgr -c -d /dev/sda -p 1 -l \\EFI\\redhat\\shim.efi -L rhel-redundant2
   ```

4. Reorder boot sequence by entering the following command:

   ```
   efibootmgr -o 0012,0011,0002,0000,0001,0003,0004,0005,0006,0007,0008,000A,0009,000C,000B
   ```



Red Hat Enterprise Linux (RHEL) 6.8

Manually Partitioning through Rescue mode

Partition the disk manually in Rescue mode before proceeding to the normal installation process. Do not use the RHEL GUI installer.

1. Boot from the RHEL 6.8 DVD image.
2. Select **rescue** from the GRUB boot menu.

   After Language, Keyboard and Media selection, the following prompt is displayed:

Select “Continue”, then start the shell.

3. To create partitions on the first disk (/dev/sda), type the following commands.

```
parted /dev/sda mklabel gpt
```

4. Type “Yes” to confirm changes are made to the existing disk label.

The following is displayed:

```
parted /dev/sda mkpart primary fat32 0 200MiB
```

5. Type “Ignore” to ignore the size mismatch.

The following is displayed:

```
parted /dev/sda mkpart primary ext2 200MiB 16GiB
```

```
parted /dev/sda print
```

6. Refer to the screenshot for detail partitioning instruction and information for /dev/sda.

```
bash-4.1# parted /dev/sda mklabel gpt
Warning: The existing disk label on /dev/sda will be destroyed and all data on this disk will be lost. Do you want to continue?
Yes/No? Yes
Information: You may need to update /etc/fstab.

bash-4.1# parted /dev/sda mkpart primary fat32 0 200MiB
Warning: The resulting partition is not properly aligned for best performance.
Ignore/Cancel? Ignore
Information: You may need to update /etc/fstab.

bash-4.1# parted /dev/sda mkpart primary ext2 200MiB 16GiB
Warning: The resulting partition is not properly aligned for best performance.
Ignore/Cancel? Ignore
Information: You may need to update /etc/fstab.

bash-4.1# parted /dev/sda print
Model: ATA ST500LT012-1DG14 (scsi)
Disk /dev/sda: 500GB
Sector size (logical/physical): 512B/4096B
Partition Table: gpt

Number  Start   End     Size    File system  Name     Flags
 1      17.4kB  210MB   210MB                primary
 2      210MB   17.2GB  17.0GB               primary

bash-4.1# _
```

7. Repeat step 5 for the second disk (/dev/sdb).

Refer to the screenshot for detail partitioning instruction and information for /dev/sdb.

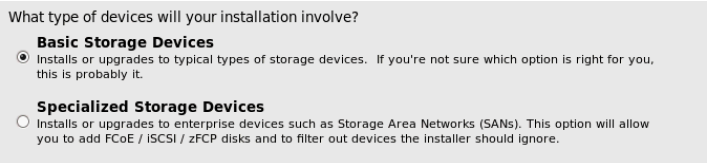
```
bash-4.1# parted /dev/sdb mklabel gpt
Warning: The existing disk label on /dev/sdb will be destroyed and all data on this disk will be lost. Do you want to continue?
Yes/No? Yes
Information: You may need to update /etc/fstab.

bash-4.1# parted /dev/sdb mkpart primary fat32 0 200MiB
Warning: The resulting partition is not properly aligned for best performance.
Ignore/Cancel? Ignore
Information: You may need to update /etc/fstab.

bash-4.1# parted /dev/sdb mkpart primary ext2 200MiB 16GiB
Warning: The resulting partition is not properly aligned for best performance.
Ignore/Cancel? Ignore
Information: You may need to update /etc/fstab.

bash-4.1# parted /dev/sdb print
Model: ATA ST500LT012-1DG14 (scsi)
Disk /dev/sdb: 500GB
Sector size (logical/physical): 512B/4096B
Partition Table: gpt

Number  Start   End     Size    File system  Name     Flags
 1      17.4kB  210MB   210MB                primary
 2      210MB   17.2GB  17.0GB               primary

bash-4.1# _
```

8. Reboot to proceed with Red Hat installation.

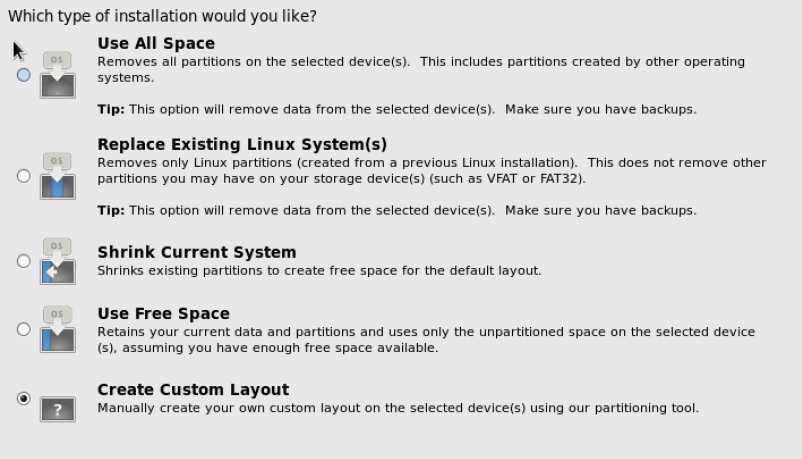
Normal Installation Process

The software RAID installation differs from the normal installation process only in the “Create Custom Layout” step. In “Create Custom Layout”, specify the ESP, swap, and root partition respectively.

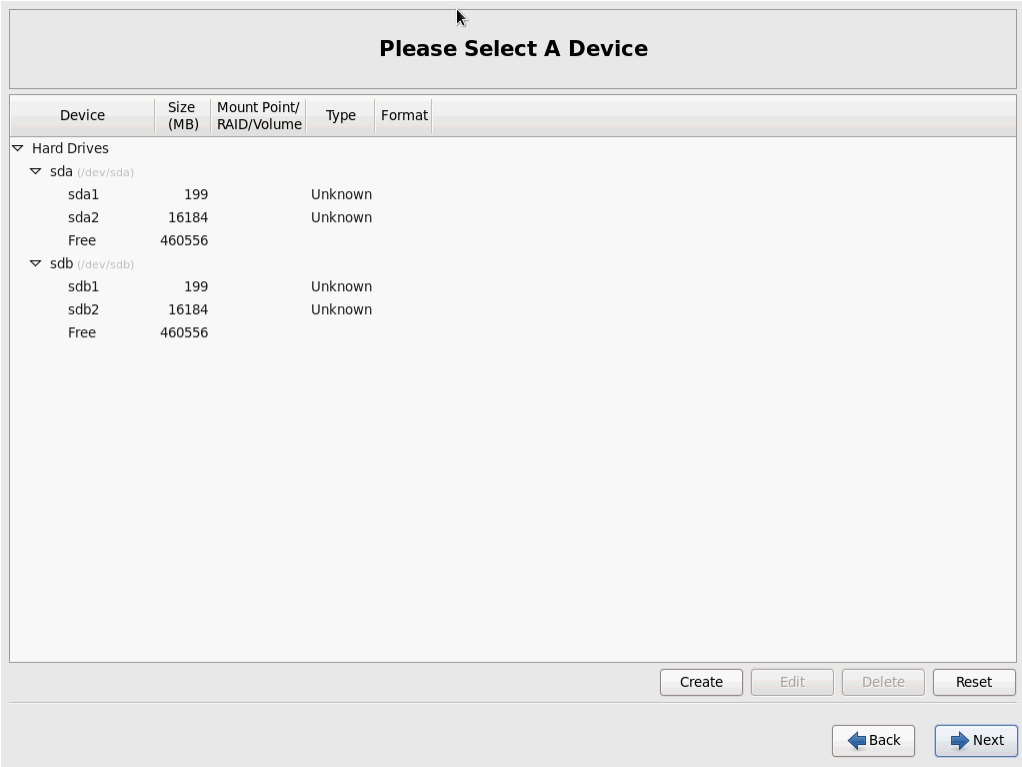
Select “Basic Storage Device” in the installation device selection menu:



Select “Create Custom Layout” in the installation type selection menu:



Then, the following is displayed:

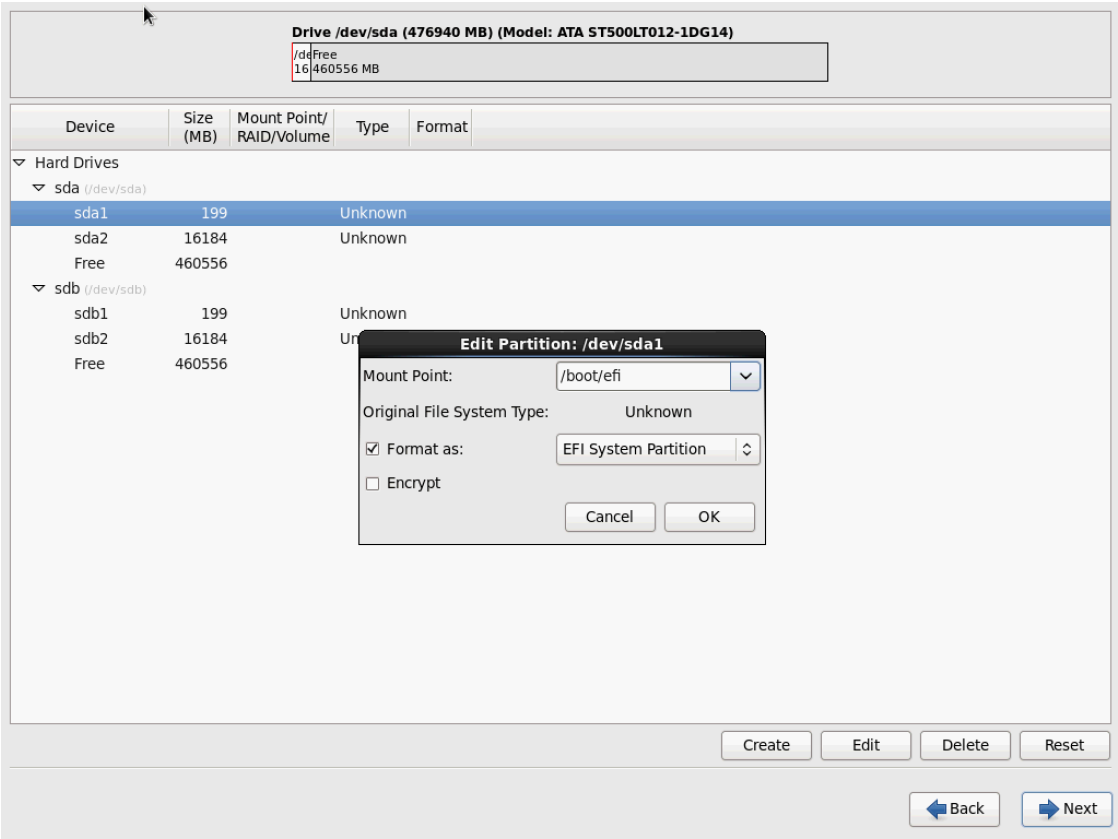


Specifying the ESP

The ESP is the partition that contains the boot loaders used by the UEFI firmware.

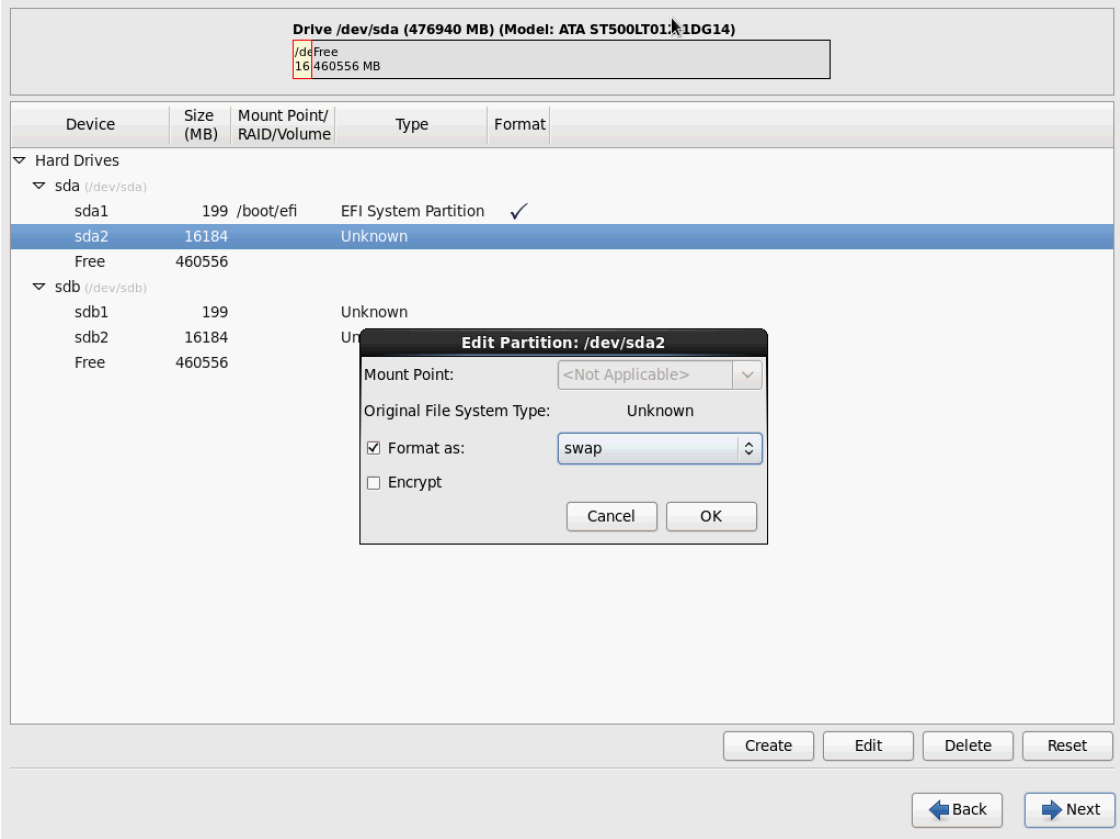
1. Select **sda1** under sda, then click **Edit**.
2. Check “**Format as:**” and select **EFI System Partition**.

3. In the Mount Point field, enter `/boot/efi`.
4. Click **OK**.



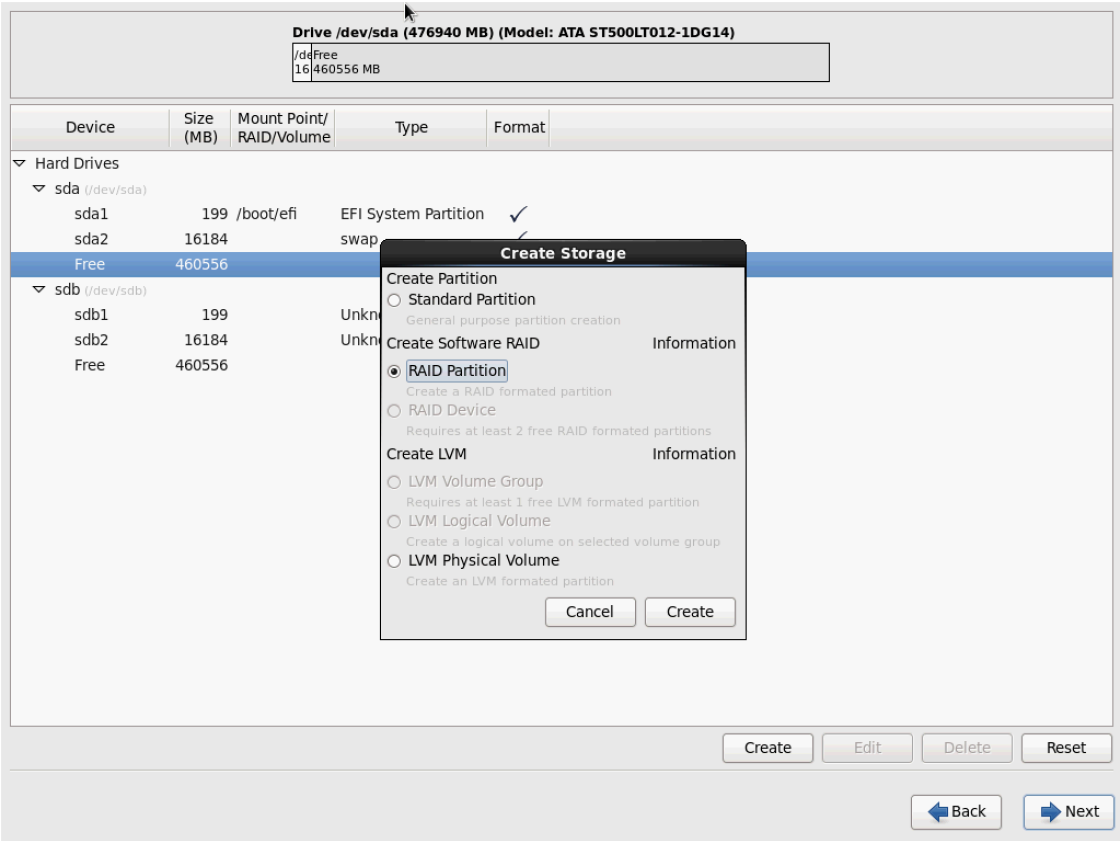
Specifying the swap directory

4. Select **sda2** under sda, then click **Edit**.
5. Click "**Format as:**" and select **swap**.
6. Click **OK**.

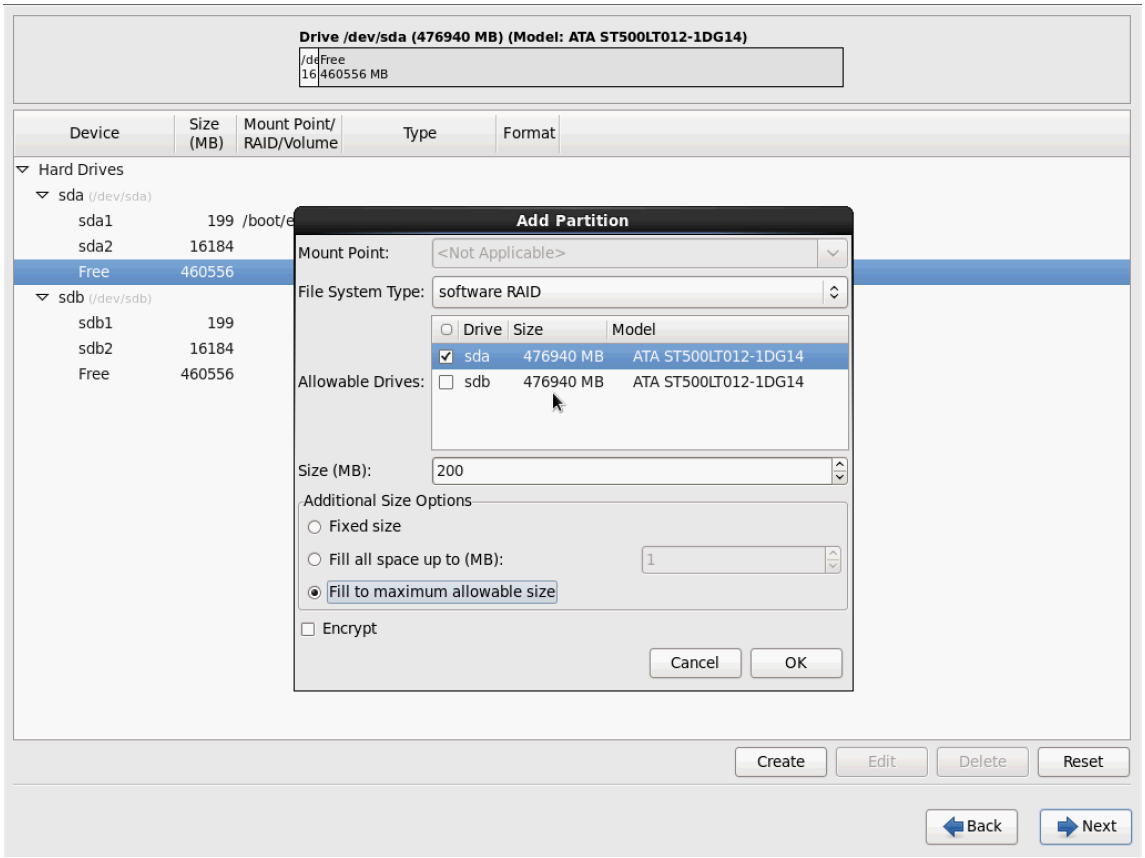


Creating root disk as RAID1

1. Select **Free** under sda, then click **Create**.
2. Click **RAID Partition**.



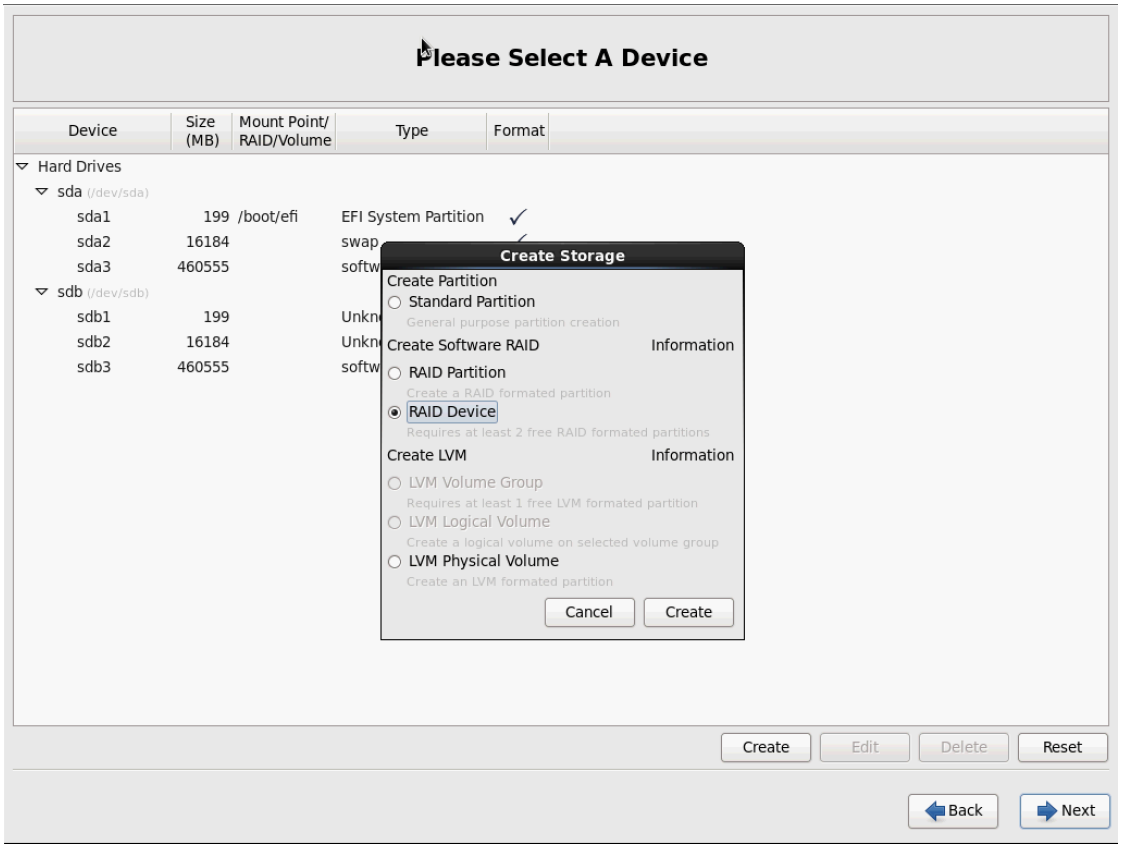
3. Check **sda** in the Add Partition screen, then click **Fill to maximum allowable size** in Additional Size Options. Then click **OK**.



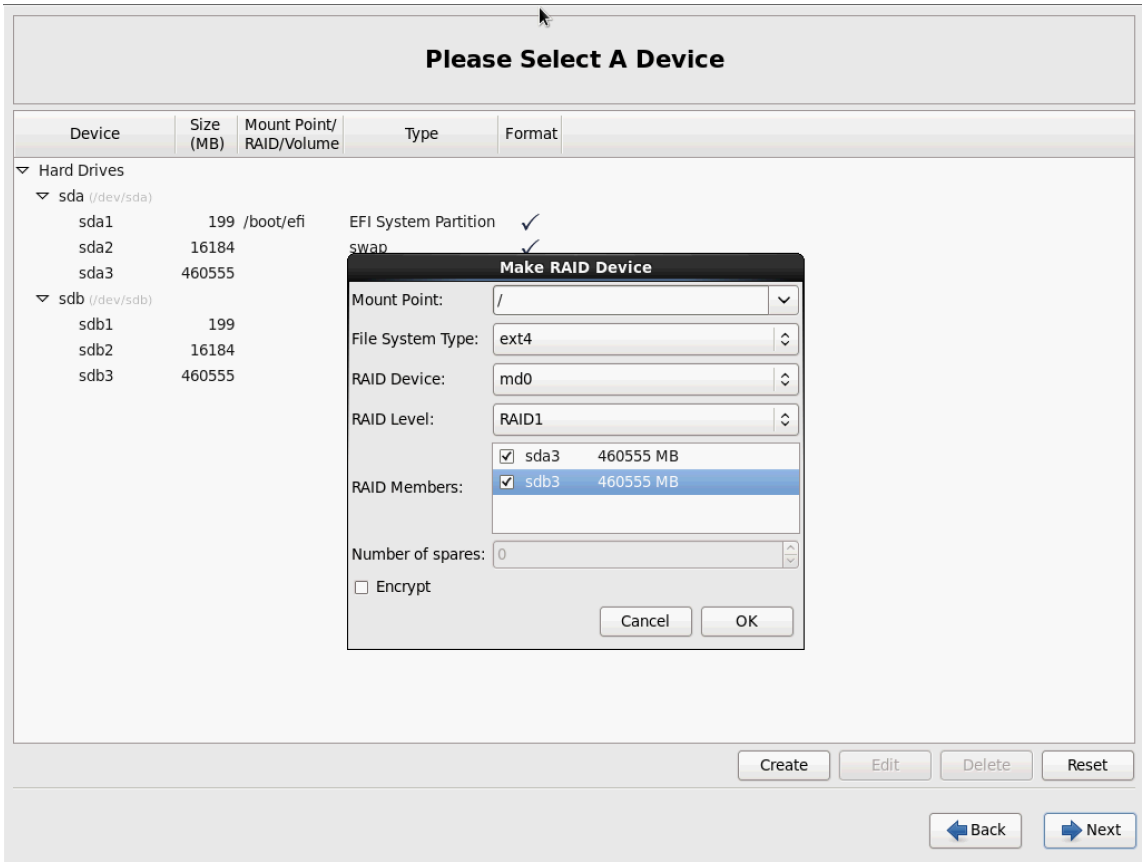
4. Repeat step 1, 2 and 3 for **sdb**.

Create a RAID1 root partition

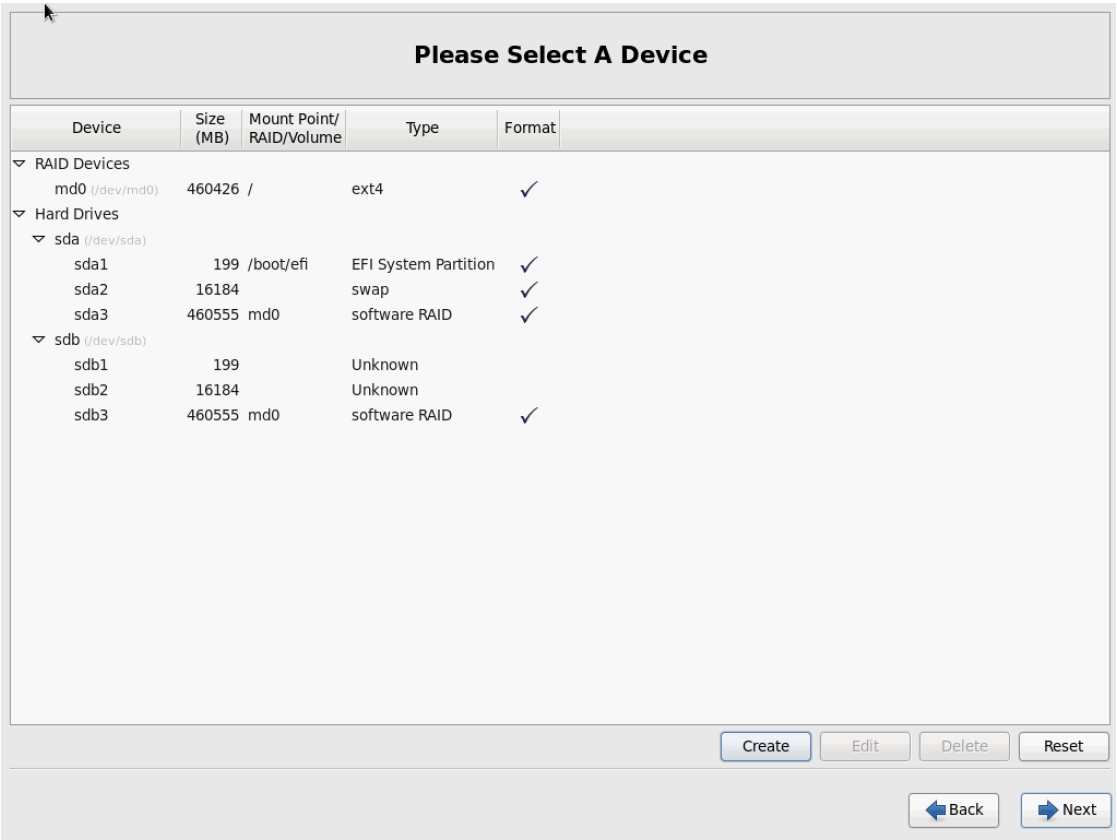
1. Click **Create** in the device selection screen.
2. Click **RAID Device** in the Create Storage screen, then click **Create**.



3. In the Make RAID Device screen, enter “/” as mount point. File System Type is **ext4**, RAID Device is **md0** and RAID Level is **RAID1**. Check **sda** and **sdb**, then click **OK**.



4. The following is displayed:



5. Click **Next**. Format **ESP** and **swap** partition and confirm changes to disk.
6. Continue normal installation.

Creating the Redundant ESP

1. Log in to Red Hat.
2. To clone the ESP partition from `/dev/sda1` to `/dev/sdb1`, enter the following command.

   `dd if=/dev/sda1 of=/dev/sdb1`

   “if” means the input and “of” is the output.

```
Red Hat Enterprise Linux Server release 6.8 (Santiago)
Kernel 2.6.32-642.el6.x86_64 on an x86_64

localhost login: root
Password:
[root@localhost ~]# dd if=/dev/sda1 of=/dev/sdb1
409567+0 records in
409567+0 records out
209698304 bytes (210 MB) copied, 4.9163 s, 42.7 MB/s
[root@localhost ~]#
```

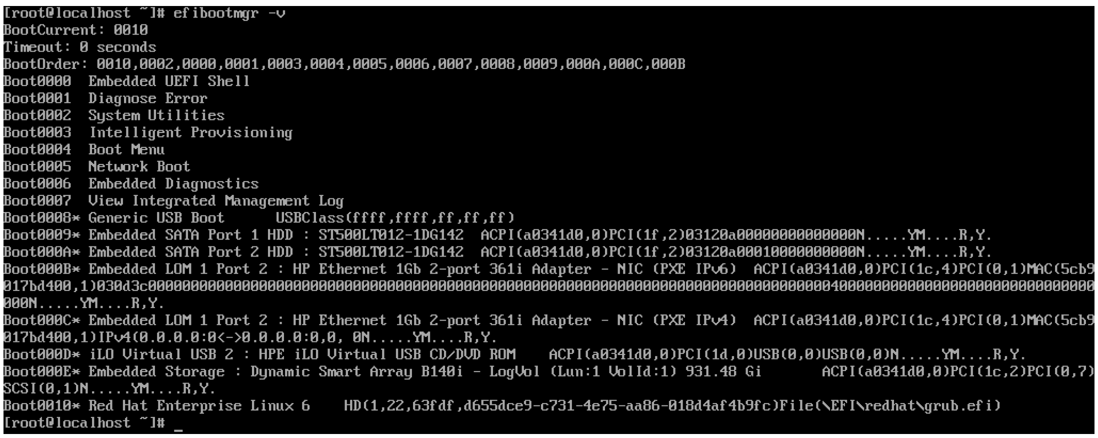
Creating a New Entry in UEFI Boot Manager

Before creating a new entry for the Redundant ESP for /dev/sdb1, examine the current EFI boot manager. Make sure the contents of the new entry match the existing entry for RHEL.

1. To list the entries in the EFI boot manager, type the following command.

   `efibootmgr -v`

   The screenshot shows that entry Boot0011 is the RHEL entry created by the installer.



2. Create a new entry and name it "rhel-redundant" using the following command.

   `efibootmgr -c -d /dev/sdb -p 1 -l \\EFI\\redhat\\grub.efi -L "rhel-redundant"`

3. The "rhel-redundant" entry is created as Boot000f.

   It is selected as the first boot option. It should be moved to second boot option.

   `efibootmgr -o 00010,000F,0002,0000,0001,0003,0004,0005,0006,0007,0008,0009,000A,000C,000B`

```
[root@localhost ~]# efibootmgr -c -d /dev/sdb -p 1 -l \\EFI\\redhat\\grub.efi -L "rhel-redundant"
BootCurrent: 0010
Timeout: 0 seconds
BootOrder: 000F,0010,0002,0000,0001,0003,0004,0005,0006,0007,0008,0009,000A,000C,000B
Boot0000  Embedded UEFI Shell
Boot0001  Diagnose Error
Boot0002  System Utilities
Boot0003  Intelligent Provisioning
Boot0004  Boot Menu
Boot0005  Network Boot
Boot0006  Embedded Diagnostics
Boot0007  View Integrated Management Log
Boot0008* Generic USB Boot
Boot0009* Embedded SATA Port 1 HDD : ST500LT012-1DG142
Boot000A* Embedded SATA Port 2 HDD : ST500LT012-1DG142
Boot000B* Embedded LOM 1 Port 2 : HP Ethernet 1Gb 2-port 361i Adapter - NIC (PXE IPv6)
Boot000C* Embedded LOM 1 Port 2 : HP Ethernet 1Gb 2-port 361i Adapter - NIC (PXE IPv4)
Boot000D* iLO Virtual USB 2 : HPE iLO Virtual USB CD/DVD ROM
Boot000E* Embedded Storage : Dynamic Smart Array B140i - LogVol (Lun:1 VolId:1) 931.48 Gi
Boot0010* Red Hat Enterprise Linux 6
Boot000F* rhel-redundant
[root@localhost ~]# efibootmgr -o 0010,000F,0002,0000,0001,0003,0004,0005,0006,0007,0008,0009,000A,000C,000B
BootCurrent: 0010
Timeout: 0 seconds
BootOrder: 0010,000F,0002,0000,0001,0003,0004,0005,0006,0007,0008,0009,000A,000C,000B
Boot0000  Embedded UEFI Shell
Boot0001  Diagnose Error
Boot0002  System Utilities
Boot0003  Intelligent Provisioning
Boot0004  Boot Menu
Boot0005  Network Boot
Boot0006  Embedded Diagnostics
Boot0007  View Integrated Management Log
Boot0008* Generic USB Boot
Boot0009* Embedded SATA Port 1 HDD : ST500LT012-1DG142
Boot000A* Embedded SATA Port 2 HDD : ST500LT012-1DG142
Boot000B* Embedded LOM 1 Port 2 : HP Ethernet 1Gb 2-port 361i Adapter - NIC (PXE IPv6)
Boot000C* Embedded LOM 1 Port 2 : HP Ethernet 1Gb 2-port 361i Adapter - NIC (PXE IPv4)
Boot000D* iLO Virtual USB 2 : HPE iLO Virtual USB CD/DVD ROM
Boot000E* Embedded Storage : Dynamic Smart Array B140i - LogVol (Lun:1 VolId:1) 931.48 Gi
Boot000F* rhel-redundant
Boot0010* Red Hat Enterprise Linux 6
[root@localhost ~]#
```

4. The actual number for entries depends on the system configuration.

   Check the system configuration by typing:

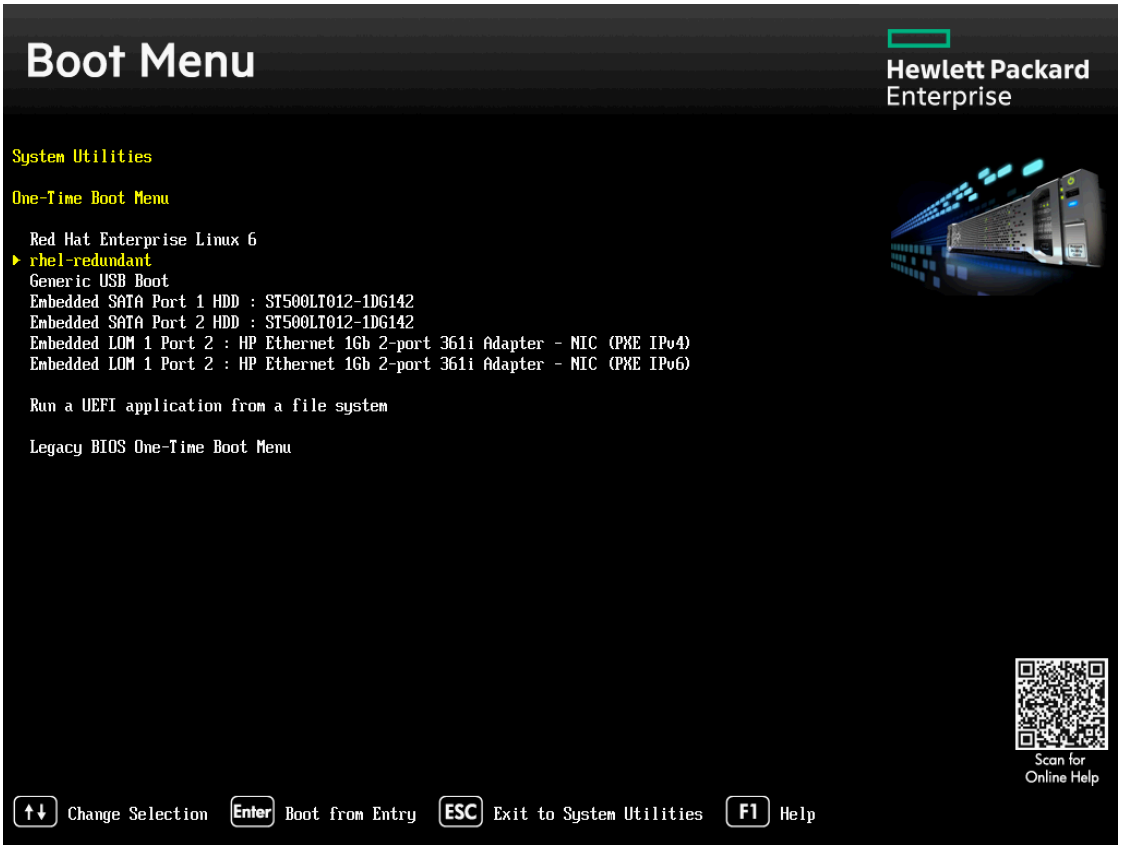
   ```
   efibootmgr -v
   ```

5. Verify the boot entry by rebooting the system.

   c. Press **F11** to go to the boot menu.

   d. Choose **rhel-redundant** from the boot menu.

6. Log in to the system.



Recovering a failed disk and repairing Software RAID

In the event of a failed disk, it is necessary to recover the failed partition and restore the software RAID. Logging in to the system through the second disk is possible when the EFI boot entries are set properly.

2. Examine the status of the RAID configuration using the following command.

```
mdadm --detail /dev/md/root
```

- Total Devices report “1”.
- State reports as “clean, degraded”.
- /dev/sdb3 has become /dev/sda3

It is the only available disk.

Recover the RAID system

7. Prepare a new disk, partitioned as previously described.
8. From the boot menu, choose **rhel-redundant**.

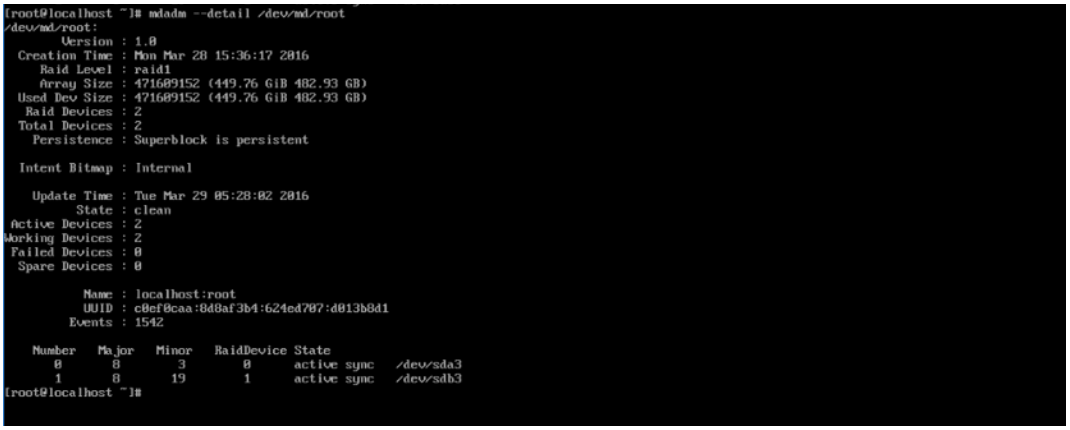
   The new disk is shown as `/dev/sda`.

   The original second disk will appear as `/dev/sdb`.
9. Type the following command to add the new /dev/sda3 to rebuild the RAID.

   ```
   mdadm --add /dev/md/root /dev/sda3
   ```
10. Enter the following command:

    ```
    mdadm --detail /dev/md/root
    ```

    The State will change to “clean, degraded, recovering” and the Rebuild Status will report “75% complete” (or other progress number).
11. Once the rebuild has completed, State will report as “clean”.
12. The recovery is complete.



Complete the recovery process

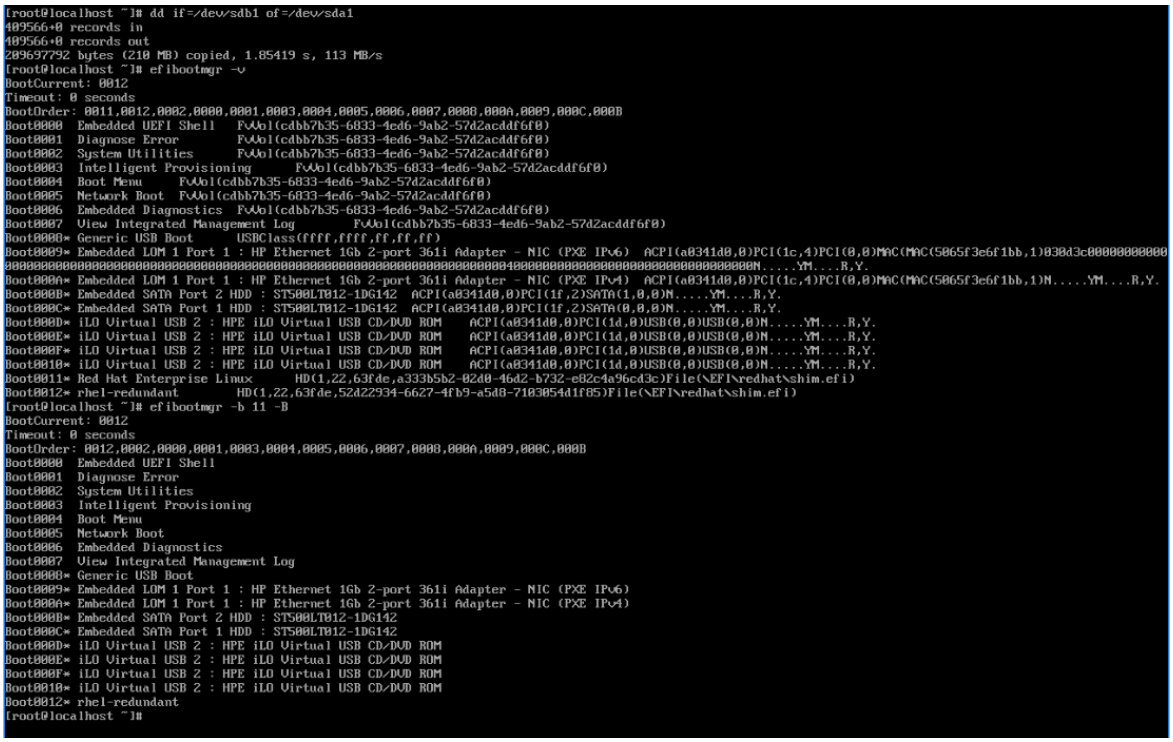
Repeat the process described in "Creating the Redundant ESP" to make a redundant copy of the ESP, and add a new entry to EFI Boot Manager to complete the recovery process.

5. To replicate the ESP from /dev/sdb1 back to /dev/sda1, enter the following command.

   ```
   dd -if=/dev/sdb1 -of=/dev/sda1
   ```

6. To remove the existing RHEL boot entry, enter the following command.

   ```
   efibootmgr -b 11 -B
   ```

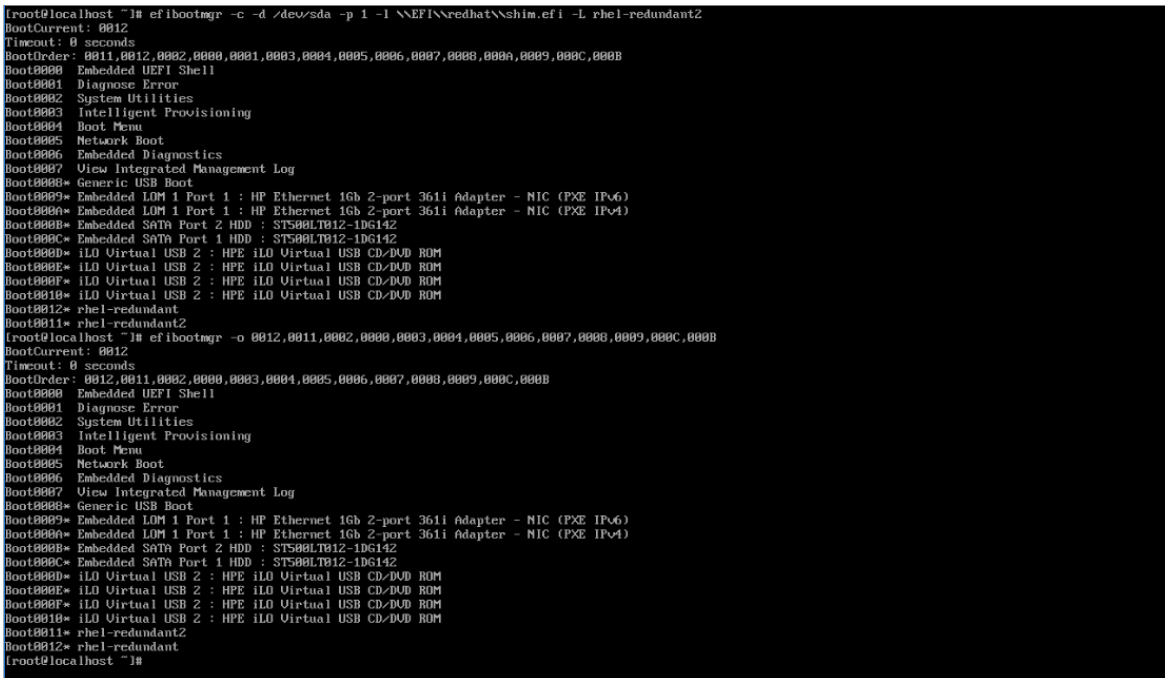


7. Create new entry for the replicated ESP by entering the following command:

   ```
   efibootmgr -c -d /dev/sda -p 1 -l \\EFI\\redhat\\grub.efi -L rhel-redundant2
   ```

8. Reorder boot sequence by entering the following command:

   ```
   efibootmgr -o 0012,0011,0002,0000,0001,0003,0004,0005,0006,0007,0008,000A,0009,000C,000B
   ```



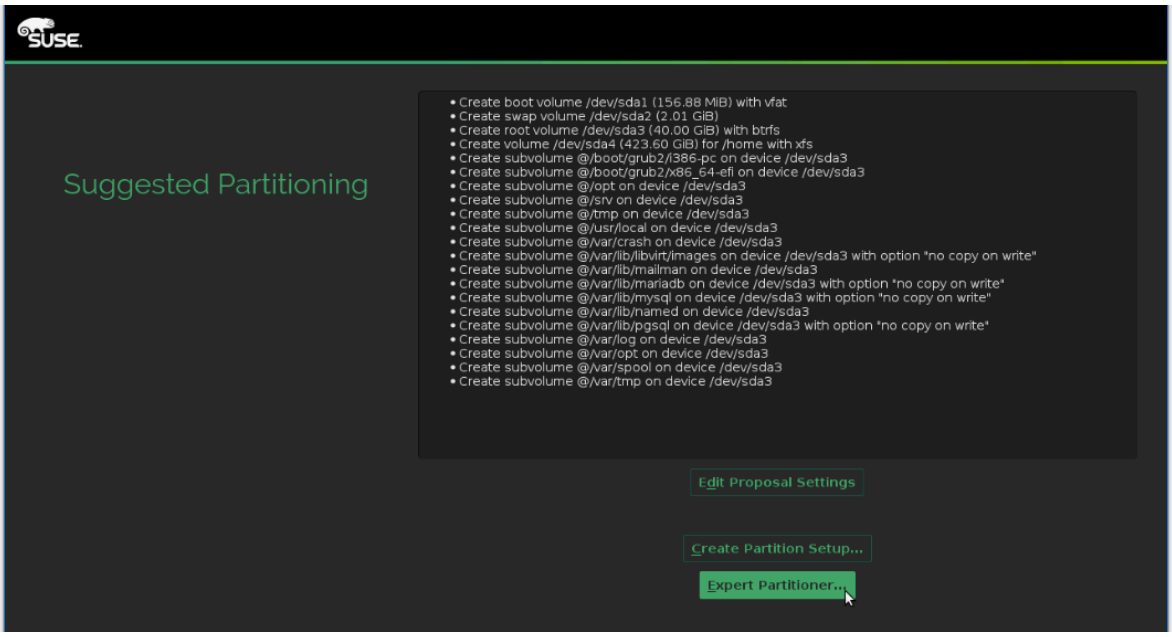
SuSE Linux Enterprise Server (SLES) 12 SP2

Installation process

Only the partition scheme is different in the Software RAID installation process compare to the standard installation process.

Partitioning drives for SLES

1. From the Suggested Partitioning screen, select **Expert Partitioner…**

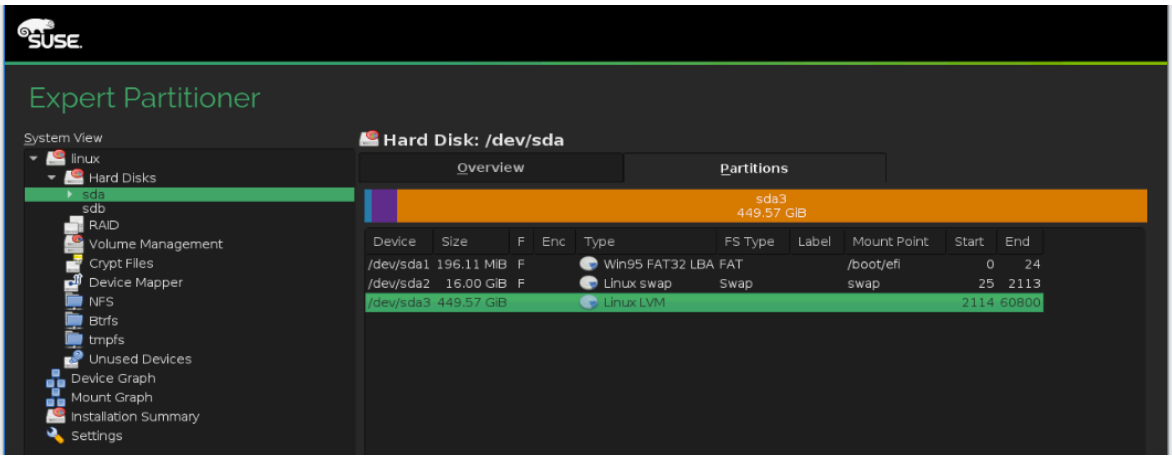


2. Delete the Expert Partitioner default partition scheme.
3. Partition /dev/sda as follows:

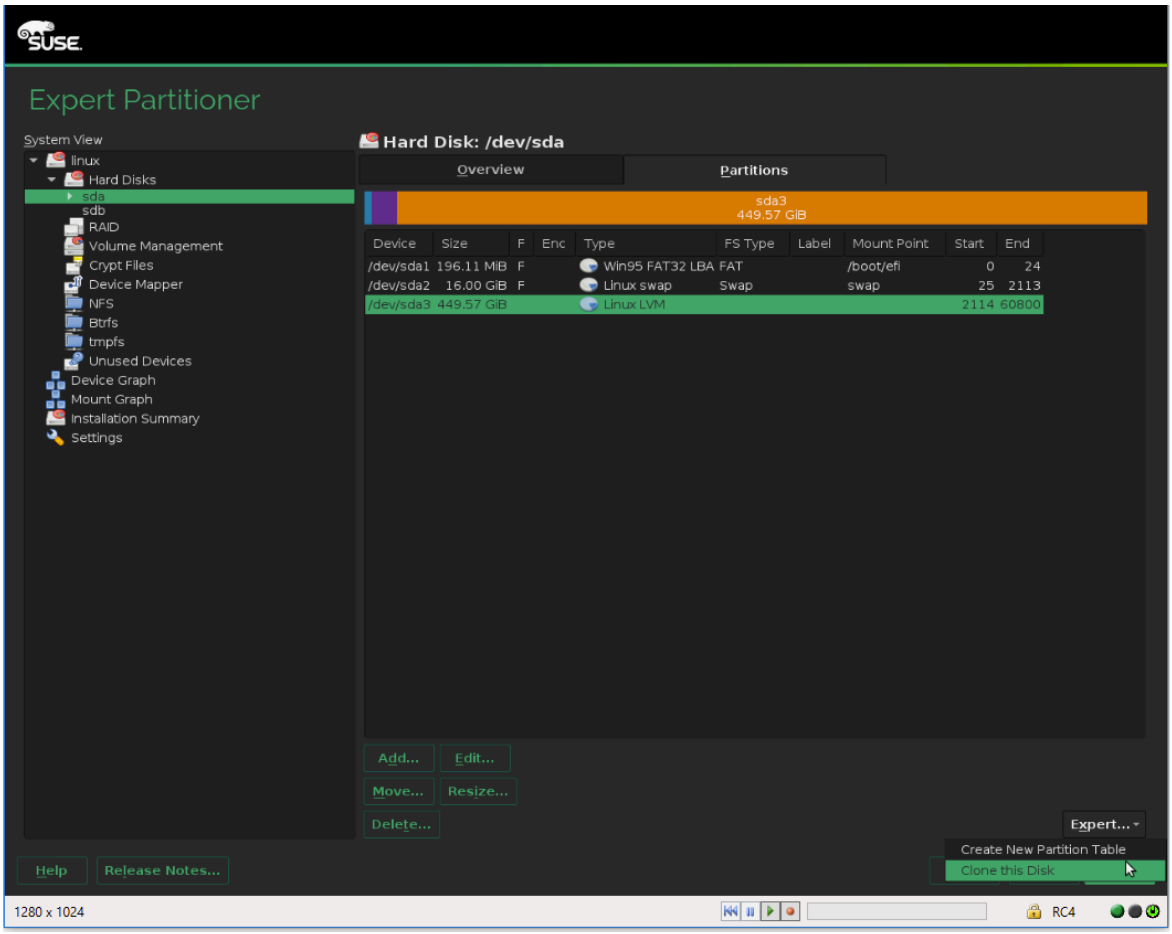
   /dev/sda1, size = 200MB, mount point = /boot/efi, format as “FAT”

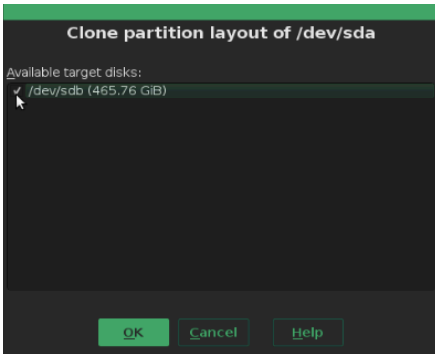
   /dev/sda2, size = 16GB, format as “Swap”

   /dev/sda3, size = rest of the disk space.

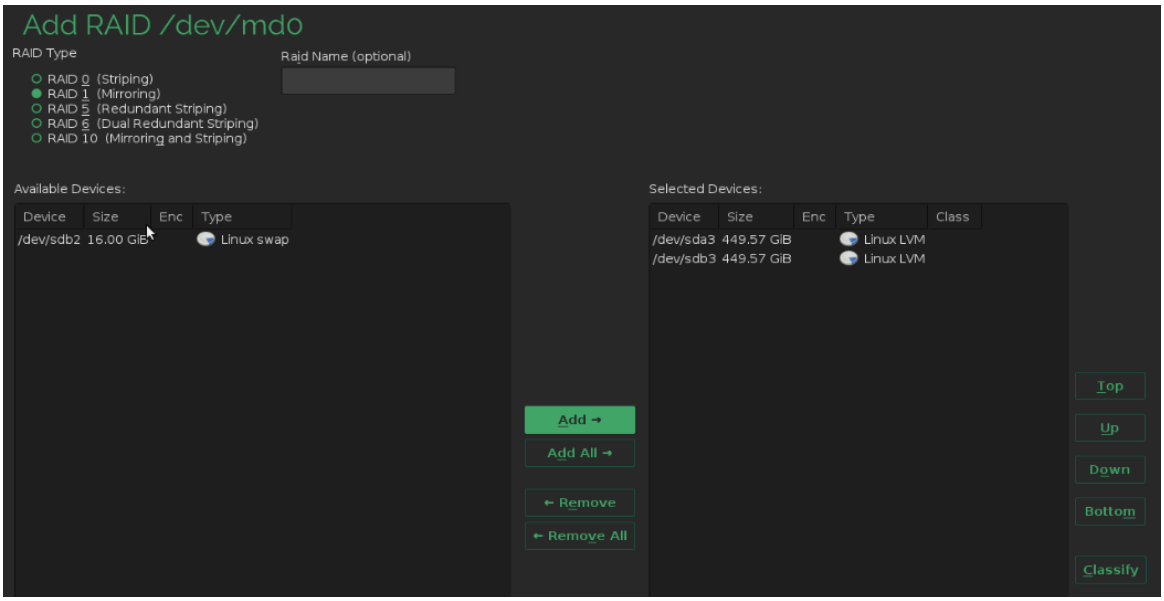


4. After successfully partitioning the first disk, use **Expert** > **Clone this disk…** function to clone the partition scheme to the second disk.

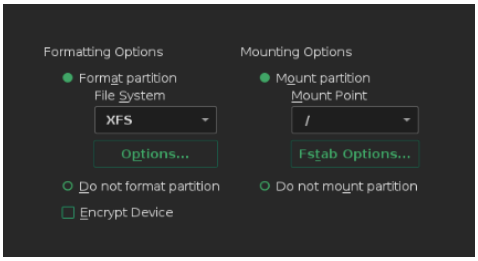




5. In the RAID section, create a RAID1 that includes `/dev/sda3 and /dev/sdb3`:
   a. Click **RAID**.
   b. Choose RAID1 (mirroring).
   c. Select each partition and click **Add** to move them to Selected Devices.

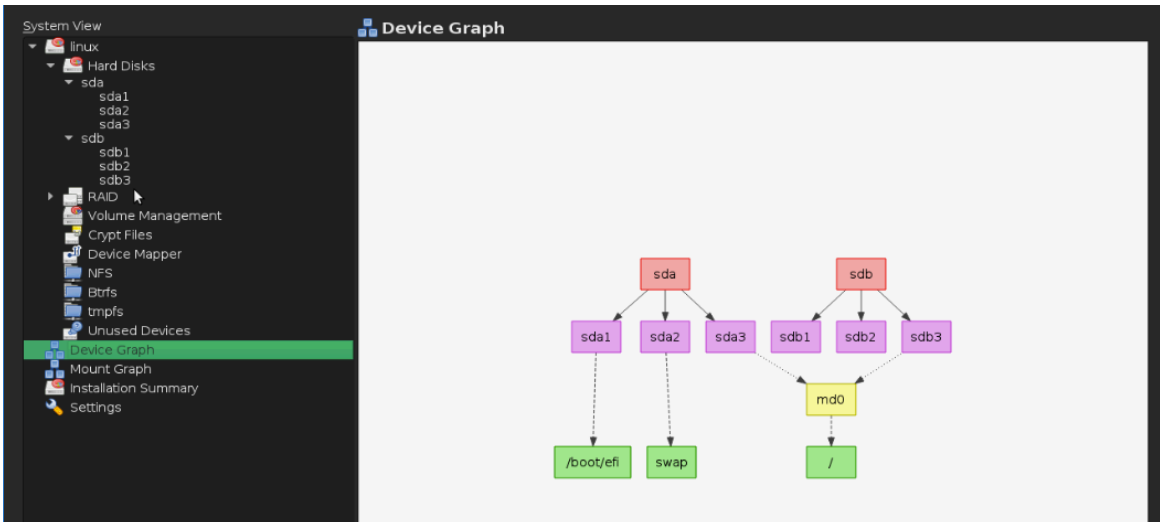


6. Accept default setting such as 4KB Chunk Size, format as XFS and mount it to “/” (root).

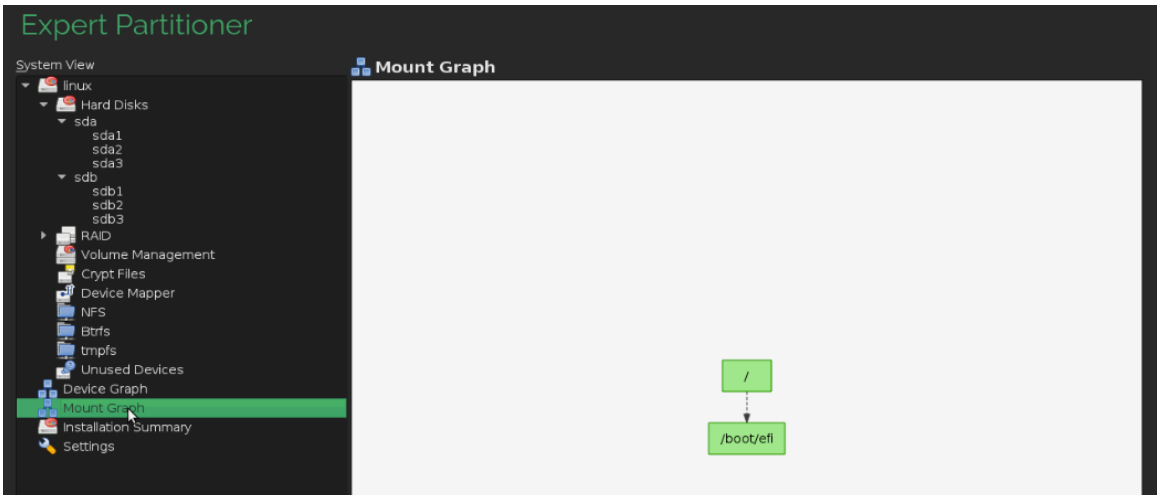


7. Click **Finish**.

   Examine the Device Graph. It should match the screenshot.



8. Examine the Mount Graph. It should match the screenshot.



9. Proceed to finish the installation

Creating the Redundant ESP

1. Log in to SLES.
2. To clone the ESP partition from /dev/sda1 to /dev/sdb1, type the following command.

   ```
   dd if=/dev/sda1 of=/dev/sdb1
   ```

3. “If” means the input, and “of” is the output.

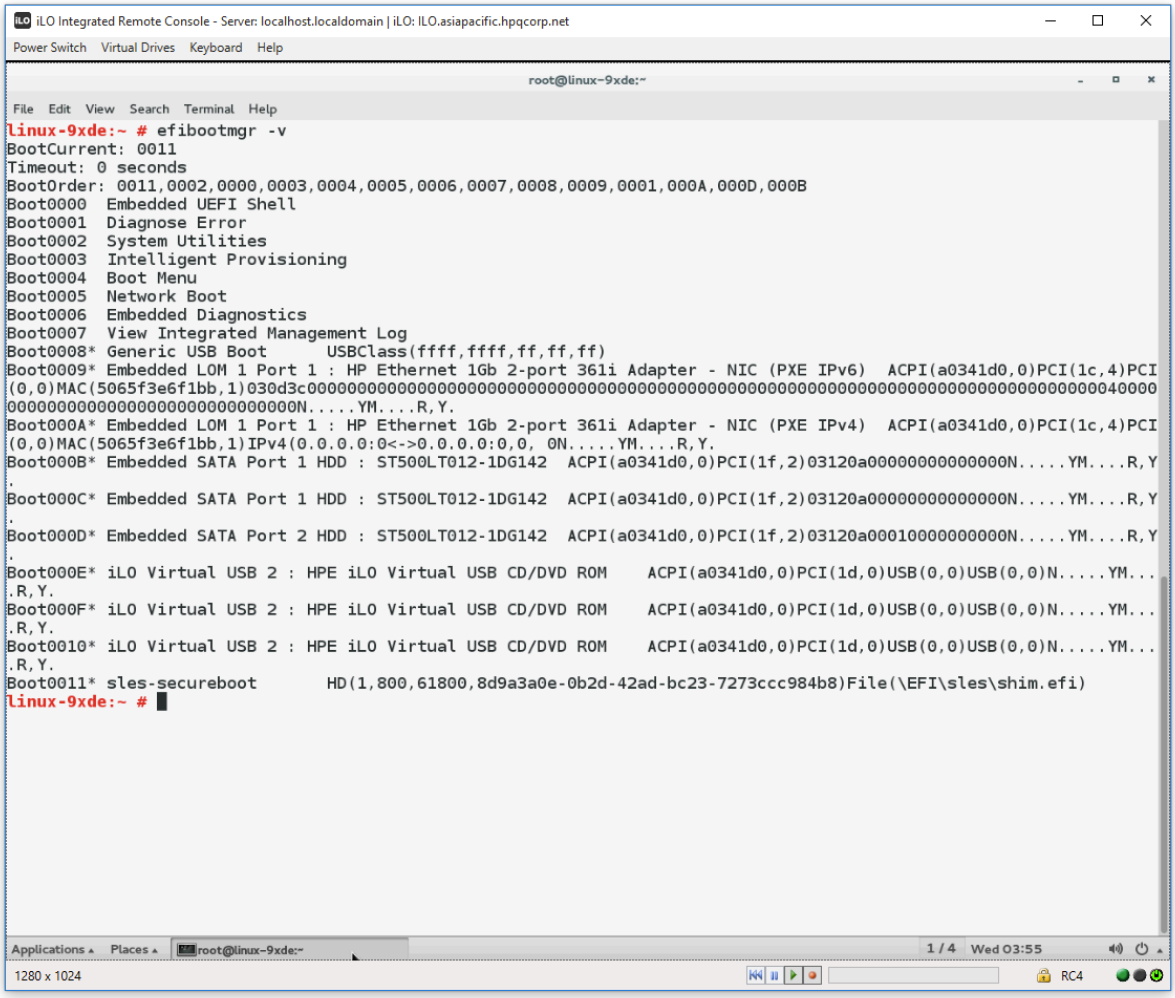
Creating a New Entry in the UEFI Boot Manager

Before creating a new entry for the Redundant ESP for /dev/sdb1, examine the current EFI boot manager. Make sure the contents of the new entry match the existing entry for SLES.

1. To list the entries in the EFI boot manager, type the following command.

   ```
   efibootmgr -v
   ```

2. The following screenshot shows that entry Boot0011 is the SLES entry created by the installer.



3. Create a new entry and name it ‘sles-secureboot2”.

```
efibootmgr –c –d /dev/sdb –p 1 –l \\EFI\\sles\\shim.efi -L “sles-
secureboot2”
```

```
linux-9xde:~ # efibootmgr -c -d /dev/sda -p 1 -l \\EFI\\sles\\shim.efi -L "sles-secureboot2"
BootCurrent: 0011
Timeout: 0 seconds
BootOrder: 0012,0011,0002,0000,0003,0004,0005,0006,0007,0008,0009,000C,0001,000A,000B,000D
Boot0000  Embedded UEFI Shell
Boot0001  Diagnose Error
Boot0002  System Utilities
Boot0003  Intelligent Provisioning
Boot0004  Boot Menu
Boot0005  Network Boot
Boot0006  Embedded Diagnostics
Boot0007  View Integrated Management Log
Boot0008* Generic USB Boot
Boot0009* Embedded LOM 1 Port 1 : HP Ethernet 1Gb 2-port 361i Adapter - NIC (PXE IPv6)
Boot000A* Embedded LOM 1 Port 1 : HP Ethernet 1Gb 2-port 361i Adapter - NIC (PXE IPv4)
Boot000B* iLO Virtual USB 2 : HPE iLO Virtual USB CD/DVD ROM
Boot000C* Embedded SATA Port 1 HDD : ST500LT012-1DG142
Boot000D* Embedded SATA Port 2 HDD : ST500LT012-1DG142
Boot000E* iLO Virtual USB 2 : HPE iLO Virtual USB CD/DVD ROM
Boot000F* iLO Virtual USB 2 : HPE iLO Virtual USB CD/DVD ROM
Boot0010* iLO Virtual USB 2 : HPE iLO Virtual USB CD/DVD ROM
Boot0011* sles-secureboot
Boot0012* sles-secureboot2
linux-9xde:~ #
```

4. The “sles-secureboot2” entry will be created as Boot0012.

   This process will place it as the first boot option. Move it to the second boot option.

   ```
   efibootmgr -o
   ```

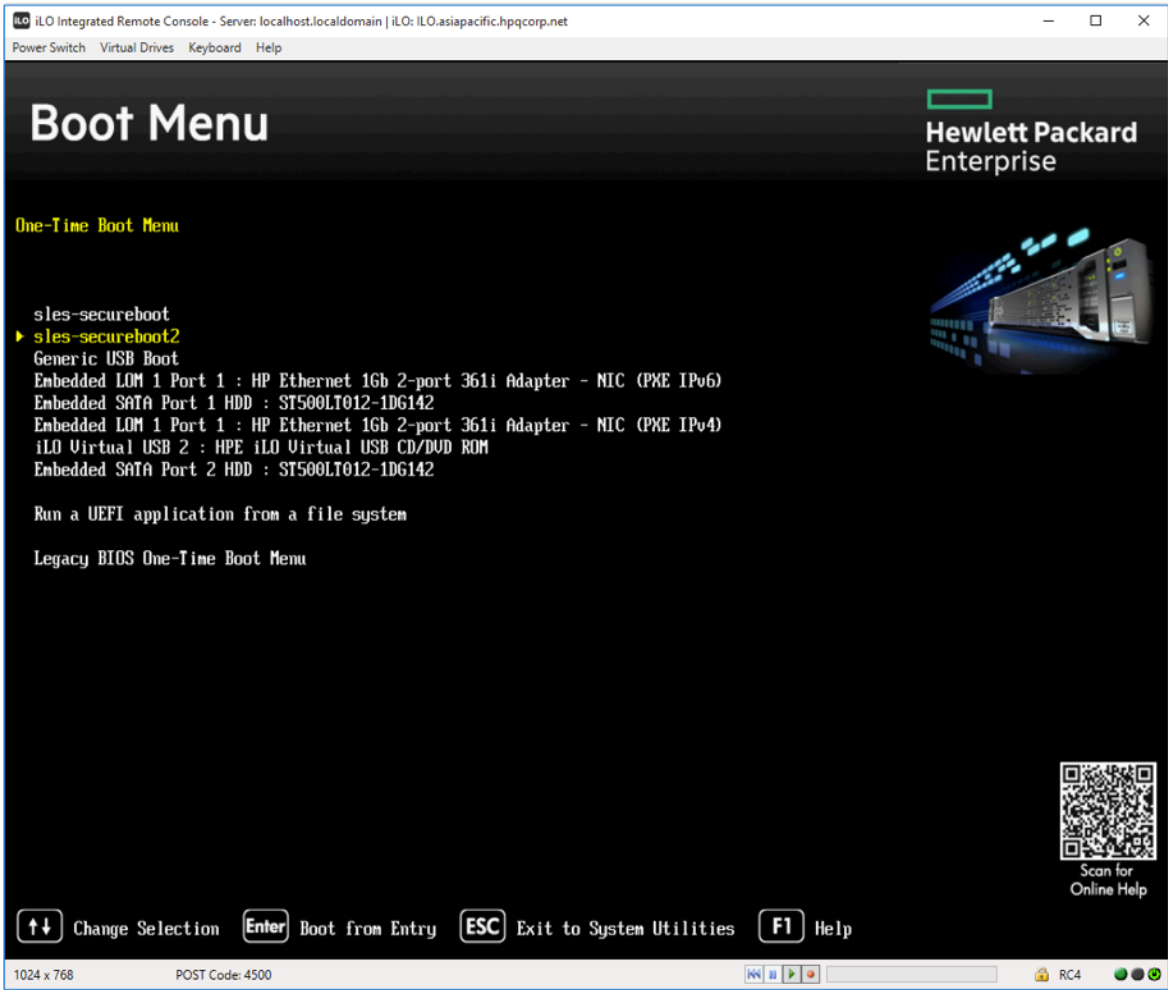
   ```
   0011,0012,0002,0000,0003,0004,0005,0006,0007,0008, 0009,
   000C,0001,000A,000B,000D
   ```

```
linux-9xde:~ # efibootmgr -o 0011,0012,0002,0000,0003,0004,0005,0006,0007,0008,0009,000C,0001,000A,000B,000D
BootCurrent: 0011
Timeout: 0 seconds
BootOrder: 0011,0012,0002,0000,0003,0004,0005,0006,0007,0008,0009,000C,0001,000A,000B,000D
Boot0000  Embedded UEFI Shell
Boot0001  Diagnose Error
Boot0002  System Utilities
Boot0003  Intelligent Provisioning
Boot0004  Boot Menu
Boot0005  Network Boot
Boot0006  Embedded Diagnostics
Boot0007  View Integrated Management Log
Boot0008* Generic USB Boot
Boot0009* Embedded LOM 1 Port 1 : HP Ethernet 1Gb 2-port 361i Adapter - NIC (PXE IPv6)
Boot000A* Embedded LOM 1 Port 1 : HP Ethernet 1Gb 2-port 361i Adapter - NIC (PXE IPv4)
Boot000B* iLO Virtual USB 2 : HPE iLO Virtual USB CD/DVD ROM
Boot000C* Embedded SATA Port 1 HDD : ST500LT012-1DG142
Boot000D* Embedded SATA Port 2 HDD : ST500LT012-1DG142
Boot000E* iLO Virtual USB 2 : HPE iLO Virtual USB CD/DVD ROM
Boot000F* iLO Virtual USB 2 : HPE iLO Virtual USB CD/DVD ROM
Boot0010* iLO Virtual USB 2 : HPE iLO Virtual USB CD/DVD ROM
Boot0011* sles-secureboot
Boot0012* sles-secureboot2
linux-9xde:~ #
```

5. The actual number of entries depends on the system configuration. Check the entries by entering:

   ```
   efibootmgr -v
   ```

6. Verify the boot entry by rebooting the system, press **F11** to the boot menu. “sles-secureboot2” should be in the boot menu.
7. Boot in to the system to verify it works.
8. Log in the system.



Recovering a failed disk and repairing Software RAID

In the event of a failed disk, it is necessary to recover the failed partition and restore the software RAID. Logging in to the system through the second disk is possible when the EFI boot entries are set properly.

Examine the RAID status

1. To examine the status of the RAID configuration, enter the following:

   `mdadm --detail /dev/md0`

   - Total Devices became “1”.
   - State changed to “clean, degraded”.
   - Disk `/dev/sdb3` has become `/dev/sda3`.

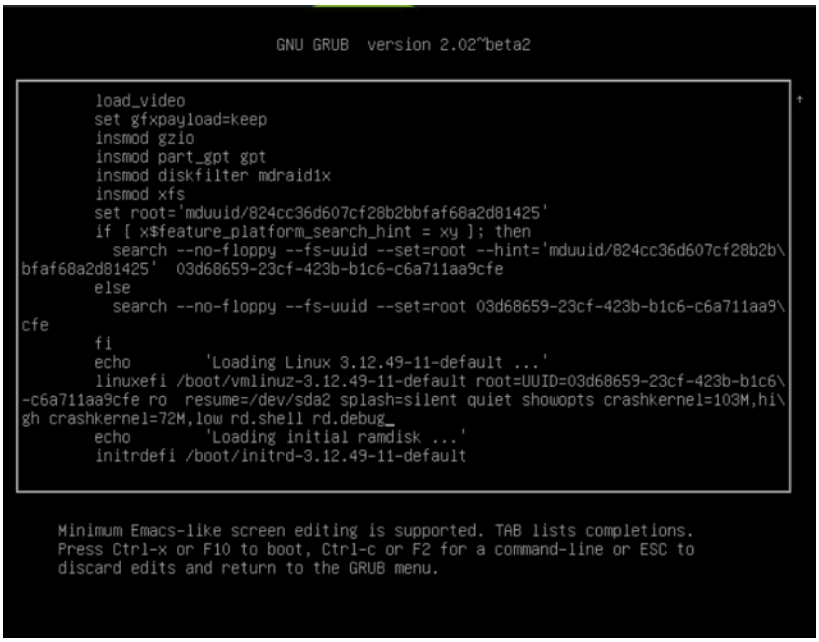
   It is the only available disk.

Add two additional kernel parameters to allow booting from the second disk

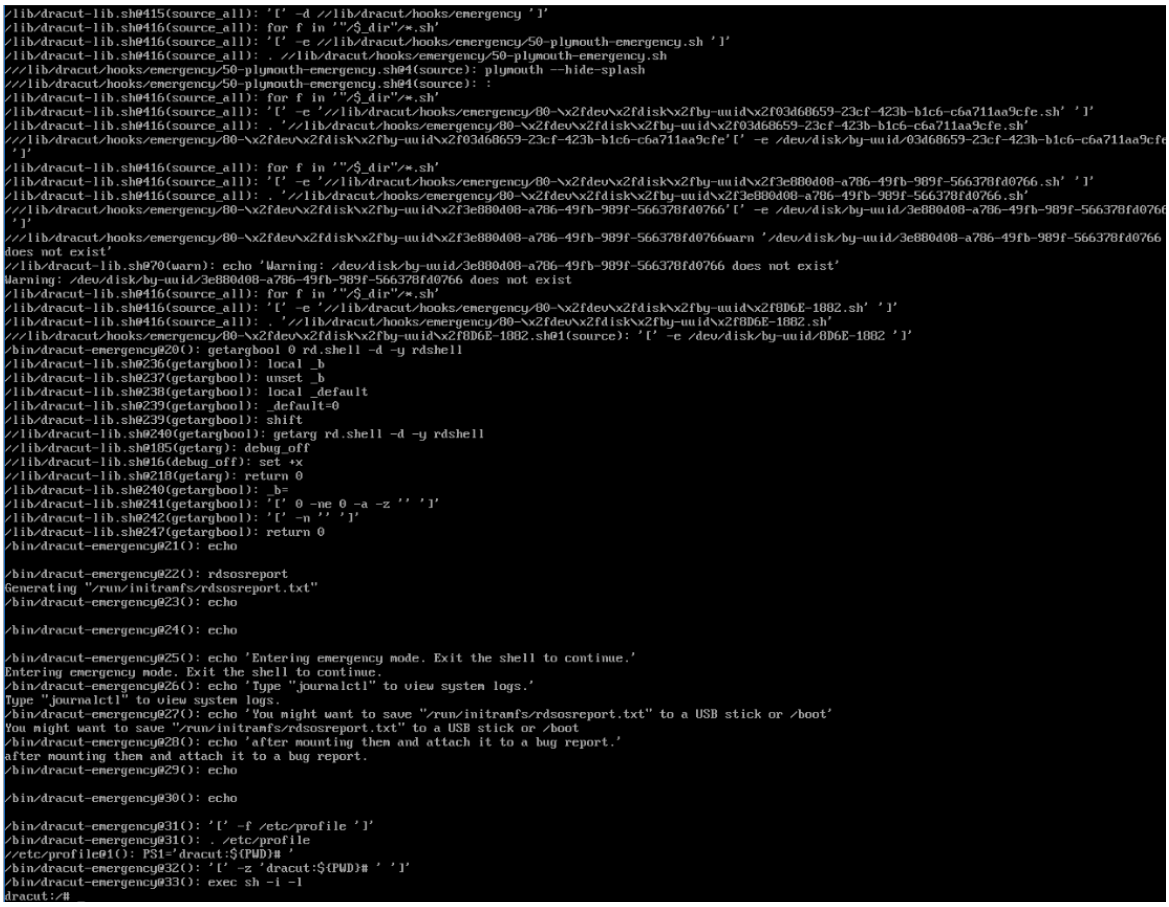
In SLES, if the first disk fails two additional kernel parameters must be added to allow the system to successfully boot from the second disk.

1. From the GRUB menu, press the **e** key to edit the kernel parameter.
2. Find the line ending with `crashkerel=72M,low`
3. Append `rd.shell rd.debug`
4. Press **Ctrl-x** or **F10** to boot with the new setting.

   This is a one-time setting only. It will not impact subsequent boots.



After a few minutes, the screen will enter a rescue shell.



Recovering the failed partition

1. Prepare a new disk portioned as described in “Partitioning a drive for SLES.”
2. Boot from the “sles-secureboot2”.

   Make sure proper kernel parameters (rd.shell rd.debug) were added to enter the rescue shell.

   The new disk will be shown as /dev/sda, and the original second disk will appear as /dev/sdb.

   To add the new /dev/sda3 to rebuild the RAID, type the following command in the rescue shell.

   ```
   mdadm --add /dev/md0 /dev/sda3
   ```

3. Enter the following command.

   ```
   mdadm --detail /dev/md0
   ```

   The State will change to “clean, degraded, recovering” and the Rebuild Status “75% complete” (or other progress number).

4. Once the rebuild has completed, the State will change to “clean”,

   The recovery is complete.

```
linux-9xde:~ # mdadm --add /dev/md0 /dev/sda3
mdadm: added /dev/sda3
linux-9xde:~ # mdadm --detail /dev/md0
/dev/md0:
        Version : 1.0
  Creation Time : Tue Mar 29 16:43:01 2016
     Raid Level : raid1
     Array Size : 471405376 (449.57 GiB 482.72 GB)
  Used Dev Size : 471405376 (449.57 GiB 482.72 GB)
   Raid Devices : 2
  Total Devices : 2
    Persistence : Superblock is persistent

  Intent Bitmap : Internal

    Update Time : Wed Mar 30 05:48:11 2016
          State : clean, degraded, recovering
 Active Devices : 1
Working Devices : 2
 Failed Devices : 0
  Spare Devices : 1

 Rebuild Status : 0% complete

           Name : any:0
           UUID : 824cc36d:607cf28b:2bbfaf68:a2d81425
         Events : 1742

    Number   Major   Minor   RaidDevice State
       2       8        3        0      spare rebuilding   /dev/sda3
       1       8       19        1      active sync   /dev/sdb3
linux-9xde:~ # _
```

Complete the recovery process

To make a redundant copy of the ESP, repeat the process described in "Creating a redundant ESP."

Add a new entry to EFI Boot Manager to complete the recovery process.

1. Replicate the ESP from /dev/sdb1 back to /dev/sda1.

   ```
   dd –if=/dev/sdb1 –of=/dev/sda1
   ```

2. Remove the existing SLES boot entry:

   ```
   efibootmgr –b 11 –B
   ```

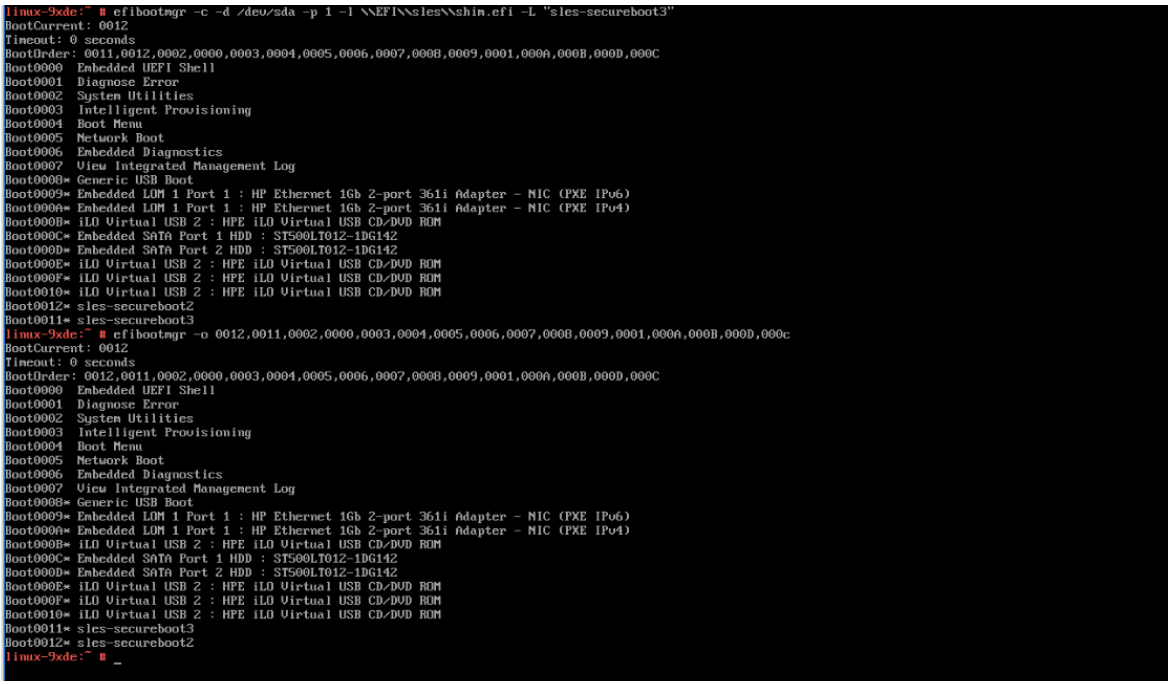
```
linux-9xde:~ # dd if=/dev/sdb1 of=/dev/sda1
399360+0 records in
399360+0 records out
204472320 bytes (204 MB) copied, 4.98957 s, 41.0 MB/s
linux-9xde:~ # efibootmgr -b 11 -B
BootCurrent: 0012
Timeout: 0 seconds
BootOrder: 0012,0002,0000,0003,0004,0005,0006,0007,0008,0009,0001,000A,000B,000D,000C
Boot0000  Embedded UEFI Shell
Boot0001  Diagnose Error
Boot0002  System Utilities
Boot0003  Intelligent Provisioning
Boot0004  Boot Menu
Boot0005  Network Boot
Boot0006  Embedded Diagnostics
Boot0007  View Integrated Management Log
Boot0008* Generic USB Boot
Boot0009* Embedded LOM 1 Port 1 : HP Ethernet 1Gb 2-port 361i Adapter - NIC (PXE IPv6)
Boot000A* Embedded LOM 1 Port 1 : HP Ethernet 1Gb 2-port 361i Adapter - NIC (PXE IPv4)
Boot000B* iLO Virtual USB 2 : HPE iLO Virtual USB CD/DVD ROM
Boot000C* Embedded SATA Port 1 HDD : ST500LT012-1DG142
Boot000D* Embedded SATA Port 2 HDD : ST500LT012-1DG142
Boot000E* iLO Virtual USB 2 : HPE iLO Virtual USB CD/DVD ROM
Boot000F* iLO Virtual USB 2 : HPE iLO Virtual USB CD/DVD ROM
Boot0010* iLO Virtual USB 2 : HPE iLO Virtual USB CD/DVD ROM
Boot0012* sles-secureboot2
linux-9xde:~ #
```

3. Create new entry for the replicated ESP:

   ```
   efibootmgr –c –d /dev/sda –p 1 –l \\EFI\\sles\\shim.efi -L "sles-secureboot2"
   ```

4. Reorder the boot sequence:

```
efibootmgr -o
0012,0011,0002,0000,0003,0004,0005,0006,0007,0008,0009,0001,0001,000A,0
00B,000D,000C
```



Appendix B: Example server configurations

PXE server configuration

The PXE configuration file is located in **/data/tftpboot/EFI/eilo.cfg**. It may be in a different location in your environment.

The following sample configuration shows how to specify the default entry, timeout, etc. As you proceed, you will create additional PXE entries in this file.

```
chooser=simple #This setting will directly boot into default entry for
mass deployment use. If you want to manually select, you can modify to
textmenu.

#message=textmenu-message.msg

prompt

delay=0

timeout=10 #Time out (second)

default=toolkit10.40.RHEL7.3  #The default boot entry.


# For RHEL7.3 Multiple Servers Deployment

image=/tools/toolkit10.40/vmlinuz

label=toolkit10.40.RHEL7.3

description = "HPE Scripting Toolkit 10.40 RHEL7.3"

initrd=/tools/toolkit10.40/initrd.img

append="root=/dev/ram0 rw ramdisk_size=785612 quiet=1 sstk_nic=eth0
network=1 media=net numa=off sstk_conf=toolkit.conf
sstk_script=/deploy.sh sstk_tgz=http://172.1.1.100/answers/STK/hpe-
scripting-toolkit-linux-10.40-rhel7_3.tar.gz" #The place to change file
path.


# For SLES 12 SP2 Multiple Server Deployment

image=/tools/toolkit10.40/vmlinuz

label=toolkit10.40.SLE12SP2

description = "HP Scripting Toolkit 10.40 SUSE 12 SP2"

initrd=/tools/toolkit10.40/initrd.img
```

```
append="root=/dev/ram0 rw ramdisk_size=785612 quiet=1 sstk_nic=eth0
network=1 media=net numa=off sstk_conf=toolkit.conf
sstk_script=/deploy.sh sstk_tgz=http://172.1.1.100/answers/STK/hpe-
scripting-toolkit-linux-10.40-sle12sp2.tar.gz" #The place to change
file path.


# For RHEL7.3 Single Machine Deployment

image=/RHEL/RHEL-7.3Server-x86_64/vmlinuz

label=RHEL-7.3Server-x86_64_ks

description = "RHEL 7.3 Server RAID1 kickstart"

initrd=/RHEL/RHEL-7.3Server-x86_64/initrd.img

append="ipv6.disable=1
inst.ks=http://172.1.1.100/answers/RHEL7_3_RAID1_ks.cfg" #The place to
change file path.


# For SLES 12 SP2 Single Machine Deployment

image=/SLE/SLE-12-SP2-Server-x86_64/linux

label=SLE-12-SP2-Server-x86_64_ks

description = "SLES 12 SP2 RAID1 ks"

initrd=/SLE/SLE-12-SP2-Server-x86_64/initrd

append="vga=normal netdev=eth1
autoyast=http://172.1.1.100/answers/SLES12SP2_RAID1_autoinst.xml instal
l=http://172.1.1.100/mrepo/SLE-12-SP2-Server-x86_64/disc1" #The place
to change file path.
```

TFTP server configuration

The TFTP configuration file is located in **/etc/xinetd.d/tftp**.

```
# default: off

# description: The tftp server serves files using the trivial file
transfer \

# protocol. The tftp protocol is often used to boot diskless \

# workstations, download configuration files to network-aware printers,
\

# and to start the installation process for some operating systems.
```

```
service tftp
{
    socket_type = dgram
    protocol = udp
    wait = yes
    user = root
    server = /usr/sbin/in.tftpd
    server_args = -s /data/tftpboot #Where your tftp root directory
path
    disable = no
    per_source = 11
    cps = 100 2
    flags = IPv4
}
```

DHCP server configuration

The DHCP configuration file can be found in:

```
#
# DHCP Server Configuration file.
# see /usr/share/doc/dhcp*/dhcpd.conf.example
# see dhcpd.conf(5) man page
#
ddns-update-style none;
ignore client-updates;
default-lease-time 259200;
max-lease-time 518400;
option routers 172.1.1.100; #Where you DHCP server IP
option domain-name "tw.linux.rdlab";
option space PXE;
option PXE.mtftp-ip code 1 = ip-address;
option PXE.mtftp-cport code 2 = unsigned integer 16;
```

```
option PXE.mtftp-sport code 3 = unsigned integer 16;
option PXE.mtftp-tmout code 4 = unsigned integer 8;
option PXE.mtftp-delay code 5 = unsigned integer 8;
option arch code 93 = unsigned integer 16; # RFC4578
allow booting;
allow bootp;
authoritative;
#option option-128 code 128 = string;
#option option-129 code 129 = text;
#next-server 172.1.1.254;
#filename "pxelinux.0";

class "pxe-clients" {
    match if substring (option vendor-class-identifier, 0, 9) =
"PXEClient";
    next-server 172.1.1.100; #Where you tftp server IP
    if option arch = 00:07 {
        filename "EFI/bootx64.efi";
    } else {
        filename "pxelinux.0";
    }
}
subnet 172.1.1.0 netmask 255.255.255.0 {
    range 172.1.1.101 172.1.1.200; #Where you DHCP IP range.
}
```

Appendix C: Example OS-specific installation scripts

KickStart Script for RHEL 7.3

For the example KickStart script, see
http://downloads.linux.hpe.com/SDR/project/lsrrb/current/RHEL7_3_RAID1_ks.cfg

Place the script in your local TFTP server where your PXE installation can connect to it.

In RHEL 7.3, you will need one extra package, which is can be downloaded from:

http://downloads.linux.hpe.com/SDR/project/lsrrb/current/lsrrb-1.2.0-2.x86_64.rpm

Download it from the above URL and place on your local TFTP server, and specify them in the installation script.

Modifying the KickStart script for RHEL 7.3

In the KickStart script, there are configurable parameters that user should adjust to fit the deployment environments.

Parameter Name	Description and Example
url	The URL for the RHEL installation media `url –url "http://172.1.1.100/mrepo/RHEL-7.3Server-x86_64/disc1/"`
rootpw	The password for the root user `rootpw –plaintext "Passw0rd"`

%packages … %end	Packages to install
	`%packages`
	`@base`
	`@core`
	`wget`
	`net-tools`
	`dhcp`
	`mdadm`
	`gdisk`

	smartmontools %end
part	Disk partition information. This example creates a 256 MB ESP partition, a 16384RAID MB swap partition, and a raid volume that takes the remaining space. (For NVMe disks, replace sda with nvme0n1p1 and sdb with nvme1n1p1) part /boot/efi --fstype=efi --ondisk=sda --size=256 part swap --fstype=swap --ondisk=sda –size=16384 part raid.01 --fstype=raid --ondisk=sda --size=1 --grow part none.01 --fstype=efi --ondisk=sdb --size=256 part none.02 --fstype=vfat --ondisk=sdb --size=16384 part raid.02 --fstype=raid
raid	RAID configuration raid / --device=md0 --fstype=xfs --level=1 raid.01 raid.02
%post	Specify the log path for the post-install scripts %post --interpreter /bin/bah --log /var/log/ks.cfg.log
wget	The path to get the RPM package wget -P /tmp http://172.1.1.100/answers/mdsync/lsrrb-1.2.0-2.x86_64.rpm

KickStart Script for RHEL 6.8

For the example KickStart script, see
http://downloads.linux.hpe.com/SDR/project/lsrrb/current/RHEL6_8_RAID1_ks.cfg

Place the script in your local TFTP server where your PXE installation can connect to it.

In RHEL 6.8, you will need one extra package, which is can be downloaded from:

http://downloads.linux.hpe.com/SDR/project/lsrrb/current/lsrrb-1.2.0-2.el6.x86_64.rpm

Download it from the above URL and place on your local TFTP server, and specify them in the installation script.

Modifying the KickStart script for RHEL 6.8

In the KickStart script, there are configurable parameters that user should adjust to fit the deployment environments.

Parameter Name	Description and Example
url	The URL for the RHEL installation media `url –url "http://172.1.1.100/mrepo/RHEL-7.3Server-x86_64/disc1/"`
rootpw	The password for the root user `rootpw –plaintext "Passw0rd"`

%packages … %end	Packages to install
	`%packages`
	`@base`
	`@core`
	`wget`
	`net-tools`
	`dhcp`
	`mdadm`
	`gdisk`
	`smartmontools`
	`%end`

part	Disk partition information. This example creates a 256 MB ESP partition, a 16384RAID MB swap partition, and a raid volume that takes the remaining space. (For NVMe disks, replace sda with nvme0n1p1 and sdb with nvme1n1p1)
	`part /boot/efi --fstype=efi --ondisk=sda --size=256`
	`part swap --fstype=swap --ondisk=sda –size=16384`
	`part raid.01 --fstype=raid --ondisk=sda --size=1 --grow`
	`part none.01 --fstype=efi --ondisk=sdb --size=256`
	`part none.02 --fstype=vfat --ondisk=sdb --size=16384`
	`part raid.02 --fstype=raid`

raid	RAID configuration `raid / --device=md0 --fstype=xfs --level=1 raid.01 raid.02`
%post	Specify the log path for the post-install scripts `%post --interpreter /bin/bah --log /var/log/ks.cfg.log`
wget	The path to get the RPM package

	`wget -P /tmp http://172.1.1.100/answers/mdsync/lsrrb-1.2.0-2.el6.x86_64.rpm`

AutoYast Script for SLES 12 SP2

For the example AutoYast script, see (use wget to retrieve the file)
http://downloads.linux.hpe.com/SDR/project/lsrrb/current/SLES12SP2_RAID1_autoinst.xml

Place the script in your local TFTP server where your PXE installation can connect to it.

In SLES 12 SP2, you will need one extra package, which can be downloaded from:

http://downloads.linux.hpe.com/SDR/project/lsrrb/current/lsrrb-1.2.0-2.x86_64.rpm

Download it from the above URL and place it on your local TFTP server. Specify it in the installation script.

Modifying the AutoYast script for SLES 12 SP2

In the AutoYast script, there are configurable parameters that user should adjust to fit the deployment environments.

Parameter Name	**Description and Example**
wget	The path to get the RPM package. `wget -P /tmp http://172.1.1.100/answers/mdsync/lsrrb-1.2.0-2.x86_64.rpm`

<drive> … </drive>	Hard drive configuration. Check the AutoYast file. This example is for two identical 500GB hard drives. Each drive is partitioned as 1) 187 MB ESP partition; 2) 16 GB of swap partition; 3) remaining 482 GB for data. (For NVMe disks, replace sda with nvme0n1p1 and sdb with nvme1n1p1)
	The RAID device `/dev/md0` will be create to include `/dev/sda3` and `/dev/sdb3`.
	`<drive> # Where to modify HD partitions. Default is for the two 500G HDs.`
	`  <device>/dev/md</device>`
	`  <disklabel>msdos</disklabel>`
	`<enable_snapshots config:type="boolean">true</enable_snapshots>`
	`  <initialize config:type="boolean">true</initialize>`
	`  <partitions config:type="list">`
	`  <partition>`
	`  <create config:type="boolean">true</create>`
	`  <crypt_fs config:type="boolean">false</crypt_fs>`
	`  <filesystem config:type="symbol">xfs</filesystem>`
	`  <format config:type="boolean">true</format>`

```
      <loop_fs config:type="boolean">false</loop_fs>
      <mount>/</mount>
      <mountby config:type="symbol">uuid</mountby>
      <partition_nr config:type="integer">0</partition_nr>
      <raid_options>
        <device_order config:type="list">
          <device>/dev/sda3</device>
          <device>/dev/sdb3</device>
        </device_order>
<persistent_superblock config:type="boolean">false</persistent_s
uperblock>
        <raid_type>raid1</raid_type>
      </raid_options>
      <resize config:type="boolean">false</resize>
    </partition>
  </partitions>
  <pesize/>
  <type config:type="symbol">CT_MD</type>
  <use>all</use>
</drive>
<drive>
  <device>/dev/sda</device>
  <disklabel>gpt</disklabel>
<enable_snapshots config:type="boolean">true</enable_snapshots>
  <initialize config:type="boolean">true</initialize>
  <partitions config:type="list">
    <partition>
      <create config:type="boolean">true</create>
      <crypt_fs config:type="boolean">false</crypt_fs>
      <filesystem config:type="symbol">vfat</filesystem>
      <format config:type="boolean">true</format>
      <fstopt>umask=0002,utf8=true</fstopt>
      <loop_fs config:type="boolean">false</loop_fs>
      <mount>/boot/efi</mount>
      <mountby config:type="symbol">uuid</mountby>
<partition_id config:type="integer">259</partition_id>
<partition_nr config:type="integer">1</partition_nr>
      <resize config:type="boolean">false</resize>
      <size>196247040</size>
    </partition>
    <partition>
      <create config:type="boolean">true</create>
      <crypt_fs config:type="boolean">false</crypt_fs>
      <filesystem config:type="symbol">swap</filesystem>
      <format config:type="boolean">true</format>
      <loop_fs config:type="boolean">false</loop_fs>
      <mount>swap</mount>
      <mountby config:type="symbol">uuid</mountby>
    <partition_id config:type="integer">130</partition_id>
      <partition_nr config:type="integer">2</partition_nr>
      <resize config:type="boolean">false</resize>
      <size>17174789632</size>
    </partition>
    <partition>
```

```
      <create config:type="boolean">true</create>
      <crypt_fs config:type="boolean">false</crypt_fs>
      <format config:type="boolean">false</format>
      <loop_fs config:type="boolean">false</loop_fs>
      <mountby config:type="symbol">device</mountby>
    <partition_id config:type="integer">253</partition_id>
      <partition_nr config:type="integer">3</partition_nr>
      <raid_name>/dev/md0</raid_name>
      <resize config:type="boolean">false</resize>
      <size>482711076352</size>
    </partition>
  </partitions>
  <pesize/>
  <type config:type="symbol">CT_DISK</type>
  <use>all</use>
</drive>
<drive>
  <device>/dev/sdb</device>
  <disklabel>gpt</disklabel>
<enable_snapshots config:type="boolean">true</enable_snapshots>
  <initialize config:type="boolean">true</initialize>
  <partitions config:type="list">
    <partition>
      <create config:type="boolean">true</create>
      <crypt_fs config:type="boolean">false</crypt_fs>
      <filesystem config:type="symbol">vfat</filesystem>
      <format config:type="boolean">true</format>
      <fstopt>umask=0002,utf8=true</fstopt>
      <loop_fs config:type="boolean">false</loop_fs>
      <mount>/boot/efi</mount>
      <mountby config:type="symbol">uuid</mountby>
<partition_id config:type="integer">259</partition_id>
<partition_nr config:type="integer">1</partition_nr>
      <resize config:type="boolean">false</resize>
      <size>196247040</size>
    </partition>
    <partition>
      <create config:type="boolean">true</create>
      <crypt_fs config:type="boolean">false</crypt_fs>
      <filesystem config:type="symbol">swap</filesystem>
      <format config:type="boolean">true</format>
      <loop_fs config:type="boolean">false</loop_fs>
      <mount>swap</mount>
      <mountby config:type="symbol">uuid</mountby>
    <partition_id config:type="integer">130</partition_id>
      <partition_nr config:type="integer">2</partition_nr>
      <resize config:type="boolean">false</resize>
      <size>17174789632</size>
    </partition>
    <partition>
      <create config:type="boolean">true</create>
      <crypt_fs config:type="boolean">false</crypt_fs>
      <format config:type="boolean">false</format>
      <loop_fs config:type="boolean">false</loop_fs>
```

	<mountby config:type="symbol">device</mountby> <partition_id config:type="integer">253</partition_id> <partition_nr config:type="integer">3</partition_nr> <raid_name>/dev/md0</raid_name> <resize config:type="boolean">false</resize> <size>482711076352</size> </partition> </partitions> <pesize/> <type config:type="symbol">CT_DISK</type> <use>all</use> </drive>
<http_proxy> ... </http_proxy> >	The http proxy used in the deployment environment. <http_proxy>http://proxy:port</http_proxy>
<software> … </software>	The software packages to install. <software> <image/> <instsource/> <packages config:type="list"> <package>xfsprogs</package> <package>sles-release</package> <package>shim</package> <package>mokutil</package> <package>mdadm</package> <package>numactl</package> <package>kexec-tools</package> <package>kdump</package> <package>irqbalance</package> <package>grub2-x86_64-efi</package> <package>glibc</package> <package>efibootmgr</package> <package>dosfstools</package> <package>perl-Bootloader-YAML</package> </packages> <patterns config:type="list"> <pattern>apparmor</pattern> <pattern>x11</pattern> <pattern>documentation</pattern> <pattern>base</pattern> <pattern>gnome-basic</pattern> <pattern>Minimal</pattern> <pattern>32bit</pattern> </patterns> </software>
<users> .. </users>	The users described in this section will be created. In the example, user ‘hpe’ will be created with password ‘Passw0rd’.

Appendix D Support for Gen10 and AMD Platform

This section outlines procedures for configuring Software RAID for HPE ProLiant Gen10 servers and ProLiant servers utilizing AMD processors.

The following platforms are covered:

- AMD Platform with AMD's FCH AHCI controller, with two traditional hard drives.
- Gen10 Platform with two M.2 SSD drives.
- Gen10 Platform with two NVMe drives.

The operating systems covered in this section are:

- Red Hat Enterprise Linux 7.3
- SuSE Linux Enterprise Server 12 SP2

AMD Platform with AMD FCH AHCI Controller

Red Hat Enterprise Linux (RHEL) 7.3

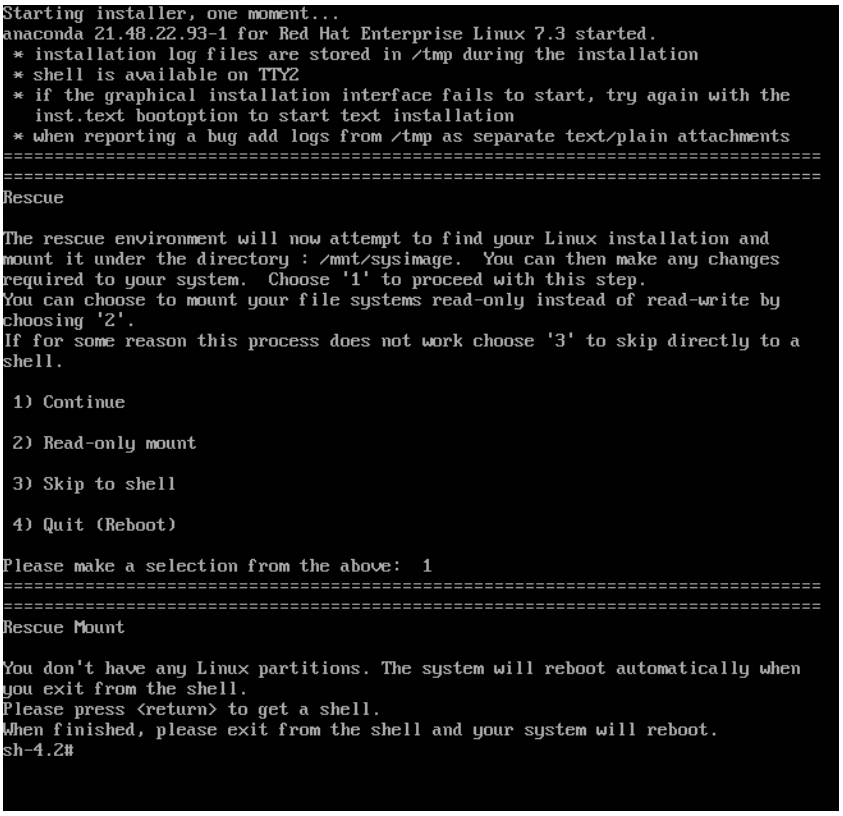
Manually Partitioning through Rescue mode

Partition the disk manually in Rescue mode before proceeding to the normal installation process.

Do not use the RHEL GUI installer.

1. Boot from the RHEL 7.3 DVD image.
2. Select Troubleshooting > Rescue a Red Hat Enterprise Linux system.
3. Select 1) Continue.

The following prompt is displayed:



4. To create partitions on the first disk (/dev/sdb), type the following commands. (In this setup, we use external USB driver as the installation media, which will occupy /dev/sda, but it won't affect our settings)

   ```
   parted /dev/sdb mklabel gpt
   ```

5. Type "Yes" to confirm changes are made to the existing disk label.

   The following is displayed:

   ```
   parted /dev/sdb mkpart primary fat32 0 200MB
   ```

6. Type "Ignore" to ignore the size mismatch.

   The following is displayed:

   ```
   parted /dev/sdb mkpart primary ext2 200MB 16GB
   ```

   ```
   parted /dev/sdb print
   ```

7. Refer to the screenshot for detail partitioning instruction and information for /dev/sdb.

```
sh-4.2# parted /dev/sdb print
Model: ATA ST500LT012-1DG14 (scsi)
Disk /dev/sdb: 500GB
Sector size (logical/physical): 512B/4096B
Partition Table: gpt
Disk Flags:

Number  Start   End     Size    File system     Name     Flags
 1      17.4kB  200MB   200MB   fat16           primary
 2      200MB   16.0GB  15.8GB  linux-swap(v1)  primary

sh-4.2# _
```

8. Repeat step 5 for the second disk (/dev/sdc).

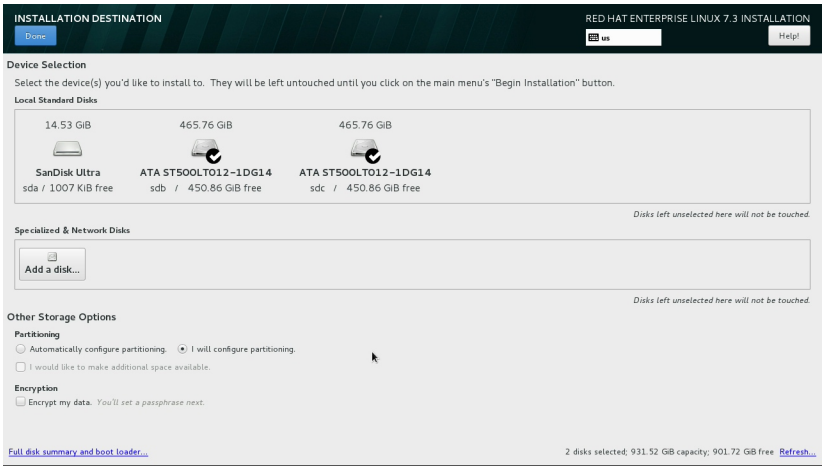
   Refer to the screenshot for detail partitioning instruction and information for /dev/sdc.

```
sh-4.2# parted /dev/sdc print
Model: ATA ST500LT012-1DG14 (scsi)
Disk /dev/sdc: 500GB
Sector size (logical/physical): 512B/4096B
Partition Table: gpt
Disk Flags:

Number  Start   End     Size    File system  Name     Flags
 1      17.4kB  200MB   200MB   fat16        primary
 2      200MB   16.0GB  15.8GB               primary

sh-4.2# _
```

9. Reboot to proceed with Red Hat installation.

Normal Installation Process

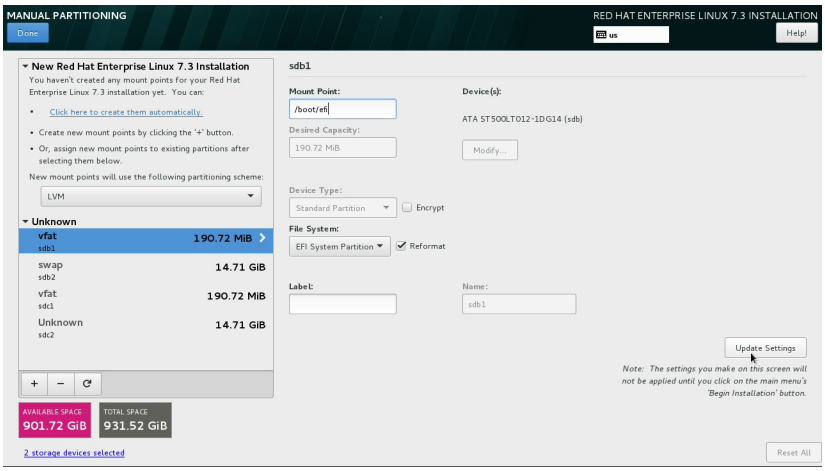
The software RAID installation differs from the normal installation process only in the “Installation Destination” step. In the “Installation Destination”, specify the ESP, swap and root partition respectively. In the “Installation Destination” step, make sure both disks are selected, and “I will configure partitioning” is selected.



Specifying the ESP

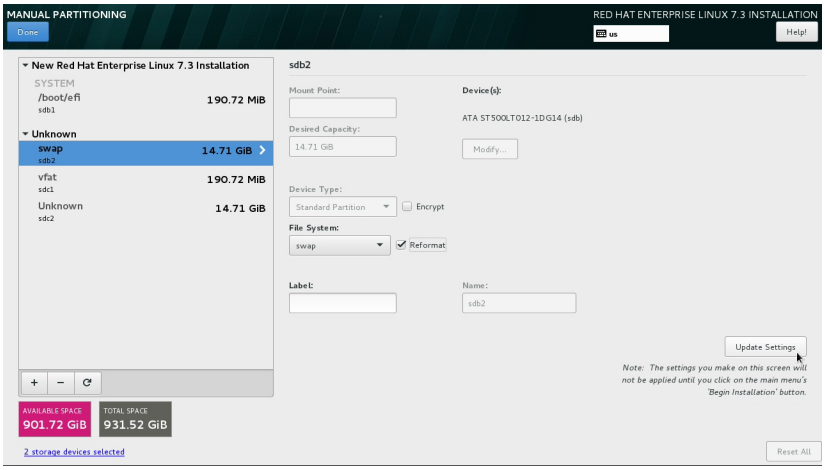
The ESP is the partition that contains the boot loaders used by the UEFI firmware.

1. Select **sda1** under Unknown in the left pane.
2. Under File System, select **EFI System Partition** and check **Reformat**.
3. In the Mount Point field, enter `/boot/efi`.
4. Click **Update Settings**.



Specifying the swap directory

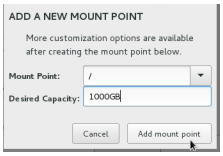
1. Select **sda2** in the “Unknown” section.
2. In the File System dropdown, select **swap** and check **Reformat**.
3. Click **Update Settings**.



Creating root disk as RAID1

1. Click **+**.
2. To choose the root directory, enter “/” as mount point.
3. Enter “1000GB” in Desired Capacity.

   The system will calculate the correct size.
4. Click **Add mount point**.

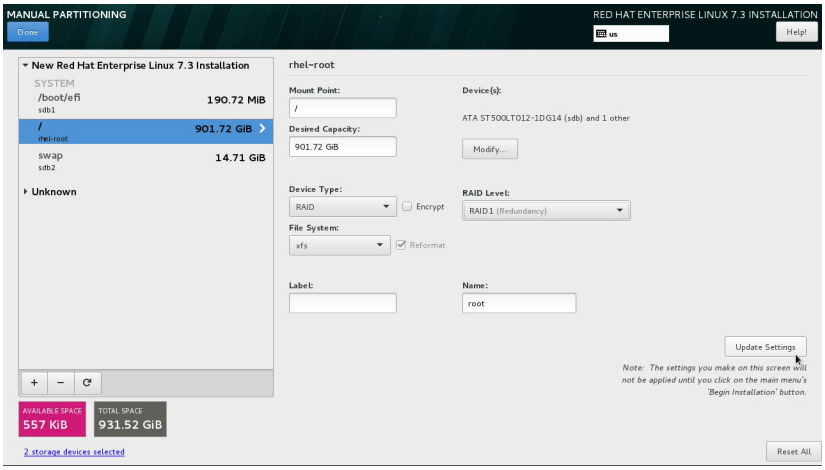


Create a RAID1 root partition

1. Select **/ rhel-root** in the left pane.
2. Select **RAID** in Device Type.
3. Choose **xfs** or other desired file system.
4. Make sure **RAID1 (Redundancy)** in RAID Level is selected.
5. In the Name field, type “root”.
6. Click **Update Settings**.

   The system will calculate the final size for the RAID partition.

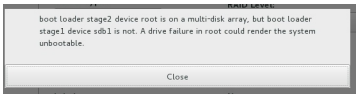
   The system will create a new md device in `/dev/md/root`.



7. Continue the installation by clicking **Done**.

   The system will show a warning message.

   This message can be ignored.

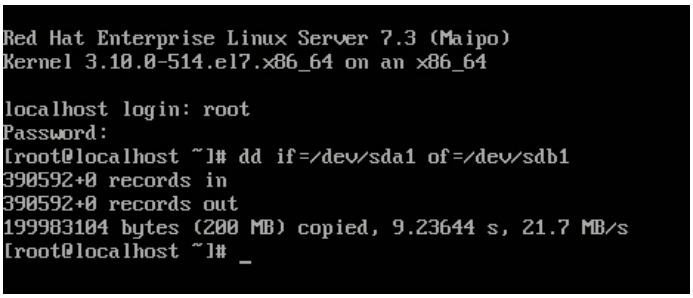


Creating the Redundant ESP

1. Log in to Red Hat Enterprise Linux 7.3.
2. To clone the ESP partition from `/dev/sda1 to /dev/sdb1,` enter the following command.

   `dd if=/dev/sda1 of=/dev/sdb1`

   where “if” is the input file, and “of” is the output file.
3. For example output, see the following screenshot.



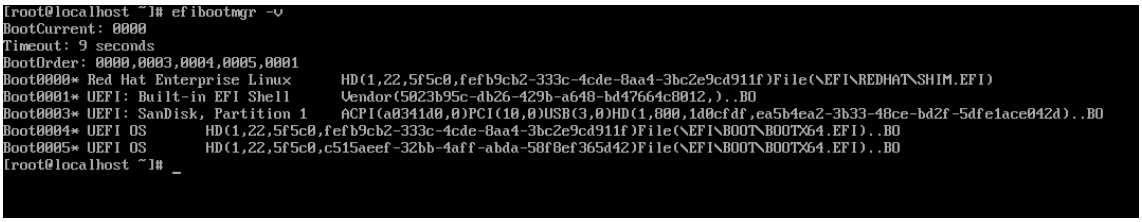
Creating a New Entry in UEFI Boot Manager

Before creating a new entry for the Redundant ESP for /dev/sdb1, examine the current EFI boot manager. Make sure the contents of the new entry match the existing entry for RHEL.

1. To list the entries in the EFI boot manager, type the following command.

```
efibootmgr -v
```

The screenshot shows that entry Boot0000 is the “Red Hat Enterprise Linux” entry created by the installer.



2. Create a new entry and name it “Red Hat Enterprise Linux-redundant” using the following command.

   ```
   efibootmgr -c -d /dev/sdb -p 1 -l \\EFI\\redhat\\shim.efi -L “Red Hat Enterprise Linux-redundant”
   ```

3. The “Red Hat Enterprise Linux-redundant” entry is created as Boot0002. It is selected as the first boot option. It should be moved to second boot option.

   ```
   efibootmgr -o 0000,0002,0003,0004,0005,0001
   ```

4. The actual number for entries depends on the system configuration.

   Check the system configuration by typing:

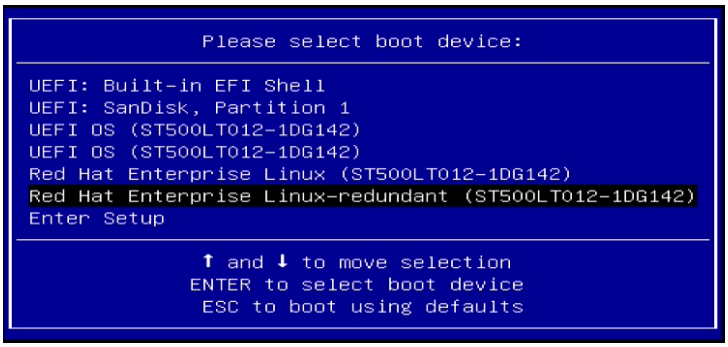
   ```
   efibootmgr -v
   ```

5. Verify the boot entry by rebooting the system.

   a. Press **F11** to go to the boot menu.

   b. Choose Red Hat Enterprise Linux-redundant from the boot menu.

6. Log in to the system.



Recovering a failed disk and repairing Software RAID

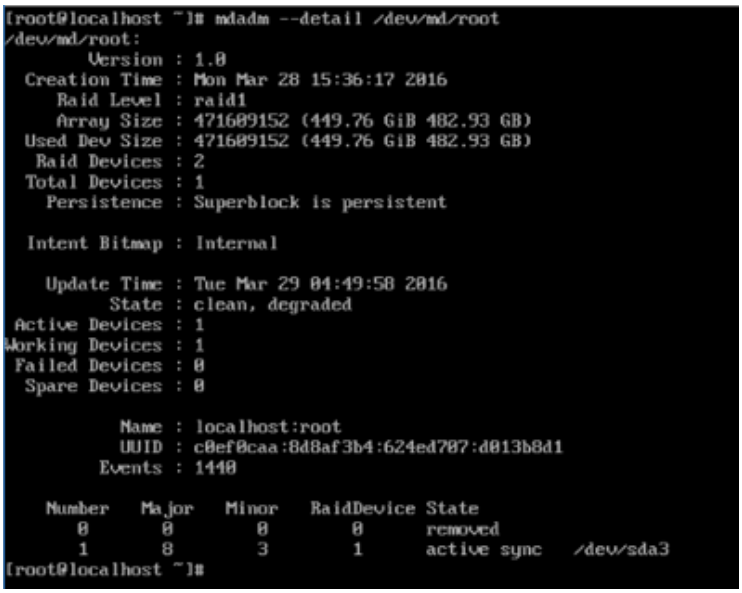
In the event of a failed disk, it is necessary to recover the failed partition and restore the software RAID. Logging in to the system through the second disk is possible when the EFI boot entries are set properly.

1. Examine the status of the RAID configuration using the following command.

   ```
   mdadm --detail /dev/md/root
   ```

   - Total Devices report “1”.
   - State reports as “clean, degraded”.
   - /dev/sdb3 has become /dev/sda3

     It is the only available disk.



Recover the RAID system

1. Prepare a new disk, partitioned as previously described.

2. From the boot menu, choose Red Hat Enterprise Linux-redundant.

   The new disk is shown as `/dev/sda`.

   The original second disk will appear as `/dev/sdb`.

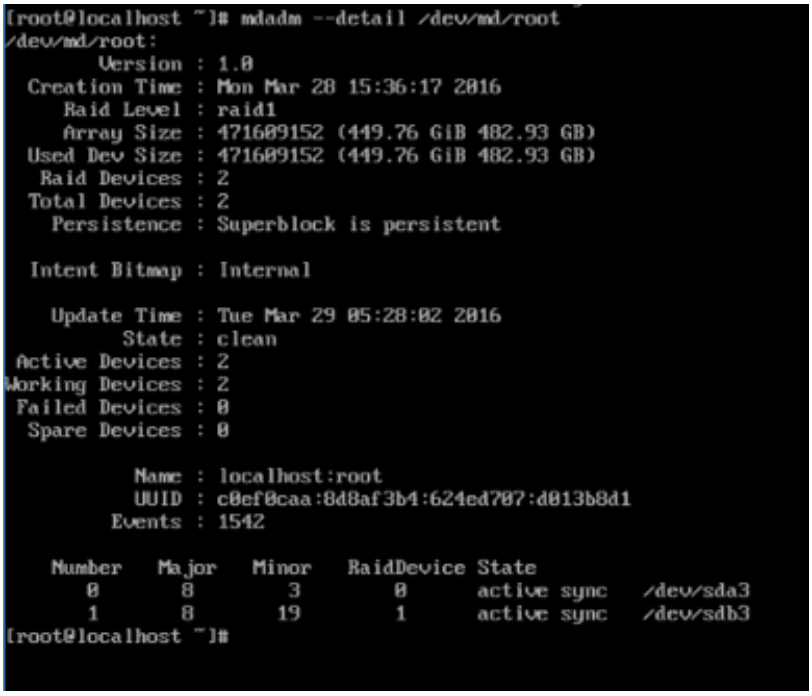
3. Type the following command to add the new /dev/sda3 to rebuild the RAID.

   ```
   mdadm --add /dev/md/root /dev/sda3
   ```

4. Enter `mdadm --detail /dev/md/root`

The State will change to “clean, degraded, recovering” and the Rebuild Status will report “75% complete” (or other progress number).

5. Once the rebuild has completed, State will report as “clean”.
6. The recovery is complete.



Complete the recovery process

Repeat the process described in “Creating the Redundant ESP” to make a redundant copy of the ESP, and add a new entry to EFI Boot Manager to complete the recovery process.

1. To replicate the ESP from /dev/sdb1 back to /dev/sda1, enter the following command.

   ```
   dd if=/dev/sdb1 of=/dev/sda1
   ```

2. Create new entry for the replicated ESP by entering the following command:

   ```
   efibootmgr -c -d /dev/sda -p 1 -l \\EFI\\redhat\\shim.efi -L “Red Hat Enterprise Linux-redundant2”
   ```

3. Reorder the boot sequence by entering the following command:

```
efibootmgr -o 0002,0000,0004,0005,0001
```

```
[root@localhost ~]# efibootmgr -c -d /dev/sdc -p 1 -l \\EFI\\redhat\\shim.efi -L "Red Hat Enterprise Linux-redundant2"
BootCurrent: 0000
Timeout: 9 seconds
BootOrder: 0000,0002,0004,0005,0001
Boot0001* UEFI: Built-in EFI Shell
Boot0002* Red Hat Enterprise Linux-redundant
Boot0004* UEFI OS
Boot0005* UEFI OS
Boot0000* Red Hat Enterprise Linux-redundant2
[root@localhost ~]# efibootmgr -o 0002,0000,0004,0005,0001
BootCurrent: 0000
Timeout: 9 seconds
BootOrder: 0002,0000,0004,0005,0001
Boot0000* Red Hat Enterprise Linux-redundant2
Boot0001* UEFI: Built-in EFI Shell
Boot0002* Red Hat Enterprise Linux-redundant
Boot0004* UEFI OS
Boot0005* UEFI OS
[root@localhost ~]#
```

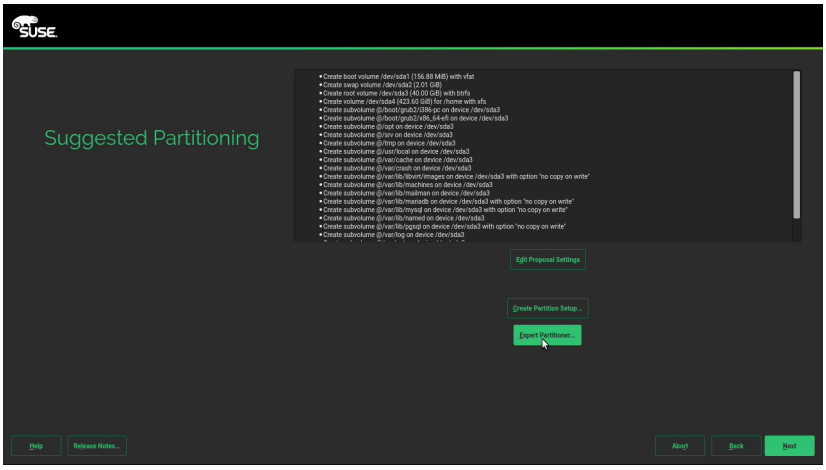
SuSE Linux Enterprise Server (SLES) 12 SP2

Installation process

Only the partition scheme is different in the Software RAID installation process compare to the standard installation process.

Partitioning drives for SLES

1. From the Suggested Partitioning screen, select **Expert Partitioner…**

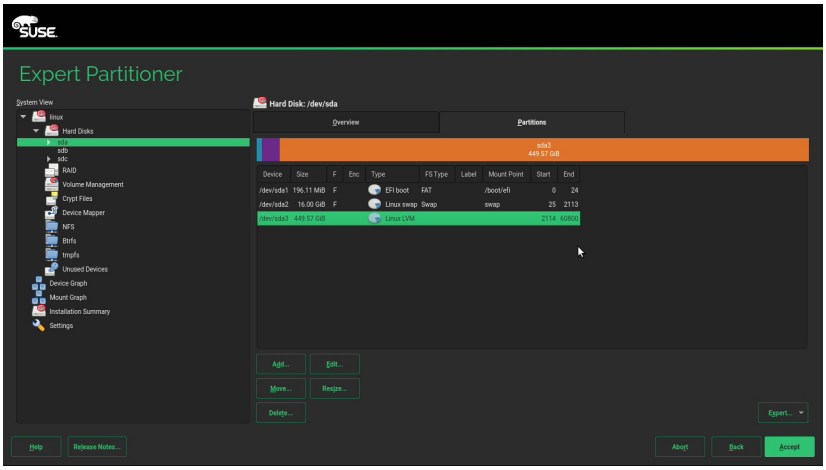


2. Delete the Expert Partitioner default partition scheme.
3. Partition /dev/sda as follows:

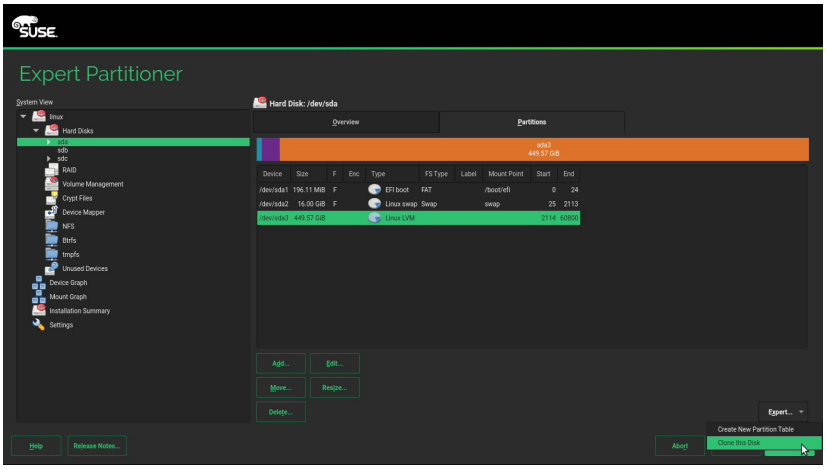
   /dev/sda1, size = 200MB, role as “EFI Boot Partition”, mount point = /boot/efi, format as “FAT”

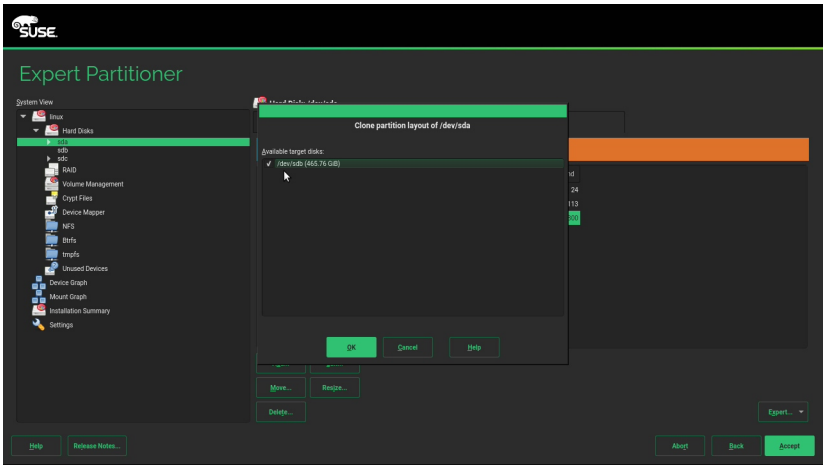
   /dev/sda2, size = 16GB, role as “Swap”

   /dev/sda3, size = Maximum Size (rest of the disk space), role as “Raw Volume”.



4. After successfully partitioning the first disk, use **Expert** > **Clone this disk…** function to clone the partition scheme to the second disk.



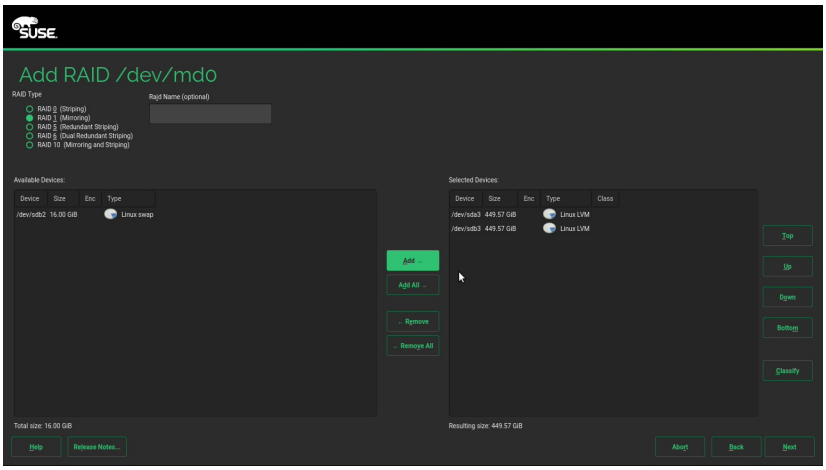


5. In the RAID section, create a RAID1 that includes `/dev/sda3 and /dev/sdb3`:

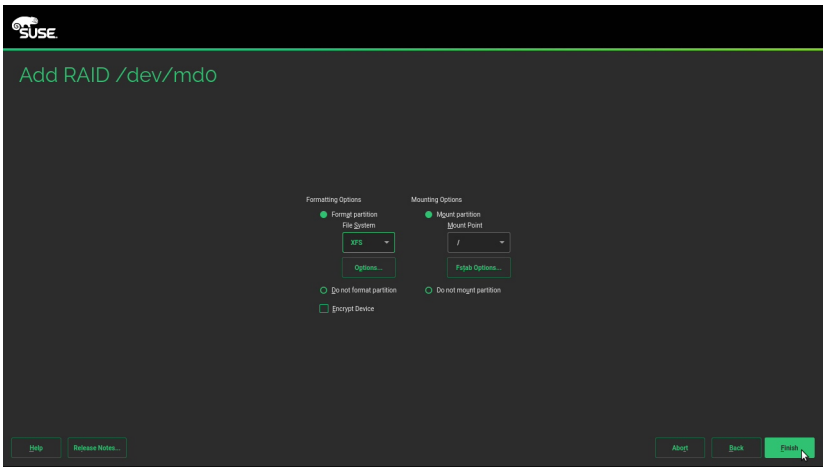
a. Click **RAID**.

b. Choose RAID1 (mirroring).

c. Select each partition and click **Add** to move them to Selected Devices.

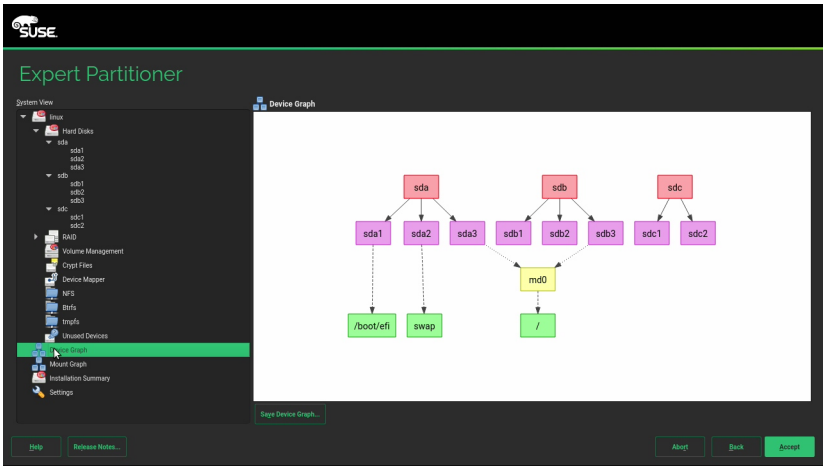


6. Set the following options: 4KB Chunk Size, role as “Operating System”, format as XFS and mount it to “/” (root).

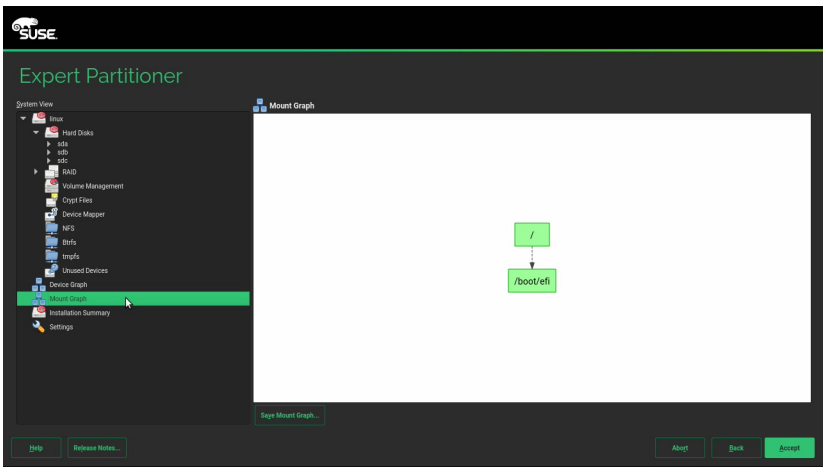


7. Click **Finish**.

   Examine the Device Graph. It should match the screenshot.



8. Examine the Mount Graph. It should match the screenshot.



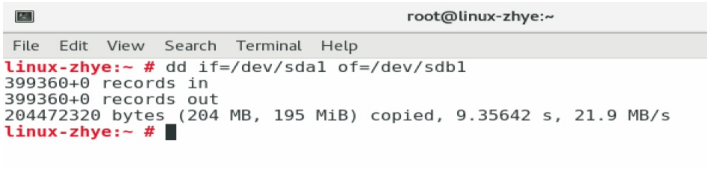
9. Proceed to finish the installation

Creating the Redundant ESP

1. Log in to SLES 12SP2 and open a Terminal.
2. To clone the ESP partition from /dev/sda1 to /dev/sdb1, type the following command.

   ```
   dd if=/dev/sda1 of=/dev/sdb1
   ```

   where “If” is the input file, and “of” is the output file.
3. You should see something like below screenshot:



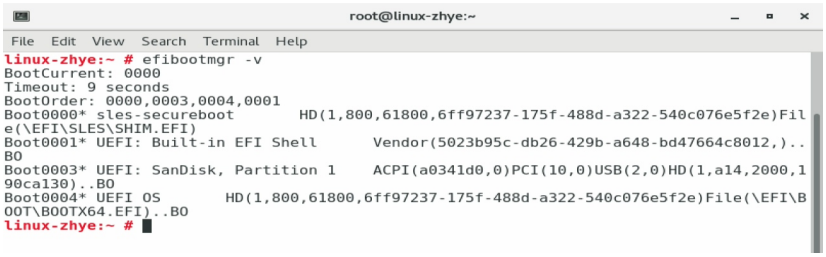
Creating a New Entry in the UEFI Boot Manager

Before creating a new entry for the Redundant ESP for /dev/sdb1, examine the current EFI boot manager. Make sure the contents of the new entry match the existing entry for Ubuntu.

1. To list the entries in the EFI boot manager, type the following command.

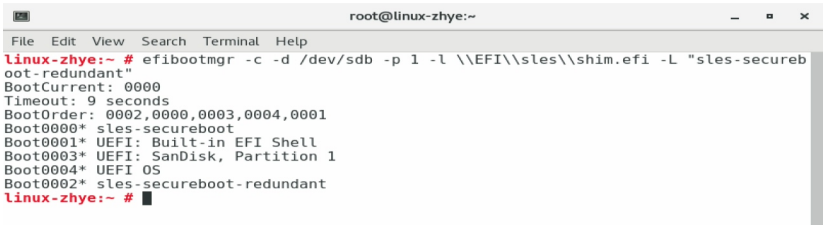
   ```
   efibootmgr -v
   ```

2. The following screenshot shows that entry Boot0011 is the SLES entry created by the installer.



3. Create a new entry and name it ‘sles-secureboot-redundant”.

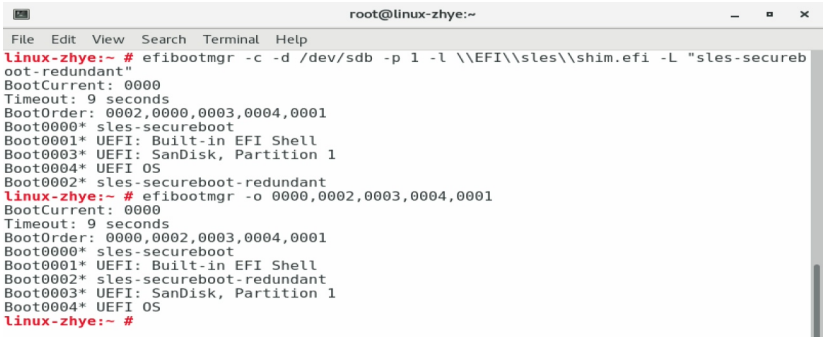
   ```
   efibootmgr -c -d /dev/sdb -p 1 -l \\EFI\\sles\\shim.efi -L “sles-secureboot-redundant”
   ```



4. The “sles-secureboot-redundant” entry will be created as Boot0002.

   This process will place it as the first boot option. Move it to the second boot option.

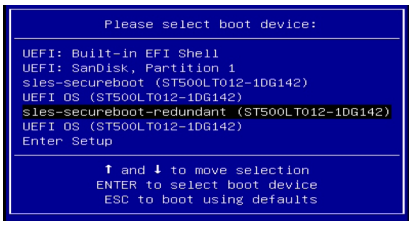
   ```
   efibootmgr -o 0000,0002,0003,0004,0001
   ```



5. The actual number of entries depends on the system configuration. Check the entries by entering:

   `efibootmgr -v`

6. Verify the boot entry by rebooting the system, press **F11** to the boot menu. “sles-secureboot-redundant” should be in the boot menu.
7. Boot in to the system to verify it works.
8. Log in the system.



Recovering a failed disk and repairing Software RAID

In the event of a failed disk, it is necessary to recover the failed partition and restore the software RAID. Logging in to the system through the second disk is possible when the EFI boot entries are set properly.

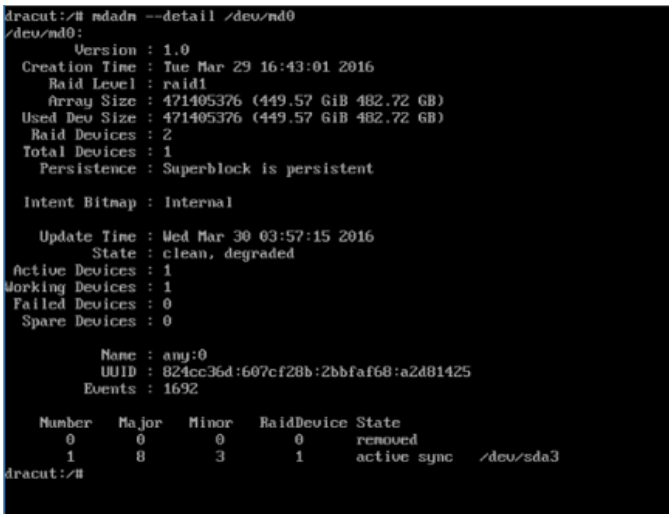
Examine the RAID status

1. To examine the status of the RAID configuration, enter the following:

   `mdadm --detail /dev/md0`

   - Total Devices became “1”.
   - State changed to “clean, degraded”.
   - Disk `/dev/sdb3` has become `/dev/sda3`.

   It is the only available disk.



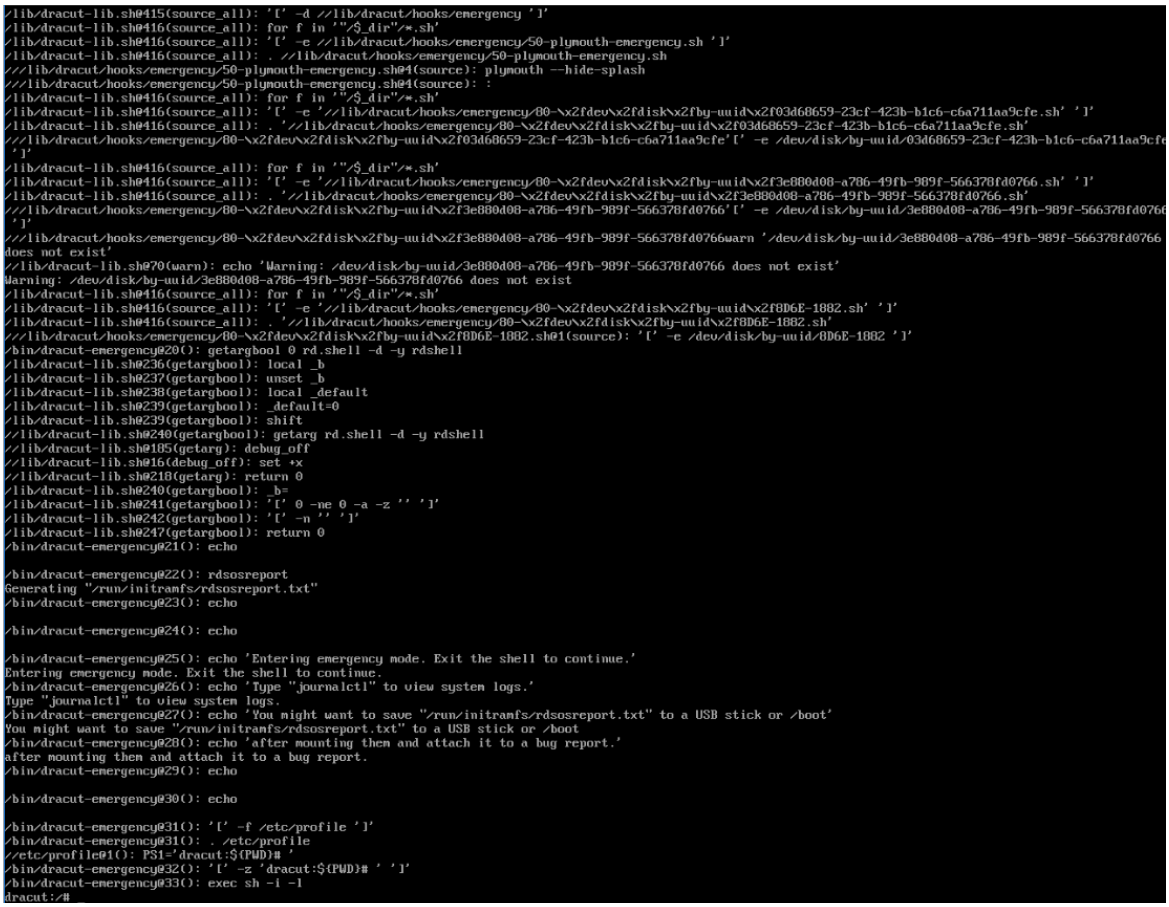
Add two additional kernel parameters to allow booting from the second disk

In SLES, if the first disk fails two additional kernel parameters must be added to allow the system to successfully boot from the second disk.

1. From the GRUB menu, press the **e** key to edit the kernel parameter.
2. Find the line ending with `crashkerel=72M,low`
3. Append `rd.shell rd.debug`
4. Press **Ctrl-x** or **F10** to boot with the new setting.

   This is a one-time setting only. It will not impact subsequent boots.

After a few minutes, the screen will enter a rescue shell.



Recovering the failed partition

1. Prepare a new disk portioned as described in “Partitioning a drive for SLES.”
2. Boot from “sles-secureboot-redunant”.

   Make sure the proper kernel parameters (rd.shell rd.debug) were added to enter the rescue shell.

   The new disk will be shown as /dev/sda, and the original second disk will appear as /dev/sdb.

   To add the new /dev/sda3 to rebuild the RAID, type the following command in the rescue shell.

   `mdadm --add /dev/md0 /dev/sda3`
3. Enter `mdadm --detail /dev/md0`

   The State will change to “clean, degraded, recovering” and the Rebuild Status “75% complete” (or other progress number).
4. Once the rebuild has completed, the State will change to “clean”,

   The recovery is complete.

```
linux-9xde:~ # mdadm --add /dev/md0 /dev/sda3
mdadm: added /dev/sda3
linux-9xde:~ # mdadm --detail /dev/md0
/dev/md0:
        Version : 1.0
  Creation Time : Tue Mar 29 16:43:01 2016
     Raid Level : raid1
     Array Size : 471405376 (449.57 GiB 482.72 GB)
  Used Dev Size : 471405376 (449.57 GiB 482.72 GB)
   Raid Devices : 2
  Total Devices : 2
    Persistence : Superblock is persistent

  Intent Bitmap : Internal

    Update Time : Wed Mar 30 05:48:11 2016
          State : clean, degraded, recovering
 Active Devices : 1
Working Devices : 2
 Failed Devices : 0
  Spare Devices : 1

 Rebuild Status : 0% complete

           Name : any:0
           UUID : 824cc36d:607cf28b:2bbfaf68:a2d81425
         Events : 1742

    Number   Major   Minor   RaidDevice State
       2       8        3        0      spare rebuilding   /dev/sda3
       1       8       19        1      active sync   /dev/sdb3
linux-9xde:~ # _
```

Complete the recovery process

To make a redundant copy of the ESP, repeat the process described in "Creating a redundant ESP."

Add a new entry to EFI Boot Manager to complete the recovery process.

1. Replicate the ESP from /dev/sdb1 back to /dev/sda1.

   ```
   dd if=/dev/sdb1 of=/dev/sda1
   ```

2. Remove the existing SLES boot entry:

   ```
   efibootmgr -b 0000 -B
   ```

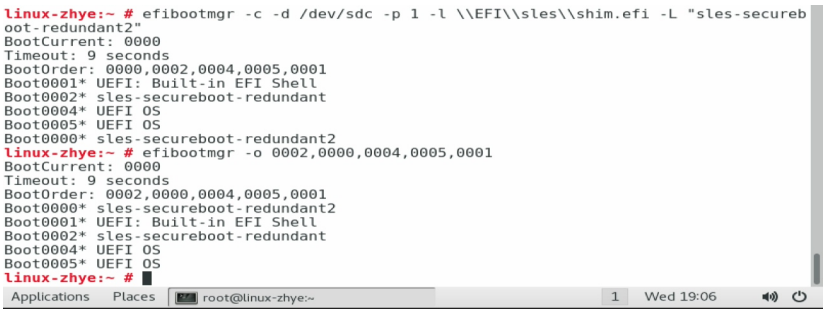
```
root@linux-zhye:~
File  Edit  View  Search  Terminal  Help
linux-zhye:~ # efibootmgr -b 0000 -B
BootCurrent: 0000
Timeout: 9 seconds
BootOrder: 0002,0004,0005,0001
Boot0001* UEFI: Built-in EFI Shell
Boot0002* sles-secureboot-redundant
Boot0004* UEFI OS
Boot0005* UEFI OS
```

3. Create new entry for the replicated ESP:

   ```
   efibootmgr -c -d /dev/sda -p 1 -l \\EFI\\sles\\shim.efi -L "sles-secureboot-redundant2"
   ```

4. Reorder the boot sequence:

   ```
   efibootmgr -o 0002,0000,0004,0005,0001
   ```



SATA-based PCI-e M.2 SSD

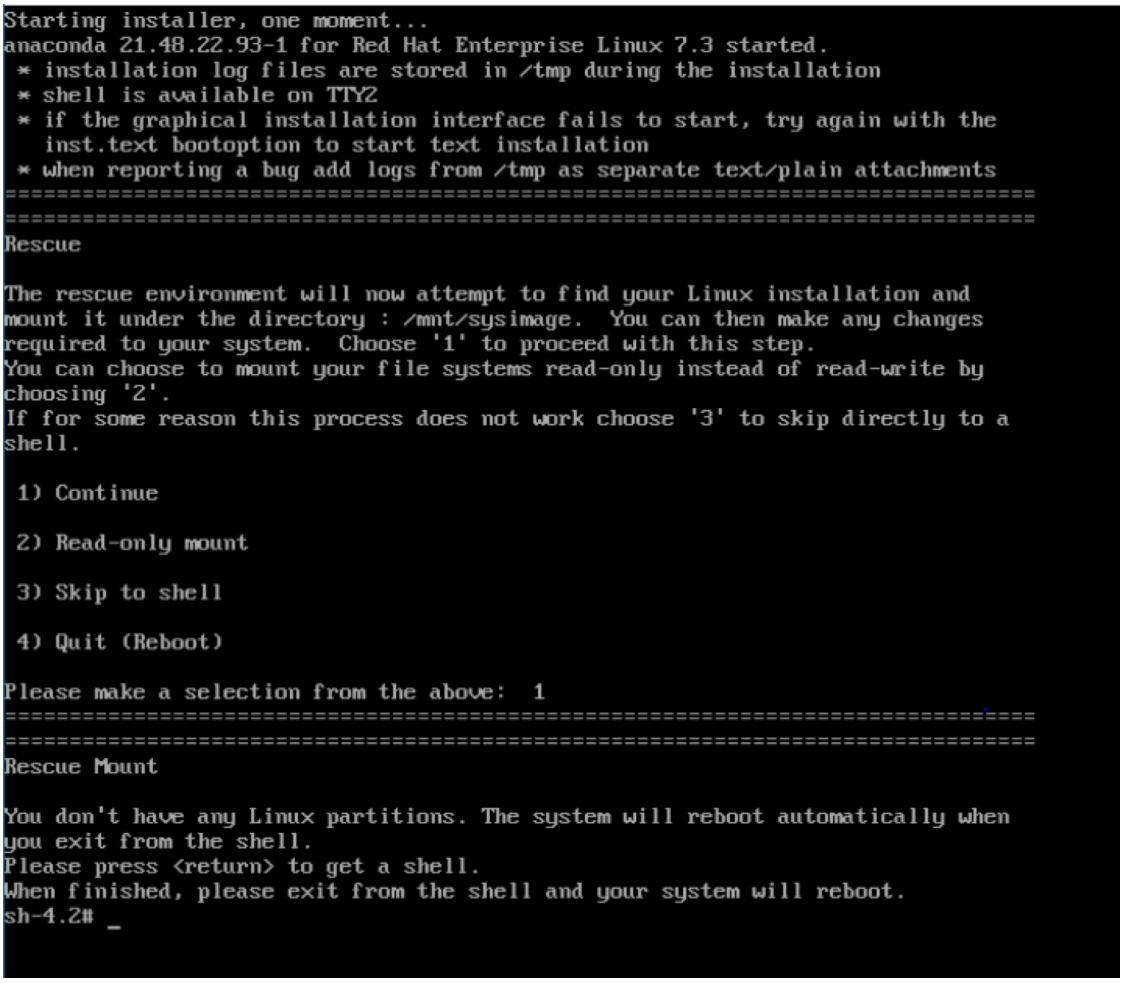
Red Hat Enterprise Linux (RHEL) 7.3

Manually Partitioning through Rescue mode

Partition the disk manually in Rescue mode before proceeding to the normal installation process. Do not use the RHEL GUI installer.

1. Boot from the RHEL 7.3 DVD image.
2. Select Troubleshooting > Rescue a Red Hat Enterprise Linux system.
3. Select 1) Continue.

   The following prompt is displayed:



4. To create partitions on the first disk (/dev/sda), type the following commands.

   ```
   parted /dev/sda mklabel gpt
   ```

5. Type “Yes” to confirm changes are made to the disk label.

   The following is displayed:

   ```
   parted /dev/sda mkpart primary fat32 0 200MB
   ```

6. Type “Ignore” to ignore the size mismatch.

   The following is displayed:

   ```
   parted /dev/sda mkpart primary ext2 200MB 16GB

   parted /dev/sda print
   ```

7. Refer to the screenshot for detail partitioning instruction and information for /dev/sda.

```
[anaconda root@localhost ~]# parted /dev/sda print
Model: ATA VR0120GEJXL (scsi)
Disk /dev/sda: 120GB
Sector size (logical/physical): 512B/4096B
Partition Table: gpt
Disk Flags:

Number  Start   End     Size    File system  Name     Flags
 1      17.4kB  200MB   200MB                primary
 2      200MB   16.0GB  15.8GB               primary
```

8. Repeat step 5 for the second disk (/dev/sdb).

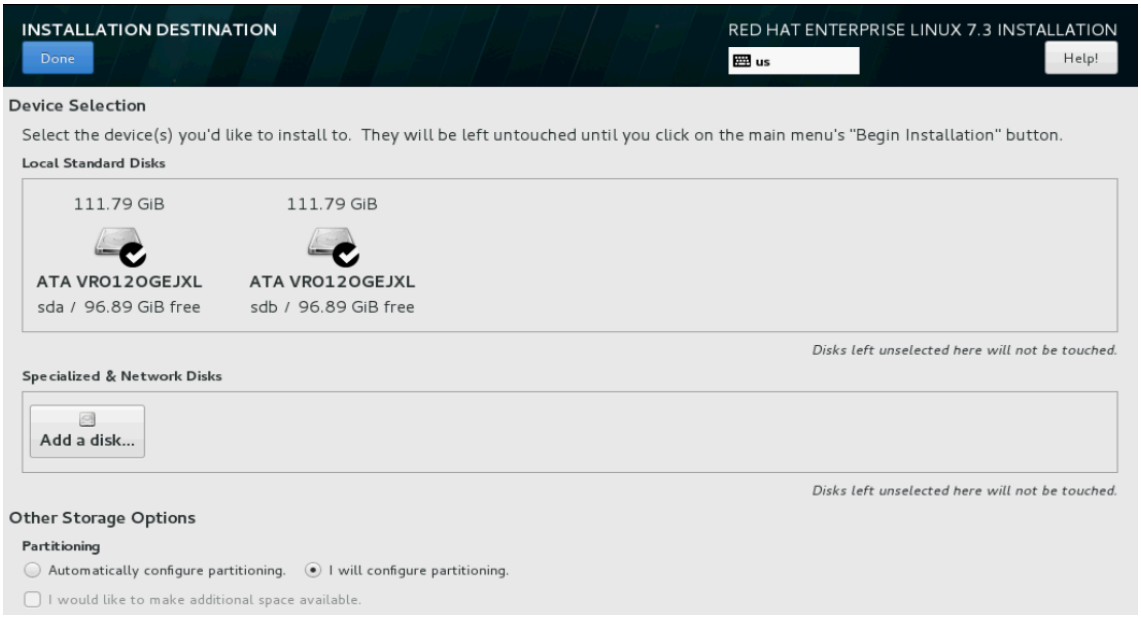
   Refer to the screenshot for detail partitioning instruction and information for /dev/sdb.

```
[anaconda root@localhost ~]# parted /dev/sdb print
Model: ATA VR0120GEJXL (scsi)
Disk /dev/sdb: 120GB
Sector size (logical/physical): 512B/4096B
Partition Table: gpt
Disk Flags:

Number  Start   End     Size    File system  Name     Flags
 1      17.4kB  200MB   200MB                primary
 2      200MB   16.0GB  15.8GB               primary
```

9. Reboot to proceed with Red Hat installation.

Normal Installation Process

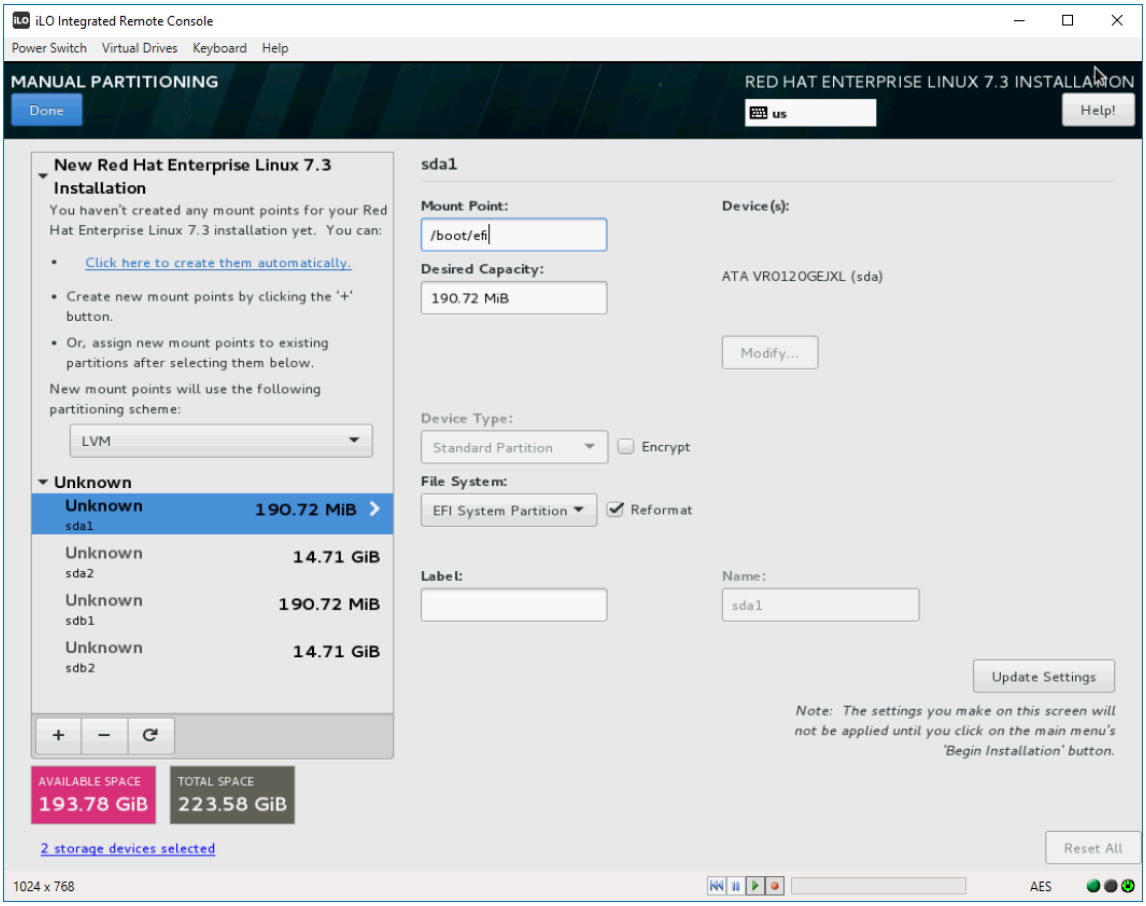
The software RAID installation differs from the normal installation process only in the “Installation Destination” step. In the “Installation Destination”, specify the ESP, swap and root partition respectively. In the “Installation Destination” step, make sure both disks are selected, and “I will configure partitioning” is selected.



Specifying the ESP

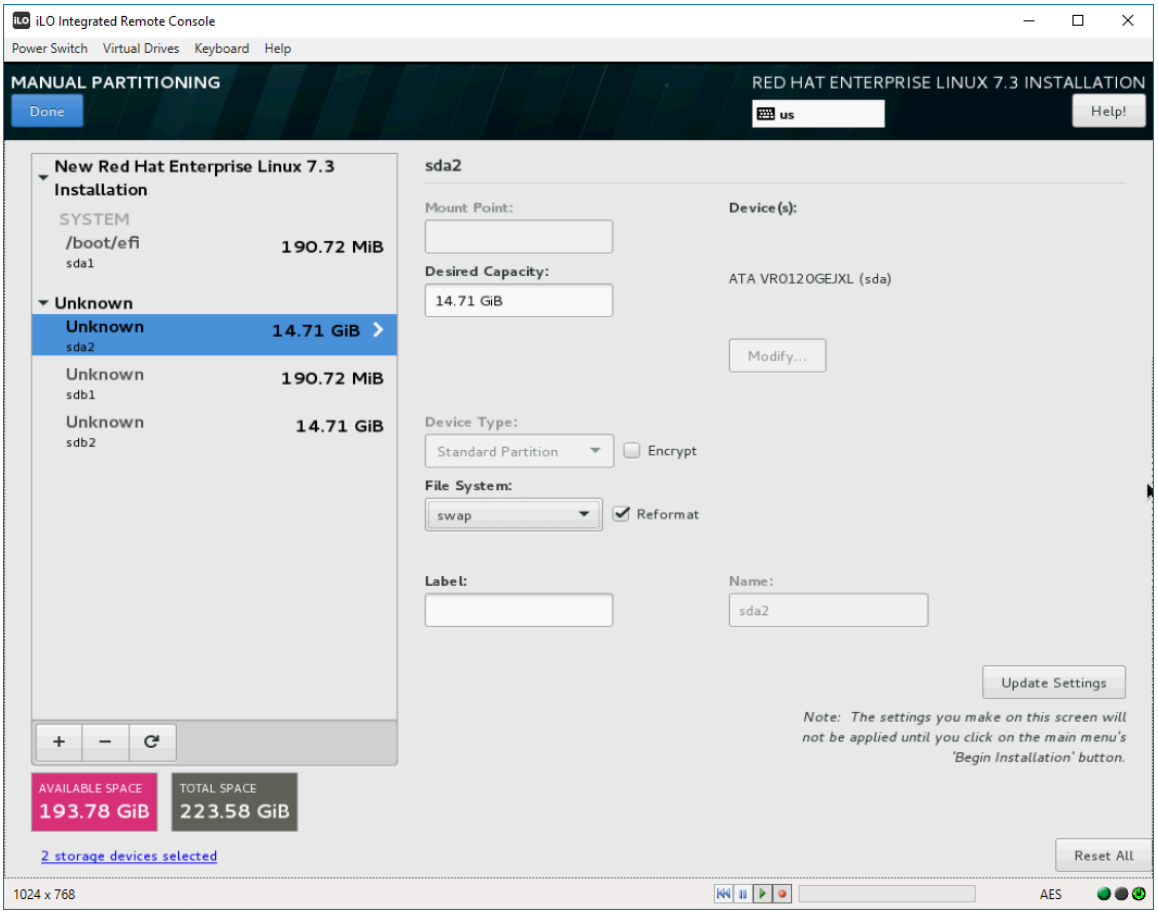
The ESP is the partition that contains the boot loaders used by the UEFI firmware.

5. Select **sda1** under Unknown in the left pane.
6. Under File System, select **EFI System Partition** and check **Reformat**.
7. In the Mount Point field, enter `/boot/efi`.
8. Click **Update Settings**.



Specifying the swap directory

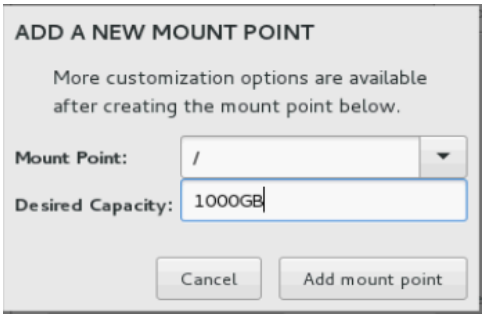
1. Select **sda2** in the “Unknown” section.
2. In the File System dropdown, select **swap** and check **Reformat**.
3. Click Update Settings.



Creating root disk as RAID1

1. Click **+**.
2. To choose the root directory, enter “/” as mount point.
3. Enter “1000GB” in Desired Capacity.

   The system will calculate the correct size.
4. Click **Add mount point**.

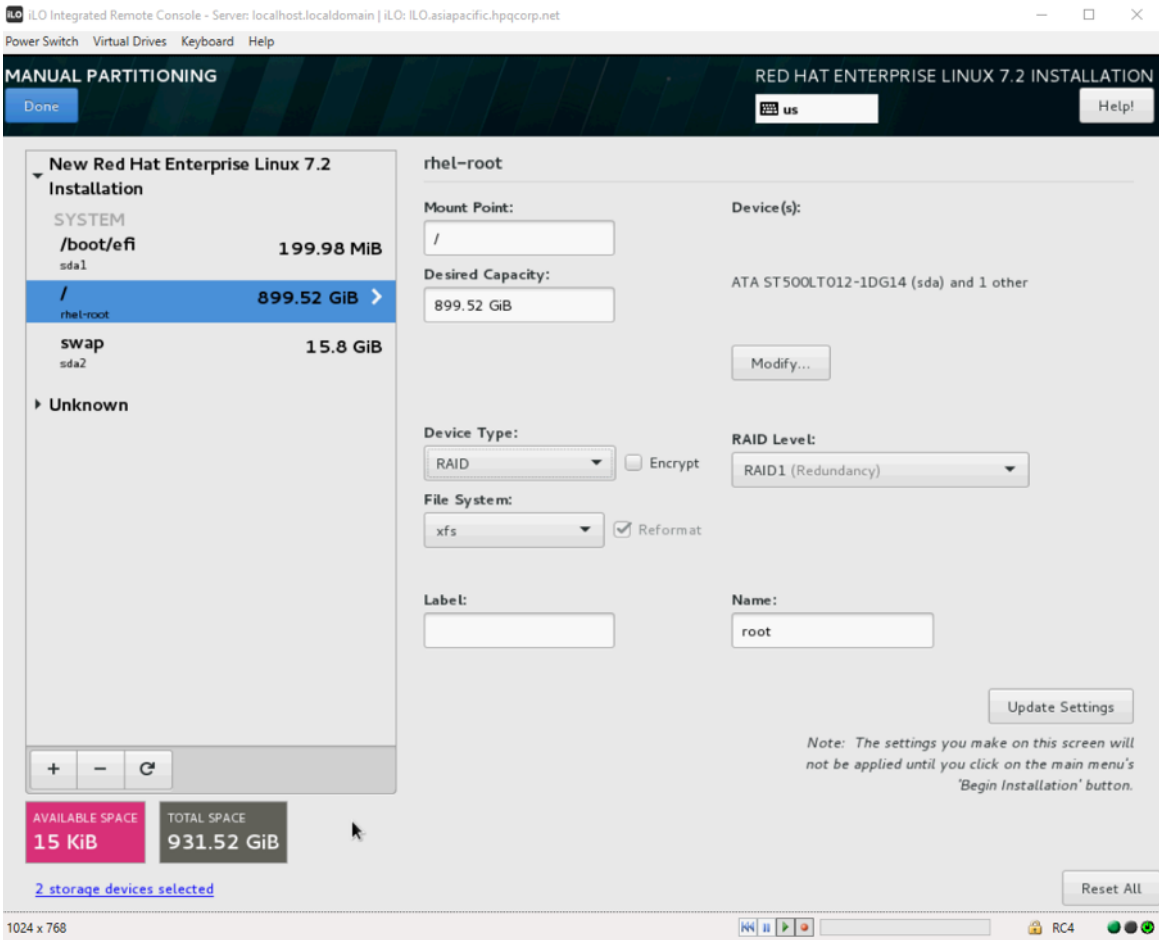


Create a RAID1 root partition

8. Select **/ rhel-root** in the left pane.
9. Select **RAID** in Device Type.
10. Choose **xfs** or other desired file system.
11. Make sure **RAID1 (Redundancy)** in RAID Level is selected.
12. In the Name field, type “root”.
13. Click **Update Settings**.

    The system will calculate the final size for the RAID partition.

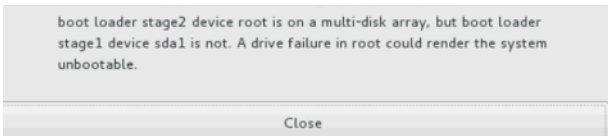
    The system will create a new md device in `/dev/md/root`.



14. Continue the installation by clicking **Done**.

    The system will show a warning message.

    This message can be ignored.



Creating the Redundant ESP

1. Log in to Red Hat Enterprise Linux 7.3.
2. To clone the ESP partition from `/dev/sda1 to /dev/sdb1,` enter the following command.

   ```
   dd if=/dev/sda1 of=/dev/sdb1
   ```

   “If” is the input file, and “of” is the output file.

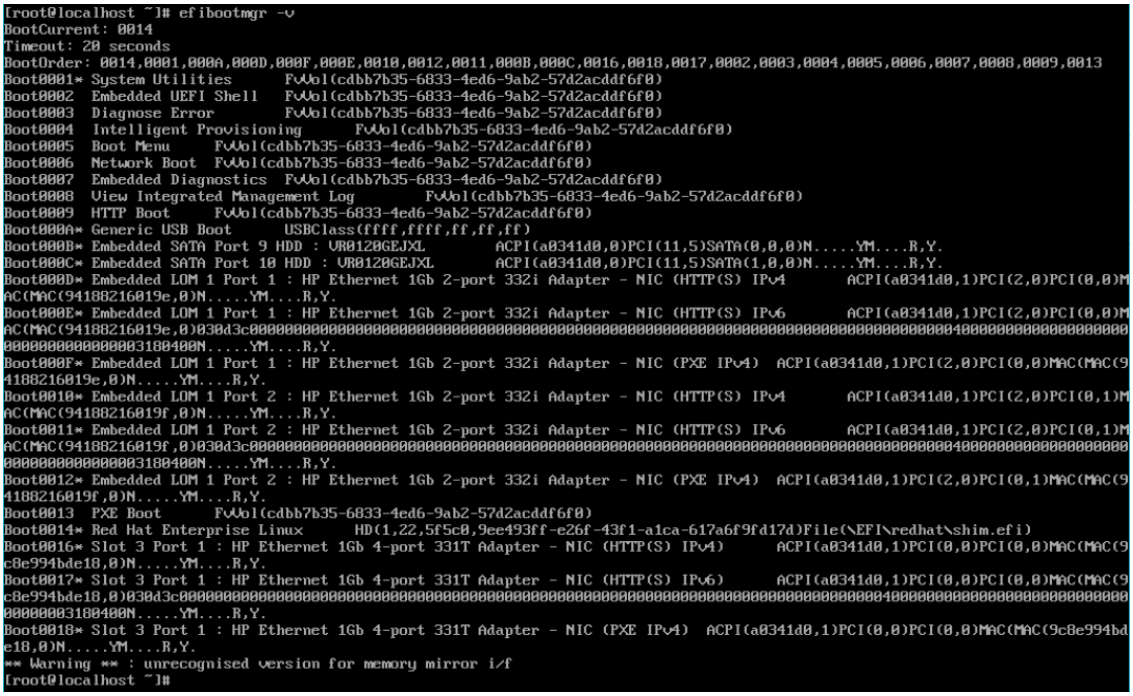
Creating a New Entry in UEFI Boot Manager

Before creating a new entry for the Redundant ESP for /dev/sdb1, examine the current EFI boot manager. Make sure the contents of the new entry match the existing entry for RHEL.

1. To list the entries in the EFI boot manager, type the following command.

   ```
   efibootmgr -v
   ```

   The screenshot shows that entry Boot0014 is the “Red Hat Enterprise Linux” entry created by the installer.



2. Create a new entry and name it “Red Hat Enterprise Linux-redundant” using the following command.

   ```
   efibootmgr –c –d /dev/sdb –p 1 –l \\EFI\\redhat\\shim.efi -L “Red Hat Enterprise Linux-redundant”
   ```

3. The “Red Hat Enterprise Linux-redundant” entry is created as Boot0000. It is selected as the first boot option. It should be moved to second boot option.

   ```
   efibootmgr –o
   0014,0000,0001,000A,000D,000F,000E,0010,0012,0011,000B,000C,0016,0018,0017,0002,0003,0004,0005,0006,0007,0008,0009,0013
   ```

```
[root@localhost ~]# efibootmgr -c -d /dev/sdb -p 1 -l \\EFI\\redhat\\shim.efi -L "Red Hat Enterprise Linux-redundant"
BootCurrent: 0014
Timeout: 20 seconds
BootOrder: 0000,0014,0001,000A,000D,000F,000E,0010,0012,0011,000B,000C,0016,0018,0017,0002,0003,0004,0005,0006,0007,0008,0009,00
13
Boot0001* System Utilities
Boot0002  Embedded UEFI Shell
Boot0003  Diagnose Error
Boot0004  Intelligent Provisioning
Boot0005  Boot Menu
Boot0006  Network Boot
Boot0007  Embedded Diagnostics
Boot0008  View Integrated Management Log
Boot0009  HTTP Boot
Boot000A* Generic USB Boot
Boot000B* Embedded SATA Port 9 HDD : VR0120GEJXL
Boot000C* Embedded SATA Port 10 HDD : VR0120GEJXL
Boot000D* Embedded LOM 1 Port 1 : HP Ethernet 1Gb 2-port 332i Adapter - NIC (HTTP(S) IPv4
Boot000E* Embedded LOM 1 Port 1 : HP Ethernet 1Gb 2-port 332i Adapter - NIC (HTTP(S) IPv6
Boot000F* Embedded LOM 1 Port 1 : HP Ethernet 1Gb 2-port 332i Adapter - NIC (PXE IPv4)
Boot0010* Embedded LOM 1 Port 2 : HP Ethernet 1Gb 2-port 332i Adapter - NIC (HTTP(S) IPv4
Boot0011* Embedded LOM 1 Port 2 : HP Ethernet 1Gb 2-port 332i Adapter - NIC (HTTP(S) IPv6
Boot0012* Embedded LOM 1 Port 2 : HP Ethernet 1Gb 2-port 332i Adapter - NIC (PXE IPv4)
Boot0013  PXE Boot
Boot0014* Red Hat Enterprise Linux
Boot0016* Slot 3 Port 1 : HP Ethernet 1Gb 4-port 331T Adapter - NIC (HTTP(S) IPv4)
Boot0017* Slot 3 Port 1 : HP Ethernet 1Gb 4-port 331T Adapter - NIC (HTTP(S) IPv6)
Boot0018* Slot 3 Port 1 : HP Ethernet 1Gb 4-port 331T Adapter - NIC (PXE IPv4)
Boot0000* Red Hat Enterprise Linux-redundant
** Warning ** : unrecognised version for memory mirror i/f
[root@localhost ~]#
```

```
[root@localhost ~]# efibootmgr -o 0014,0000,0001,000A,000D,000F,000E,0010,0012,0011,000B,000C,0016,0018,0017,0002,0003,0004,0005
,0006,0007,0008,0009,0013
BootCurrent: 0014
Timeout: 20 seconds
BootOrder: 0014,0000,0001,000A,000D,000F,000E,0010,0012,0011,000B,000C,0016,0018,0017,0002,0003,0004,0005,0006,0007,0008,0009,00
13
Boot0000* Red Hat Enterprise Linux-redundant
Boot0001* System Utilities
Boot0002  Embedded UEFI Shell
Boot0003  Diagnose Error
Boot0004  Intelligent Provisioning
Boot0005  Boot Menu
Boot0006  Network Boot
Boot0007  Embedded Diagnostics
Boot0008  View Integrated Management Log
Boot0009  HTTP Boot
Boot000A* Generic USB Boot
Boot000B* Embedded SATA Port 9 HDD : VR0120GEJXL
Boot000C* Embedded SATA Port 10 HDD : VR0120GEJXL
Boot000D* Embedded LOM 1 Port 1 : HP Ethernet 1Gb 2-port 332i Adapter - NIC (HTTP(S) IPv4
Boot000E* Embedded LOM 1 Port 1 : HP Ethernet 1Gb 2-port 332i Adapter - NIC (HTTP(S) IPv6
Boot000F* Embedded LOM 1 Port 1 : HP Ethernet 1Gb 2-port 332i Adapter - NIC (PXE IPv4)
Boot0010* Embedded LOM 1 Port 2 : HP Ethernet 1Gb 2-port 332i Adapter - NIC (HTTP(S) IPv4
Boot0011* Embedded LOM 1 Port 2 : HP Ethernet 1Gb 2-port 332i Adapter - NIC (HTTP(S) IPv6
Boot0012* Embedded LOM 1 Port 2 : HP Ethernet 1Gb 2-port 332i Adapter - NIC (PXE IPv4)
Boot0013  PXE Boot
Boot0014* Red Hat Enterprise Linux
Boot0016* Slot 3 Port 1 : HP Ethernet 1Gb 4-port 331T Adapter - NIC (HTTP(S) IPv4)
Boot0017* Slot 3 Port 1 : HP Ethernet 1Gb 4-port 331T Adapter - NIC (HTTP(S) IPv6)
Boot0018* Slot 3 Port 1 : HP Ethernet 1Gb 4-port 331T Adapter - NIC (PXE IPv4)
** Warning ** : unrecognised version for memory mirror i/f
[root@localhost ~]#
```

4. The actual number for entries depends on the system configuration.

   Check the system configuration by typing:

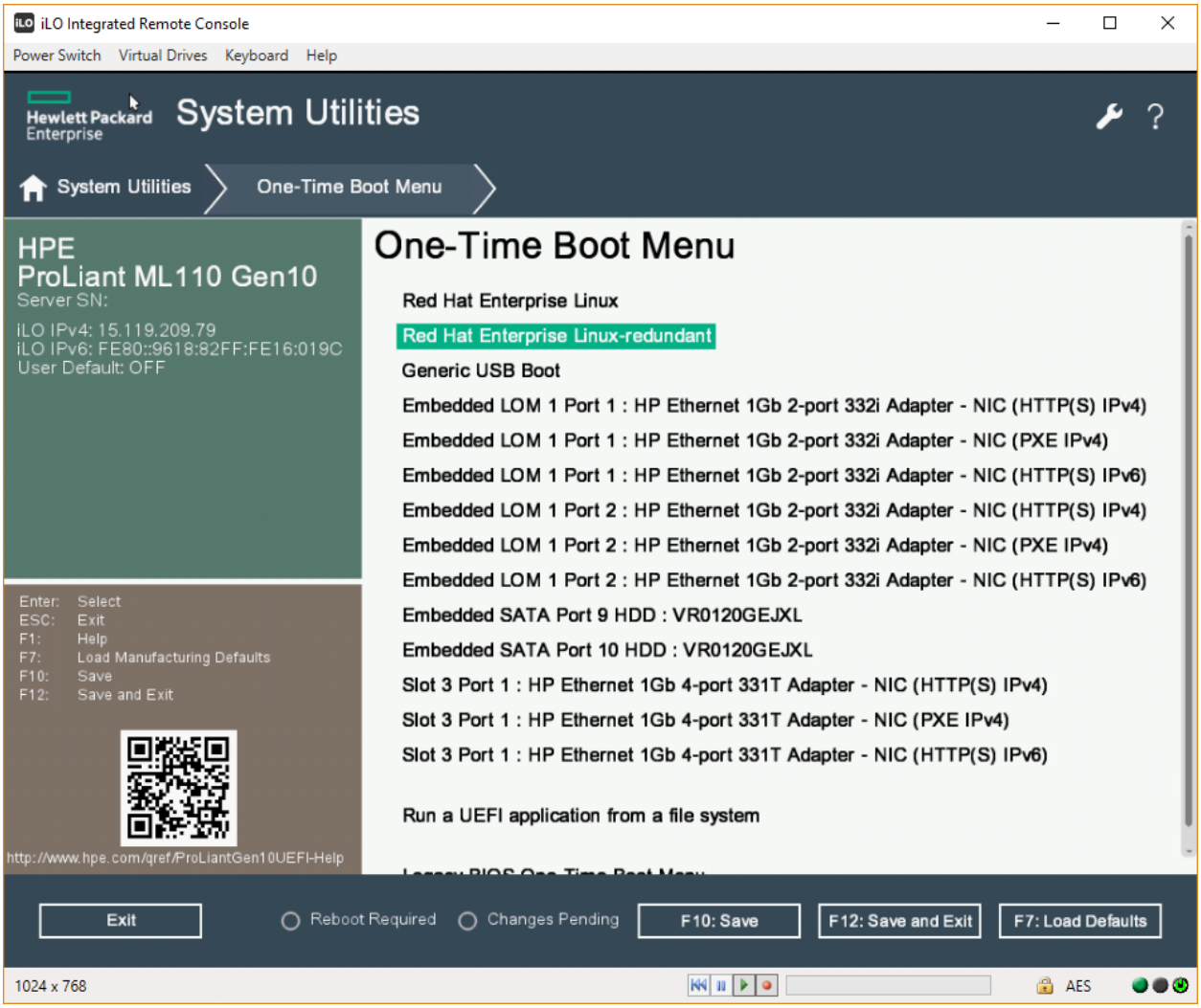
   efibootmgr –v

5. Verify the boot entry by rebooting the system.

   a. Press **F11** to go to the boot menu.

   b. Choose Red Hat Enterprise Linux-redundant from the boot menu.

6. Log in to the system.



Recovering a failed disk and repairing Software RAID

In the event of a failed disk, it is necessary to recover the failed partition and restore the software RAID. Logging in to the system through the second disk is possible when the EFI boot entries are set properly.

1. Examine the status of the RAID configuration using the following command.

   mdadm --detail /dev/md/root

   - Total Devices report “1”.
   - State reports as “clean, degraded”.
   - /dev/sdb3 has become /dev/sda3

   It is the only available disk.

Recover the RAID system

1. Prepare a new disk, partitioned as previously described.
2. From the boot menu, choose Red Hat Enterprise Linux-redundant.

The new disk is shown as `/dev/sda`.

The original second disk will appear as `/dev/sdb`.

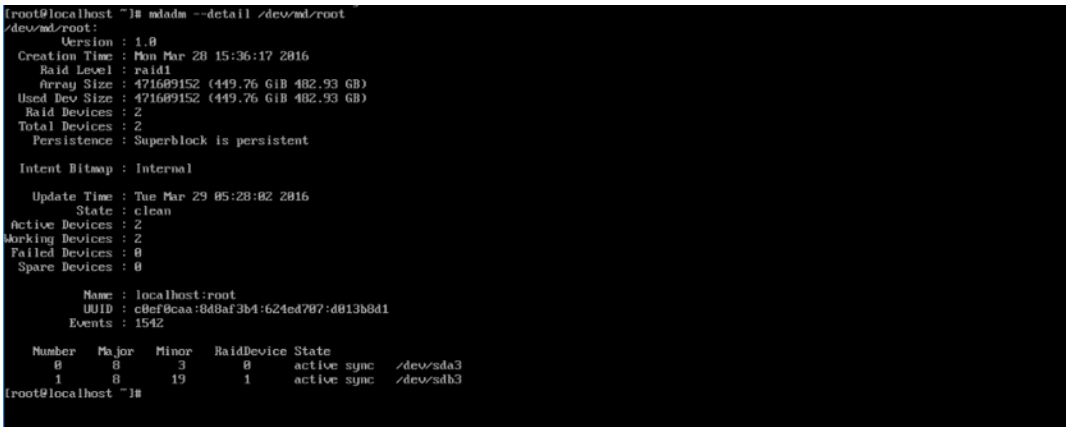
3. Type the following command to add the new /dev/sda3 to rebuild the RAID.

   ```
   mdadm --add /dev/md/root /dev/sda3
   ```

4. Enter `mdadm --detail /dev/md/root`

   The State will change to “clean, degraded, recovering” and the Rebuild Status will report “75% complete” (or other progress number).

5. Once the rebuild has completed, State will report as “clean”.
6. The recovery is complete.



Complete the recovery process

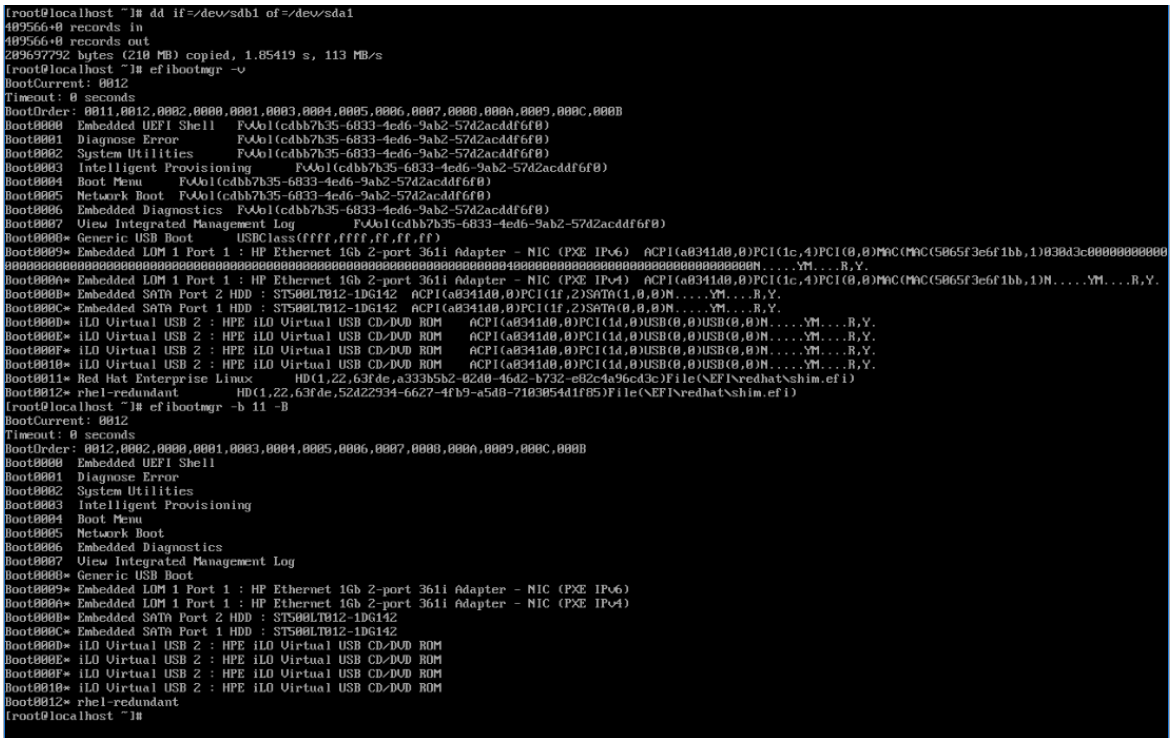
Repeat the process described in "Creating the Redundant ESP" to make a redundant copy of the ESP, and add a new entry to EFI Boot Manager to complete the recovery process.

1. To replicate the ESP from /dev/sdb1 back to /dev/sda1, enter the following command.

   ```
   dd if=/dev/sdb1 of=/dev/sda1
   ```

2. To remove the existing RHEL boot entry, enter the following command.

   ```
   efibootmgr -b 11 -B
   ```

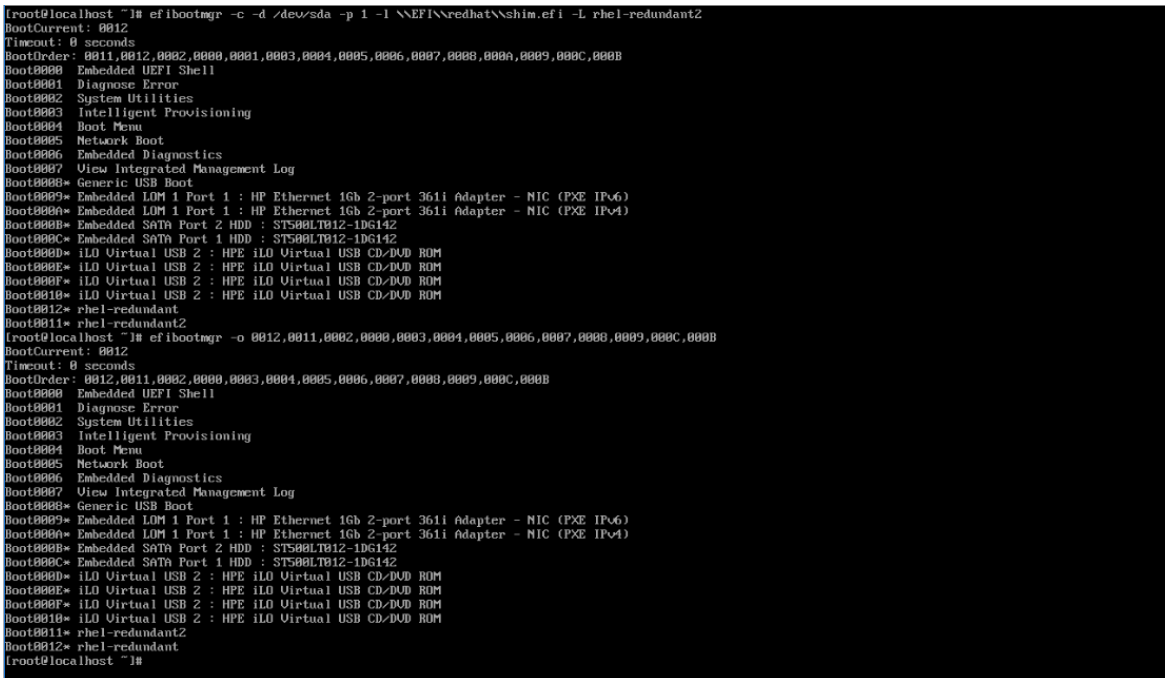


3. Create new entry for the replicated ESP by entering the following command:

   ```
   efibootmgr -c -d /dev/sda -p 1 -l \\EFI\\redhat\\shim.efi -L "Red Hat Enterprise Linux-redundant2"
   ```

4. Reorder boot sequence by entering the following command:

   ```
   efibootmgr -o 0012,0011,0002,0000,0001,0003,0004,0005,0006,0007,0008,000A,0009,000C,000B
   ```



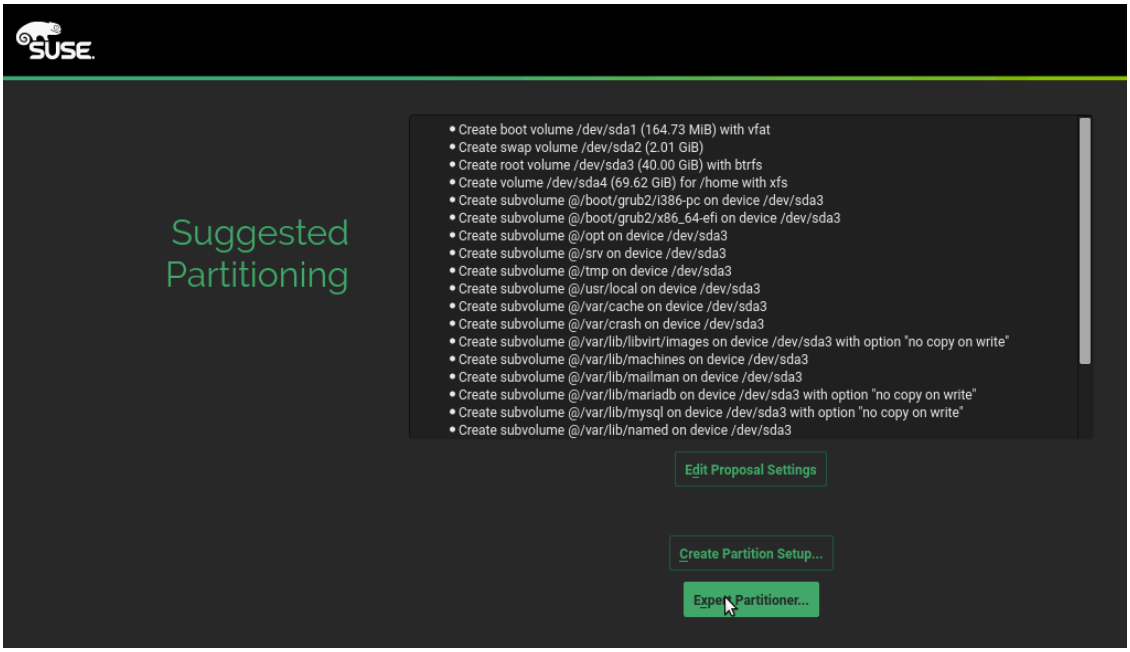
SuSE Linux Enterprise Server (SLES) 12 SP2

Installation process

Only the partition scheme is different in the Software RAID installation process compare to the standard installation process.

Partitioning drives for SLES

1. From the Suggested Partitioning screen, select **Expert Partitioner…**

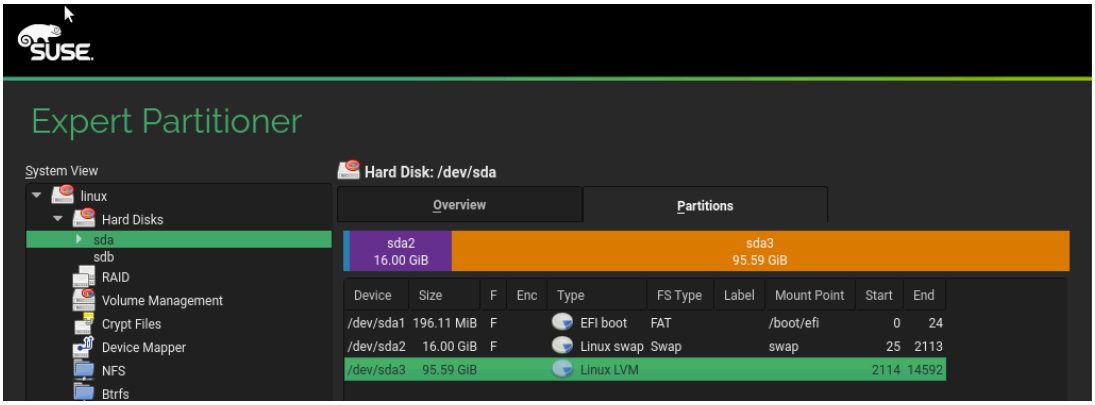


2. Delete the Expert Partitioner default partition scheme.
3. Partition /dev/sda as follows:

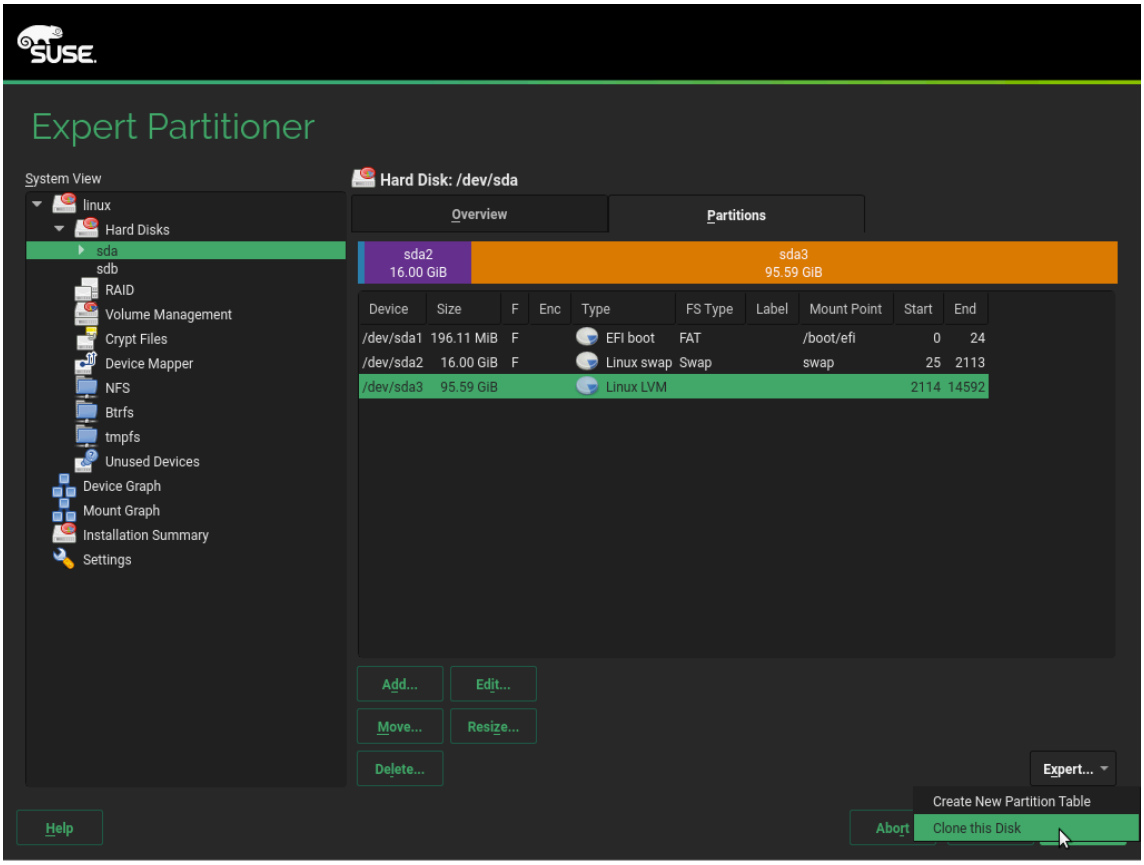
   /dev/sda1, size = 200MB, role as “EFI Boot Partition”, mount point = /boot/efi, format as “FAT”

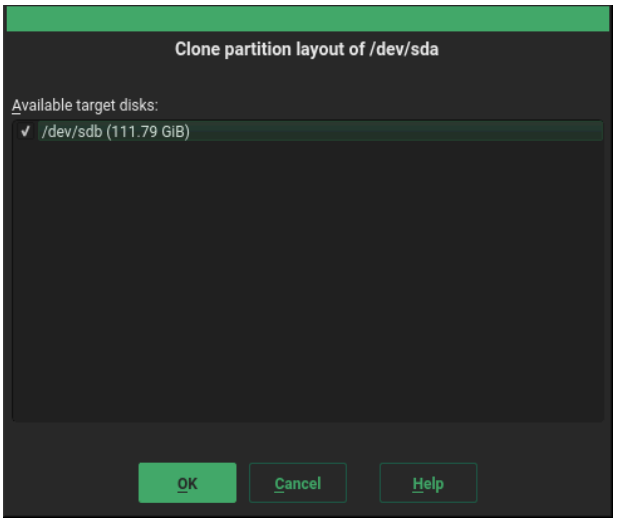
   /dev/sda2, size = 16GB, role as “Swap”

   /dev/sda3, size = Maximum Size (rest of the disk space), role as “Raw Volume”.

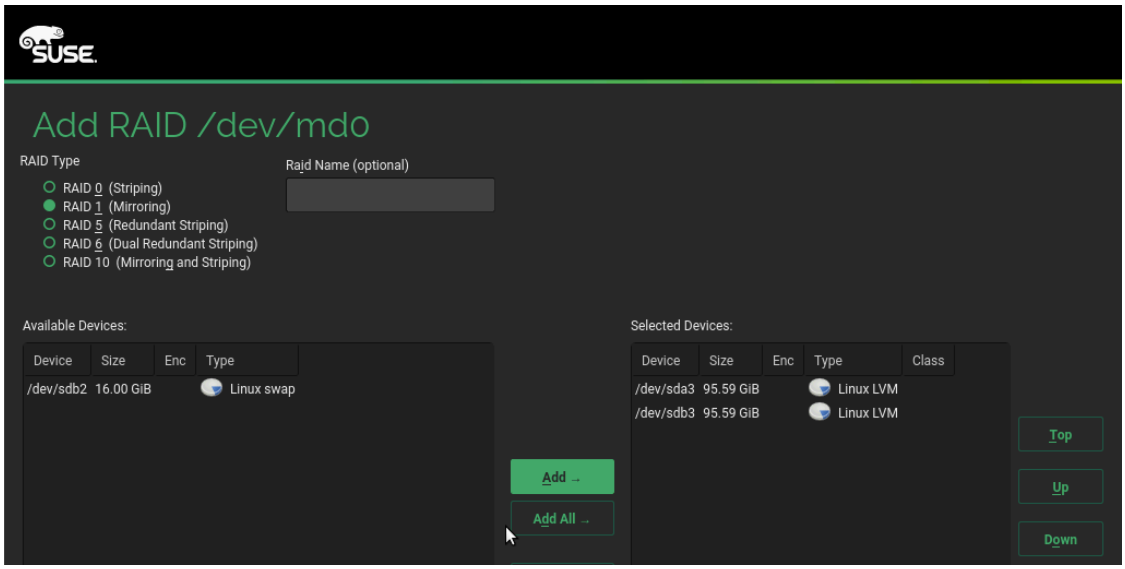


4. After successfully partitioning the first disk, use **Expert** > **Clone this disk…** function to clone the partition scheme to the second disk.

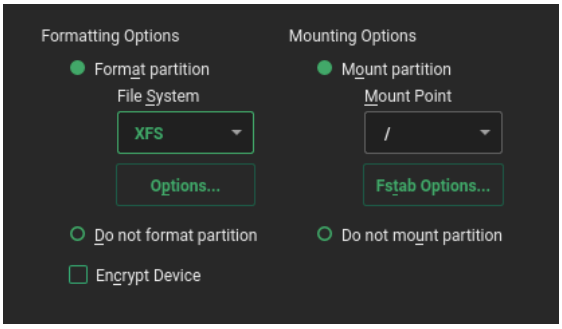




5. In the RAID section, create a RAID1 that includes `/dev/sda3 and /dev/sdb3`:
   a. Click **RAID**.
   b. Choose RAID1 (mirroring).
   c. Select each partition and click **Add** to move them to Selected Devices.

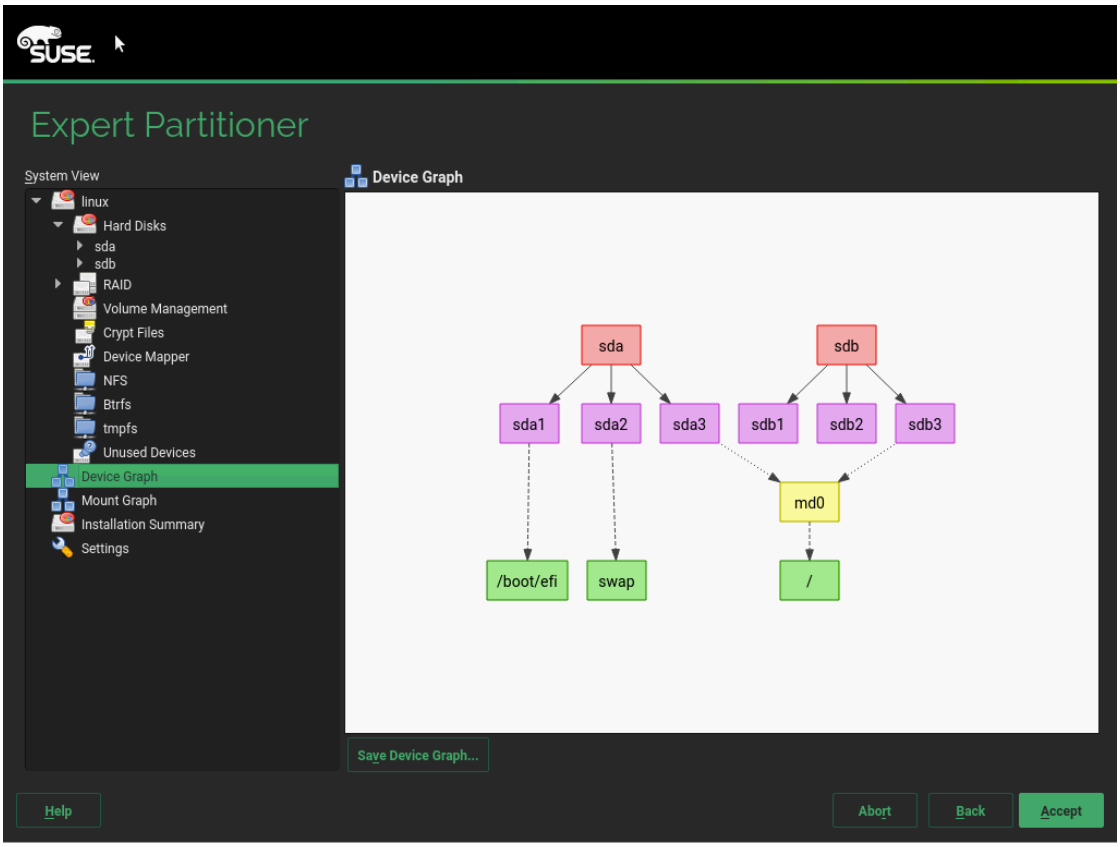


6. Set the following options: 4KB Chunk Size, role as “Operating System”, format as XFS and mount it to “/” (root).

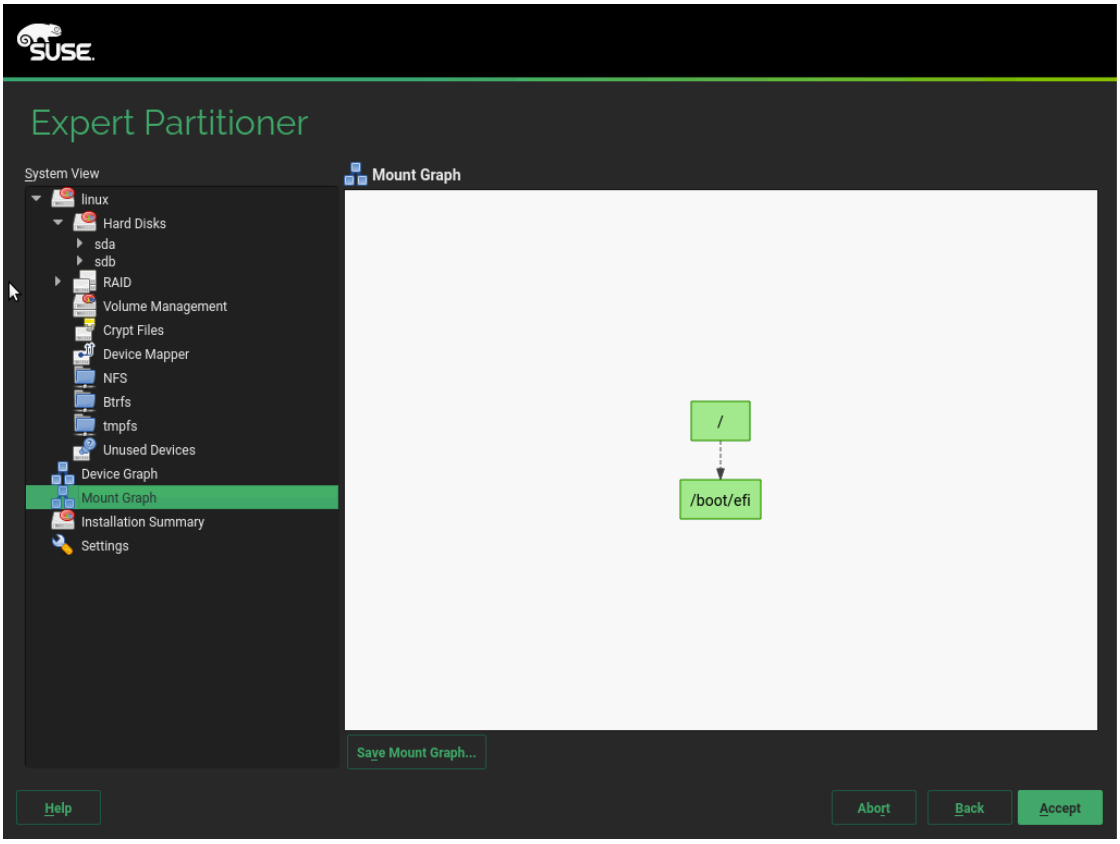


7. Click **Finish**.

   Examine the Device Graph. It should match the screenshot.



8. Examine the Mount Graph. It should match the screenshot.



9. Proceed to finish the installation

Creating the Redundant ESP

1. Log in to SLES 12SP2 and open a Terminal.
2. To clone the ESP partition from /dev/sda1 to /dev/sdb1, type the following command.

   ```
   dd if=/dev/sda1 of=/dev/sdb1
   ```

   where “If” is the input file, and “of” is the output file.
3. You should see something like below screenshot:

```
linux-kymm:~ # dd if=/dev/sda1 of=/dev/sdb1

399360+0 records in
399360+0 records out
204472320 bytes (204 MB, 195 MiB) copied, 3.22669 s, 63.4 MB/s
linux-kymm:~ #
```

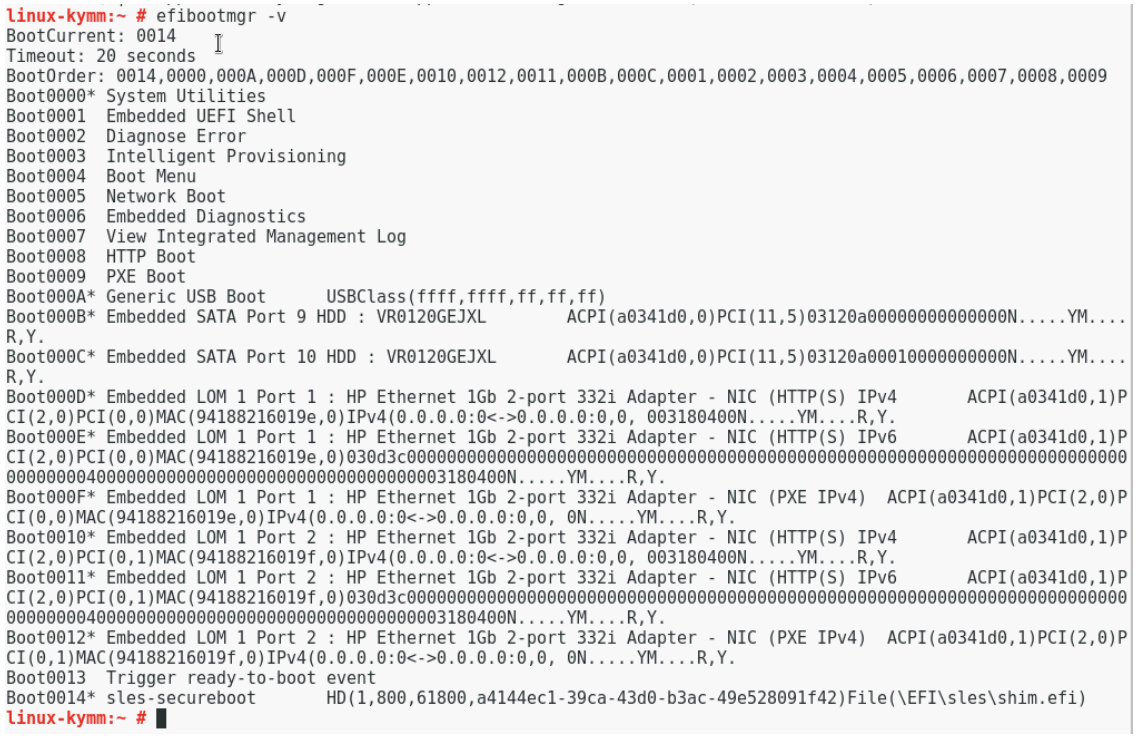
Creating a New Entry in the UEFI Boot Manager

Before creating a new entry for the Redundant ESP for /dev/sdb1, examine the current EFI boot manager. Make sure the contents of the new entry match the existing entry for SLES.

1. To list the entries in the EFI boot manager, type the following command.

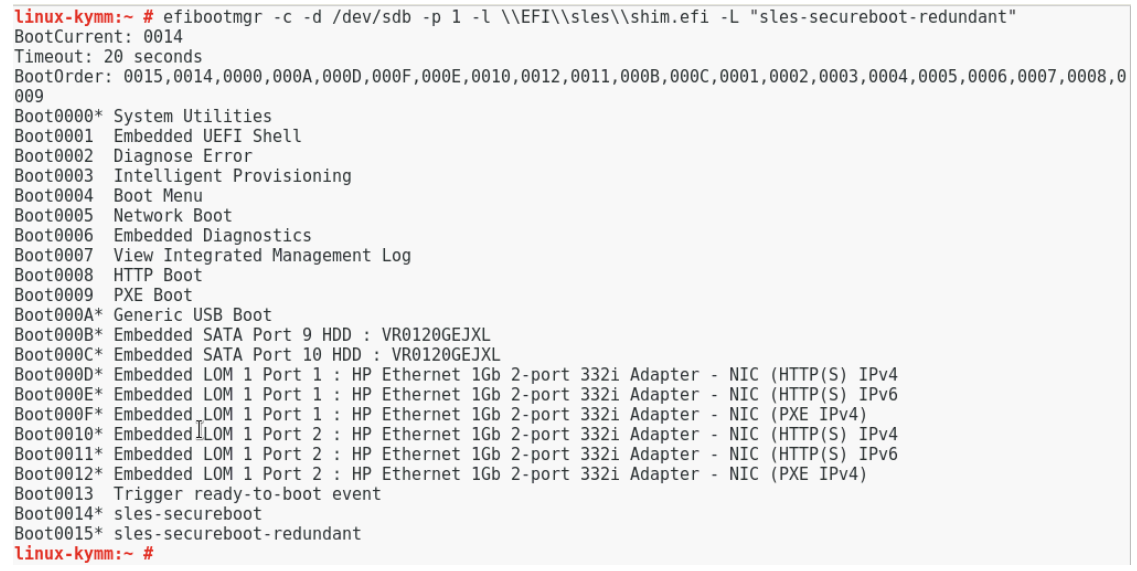
```
efibootmgr -v
```

2. The following screenshot shows that entry Boot0011 is the SLES entry created by the installer.



3. Create a new entry and name it ‘sles-secureboot-redundant”.

```
efibootmgr -c -d /dev/sdb -p 1 -l \\EFI\\sles\\shim.efi -L “sles-secureboot-redundant”
```



4. The “sles-secureboot-redundant” entry will be created as Boot0015.

   This process will place it as the first boot option. Move it to the second boot option.

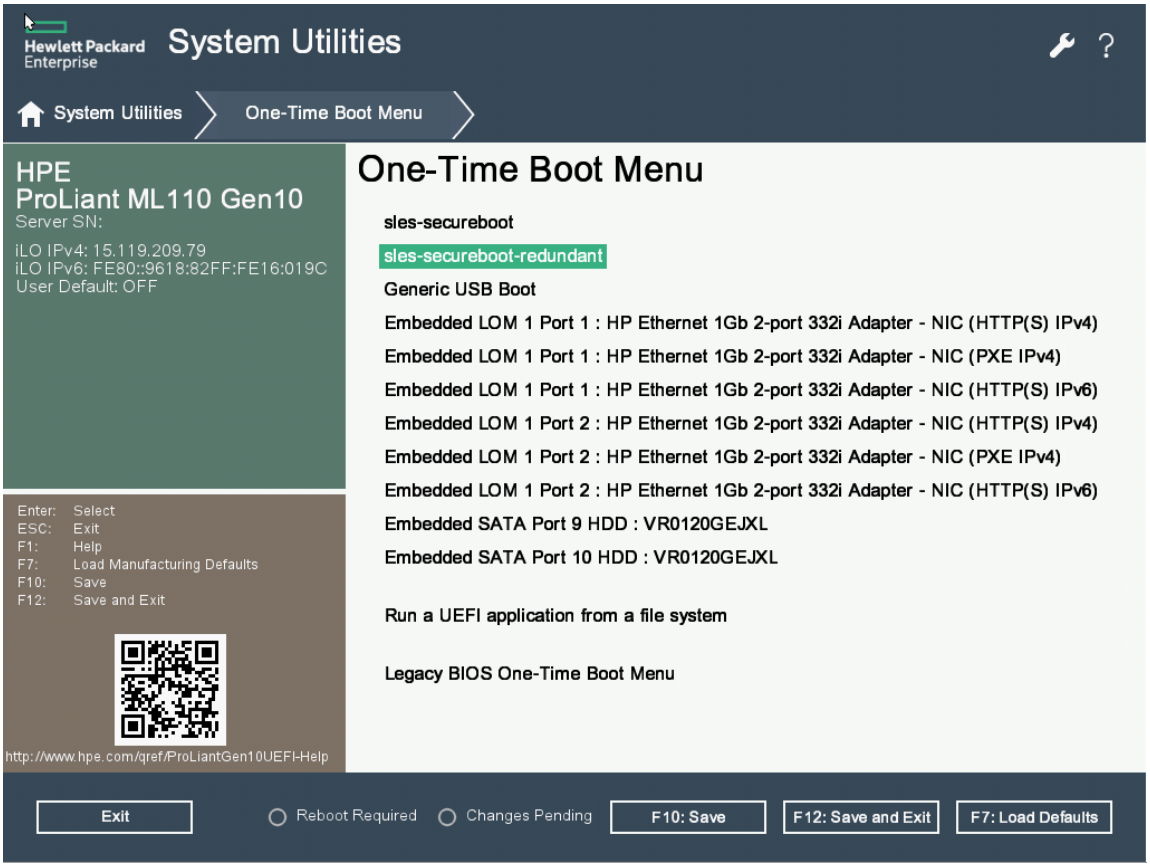
   ```
   efibootmgr -o
   0014,0015,0000,000A,000D,000F,000E,0010,0012,0011,000B,000C,0001,0002,0
   003,0004,0005,0006,0007,0008,0009
   ```

```
linux-kymm:~ # efibootmgr -o 0014,0015,0000,000A,000D,000F,000E,0010,0012,0011,000B,000C,0001,0002,0003,0004,000
5,0006,0007,0008,0009
BootCurrent: 0014
Timeout: 20 seconds
BootOrder: 0014,0015,0000,000A,000D,000F,000E,0010,0012,0011,000B,000C,0001,0002,0003,0004,0005,0006,0007,0008,0
009
Boot0000* System Utilities
Boot0001  Embedded UEFI Shell
Boot0002  Diagnose Error
Boot0003  Intelligent Provisioning
Boot0004  Boot Menu
Boot0005  Network Boot
Boot0006  Embedded Diagnostics
Boot0007  View Integrated Management Log
Boot0008  HTTP Boot
Boot0009  PXE Boot
Boot000A* Generic USB Boot
Boot000B* Embedded SATA Port 9 HDD : VR0120GEJXL
Boot000C* Embedded SATA Port 10 HDD : VR0120GEJXL
Boot000D* Embedded LOM 1 Port 1 : HP Ethernet 1Gb 2-port 332i Adapter - NIC (HTTP(S) IPv4
Boot000E* Embedded LOM 1 Port 1 : HP Ethernet 1Gb 2-port 332i Adapter - NIC (HTTP(S) IPv6
Boot000F* Embedded LOM 1 Port 1 : HP Ethernet 1Gb 2-port 332i Adapter - NIC (PXE IPv4)
Boot0010* Embedded LOM 1 Port 2 : HP Ethernet 1Gb 2-port 332i Adapter - NIC (HTTP(S) IPv4
Boot0011* Embedded LOM 1 Port 2 : HP Ethernet 1Gb 2-port 332i Adapter - NIC (HTTP(S) IPv6
Boot0012* Embedded LOM 1 Port 2 : HP Ethernet 1Gb 2-port 332i Adapter - NIC (PXE IPv4)
Boot0013  Trigger ready-to-boot event
Boot0014* sles-secureboot
Boot0015* sles-secureboot-redundant
linux-kymm:~ #
```

5. The actual number of entries depends on the system configuration. Check the entries by entering:

   ```
   efibootmgr -v
   ```

6. Verify the boot entry by rebooting the system, press **F11** to the boot menu. “sles-secureboot-redundant” should be in the boot menu.
7. Boot in to the system to verify it works.
8. Log in the system.



Recovering a failed disk and repairing Software RAID

In the event of a failed disk, it is necessary to recover the failed partition and restore the software RAID. Logging in to the system through the second disk is possible when the EFI boot entries are set properly.

Examine the RAID status

1. To examine the status of the RAID configuration, enter the following:

   ```
   mdadm --detail /dev/md0
   ```

   - Total Devices became “1”.
   - State changed to “clean, degraded”.
   - Disk `/dev/sdb3` has become `/dev/sda3`.

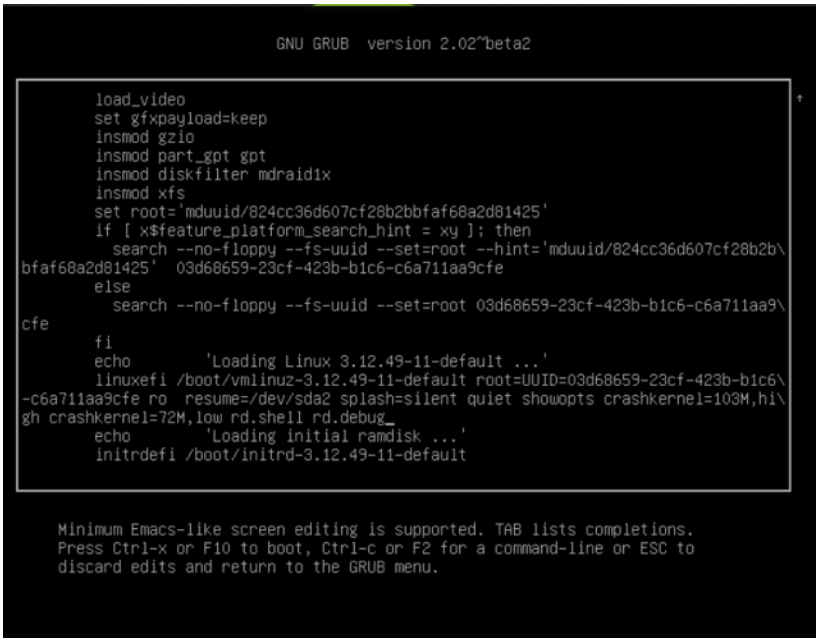
     It is the only available disk.

Add two additional kernel parameters to allow booting from the second disk

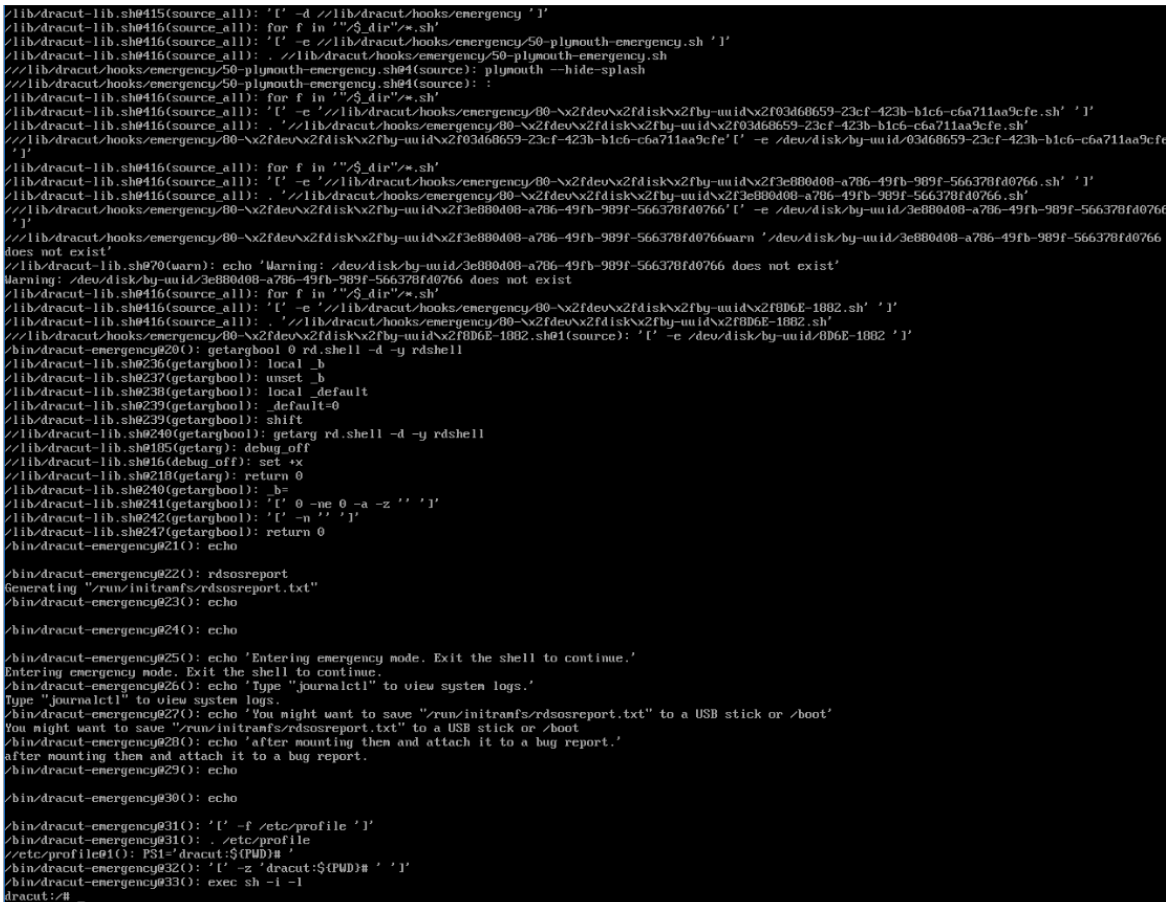
In SLES, if the first disk fails two additional kernel parameters must be added to allow the system to successfully boot from the second disk.

1. From the GRUB menu, press the **e** key to edit the kernel parameter.
2. Find the line ending with `crashkerel=72M,low`
3. Append `rd.shell rd.debug`
4. Press **Ctrl-x** or **F10** to boot with the new setting.

   This is a one-time setting only. It will not impact subsequent boots.



After a few minutes, the screen will enter a rescue shell.



Recovering the failed partition

1. Prepare a new disk portioned as described in “Partitioning a drive for SLES.”
2. Boot from the “sles-secureboot2”.

   Make sure proper kernel parameters (rd.shell rd.debug) were added to enter the rescue shell.

   The new disk will be shown as /dev/sda, and the original second disk will appear as /dev/sdb.

   To add the new /dev/sda3 to rebuild the RAID, type the following command in the rescue shell.

   `mdadm --add /dev/md0 /dev/sda3`
3. Enter `mdadm --detail /dev/md0`

   The State will change to “clean, degraded, recovering” and the Rebuild Status “75% complete” (or other progress number).
4. Once the rebuild has completed, the State will change to “clean”,

   The recovery is complete.

```
linux-9xde:~ # mdadm --add /dev/md0 /dev/sda3
mdadm: added /dev/sda3
linux-9xde:~ # mdadm --detail /dev/md0
/dev/md0:
        Version : 1.0
  Creation Time : Tue Mar 29 16:43:01 2016
     Raid Level : raid1
     Array Size : 471405376 (449.57 GiB 482.72 GB)
  Used Dev Size : 471405376 (449.57 GiB 482.72 GB)
   Raid Devices : 2
  Total Devices : 2
    Persistence : Superblock is persistent

  Intent Bitmap : Internal

    Update Time : Wed Mar 30 05:48:11 2016
          State : clean, degraded, recovering
 Active Devices : 1
Working Devices : 2
 Failed Devices : 0
  Spare Devices : 1

 Rebuild Status : 0% complete

           Name : any:0
           UUID : 824cc36d:607cf28b:2bbfaf68:a2d81425
         Events : 1742

    Number   Major   Minor   RaidDevice State
       2       8        3        0      spare rebuilding   /dev/sda3
       1       8       19        1      active sync   /dev/sdb3
linux-9xde:~ # _
```

Complete the recovery process

To make a redundant copy of the ESP, repeat the process described in "Creating a redundant ESP."

Add a new entry to EFI Boot Manager to complete the recovery process.

1. Replicate the ESP from /dev/sdb1 back to /dev/sda1.

   ```
   dd –if=/dev/sdb1 –of=/dev/sda1
   ```

2. Remove the existing SLES boot entry:

   ```
   efibootmgr –b 11 –B
   ```

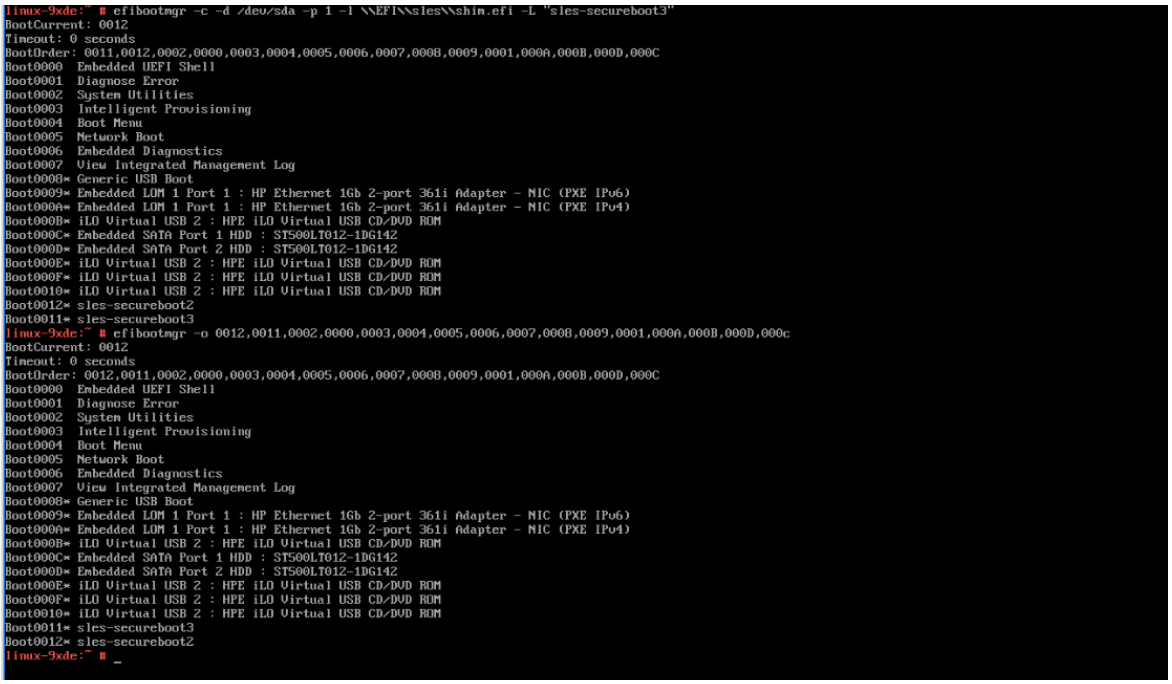
```
linux-9xde:~ # dd if=/dev/sdb1 of=/dev/sda1
399360+0 records in
399360+0 records out
204472320 bytes (204 MB) copied, 4.98957 s, 41.0 MB/s
linux-9xde:~ # efibootmgr -b 11 -B
BootCurrent: 0012
Timeout: 0 seconds
BootOrder: 0012,0002,0000,0003,0004,0005,0006,0007,0008,0009,0001,000A,000B,000D,000C
Boot0000  Embedded UEFI Shell
Boot0001  Diagnose Error
Boot0002  System Utilities
Boot0003  Intelligent Provisioning
Boot0004  Boot Menu
Boot0005  Network Boot
Boot0006  Embedded Diagnostics
Boot0007  View Integrated Management Log
Boot0008* Generic USB Boot
Boot0009* Embedded LOM 1 Port 1 : HP Ethernet 1Gb 2-port 361i Adapter - NIC (PXE IPv6)
Boot000A* Embedded LOM 1 Port 1 : HP Ethernet 1Gb 2-port 361i Adapter - NIC (PXE IPv4)
Boot000B* iLO Virtual USB 2 : HPE iLO Virtual USB CD/DVD ROM
Boot000C* Embedded SATA Port 1 HDD : ST500LT012-1DG142
Boot000D* Embedded SATA Port 2 HDD : ST500LT012-1DG142
Boot000E* iLO Virtual USB 2 : HPE iLO Virtual USB CD/DVD ROM
Boot000F* iLO Virtual USB 2 : HPE iLO Virtual USB CD/DVD ROM
Boot0010* iLO Virtual USB 2 : HPE iLO Virtual USB CD/DVD ROM
Boot0012* sles-secureboot2
linux-9xde:~ #
```

3. Create new entry for the replicated ESP:

   ```
   efibootmgr –c –d /dev/sda –p 1 –l \\EFI\\sles\\shim.efi -L "sles-secureboot-redundant"
   ```

4. Reorder the boot sequence:

   ```
   efibootmgr –o
   0012,0011,0002,0000,0003,0004,0005,0006,0007,0008,0009,0001,0001,000A,000B,000D,000C
   ```



NVMe PCI-e Disk

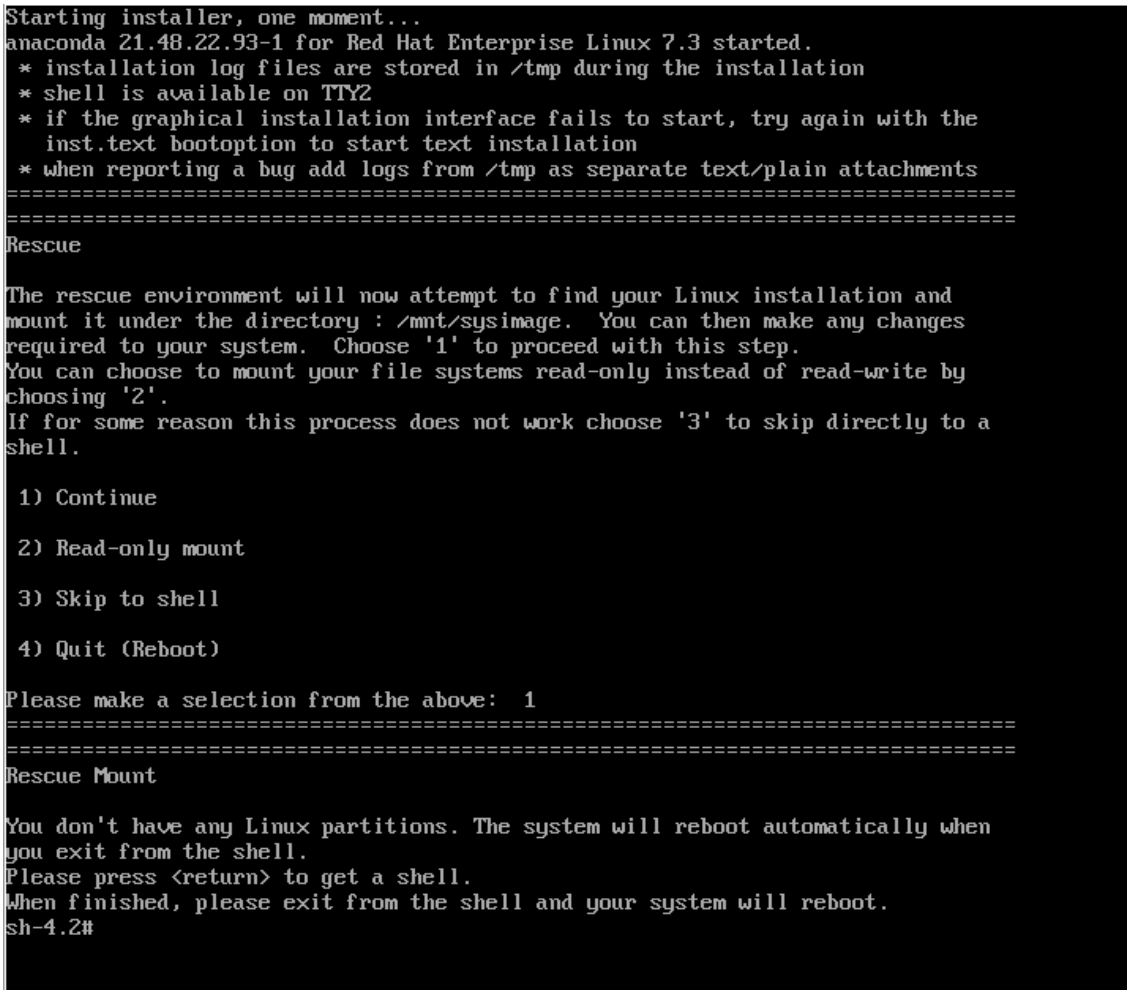
Red Hat Enterprise Linux (RHEL) 7.3

Manually Partitioning through Rescue mode

Partition the disk manually in Rescue mode before proceeding to the normal installation process. Do not use the RHEL GUI installer.

1. Boot from the RHEL 7.3 DVD image.
2. Select **Troubleshooting** > **Rescue a Red Hat Enterprise Linux system**.
3. Select **1) Continue**.

   The following prompt is displayed:



4. To create partitions on the first disk (/dev/nvme0n1), type the following commands.

   ```
   parted /dev/nvme0n1 mklabel gpt
   ```

5. Type “Yes” to confirm changes are made to the existing disk label.

   The following is displayed:

   ```
   parted /dev/nvme0n1 mkpart primary fat32 0 200MB
   ```

6. Type “Ignore” to ignore the size mismatch.

   The following is displayed:

   ```
   parted /dev/nvme0n1 mkpart primary ext2 200MB 16GB
   ```

   ```
   parted /dev/nvme0n1 print
   ```

7. Refer to the screenshot for detail partitioning instruction and information for /dev/nvme0n1.

```
sh-4.2# parted /dev/nvme0n1 print
Model: Unknown (unknown)
Disk /dev/nvme0n1: 400GB
Sector size (logical/physical): 512B/512B
Partition Table: gpt
Disk Flags:

Number  Start   End     Size    File system  Name     Flags
 1      17.4kB  200MB   200MB                primary
 2      200MB   16.0GB  15.8GB               primary

sh-4.2#
```

8. Repeat step 5 for the second disk (/dev/nvme1n1).

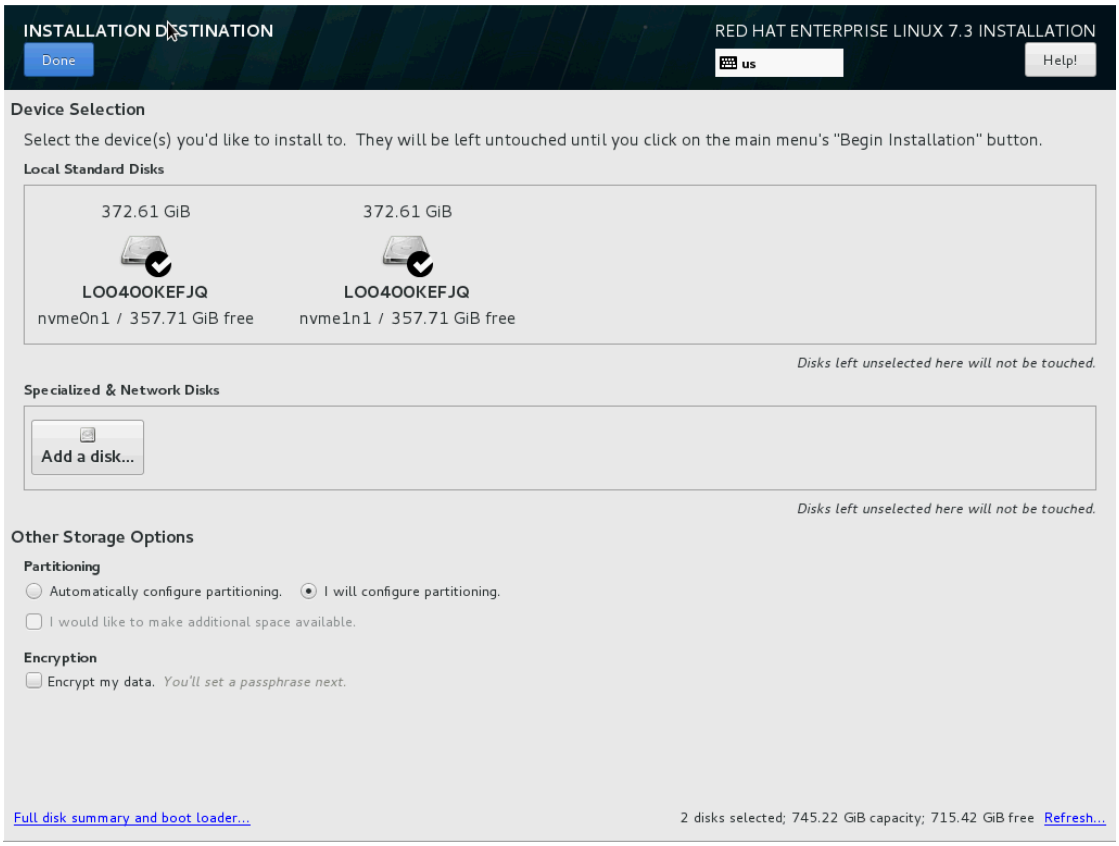
Refer to the screenshot for detail partitioning instruction and information for /dev/nvme1n1.

```
sh-4.2# parted /dev/nvme1n1 print
Model: Unknown (unknown)
Disk /dev/nvme1n1: 400GB
Sector size (logical/physical): 512B/512B
Partition Table: gpt
Disk Flags:

Number  Start   End     Size    File system  Name     Flags
 1      17.4kB  200MB   200MB                primary
 2      200MB   16.0GB  15.8GB               primary

sh-4.2#
```

9. Reboot to proceed with Red Hat installation.

Normal Installation Process

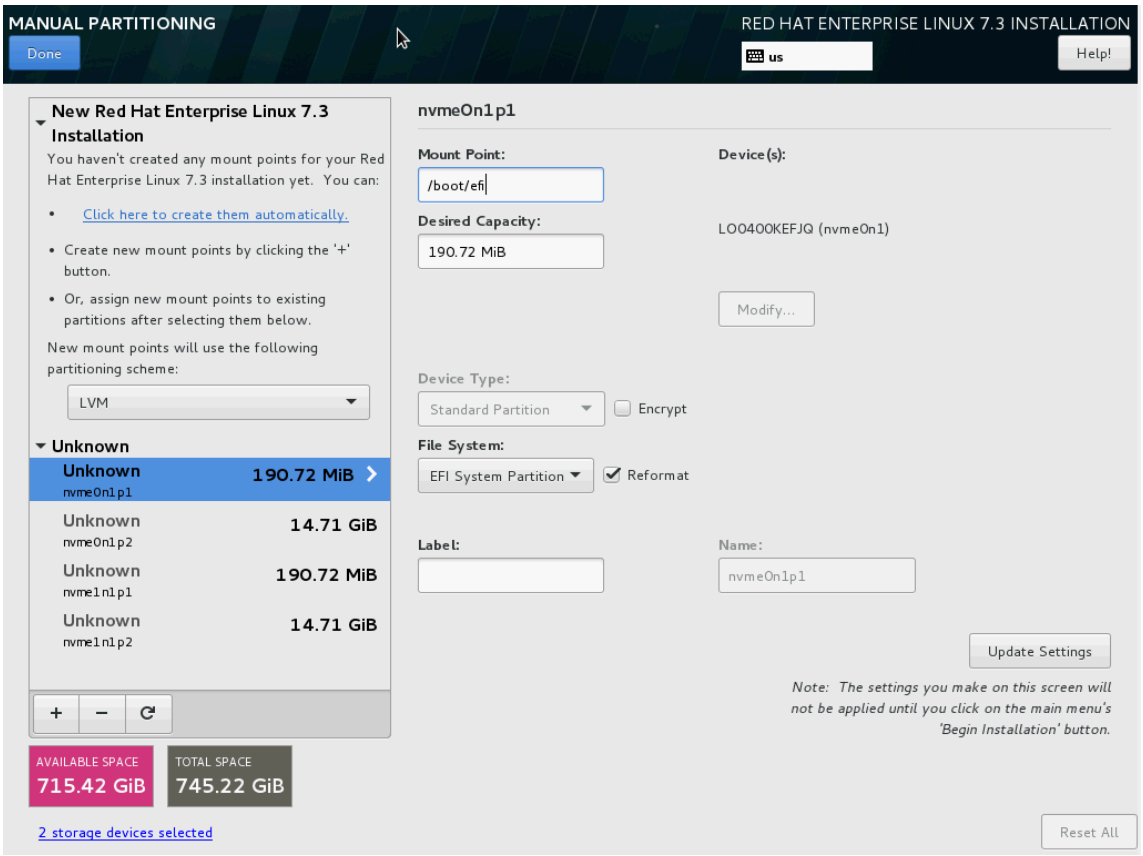
The software RAID installation differs from the normal installation process only in the “Installation Destination” step. In the “Installation Destination”, specify the ESP, swap and root partition respectively. In the “Installation Destination” step, make sure both disks are selected, and “I will configure partitioning” is selected.



Specifying the ESP

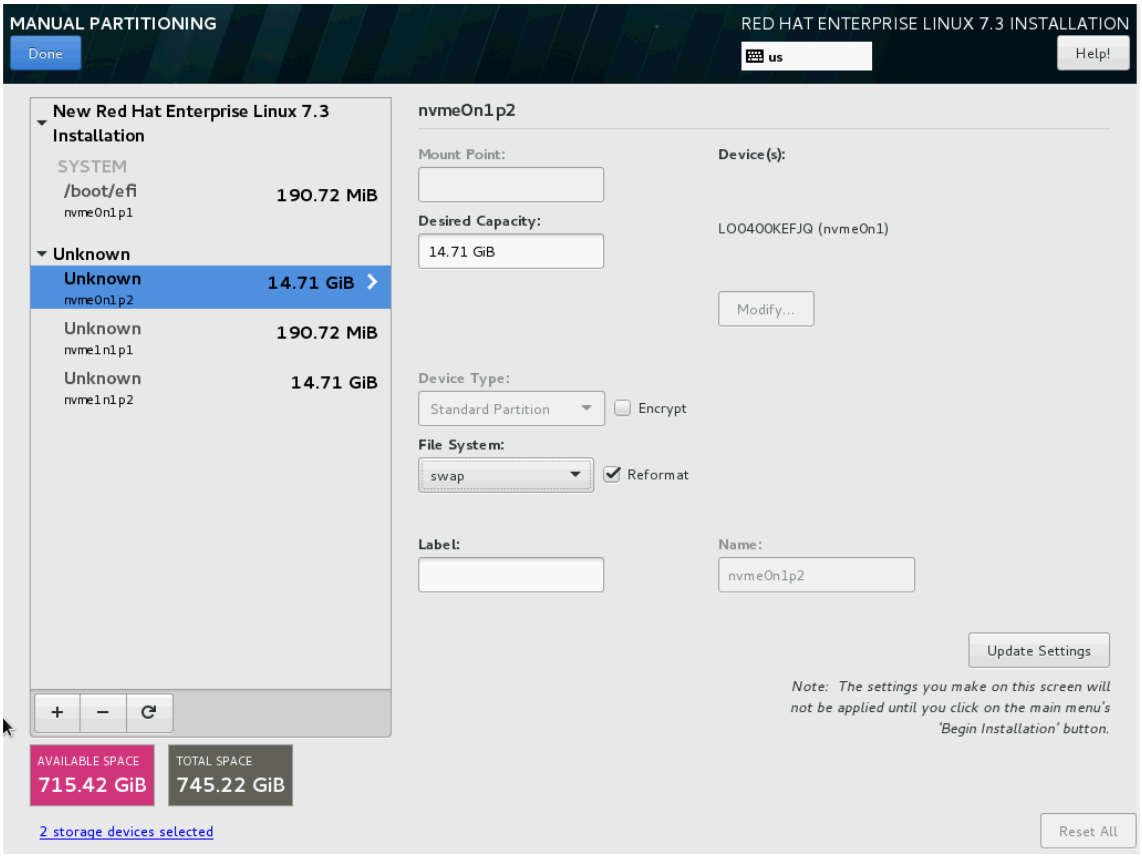
The ESP is the partition that contains the boot loaders used by the UEFI firmware.

1. Select **nvme0n1p1** under Unknown in the left pane.
2. Under File System, select **EFI System Partition** and check **Reformat**.
3. In the Mount Point field, enter `/boot/efi`.
4. Click **Update Settings**.



Specifying the swap directory

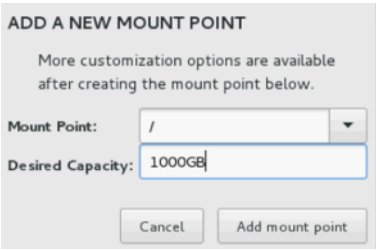
1. Select **nvme0n1p2** in the “Unknown” section.
2. In the File System dropdown, select **swap** and check **Reformat**.
3. Click Update Settings.



Creating root disk as RAID1

1. Click **+**.
2. To choose the root directory, enter “/” as mount point.
3. Enter “1000GB” in Desired Capacity.

   The system will calculate the correct size.
4. Click **Add mount point**.



Create a RAID1 root partition

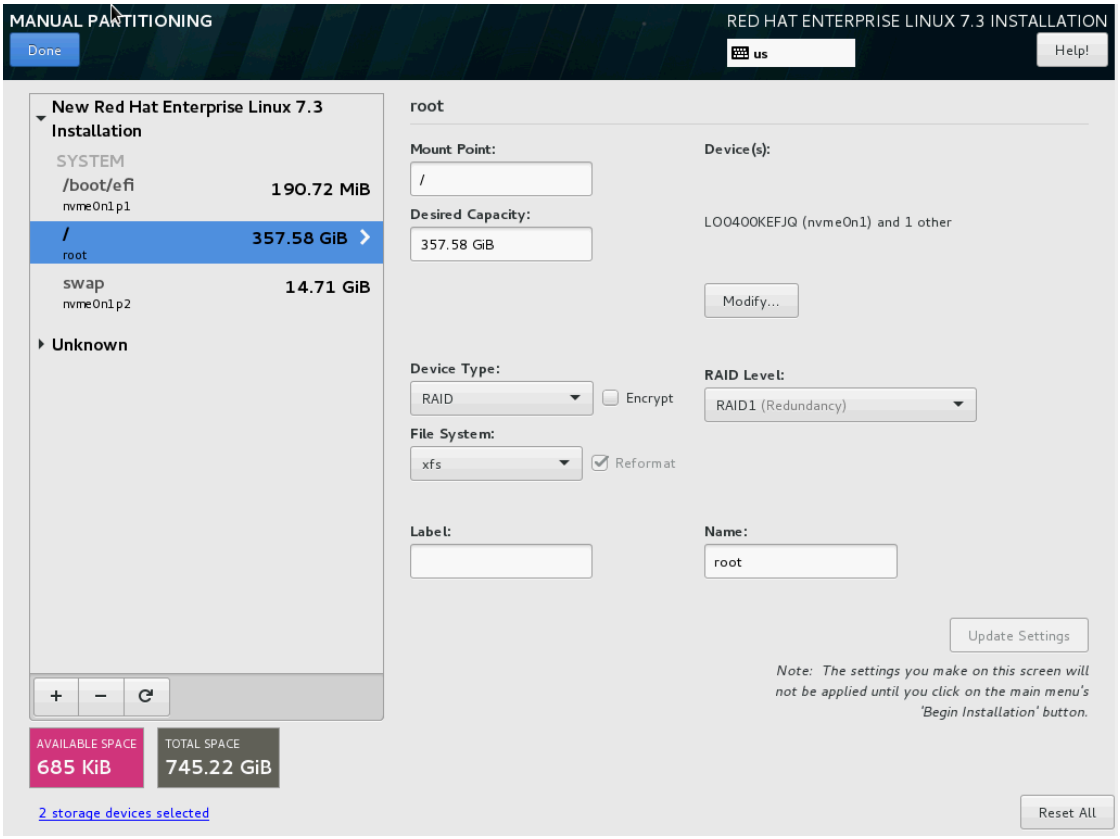
1. Select **/ rhel-root** in the left pane.
2. Select **RAID** in Device Type.

3. Choose **xfs** or other desired file system.
4. Make sure **RAID1 (Redundancy)** in RAID Level is selected.
5. Click **Update Settings**.

The system will calculate the final size for the RAID partition.

The system will create a new md device in `/dev/md/root`.

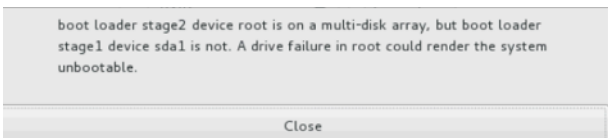
6. In the Name field, type “root”.



7. Continue the installation by clicking **Done**.

   The system will show a warning message.

   This message can be ignored.



Creating the Redundant ESP

1. Log in to Red Hat Enterprise Linux 7.3.

2. To clone the ESP partition from `/dev/nvme0n1p1` to `/dev/nvme1n1p1`, enter the following command.

   ```
   dd if=/dev/nvme0n1p1 of=/dev/nvme1n1p1
   ```

   where “if” is the input file, and “of” is the output file.

3. For example output, see the following screenshot.

```
Red Hat Enterprise Linux Server 7.3 (Maipo)
Kernel 3.10.0-514.el7.x86_64 on an x86_64

localhost login: root
Password:
[root@localhost ~]# dd if=/dev/nvme0n1p1 of=/dev/nvme1n1p1
390592+0 records in
390592+0 records out
199983104 bytes (200 MB) copied, 6.04875 s, 33.1 MB/s
[root@localhost ~]# _
```

Creating a New Entry in UEFI Boot Manager

Before creating a new entry for the Redundant ESP for /dev/nvme1n1p1, examine the current EFI boot manager. Make sure the contents of the new entry match the existing entry for RHEL.

1. To list the entries in the EFI boot manager, type the following command.

   ```
   efibootmgr -v
   ```

   The screenshot shows that entry Boot000E is the “Red Hat Enterprise Linux” entry created by the installer.

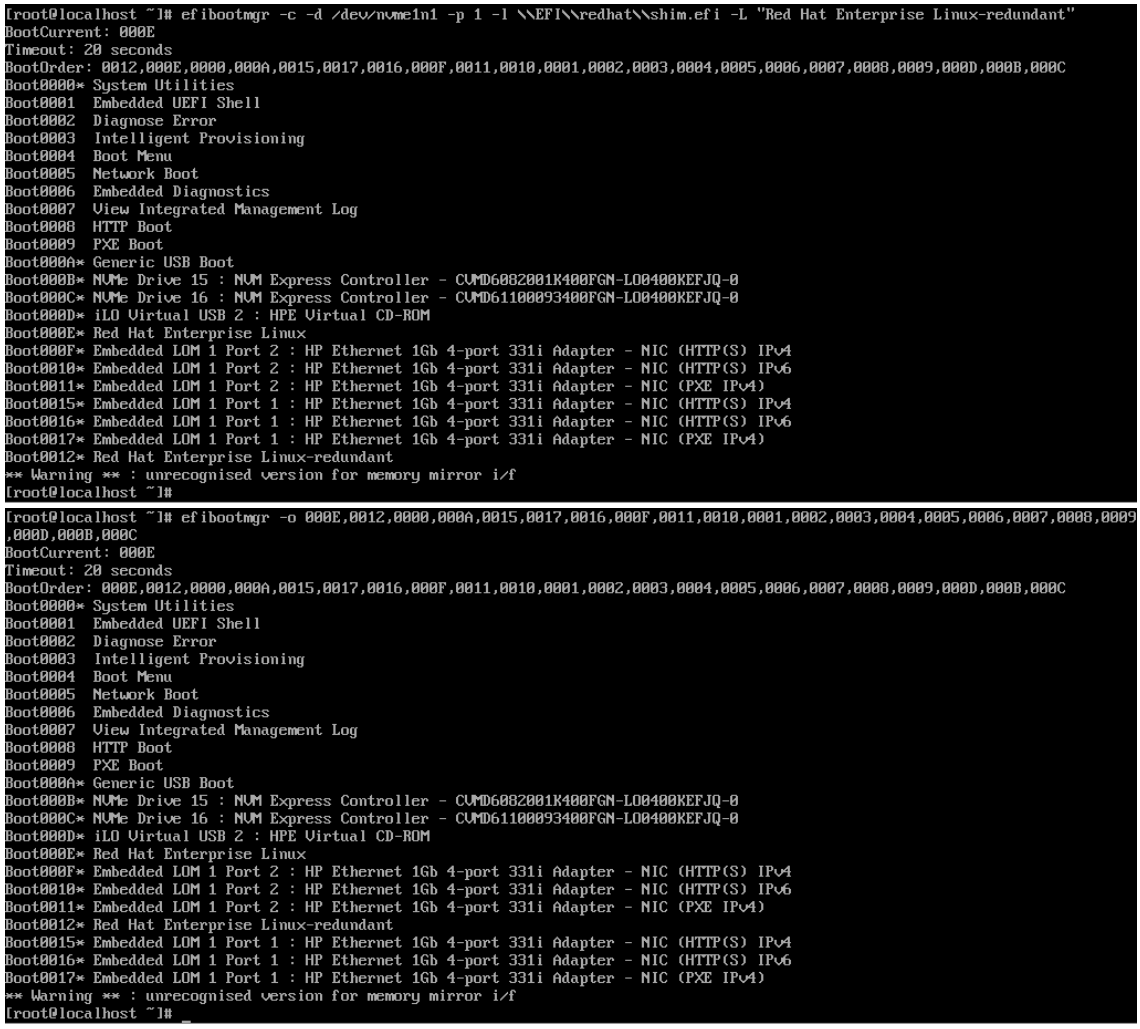
```
[root@localhost ~]# efibootmgr -v
BootCurrent: 000E
Timeout: 20 seconds
BootOrder: 000E,0000,000A,0015,0017,0016,000F,0011,0010,0001,0002,0003,0004,0005,0006,0007,0008,0009,000D,000B,000C
Boot0000* System Utilities      FvVol(cdbb7b35-6833-4ed6-9ab2-57d2acddf6f0)
Boot0001  Embedded UEFI Shell   FvVol(cdbb7b35-6833-4ed6-9ab2-57d2acddf6f0)
Boot0002  Diagnose Error        FvVol(cdbb7b35-6833-4ed6-9ab2-57d2acddf6f0)
Boot0003  Intelligent Provisioning      FvVol(cdbb7b35-6833-4ed6-9ab2-57d2acddf6f0)
Boot0004  Boot Menu     FvVol(cdbb7b35-6833-4ed6-9ab2-57d2acddf6f0)
Boot0005  Network Boot  FvVol(cdbb7b35-6833-4ed6-9ab2-57d2acddf6f0)
Boot0006  Embedded Diagnostics  FvVol(cdbb7b35-6833-4ed6-9ab2-57d2acddf6f0)
Boot0007  View Integrated Management Log        FvVol(cdbb7b35-6833-4ed6-9ab2-57d2acddf6f0)
Boot0008  HTTP Boot     FvVol(cdbb7b35-6833-4ed6-9ab2-57d2acddf6f0)
Boot0009  PXE Boot      FvVol(cdbb7b35-6833-4ed6-9ab2-57d2acddf6f0)
Boot000A* Generic USB Boot      USBClass(ffff,ffff,ff,ff,ff)
Boot000B* NVMe Drive 15 : NVM Express Controller - CVMD6082001K400FGN-LO0400KEFJQ-0     ACPI(a0341d0,1)PCI(2,0)PCI(0,0)NVME(1,0)
N.....YM....R,Y.
Boot000C* NVMe Drive 16 : NVM Express Controller - CVMD61100093400FGN-LO0400KEFJQ-0     ACPI(a0341d0,1)PCI(3,0)PCI(0,0)NVME(1,0)
N.....YM....R,Y.
Boot000D* iLO Virtual USB 2 : HPE Virtual CD-ROM        ACPI(a0341d0,0)PCI(1c,4)PCI(0,4)USB(1,0)N.....YM....R,Y.
Boot000E* Red Hat Enterprise Linux      HD(1,22,5f5c0,eb62d9bc-e5fe-439a-aa46-59b0e045c232)File(\EFI\redhat\shim.efi)
Boot000F* Embedded LOM 1 Port 2 : HP Ethernet 1Gb 4-port 331i Adapter - NIC (HTTP(S) IPv4       ACPI(a0341d0,0)PCI(1c,0)PCI(0,1)
MAC(MAC(9418821800a9,0)N.....YM....R,Y.
Boot0010* Embedded LOM 1 Port 2 : HP Ethernet 1Gb 4-port 331i Adapter - NIC (HTTP(S) IPv6       ACPI(a0341d0,0)PCI(1c,0)PCI(0,1)
MAC(MAC(9418821800a9,0)030d3c000000000000000000000000000000000000000000000000000000000000000000000000000040000000000000000
000000000000000003180400N.....YM....R,Y.
Boot0011* Embedded LOM 1 Port 2 : HP Ethernet 1Gb 4-port 331i Adapter - NIC (PXE IPv4)  ACPI(a0341d0,0)PCI(1c,0)PCI(0,1)MAC(MAC(
9418821800a9,0)N.....YM....R,Y.
Boot0015* Embedded LOM 1 Port 1 : HP Ethernet 1Gb 4-port 331i Adapter - NIC (HTTP(S) IPv4       ACPI(a0341d0,0)PCI(1c,0)PCI(0,0)
MAC(MAC(9418821800a8,0)N.....YM....R,Y.
Boot0016* Embedded LOM 1 Port 1 : HP Ethernet 1Gb 4-port 331i Adapter - NIC (HTTP(S) IPv6       ACPI(a0341d0,0)PCI(1c,0)PCI(0,0)
MAC(MAC(9418821800a8,0)030d3c000000000000000000000000000000000000000000000000000000000000000000000000000040000000000000000
000000000000000003180400N.....YM....R,Y.
Boot0017* Embedded LOM 1 Port 1 : HP Ethernet 1Gb 4-port 331i Adapter - NIC (PXE IPv4)  ACPI(a0341d0,0)PCI(1c,0)PCI(0,0)MAC(MAC(
9418821800a8,0)N.....YM....R,Y.
** Warning ** : unrecognised version for memory mirror i/f
[root@localhost ~]#
```

2. Create a new entry and name it “Red Hat Enterprise Linux-redundant” using the following command.

   ```
   efibootmgr –c –d /dev/nvme1n1 –p 1 –l \\EFI\\redhat\\shim.efi -L “Red Hat Enterprise Linux-redundant”
   ```

3. The “Red Hat Enterprise Linux-redundant” entry is created as Boot0012. It is selected as the first boot option. It should be moved to second boot option.

   ```
   efibootmgr –o 000E,0012,0000,000A,0015,0017,0016,000F,0011,0010,0001,0002,0003,0004,0005,0006,0007,0008,0009,000D,000B,000C
   ```



4. The actual number for entries depends on the system configuration.

   Check the system configuration by typing:

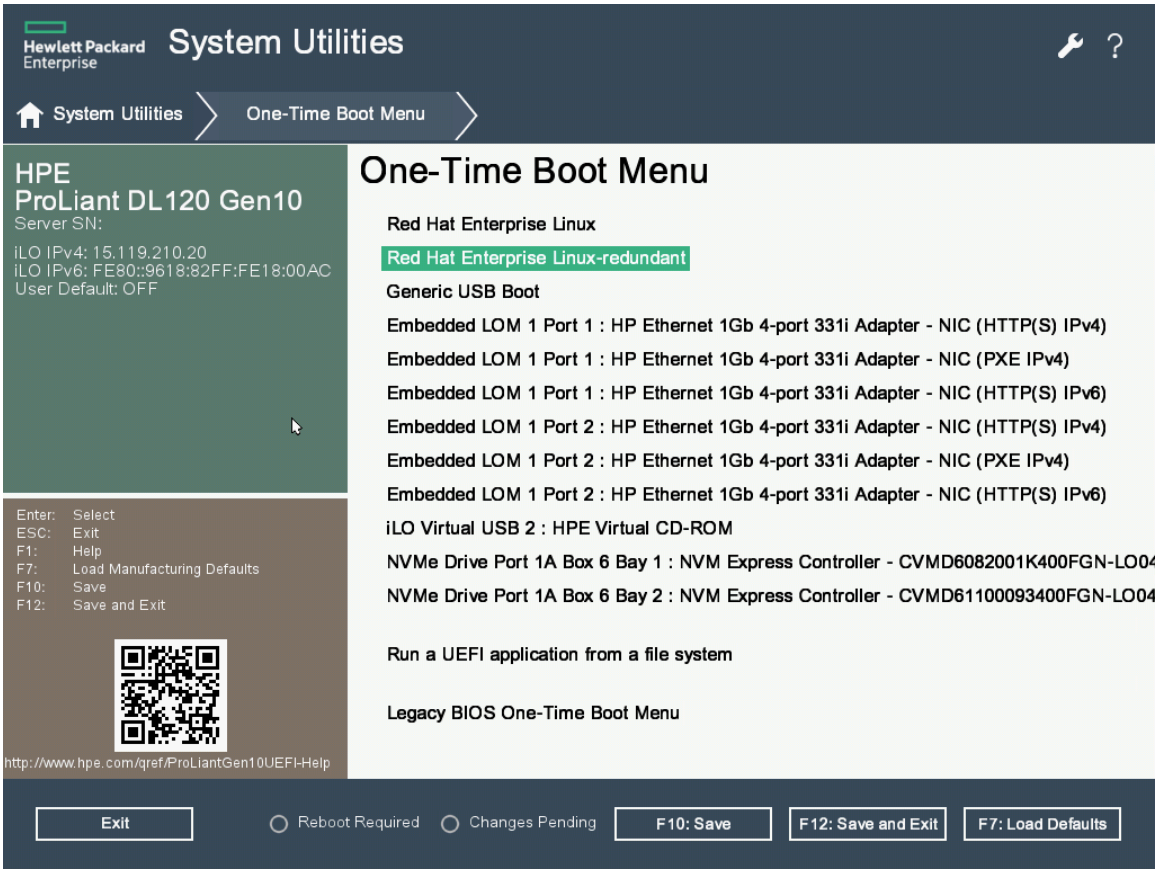
   ```
   efibootmgr –v
   ```

5. Verify the boot entry by rebooting the system.

a. Press **F11** to go to the boot menu.

b. Choose **Red Hat Enterprise Linux-redundant** from the boot menu.

6. Log in to the system.



Recovering a failed disk and repairing Software RAID

In the event of a failed disk, it is necessary to recover the failed partition and restore the software RAID. Logging in to the system through the second disk is possible when the EFI boot entries are set properly.

1. Examine the status of the RAID configuration using the following command.

```
mdadm --detail /dev/md/root
```

- Total Devices report “1”.
- State reports as “clean, degraded”.
- /dev/nvme1n1p3 has become /dev/nvme0n1p3

  It is the only available disk.

```
[root@localhost ~]# mdadm --detail /dev/md/root
/dev/md/root:
        Version : 1.0
  Creation Time : Mon Mar 28 15:36:17 2016
     Raid Level : raid1
     Array Size : 471609152 (449.76 GiB 482.93 GB)
  Used Dev Size : 471609152 (449.76 GiB 482.93 GB)
   Raid Devices : 2
  Total Devices : 1
    Persistence : Superblock is persistent

  Intent Bitmap : Internal

    Update Time : Tue Mar 29 04:49:58 2016
          State : clean, degraded
 Active Devices : 1
Working Devices : 1
 Failed Devices : 0
  Spare Devices : 0

           Name : localhost:root
           UUID : c0ef0caa:8d8af3b4:624ed707:d013b8d1
         Events : 1440

    Number   Major   Minor   RaidDevice State
       0       0        0        0      removed
       1       8        3        1      active sync   /dev/sda3
[root@localhost ~]#
```

Recover the RAID system

1. Prepare a new disk, partitioned as previously described.
2. From the boot menu, choose “Red Hat Enterprise Linux-redundant”

   The new disk is shown as `/dev/nvme0n1.`

   The original second disk will appear as `/dev/nvme1n1.`
3. Type the following command to add the new /dev/nvme0n1p3 to rebuild the RAID.

   `mdadm --add /dev/md/root /dev/nvme0n1p3`
4. Enter `mdadm --detail /dev/md/root`

   The State will change to “clean, degraded, recovering” and the Rebuild Status will report “75% complete” (or other progress number).
5. Once the rebuild has completed, State will report as “clean”.
6. The recovery is complete.

```
[root@localhost ~]# mdadm --detail /dev/md/root
/dev/md/root:
        Version : 1.0
  Creation Time : Mon Mar 28 15:36:17 2016
     Raid Level : raid1
     Array Size : 471609152 (449.76 GiB 482.93 GB)
  Used Dev Size : 471609152 (449.76 GiB 482.93 GB)
   Raid Devices : 2
  Total Devices : 2
    Persistence : Superblock is persistent

  Intent Bitmap : Internal

    Update Time : Tue Mar 29 05:28:02 2016
          State : clean
 Active Devices : 2
Working Devices : 2
 Failed Devices : 0
  Spare Devices : 0

           Name : localhost:root
           UUID : c0ef0caa:8d8af3b4:624ed707:d013b8d1
         Events : 1542

    Number   Major   Minor   RaidDevice State
       0       8        3        0      active sync   /dev/sda3
       1       8       19        1      active sync   /dev/sdb3
[root@localhost ~]#
```

Complete the recovery process

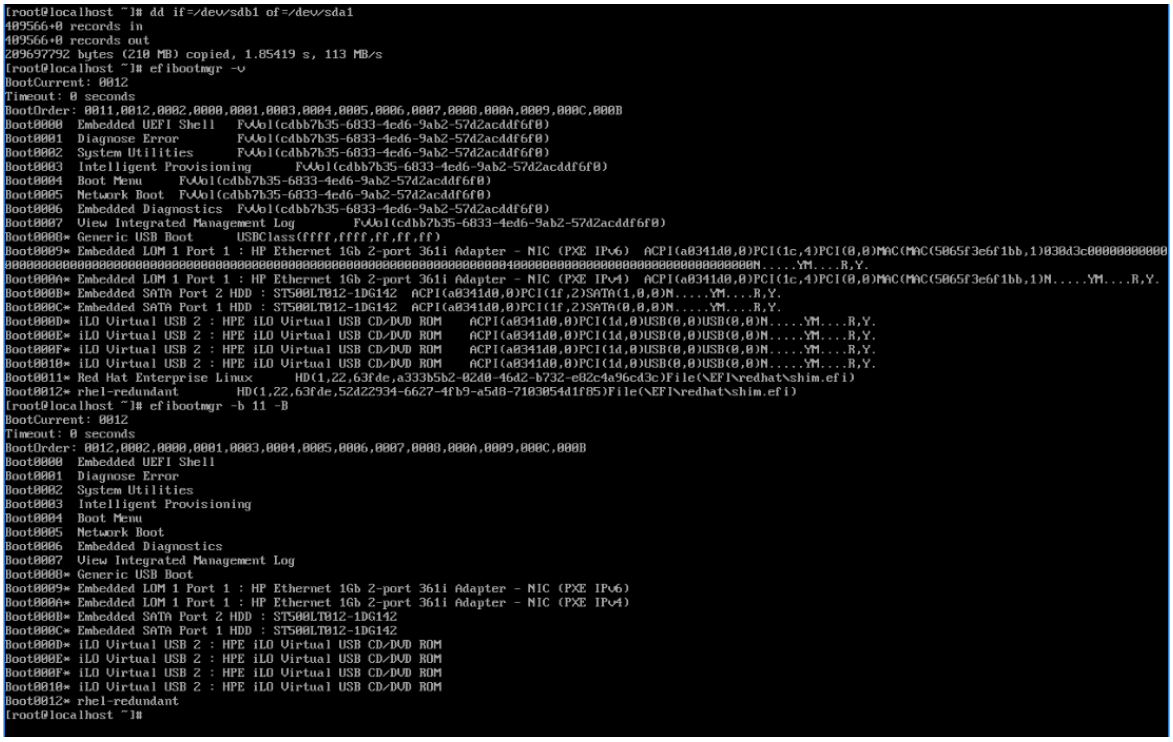
Repeat the process described in "Creating the Redundant ESP" to make a redundant copy of the ESP, and add a new entry to EFI Boot Manager to complete the recovery process.

1. To replicate the ESP from /dev/nvme1n1p1 back to /dev/nvme0n1p1, enter the following command.

   ```
   dd if=/dev/nvme1n1p1 of=/dev/nvme0n1p1
   ```

2. To remove the existing RHEL boot entry, enter the following command.

   ```
   efibootmgr -b 11 -B
   ```

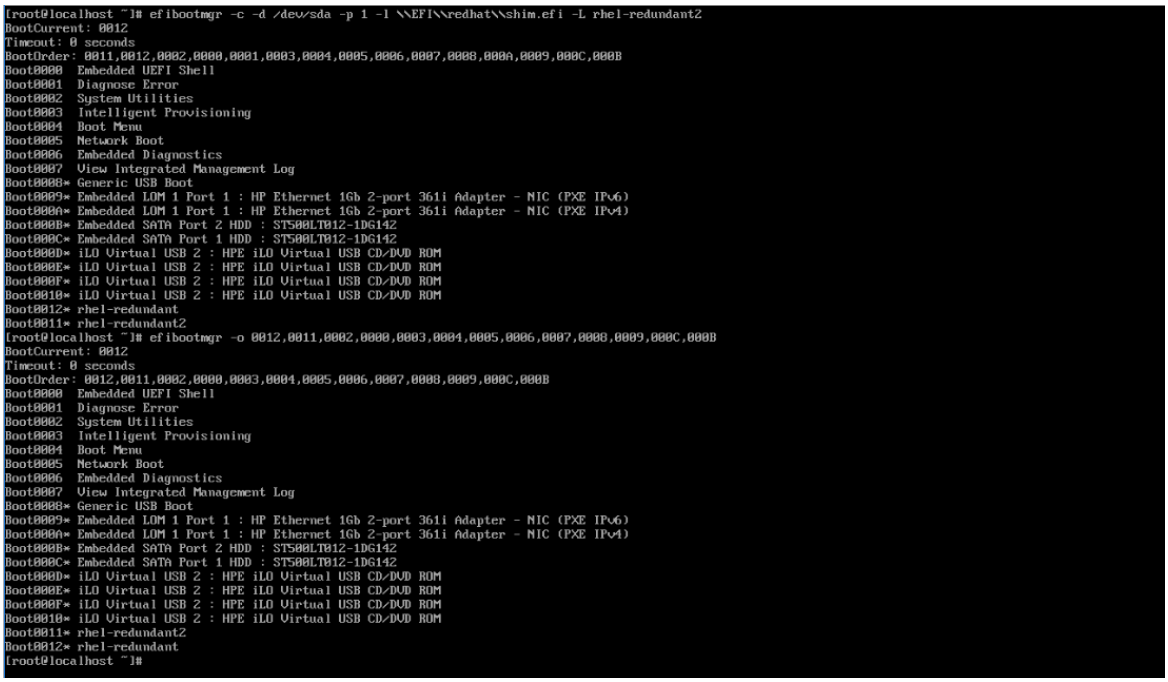


3. Create new entry for the replicated ESP by entering the following command:

   ```
   efibootmgr -c -d /dev/nvme0n1 -p 1 -l \\EFI\\redhat\\shim.efi -L "Red Hat Enterprise Linux-redundant2"
   ```

4. Reorder boot sequence by entering the following command:

   ```
   efibootmgr -o 0012,0011,0002,0000,0001,0003,0004,0005,0006,0007,0008,000A,0009,000C,000B
   ```



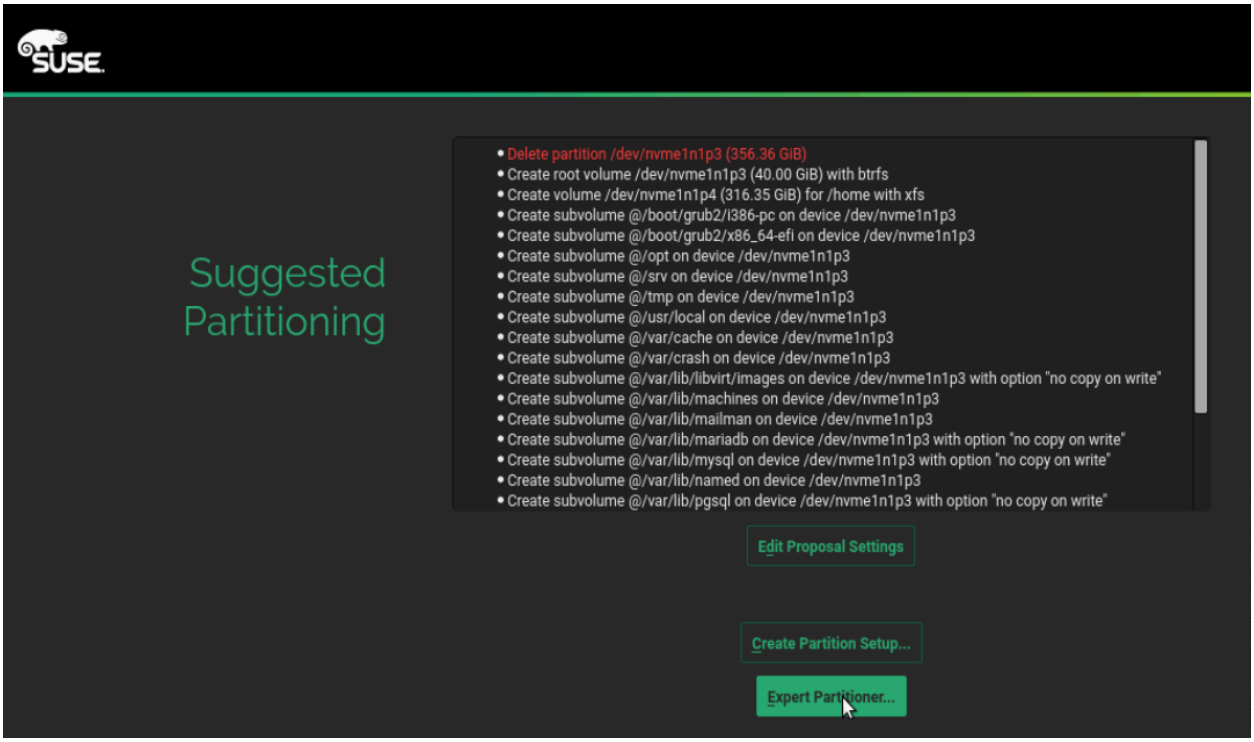
SuSE Linux Enterprise Server (SLES) 12 SP2

Installation process

Only the partition scheme is different in the Software RAID installation process compare to the standard installation process.

Partitioning drives for SLES

1. From the Suggested Partitioning screen, select **Expert Partitioner…**

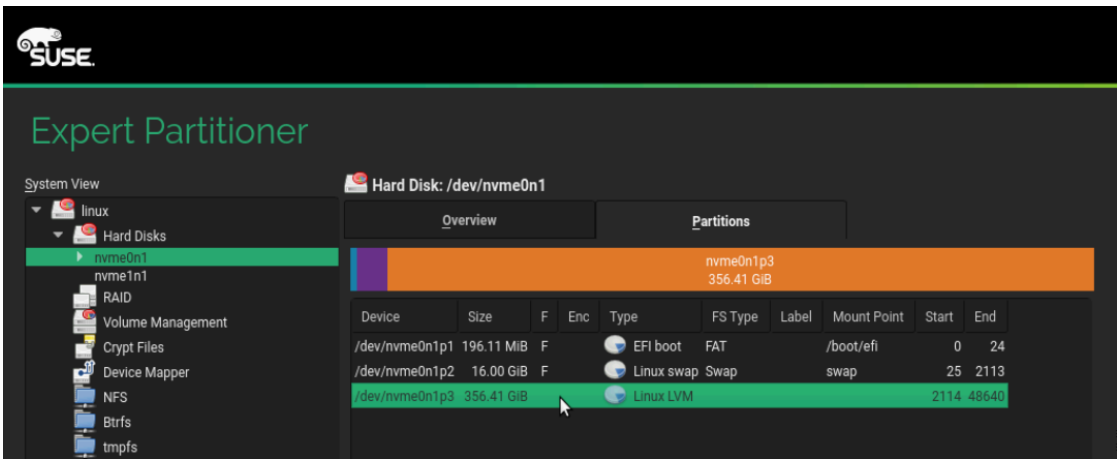


2. Delete the Expert Partitioner default partition scheme.
3. Partition /dev/sda as follows:

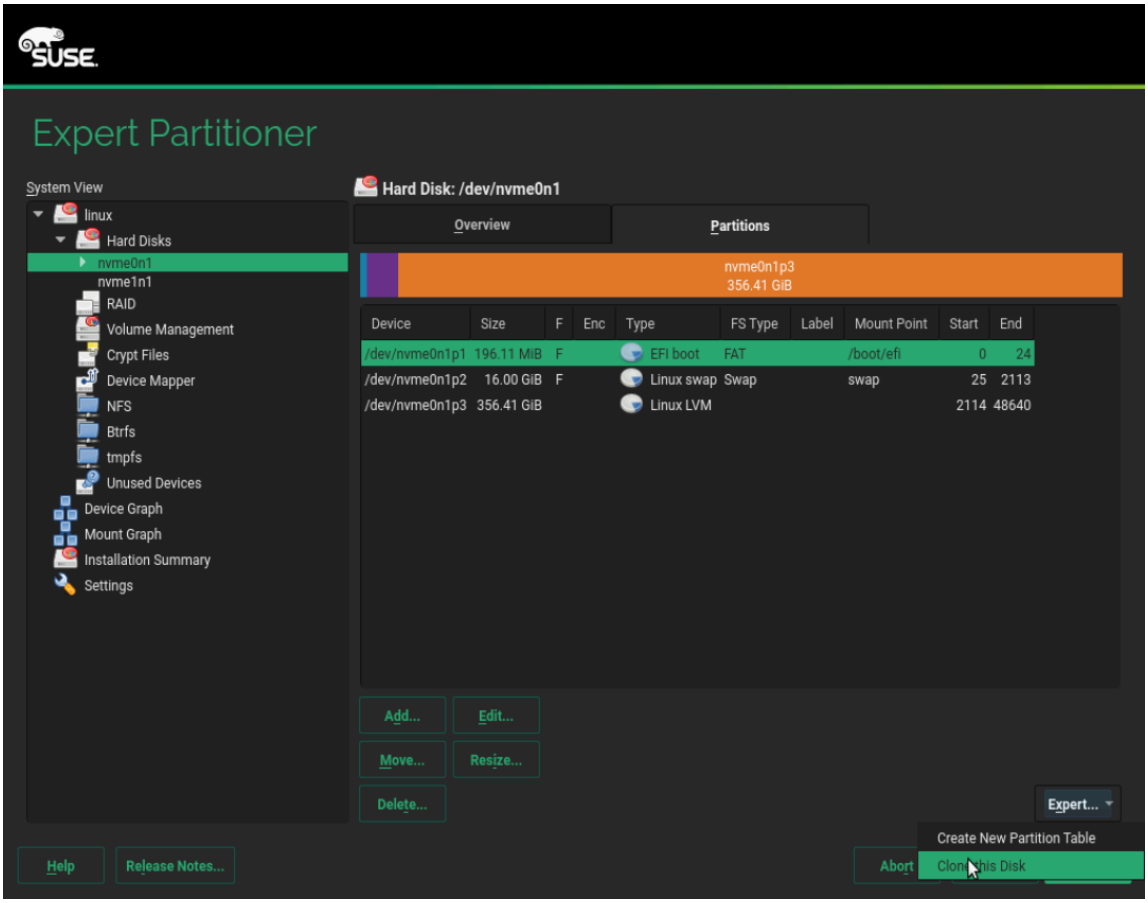
   /dev/nvme0n1p1, size = 200MB, role as “EFI Boot Partition”, mount point = /boot/efi, format as “FAT”

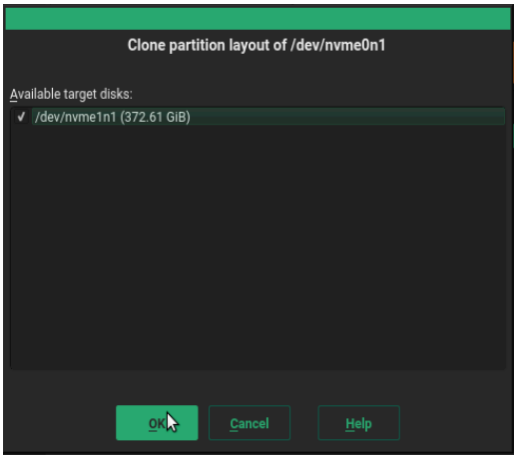
   /dev/nvme0n1p2, size = 16GB, role as “Swap”

   /dev/nvme0n1p3, size = Maximum Size (rest of the disk space), role as “Raw Volume”.



4. After successfully partitioning the first disk, use **Expert** > **Clone this disk…** function to clone the partition scheme to the second disk.



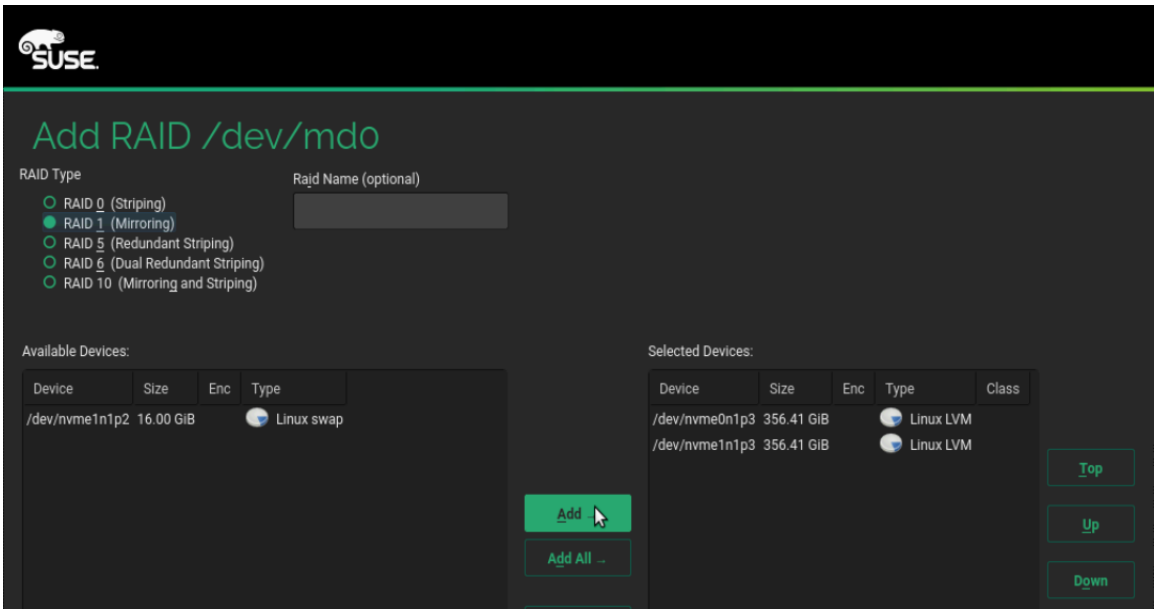


5. In the RAID section, create a RAID1 that includes `/dev/nvme0n1p3` and `/dev/nvme1n1p3`:

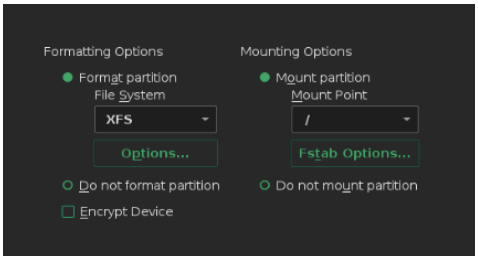
a. Click **RAID**.

b. Choose **RAID1 (mirroring).**

c. Select each partition and click **Add** to move them to Selected Devices.

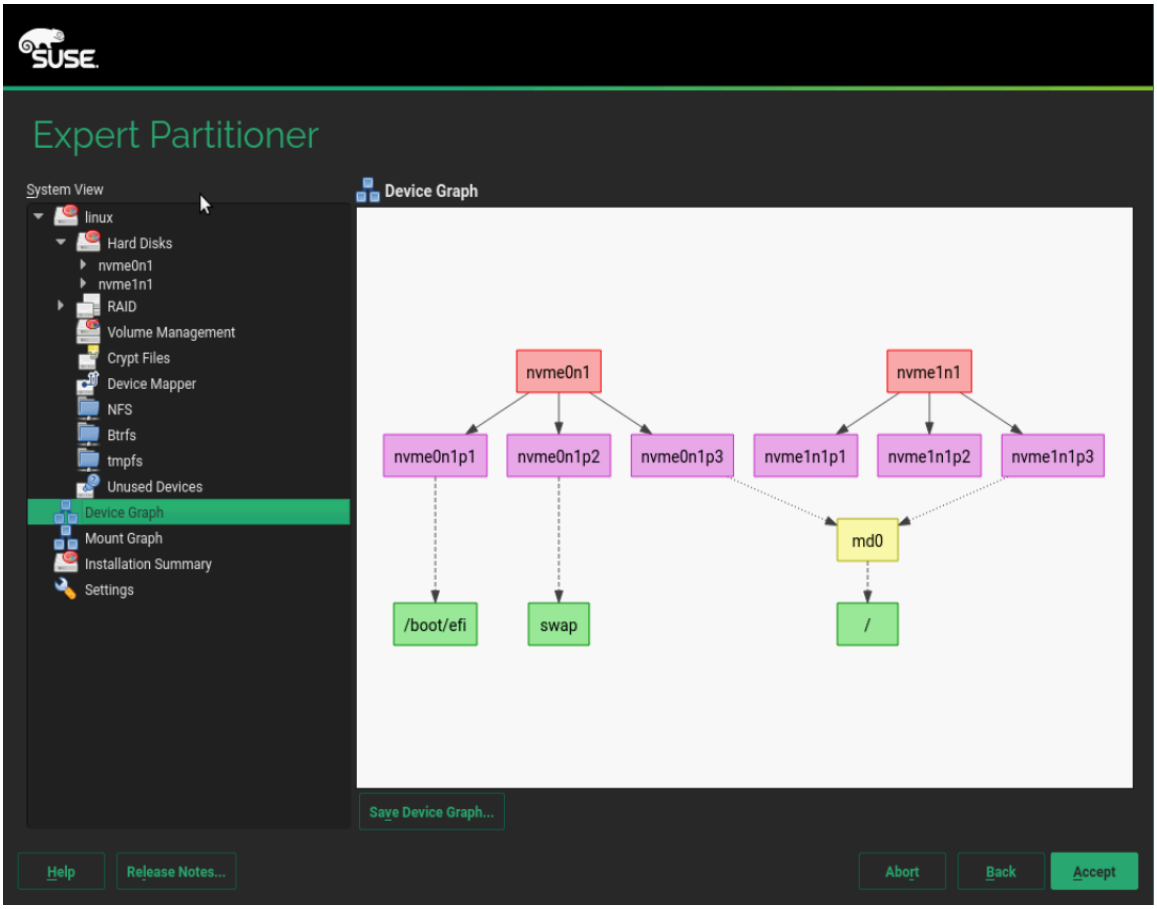


6. Set the following options: 4KB Chunk Size, role as “Operating System”, format as XFS and mount it to “/” (root).

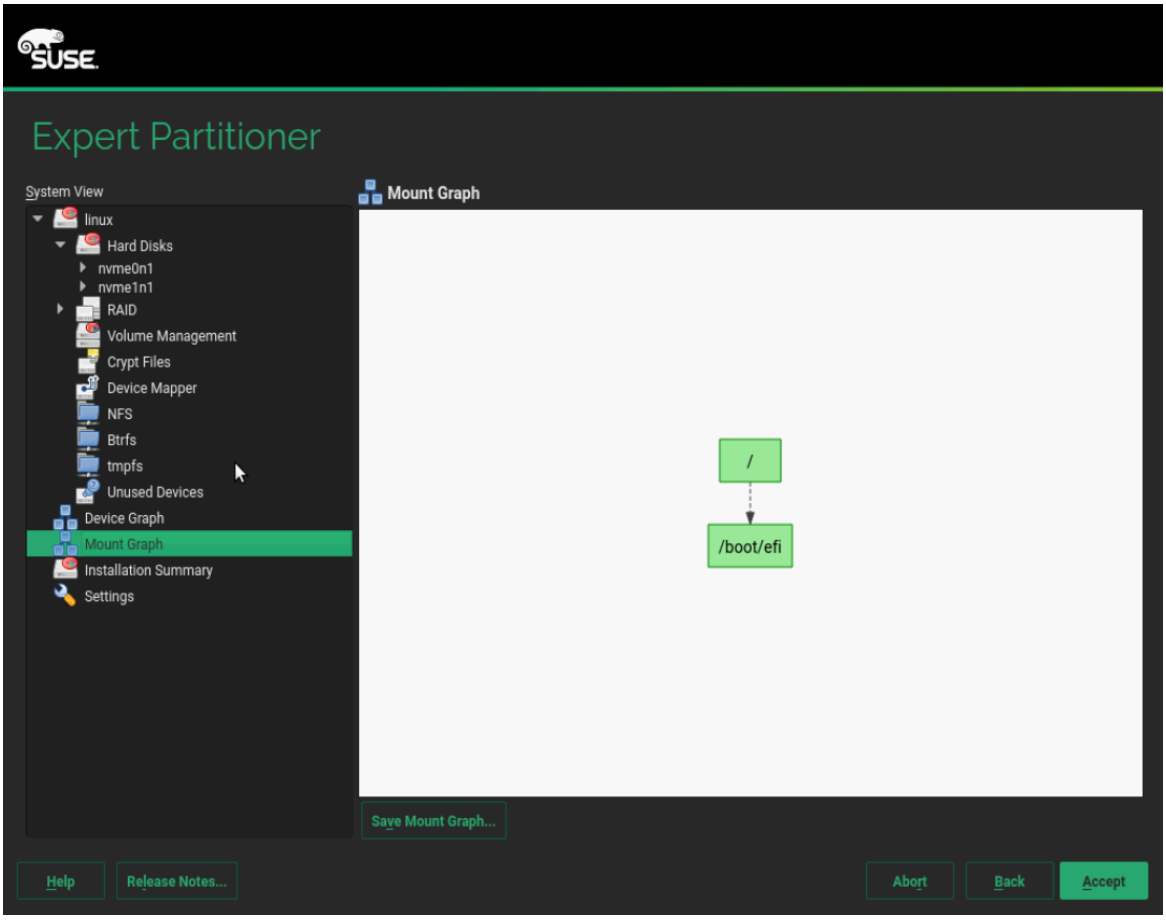


7. Click **Finish**.

   Examine the Device Graph. It should match the screenshot.



8. Examine the Mount Graph. It should match the screenshot.



9. Proceed to finish the installation

Creating the Redundant ESP

1. Log in to SLES 12 SP2 and open a Terminal.
2. To clone the ESP partition from /dev/sda1 to /dev/sdb1, type the following command.

   ```
   dd if=/dev/nvme0n1p1 of=/dev/nvme1n1p1
   ```

   "If" is the input file, and "of" is the output file.
3. You should see something like below screenshot:

```
linux-nrdo:~ # dd if=/dev/nvme0n1p1 of=/dev/nvme1n1p1
399360+0 records in
399360+0 records out
204472320 bytes (204 MB, 195 MiB) copied, 2.68261 s, 76.2 MB/s
linux-nrdo:~ #
```

Creating a New Entry in the UEFI Boot Manager

Before creating a new entry for the Redundant ESP for /dev/nvme1n1p1, examine the current EFI boot manager. Make sure the contents of the new entry match the existing entry for SLES.

1. To list the entries in the EFI boot manager, type the following command.

   `efibootmgr -v`

2. The following screenshot shows that entry Boot000C (sles-secureboot) is the SLES entry created by the installer.

```
linux-nrdo:~ # efibootmgr -v
BootCurrent: 000C
Timeout: 20 seconds
BootOrder: 000C,0000,000A,0015,0017,0016,000F,0011,0010,000B,0012,0013,0001,0002,0003,0004,0005,0006,0007,0008,0
009
Boot0000* System Utilities
Boot0001  Embedded UEFI Shell
Boot0002  Diagnose Error
Boot0003  Intelligent Provisioning
Boot0004  Boot Menu
Boot0005  Network Boot
Boot0006  Embedded Diagnostics
Boot0007  View Integrated Management Log
Boot0008  HTTP Boot
Boot0009  PXE Boot
Boot000A* Generic USB Boot      USBClass(ffff,ffff,ff,ff,ff)
Boot000B* iLO Virtual USB 2 : HPE Virtual CD-ROM        ACPI(a0341d0,0)PCI(1c,4)PCI(0,4)USB(1,0)N.....YM....R,Y.
Boot000C* sles-secureboot       HD(1,800,61800,9836a3f3-27ac-406c-8b73-2964ddda3d85)File(\EFI\sles\shim.efi)
Boot000F* Embedded LOM 1 Port 2 : HP Ethernet 1Gb 4-port 331i Adapter - NIC (HTTP(S) IPv4       ACPI(a0341d0,0)P
CI(1c,0)PCI(0,1)MAC(9418821800a9,0)IPv4(0.0.0.0:0<->0.0.0.0:0,0, 003180400N.....YM....R,Y.
Boot0010* Embedded LOM 1 Port 2 : HP Ethernet 1Gb 4-port 331i Adapter - NIC (HTTP(S) IPv6       ACPI(a0341d0,0)P
CI(1c,0)PCI(0,1)MAC(9418821800a9,0)030d3c00000000000000000000000000000000000000000000000000000000000000000000000
00000000040000000000000000000000000000000003180400N.....YM....R,Y.
Boot0011* Embedded LOM 1 Port 2 : HP Ethernet 1Gb 4-port 331i Adapter - NIC (PXE IPv4)  ACPI(a0341d0,0)PCI(1c,0)
PCI(0,1)MAC(9418821800a9,0)IPv4(0.0.0.0:0<->0.0.0.0:0,0, 0N.....YM....R,Y.
Boot0012* NVMe Drive 15 : NVM Express Controller - CVMD6082001K400FGN-L00400KEFJQ-0     ACPI(a0341d0,1)PCI(2,0)P
CI(0,0)03171000010000000000000000000000N.....YM....R,Y.
Boot0013* NVMe Drive 16 : NVM Express Controller - CVMD61100093400FGN-L00400KEFJQ-0     ACPI(a0341d0,1)PCI(3,0)P
CI(0,0)03171000010000000000000000000000N.....YM....R,Y.
Boot0015* Embedded LOM 1 Port 1 : HP Ethernet 1Gb 4-port 331i Adapter - NIC (HTTP(S) IPv4       ACPI(a0341d0,0)P
CI(1c,0)PCI(0,0)MAC(9418821800a8,0)IPv4(0.0.0.0:0<->0.0.0.0:0,0, 003180400N.....YM....R,Y.
Boot0016* Embedded LOM 1 Port 1 : HP Ethernet 1Gb 4-port 331i Adapter - NIC (HTTP(S) IPv6       ACPI(a0341d0,0)P
CI(1c,0)PCI(0,0)MAC(9418821800a8,0)030d3c00000000000000000000000000000000000000000000000000000000000000000000000
00000000040000000000000000000000000000000003180400N.....YM....R,Y.
Boot0017* Embedded LOM 1 Port 1 : HP Ethernet 1Gb 4-port 331i Adapter - NIC (PXE IPv4)  ACPI(a0341d0,0)PCI(1c,0)
PCI(0,0)MAC(9418821800a8,0)IPv4(0.0.0.0:0<->0.0.0.0:0,0, 0N.....YM....R,Y.
linux-nrdo:~ #
```

3. Create a new entry and name it “sles-secureboot-redundant”.

   `efibootmgr –c –d /dev/nvme1n1 –p 1 –l \\EFI\\sles\\shim.efi -L “sles-secureboot-redundant”`

```
linux-nrdo:~ # efibootmgr -c -d /dev/nvme1n1 -p 1 -l \\EFI\\sles\\shim.efi -L "sles-secureboot-redundant"
BootCurrent: 000C
Timeout: 20 seconds
BootOrder: 000D,000C,0000,000A,0015,0017,0016,000F,0011,0010,000B,0012,0013,0001,0002,0003,0004,0005,0006,0007,0
008,0009
Boot0000* System Utilities
Boot0001  Embedded UEFI Shell
Boot0002  Diagnose Error
Boot0003  Intelligent Provisioning
Boot0004  Boot Menu
Boot0005  Network Boot
Boot0006  Embedded Diagnostics
Boot0007  View Integrated Management Log
Boot0008  HTTP Boot
Boot0009  PXE Boot
Boot000A* Generic USB Boot
Boot000B* iLO Virtual USB 2 : HPE Virtual CD-ROM
Boot000C* sles-secureboot
Boot000F* Embedded LOM 1 Port 2 : HP Ethernet 1Gb 4-port 331i Adapter - NIC (HTTP(S) IPv4
Boot0010* Embedded LOM 1 Port 2 : HP Ethernet 1Gb 4-port 331i Adapter - NIC (HTTP(S) IPv6
Boot0011* Embedded LOM 1 Port 2 : HP Ethernet 1Gb 4-port 331i Adapter - NIC (PXE IPv4)
Boot0012* NVMe Drive 15 : NVM Express Controller - CVMD6082001K400FGN-LO0400KEFJQ-0
Boot0013* NVMe Drive 16 : NVM Express Controller - CVMD61100093400FGN-LO0400KEFJQ-0
Boot0015* Embedded LOM 1 Port 1 : HP Ethernet 1Gb 4-port 331i Adapter - NIC (HTTP(S) IPv4
Boot0016* Embedded LOM 1 Port 1 : HP Ethernet 1Gb 4-port 331i Adapter - NIC (HTTP(S) IPv6
Boot0017* Embedded LOM 1 Port 1 : HP Ethernet 1Gb 4-port 331i Adapter - NIC (PXE IPv4)
Boot000D* sles-secureboot-redundant
linux-nrdo:~ #
```

4. The “sles-secureboot-redundant” entry will be created as Boot000D.

   This process will place it as the first boot option. Move it to the second boot option.

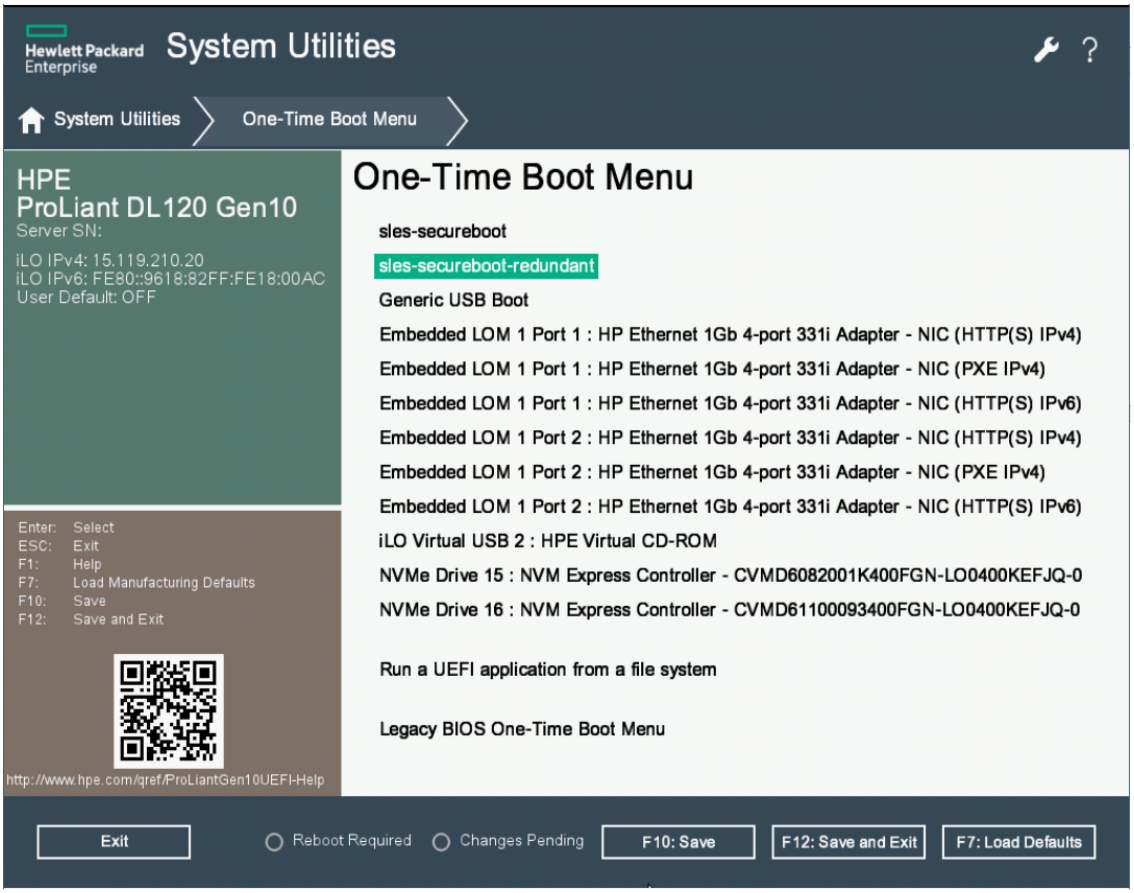
   ```
   efibootmgr -o
   000C,000D,0000,000A,0015,0017,0016,000F,0011,000B,0012,0013,0001,0002,0
   003,0004,0005,0006,0007,0008,0009
   ```

```
linux-nrdo:~ # efibootmgr -o 000C,000D,0000,000A,0015,0017,0016,000F,0011,0010,000B,0012,0013,0001,0002,0003,000
4,0005,0006,0007,0008,0009
BootCurrent: 000C
Timeout: 20 seconds
BootOrder: 000C,000D,0000,000A,0015,0017,0016,000F,0011,0010,000B,0012,0013,0001,0002,0003,0004,0005,0006,0007,0
008,0009
Boot0000* System Utilities
Boot0001  Embedded UEFI Shell
Boot0002  Diagnose Error
Boot0003  Intelligent Provisioning
Boot0004  Boot Menu
Boot0005  Network Boot
Boot0006  Embedded Diagnostics
Boot0007  View Integrated Management Log
Boot0008  HTTP Boot
Boot0009  PXE Boot
Boot000A* Generic USB Boot
Boot000B* iLO Virtual USB 2 : HPE Virtual CD-ROM
Boot000C* sles-secureboot
Boot000D* sles-secureboot-redundant
Boot000F* Embedded LOM 1 Port 2 : HP Ethernet 1Gb 4-port 331i Adapter - NIC (HTTP(S) IPv4
Boot0010* Embedded LOM 1 Port 2 : HP Ethernet 1Gb 4-port 331i Adapter - NIC (HTTP(S) IPv6
Boot0011* Embedded LOM 1 Port 2 : HP Ethernet 1Gb 4-port 331i Adapter - NIC (PXE IPv4)
Boot0012* NVMe Drive 15 : NVM Express Controller - CVMD6082001K400FGN-LO0400KEFJQ-0
Boot0013* NVMe Drive 16 : NVM Express Controller - CVMD61100093400FGN-LO0400KEFJQ-0
Boot0015* Embedded LOM 1 Port 1 : HP Ethernet 1Gb 4-port 331i Adapter - NIC (HTTP(S) IPv4
Boot0016* Embedded LOM 1 Port 1 : HP Ethernet 1Gb 4-port 331i Adapter - NIC (HTTP(S) IPv6
Boot0017* Embedded LOM 1 Port 1 : HP Ethernet 1Gb 4-port 331i Adapter - NIC (PXE IPv4)
linux-nrdo:~ #
```

5. The actual number of entries depends on the system configuration. Check the entries by entering:

```
efibootmgr -v
```

6. Verify the boot entry by rebooting the system, press **F11** to the boot menu. “sles-secureboot-redundant” should be in the boot menu.
7. Boot in to the system to verify it works.
8. Log in the system.



Recovering a failed disk and repairing Software RAID

In the event of a failed disk, it is necessary to recover the failed partition and restore the software RAID. Logging in to the system through the second disk is possible when the EFI boot entries are set properly.

Examine the RAID status

1. To examine the status of the RAID configuration, enter the following:

   ```
   mdadm --detail /dev/md0
   ```

   - Total Devices became “1”.
   - State changed to “clean, degraded”.
   - Disk `/dev/sdb3` has become `/dev/sda3`.

It is the only available disk.

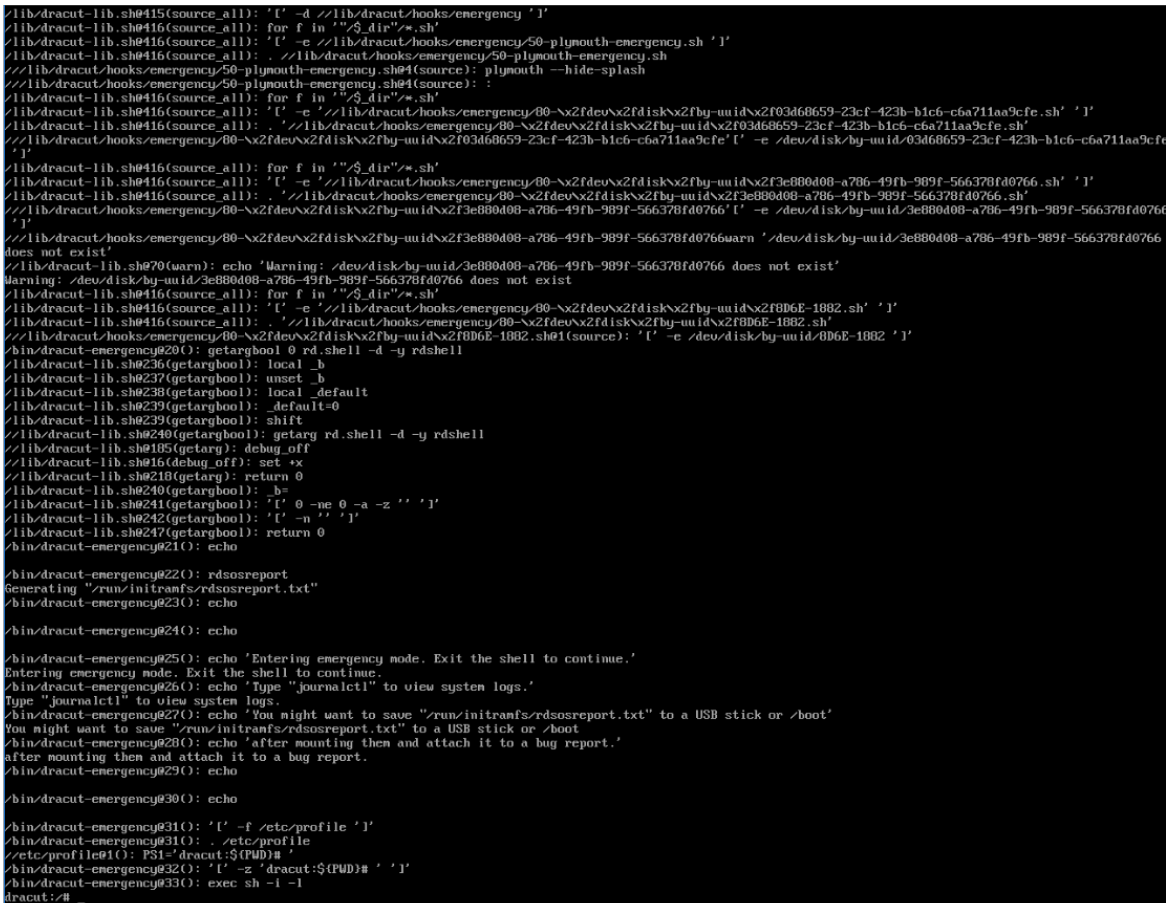
Add two additional kernel parameters to allow booting from the second disk

In SLES, if the first disk fails two additional kernel parameters must be added to allow the system to successfully boot from the second disk.

1. From the GRUB menu, press the **e** key to edit the kernel parameter.
2. Find the line ending with `crashkerel=72M,low`
3. Append `rd.shell rd.debug`
4. Press **Ctrl-x** or **F10** to boot with the new setting.

   This is a one-time setting only. It will not impact subsequent boots.

After a few minutes, the screen will enter a rescue shell.



Recovering the failed partition

1. Prepare a new disk portioned as described in “Partitioning a drive for SLES.”
2. Boot from the “sles-secureboot-redundant”.

   Make sure proper kernel parameters (rd.shell rd.debug) were added to enter the rescue shell.

   The new disk will be shown as /dev/sda, and the original second disk will appear as /dev/sdb.

   To add the new /dev/sda3 to rebuild the RAID, type the following command in the rescue shell.

   `mdadm --add /dev/md0 /dev/nvme0n1p3`
3. Enter `mdadm --detail /dev/md0`

   The State will change to “clean, degraded, recovering” and the Rebuild Status “75% complete” (or other progress number).
4. Once the rebuild has completed, the State will change to “clean”,

   The recovery is complete.

```
linux-9xde:~ # mdadm --add /dev/md0 /dev/sda3
mdadm: added /dev/sda3
linux-9xde:~ # mdadm --detail /dev/md0
/dev/md0:
        Version : 1.0
  Creation Time : Tue Mar 29 16:43:01 2016
     Raid Level : raid1
     Array Size : 471405376 (449.57 GiB 482.72 GB)
  Used Dev Size : 471405376 (449.57 GiB 482.72 GB)
   Raid Devices : 2
  Total Devices : 2
    Persistence : Superblock is persistent

  Intent Bitmap : Internal

    Update Time : Wed Mar 30 05:48:11 2016
          State : clean, degraded, recovering
 Active Devices : 1
Working Devices : 2
 Failed Devices : 0
  Spare Devices : 1

 Rebuild Status : 0% complete

           Name : any:0
           UUID : 824cc36d:607cf28b:2bbfaf68:a2d81425
         Events : 1742

    Number   Major   Minor   RaidDevice State
       2       8        3        0      spare rebuilding   /dev/sda3
       1       8       19        1      active sync   /dev/sdb3
linux-9xde:~ # _
```

Complete the recovery process

To make a redundant copy of the ESP, repeat the process described in "Creating a redundant ESP."

Add a new entry to EFI Boot Manager to complete the recovery process.

1. Replicate the ESP from /dev/sdb1 back to /dev/sda1.

   ```
   dd if=/dev/nvme1n1p1 of=/dev/nvme0n1p1
   ```

2. Remove the existing SLES boot entry:

   ```
   efibootmgr -b 11 -B
   ```

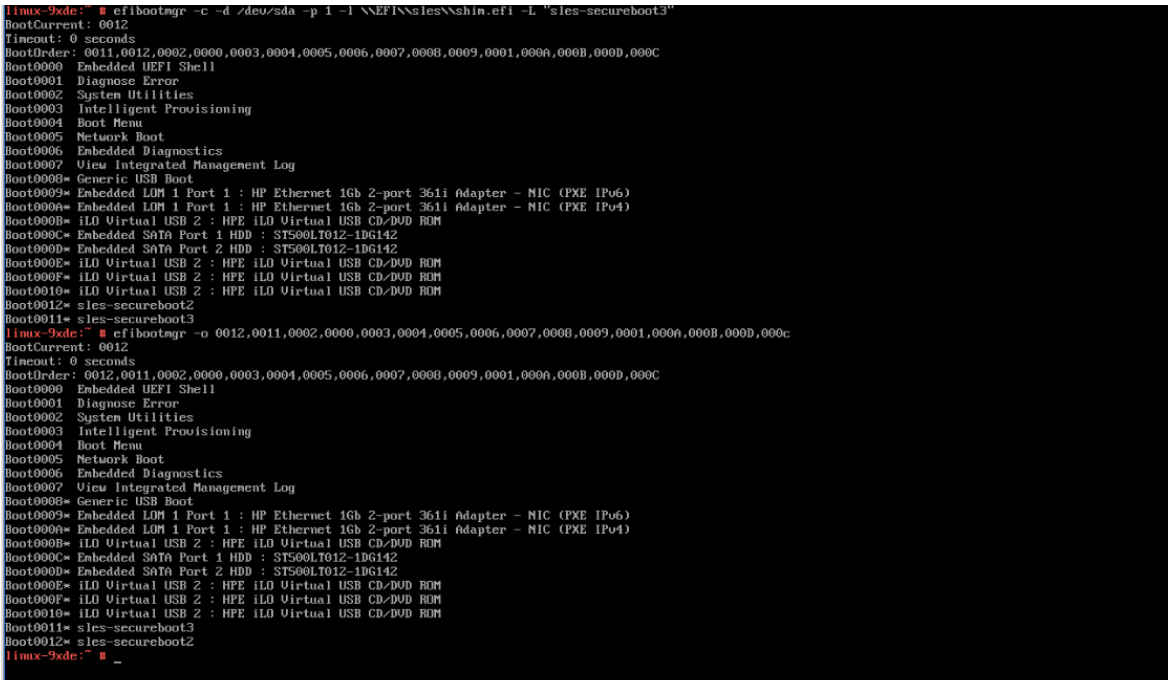
```
linux-9xde:~ # dd if=/dev/sdb1 of=/dev/sda1
399360+0 records in
399360+0 records out
204472320 bytes (204 MB) copied, 4.98957 s, 41.0 MB/s
linux-9xde:~ # efibootmgr -b 11 -B
BootCurrent: 0012
Timeout: 0 seconds
BootOrder: 0012,0002,0000,0003,0004,0005,0006,0007,0008,0009,0001,000A,000B,000D,000C
Boot0000  Embedded UEFI Shell
Boot0001  Diagnose Error
Boot0002  System Utilities
Boot0003  Intelligent Provisioning
Boot0004  Boot Menu
Boot0005  Network Boot
Boot0006  Embedded Diagnostics
Boot0007  View Integrated Management Log
Boot0008* Generic USB Boot
Boot0009* Embedded LOM 1 Port 1 : HP Ethernet 1Gb 2-port 361i Adapter - NIC (PXE IPv6)
Boot000A* Embedded LOM 1 Port 1 : HP Ethernet 1Gb 2-port 361i Adapter - NIC (PXE IPv4)
Boot000B* iLO Virtual USB 2 : HPE iLO Virtual USB CD/DVD ROM
Boot000C* Embedded SATA Port 1 HDD : ST500LT012-1DG142
Boot000D* Embedded SATA Port 2 HDD : ST500LT012-1DG142
Boot000E* iLO Virtual USB 2 : HPE iLO Virtual USB CD/DVD ROM
Boot000F* iLO Virtual USB 2 : HPE iLO Virtual USB CD/DVD ROM
Boot0010* iLO Virtual USB 2 : HPE iLO Virtual USB CD/DVD ROM
Boot0012* sles-secureboot2
linux-9xde:~ #
```

3. Create new entry for the replicated ESP:

   ```
   efibootmgr -c -d /dev/nvme0n1 -p 1 -l \\EFI\\sles\\shim.efi -L "sles-secureboot-redundant2"
   ```

4. Reorder the boot sequence:

   ```
   efibootmgr -o
   0012,0011,0002,0000,0003,0004,0005,0006,0007,0008,0009,0001,0001,000A,000B,000D,000C
   ```


linux-9xde:~ # efibootmgr -c -d /dev/sda -p 1 -l \\EFI\\sles\\shim.efi -L "sles-secureboot3"
BootCurrent: 0012
Timeout: 0 seconds
BootOrder: 0011,0012,0002,0000,0003,0004,0005,0006,0007,0008,0009,0001,000A,000B,000D,000C
Boot0000 Embedded UEFI Shell
Boot0001 Diagnose Error
Boot0002 System Utilities
Boot0003 Intelligent Provisioning
Boot0004 Boot Menu
Boot0005 Network Boot
Boot0006 Embedded Diagnostics
Boot0007 View Integrated Management Log
Boot0008* Generic USB Boot
Boot0009* Embedded LOM 1 Port 1 : HP Ethernet 1Gb 2-port 361i Adapter - NIC (PXE IPv6)
Boot000A* Embedded LOM 1 Port 1 : HP Ethernet 1Gb 2-port 361i Adapter - NIC (PXE IPv4)
Boot000B* iLO Virtual USB 2 : HPE iLO Virtual USB CD/DVD ROM
Boot000C* Embedded SATA Port 1 HDD : ST500LT012-1DG142
Boot000D* Embedded SATA Port 2 HDD : ST500LT012-1DG142
Boot000E* iLO Virtual USB 2 : HPE iLO Virtual USB CD/DVD ROM
Boot000F* iLO Virtual USB 2 : HPE iLO Virtual USB CD/DVD ROM
Boot0010* iLO Virtual USB 2 : HPE iLO Virtual USB CD/DVD ROM
Boot0012* sles-secureboot2
Boot0011* sles-secureboot3
linux-9xde:~ # efibootmgr -o 0012,0011,0002,0000,0003,0004,0005,0006,0007,0008,0009,0001,000A,000B,000D,000C
BootCurrent: 0012
Timeout: 0 seconds
BootOrder: 0012,0011,0002,0000,0003,0004,0005,0006,0007,0008,0009,0001,000A,000B,000D,000C
Boot0000 Embedded UEFI Shell
Boot0001 Diagnose Error
Boot0002 System Utilities
Boot0003 Intelligent Provisioning
Boot0004 Boot Menu
Boot0005 Network Boot
Boot0006 Embedded Diagnostics
Boot0007 View Integrated Management Log
Boot0008* Generic USB Boot
Boot0009* Embedded LOM 1 Port 1 : HP Ethernet 1Gb 2-port 361i Adapter - NIC (PXE IPv6)
Boot000A* Embedded LOM 1 Port 1 : HP Ethernet 1Gb 2-port 361i Adapter - NIC (PXE IPv4)
Boot000B* iLO Virtual USB 2 : HPE iLO Virtual USB CD/DVD ROM
Boot000C* Embedded SATA Port 1 HDD : ST500LT012-1DG142
Boot000D* Embedded SATA Port 2 HDD : ST500LT012-1DG142
Boot000E* iLO Virtual USB 2 : HPE iLO Virtual USB CD/DVD ROM
Boot000F* iLO Virtual USB 2 : HPE iLO Virtual USB CD/DVD ROM
Boot0010* iLO Virtual USB 2 : HPE iLO Virtual USB CD/DVD ROM
Boot0011* sles-secureboot3
Boot0012* sles-secureboot2
linux-9xde:~ # _

Support and other resources

Accessing Hewlett Packard Enterprise Support

- For live assistance, go to the Contact Hewlett Packard Enterprise Worldwide website:

  http://www.hpe.com/assistance

- To access documentation and support services, go to the Hewlett Packard Enterprise Support Center website:

  http://www.hpe.com/support/hpesc

Information to collect

- Technical support registration number (if applicable)
- Product name, model or version, and serial number
- Operating system name and version
- Firmware version
- Error messages
- Product-specific reports and logs
- Add-on products or components
- Third-party products or components

Accessing updates

- Some software products provide a mechanism for accessing software updates through the product interface. Review your product documentation to identify the recommended software update method.

To download product updates:

- Hewlett Packard Enterprise Support Center

  www.hpe.com/support/hpesc

- Hewlett Packard Enterprise Support Center: Software downloads

  www.hpe.com/support/downloads

- Software Depot

www.hpe.com/support/softwaredepot

- To subscribe to eNewsletters and alerts:

  www.hpe.com/support/e-updates

- To view and update your entitlements, and to link your contracts and warranties with your profile, go to the Hewlett Packard Enterprise Support Center More Information on Access to Support Materials page:

  www.hpe.com/support/AccessToSupportMaterials

  IMPORTANT:

  Access to some updates might require product entitlement when accessed through the Hewlett Packard Enterprise Support Center. You must have an HPE Passport set up with relevant entitlements.

Regulatory information

To view the regulatory information for your product, view the Safety and Compliance Information for Server, Storage, Power, Networking, and Rack Products, available at the Hewlett Packard Enterprise Support Center:

www.hpe.com/support/Safety-Compliance-EnterpriseProducts

Additional regulatory information

Hewlett Packard Enterprise is committed to providing our customers with information about the chemical substances in our products as needed to comply with legal requirements such as REACH (Regulation EC No 1907/2006 of the European Parliament and the Council). A chemical information report for this product can be found at:

www.hpe.com/info/reach

For Hewlett Packard Enterprise product environmental and safety information and compliance data, including RoHS and REACH, see:

www.hpe.com/info/ecodata

For Hewlett Packard Enterprise environmental information, including company programs, product recycling, and energy efficiency, see:

www.hpe.com/info/environment

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