

# **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](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](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](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	<a href="http://downloads.linux.hpe.com/SDR/project/lsrrb/current/hpe-scripting-toolkit-linux-10.40-rhel7_3.tar.gz">http://downloads.linux.hpe.com/SDR/project/lsrrb/current/hpe-scripting-toolkit-linux-10.40-rhel7_3.tar.gz</a>
SLES 12 SP2	<a href="http://downloads.linux.hpe.com/SDR/project/lsrrb/current/hpe-scripting-toolkit-linux-10.40-sle12sp2.tar.gz">http://downloads.linux.hpe.com/SDR/project/lsrrb/current/hpe-scripting-toolkit-linux-10.40-sle12sp2.tar.gz</a>

## 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:

<b>File Name</b>	<b>Location</b>	<b>Description</b>
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

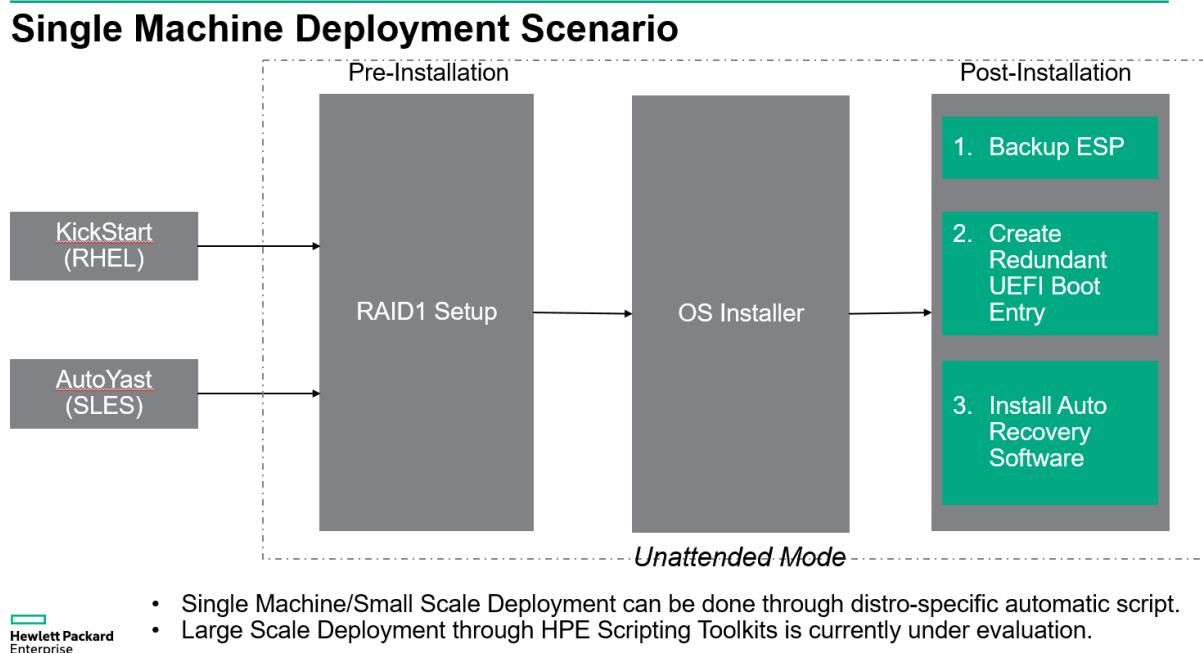
## Single machine deployment

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
12http://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 used for enabling AHCI mode programmatically. After enabled AHCI mode, the installation proceeds with the same method as in the single machine deployment.

## Multiple Machine Deployment Scenario

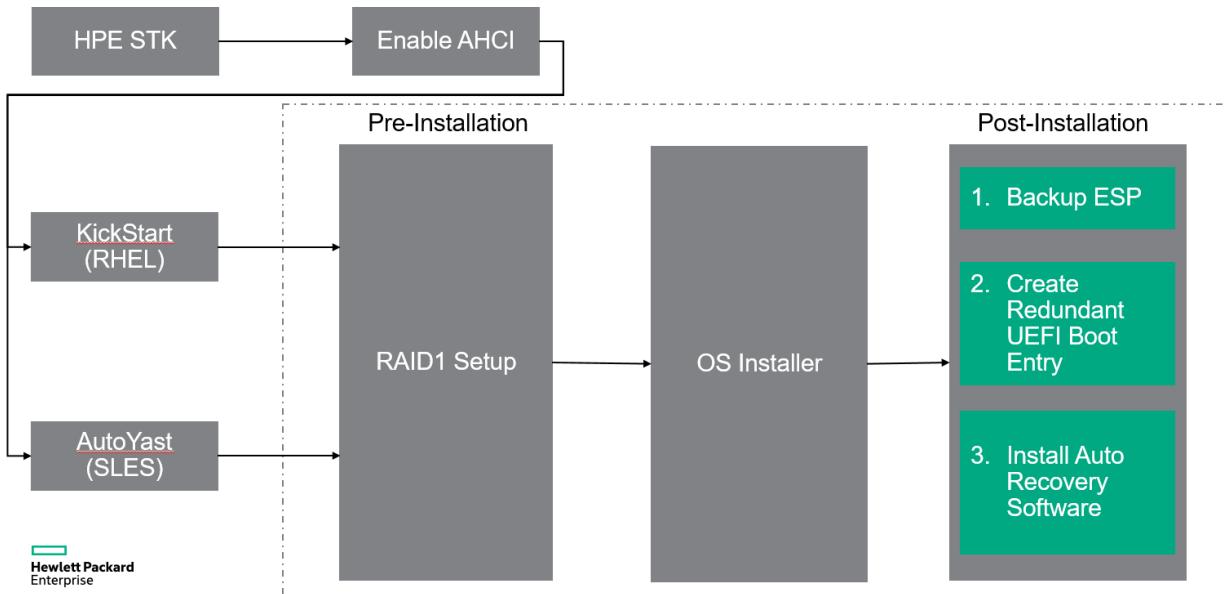


Figure 2 Multiple Machine Deployment Scenario

### 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
        net 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 then 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:

```
root@ubuntu:~# systemctl status minnow.service
● minnow.service - Minnow
   Loaded: loaded (/etc/systemd/system/minnow.service; enabled; vendor preset: enabled)
   Active: active (running) since Thu 2016-10-13 16:55:10 CDT; 3min 35s ago
     Process: 871 ExecStart=/opt/hpe/minnow/bin/minnow.sh (code=exited, status=0/SUCCESS)
    CGroup: /system.slice/minnow.service
            └─ 874 /usr/bin/python /opt/hpe/minnow/bin/md_auto_resync.py
                  ├ 875 /bin/bash /opt/hpe/minnow/bin/HPEtemp.sh
                  └─ 1001 sleep 600

Oct 13 16:55:10 ubuntu systemd[1]: Starting Minnow...
Oct 13 16:55:10 ubuntu systemd[1]: Started Minnow.
Oct 13 16:55:29 ubuntu minnow.sh[871]: 497664+0 records in
Oct 13 16:55:29 ubuntu minnow.sh[871]: 497664+0 records out
Oct 13 16:55:29 ubuntu minnow.sh[871]: 254803968 bytes (255 MB, 243 MiB) copied, 19.574 s, 13.0 MB/s
root@ubuntu:~# _
```

#### On RHEL 6.8

Use the 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
```

```
Linux-5p7d:~ # cat /proc/mdstat
Personalities : [raid1]
md0 : active raid1 sdd3[3] sdc3[2]
      471403328 blocks super 1.0 [2/2] [UU]
      bitmap: 1/4 pages [4KB], 65536KB chunk

unused devices: <none>
Linux-5p7d:~ #
```

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.

```
iLO Integrated Remote Console - iLO: ILO.asiapacific.hpqcorp.net
Power Switch Virtual Drives Keyboard Help
linux-5p7d:~ # mdadm --detail /dev/md0
/dev/md0:
  Version : 1.0
  Creation Time : Wed Oct  5 00:42:54 2016
  Raid Level : raid1
  Array Size : 471403328 (449.57 GiB 482.72 GB)
  Used Dev Size : 471403328 (449.57 GiB 482.72 GB)
  Raid Devices : 2
  Total Devices : 2
    Persistence : Superblock is persistent

  Intent Bitmap : Internal

  Update Time : Thu Oct  6 00:27:06 2016
    State : clean
  Active Devices : 2
  Working Devices : 2
  Failed Devices : 0
  Spare Devices : 0

        Name : any:0
        UUID : 0096907a:e72719cc:89501e51:19d81b6a
        Events : 2638

      Number  Major  Minor  RaidDevice State
          2      8      35        0  active sync   /dev/sdc3
          3      8      51        1  active sync   /dev/sdd3
linux-5p7d:~ #
```

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.

```
root@ubuntu:/opt/minnow# mdadm --detail /dev/md0
/dev/md0:
      Version : 1.2
Creation Time : Thu Sep  8 18:02:14 2016
      Raid Level : raid1
      Array Size : 968567808 (923.70 GiB 991.81 GB)
  Used Dev Size : 968567808 (923.70 GiB 991.81 GB)
      Raid Devices : 2
     Total Devices : 3
        Persistence : Superblock is persistent

      Intent Bitmap : Internal

      Update Time : Thu Sep  8 19:00:26 2016
                      State : clean, degraded, recovering
      Active Devices : 1
Working Devices : 2
 Failed Devices : 1
    Spare Devices : 1

Rebuild Status : 1% complete

              Name : ubuntu:0 (local to host ubuntu)
              UUID : 2fedca2c:14fd1b5c:9af6b3c9:ce0680ca
              Events : 1066

      Number  Major  Minor  RaidDevice State
          2       8       34        0  spare rebuilding  /dev/sdc2
          1       8       18        1  active sync   /dev/sdb2
          0       8       2         -  faulty
```

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.

```

root@ubuntu:/opt/minnow# mdadm --detail /dev/md0
/dev/md0:
      Version : 1.2
      Creation Time : Thu Sep  8 18:02:14 2016
      Raid Level : raid1
      Array Size : 968567808 (923.70 GiB 991.81 GB)
      Used Dev Size : 968567808 (923.70 GiB 991.81 GB)
      Raid Devices : 2
      Total Devices : 3
      Persistence : Superblock is persistent

      Intent Bitmap : Internal

      Update Time : Thu Sep  8 19:00:26 2016
                      State : clean, degraded, recovering
      Active Devices : 1
      Working Devices : 2
      Failed Devices : 1
      Spare Devices : 1

      Rebuild Status : 1% complete

              Name : ubuntu:0 (local to host ubuntu)
              UUID : 2fedca2c:14fd1b5c:9af6b3c9:ce0680ca
              Events : 1066

      Number  Major  Minor  RaidDevice State
          2      8       34        0  spare rebuilding  /dev/sdc2
          1      8       18        1  active sync   /dev/sdb2
          0      8       2         -  faulty

```

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 screenshot shows a terminal window titled "iLO Integrated Remote Console - iLO: ILO.asiapacific.hpqcorp.net". The window contains the output of the command "mdadm --detail /dev/md0". The output details a RAID1 array named "any:0" with two active devices, both in a "clean" state. The array was created on Wednesday, Oct 5 at 00:42:54 2016. It has an internal intent bitmap and a superblock persistence. The array size is 482.72 GB, and the used device size is 449.57 GiB. The RAID devices are numbered 2 and 3. The table at the bottom lists the device details: Number 2 (Major 8, Minor 35, RaidDevice 0, State active sync, /dev/sdc3) and Number 3 (Major 8, Minor 51, RaidDevice 1, State active sync, /dev/sdd3).

```
linux-5p7d:~ # mdadm --detail /dev/md0
/dev/md0:
      Version : 1.0
Creation Time : Wed Oct  5 00:42:54 2016
     Raid Level : raid1
       Array Size : 471403328 (449.57 GiB 482.72 GB)
   Used Dev Size : 471403328 (449.57 GiB 482.72 GB)
      Raid Devices : 2
     Total Devices : 2
        Persistence : Superblock is persistent

      Intent Bitmap : Internal

        Update Time : Thu Oct  6 00:27:06 2016
                      State : clean
    Active Devices : 2
Working Devices : 2
 Failed Devices : 0
  Spare Devices : 0

              Name : any:0
              UUID : 0096907a:e72719cc:89501e51:19d81b6a
            Events : 2638

      Number  Major  Minor  RaidDevice State
          2      8      35        0    active sync  /dev/sdc3
          3      8      51        1    active sync  /dev/sdd3
linux-5p7d:~ #
```

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:

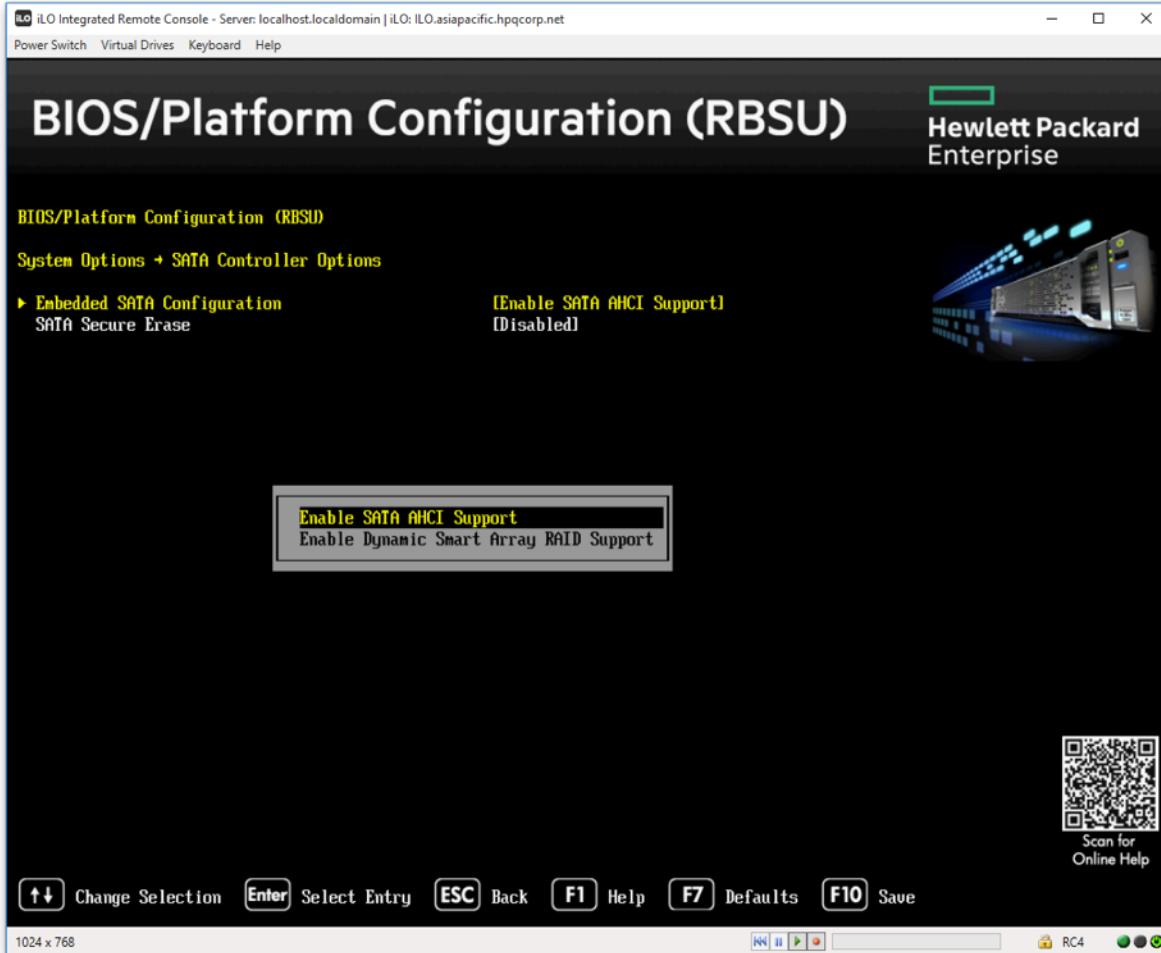
- Installation
- Configuration
- Recovery steps when a disk fails

## 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](http://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
<b>First disk</b>			
/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
<b>Second Disk</b>			
/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:

```
Starting installer, one moment...
anaconda 21.48.22.56-1 for Red Hat Enterprise Linux 7.2 started.
  * installation log files are stored in /tmp during the installation
  * shell is available on TTY2
  * if the graphical installation interface fails to start, try again with the
    inst.text bootoption to start text installation
  * when reporting a bug add logs from /tmp as separate text/plain attachments
=====
Rescue

The rescue environment will now attempt to find your Linux installation and mount it under the directory : /mnt/sysimage. You can then make any changes required to your system. Choose '1' to proceed with this step.
You can choose to mount your file systems read-only instead of read-write by choosing '2'.
If for some reason this process does not work choose '3' to skip directly to a shell.

1) Continue
2) Read-only mount
3) Skip to shell
4) Quit (Reboot)

Please make a selection from the above: 1
=====
Rescue Mount

You don't have any Linux partitions. The system will reboot automatically when you exit from the shell.
Please press <return> to get a shell.
When finished, please exit from the shell and your system will reboot.
sh-4.2# _
```

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.

```
sh-4.2# parted /dev/sda mkpart primary ext2 200MiB 16GiB
Information: You may need to update /etc/fstab.

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

Number  Start   End     Size   File system   Name   Flags
 1      17.4kB  210MB  210MB  fat16         primary
 2      210MB   17.2GB  17.0GB  linux-swap(v1) primary

sh-4.2#
```

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

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

```
Ignore/Cancel? Ignore
Information: You may need to update /etc/fstab.

sh-4.2# parted /dev/sdb mkpart primary ext2 200MiB 16GiB
Information: You may need to update /etc/fstab.

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:

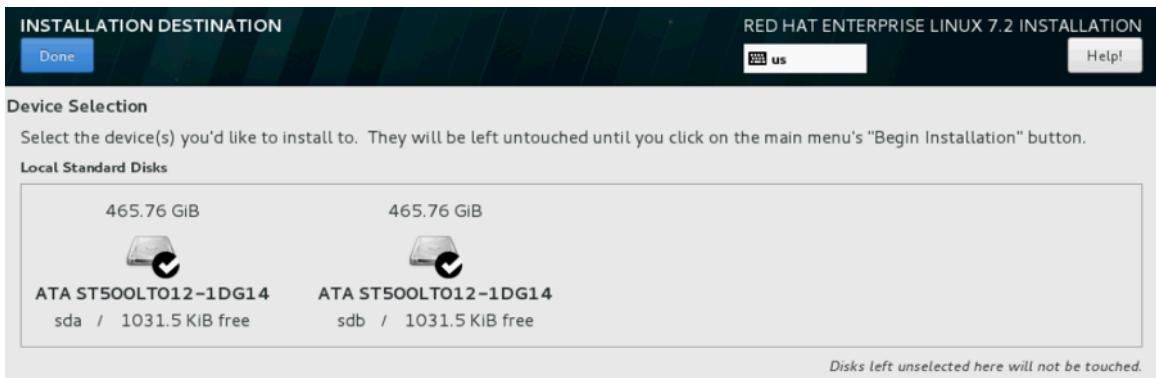
Number  Start   End     Size    File system  Name     Flags
 1      17.4kB  210MB   210MB   fat16        primary
 2      210MB   17.2GB   17.0GB   ext2         primary

sh-4.2#
```

9. Reboot to proceed with Red Hat installation.

## Normal Installation Process

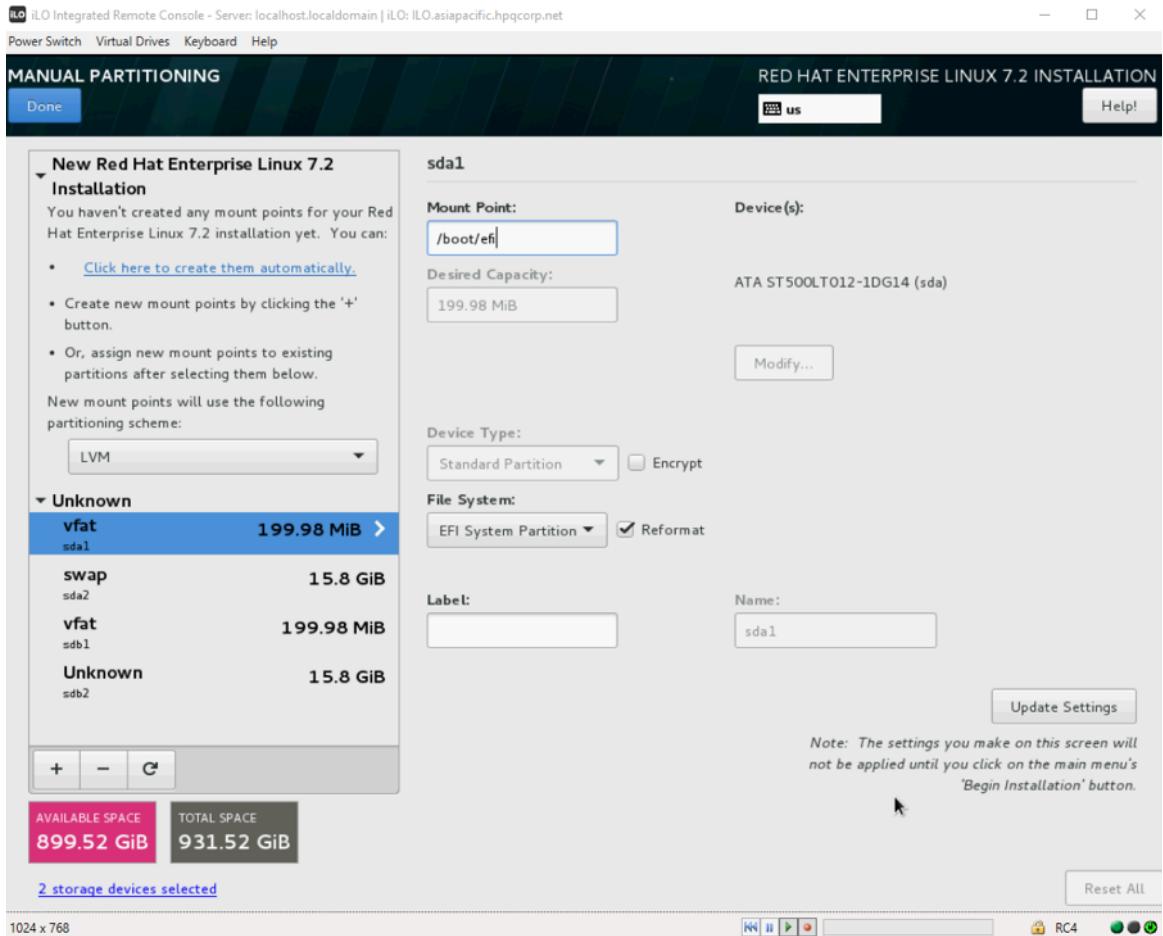
The software RAID installation differs from the normal installation process only in the “Installation Destination” step. In the “Installation Destination”, specify the ESP, swap, and root partition respectively. In the “Installation Destination” step, make sure both disks are selected, and “I will configure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



## Specifying the ESP

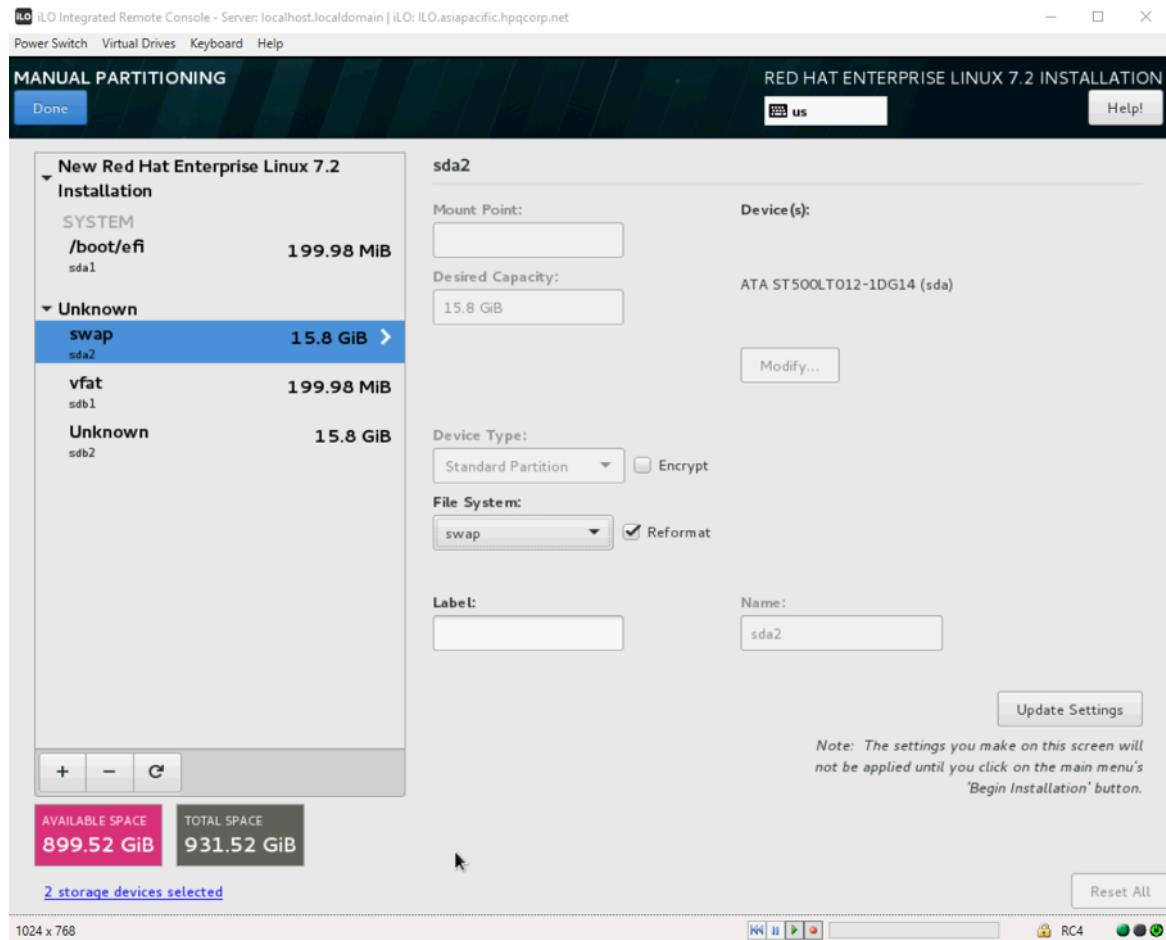
The ESP is the partition that contains the boot loaders used by the UEFI firmware.

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**.

**ADD A NEW MOUNT POINT**

More customization options are available after creating the mount point below.

Mount Point:	/
Desired Capacity:	1000GB

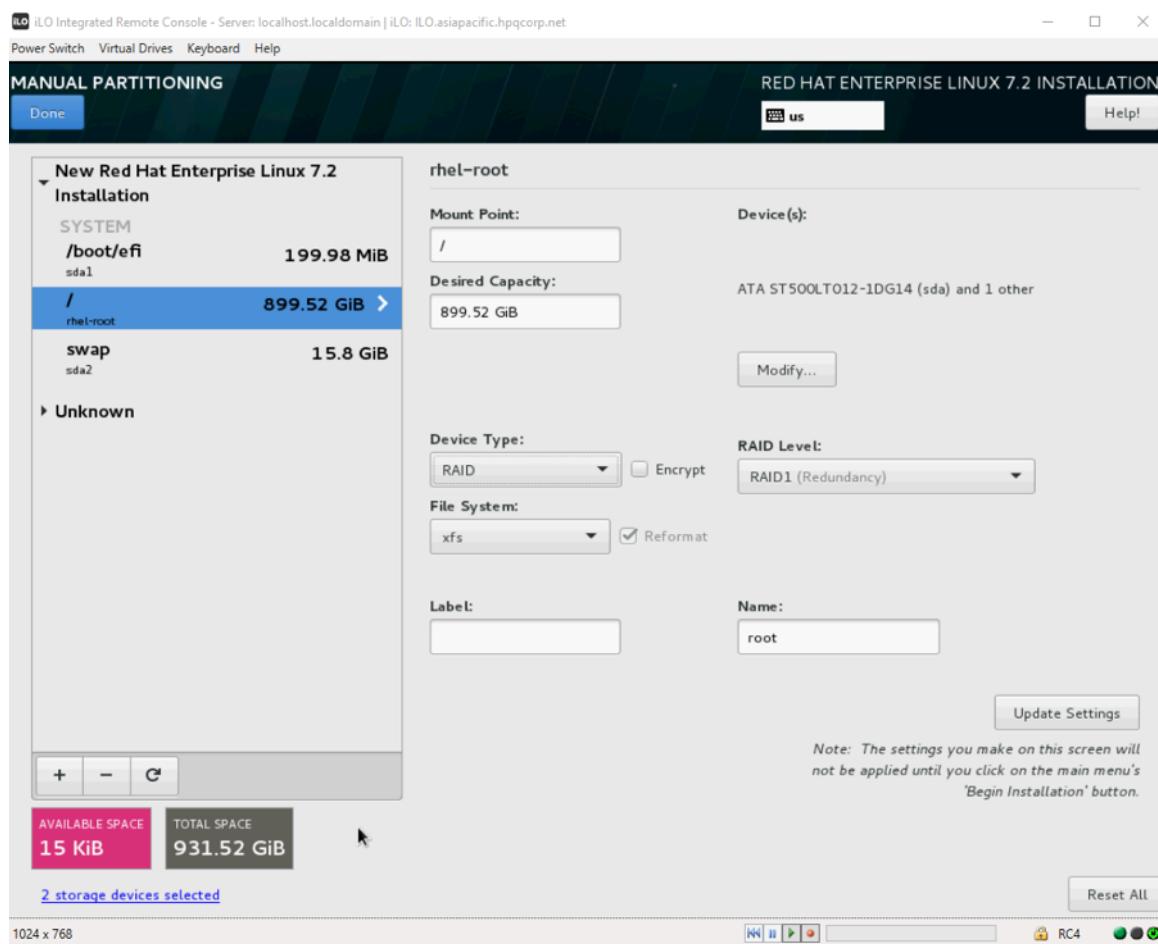
## Create a RAID1 root partition

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`.

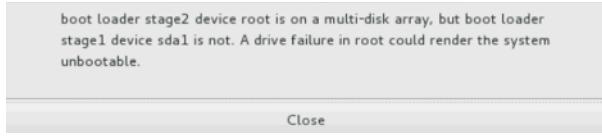
6. In the Name field, type “root”.



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.

```
Red Hat Enterprise Linux Server 7.2 (Maipo)
Kernel 3.10.0-327.el7.x86_64 on an x86_64

localhost login: root
Password:
[root@localhost ~]# dd if=/dev/sda1 of=/dev/sdb1
489566+0 records in
489566+0 records out
289697792 bytes (210 MB) copied, 18.0638 s, 11.6 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\\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
```

```
[root@localhost ~]# efibootmgr -c -d /dev/sdb -p 1 -l \\EFI\\redhat\\shim.efi -L "rhel-redundant"
BootCurrent: 0011
Timeout: 0 seconds
BootOrder: 0012,0011,0002,0000,0001,0003,0004,0005,0006,0007,0008,000A,0009,000C,000B
Boot0000 Embedded UEFI Shell
Boot0001 Diagnose Error
Boot0002 System Utilities
Boot0003 Intelligent Provisioning
Boot0004 Root 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 Embedded SATA Port 1 HDD : ST500LTB12-1DG14Z
Boot000C Embedded SATA Port 2 HDD : ST500LTB12-1DG14Z
Boot000D ILO Virtual USB 2 : HPE iLO Virtual USB CD/DVD ROM
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 Red Hat Enterprise Linux
Boot0012 rhel-redundant
[root@localhost ~]# efibootmgr -o 0011,0012,0002,0000,0001,0003,0004,0005,0006,0007,0008,000A,0009,000C,000B
BootCurrent: 0011
Timeout: 0 seconds
BootOrder: 0011,0012,0002,0000,0001,0003,0004,0005,0006,0007,0008,000A,0009,000C,000B
Boot0000 Embedded UEFI Shell
Boot0001 Diagnose Error
Boot0002 System Utilities
Boot0003 Intelligent Provisioning
Boot0004 Root 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 Embedded SATA Port 1 HDD : ST500LTB12-1DG14Z
Boot000C Embedded SATA Port 2 HDD : ST500LTB12-1DG14Z
Boot000D ILO Virtual USB 2 : HPE iLO Virtual USB CD/DVD ROM
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 Red Hat Enterprise Linux
Boot0012 rhel-redundant
[root@localhost ~]
```

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

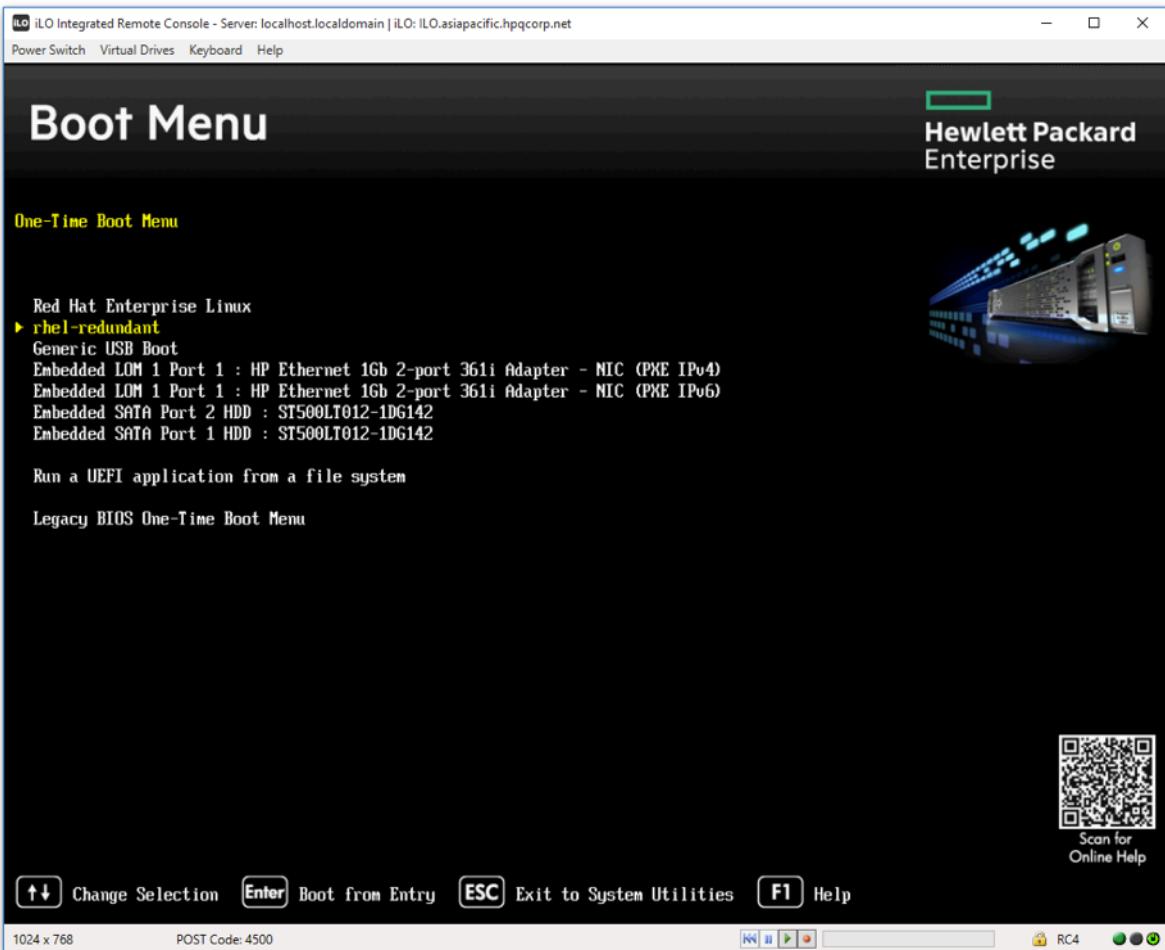
Check the system configuration by typing:

```
efibootmgr -v
```

5. Verify the boot entry by rebooting the system.

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

```

[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 : 471689152 (449.76 GiB 482.93 GB)
      Used Dev Size : 471689152 (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 : c8cf8caa:8d8af3b4:624ed787:d013b8d1
                    Events : 1440

      Number  Major  Minor  RaidDevice State
          0      8       0        0     removed   /dev/sda3
          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 **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.

```

[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 : 471689152 (449.76 GiB 482.93 GB)
      Used Dev Size : 471689152 (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 : c8cf8caa:8d8af3b4:624ed787:d013b8d1
                    Events : 1542

      Number  Major  Minor  RaidDevice State
          0      8       0        0     active sync   /dev/sda3
          1      8       3        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/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
```

```
[root@localhost ~]# dd if=/dev/sdb1 of=/dev/sda1
499566+0 records in
499566+0 records out
293657792 bytes (210 MB) copied, 1.85419 s, 113 MB/s
[root@localhost ~]# efibootmgr -v
BootCurrent: 0012
Timeout: 0 seconds
BootOrder: 0011,0012,0002,0000,0003,0004,0005,0006,0007,0008,0009,000B,000C,000B
Boot0000  Embedded UEFI Shell Fx401(cdb)7b35-6033-4ed6-9ab2-57d2acddf6f8
Boot0001 Diagnose Error Fx401(cdb)7b35-6033-4ed6-9ab2-57d2acddf6f8
Boot0002 System Utilities Fx401(cdb)7b35-6033-4ed6-9ab2-57d2acddf6f8
Boot0003 Intelligent Provisioning Fx401(cdb)7b35-6033-4ed6-9ab2-57d2acddf6f8
Boot0004 Boot Menu Fx401(cdb)7b35-6033-4ed6-9ab2-57d2acddf6f8
Boot0005 Network Boot Fx401(cdb)7b35-6033-4ed6-9ab2-57d2acddf6f8
Boot0006 Embedded Diagnostics Fx401(cdb)7b35-6033-4ed6-9ab2-57d2acddf6f8
Boot0007 View Integrated Management Log Fx401(cdb)7b35-6033-4ed6-9ab2-57d2acddf6f8
Boot0008 Generic USB Boot
USBClass((ffff,ffff,ff,ff))
Boot0009* Embedded LOM 1 Port 1 : HP Ethernet 1Gb 2-port 361i Adapter - NIC (PXE IPo6) ACPI(a8341d8,0)PCI(1c,4)PCI(0,0)MAC(MAC(S865f3e6f1bb,1))S80d3c800000000000
Boot000A* Embedded LOM 1 Port 1 : HP Ethernet 1Gb 2-port 361i Adapter - NIC (PXE IPo4) ACPI(a8341d8,0)PCI(1c,4)PCI(0,0)MAC(MAC(S865f3e6f1bb,1))M....YM...R,Y.
Boot000B* Embedded SATA Port 1 Port 2 HDD : ST500LTB12-1DG14Z ACPI(a8341d8,0)PCI(1f,2)SATA(1,0,0N,...,YM...R,Y.
Boot000C* Embedded SATA Port 1 HDD : ST500LTB12-1DG14Z ACPI(a8341d8,0)PCI(1f,2)SATA(0,0,0N,...,YM...R,Y.
Boot000D* ILO Virtual USB 2 : HPE ILO Virtual USB CD/DVD ROM ACPI(a8341d8,0)PCI(1d,0)USB(0,0)N....YM...R,Y.
Boot000E* ILO Virtual USB 2 : HPE ILO Virtual USB CD/DVD ROM ACPI(a8341d8,0)PCI(1d,0)USB(0,0)N....YM...R,Y.
Boot000F* ILO Virtual USB 2 : HPE ILO Virtual USB CD/DVD ROM ACPI(a8341d8,0)PCI(1d,0)USB(0,0)N....YM...R,Y.
Boot0010* ILO Virtual USB 2 : HPE ILO Virtual USB CD/DVD ROM ACPI(a8341d8,0)PCI(1d,0)USB(0,0)N....YM...R,Y.
Boot0011* Red Hat Enterprise Linux HD(1,22,63,de-a333hb2-02d0-46d2-b732-e82c4a96cd3c)File(\EFI\redhat\shim.efd)
Boot0012* rhel-redundant HD(1,22,63,de-52d22934-6627-4fb9-5d0-71b3054d1f05)File(\EFI\redhat\shim.efd)
[root@localhost ~]# efibootmgr -b 11 -B
BootCurrent: 0 seconds
BootOrder: 0012,0002,0000,0001,0003,0004,0005,0006,0007,0008,0009,000C,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 LOM 1 Port 1 : HP Ethernet 1Gb 2-port 361i Adapter - NIC (PXE IPo6)
Boot000A* Embedded LOM 1 Port 1 : HP Ethernet 1Gb 2-port 361i Adapter - NIC (PXE IPo4)
Boot000B* Embedded SATA Port 2 HDD : ST500LTB12-1DG14Z
Boot000C* Embedded SATA Port 1 Port 1 HDD : ST500LTB12-1DG14Z
Boot000D* ILO Virtual USB 2 : HPE ILO Virtual USB CD/DVD ROM
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* rhel-redundant
```

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

```
efibootmgr -c -d /dev/sda -p 1 -l \\EFI\\redhat\\shim.efd -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
```

```

root@localhost ~]# efibootmgr -c -d /dev/sda -p 1 -I \EFI\redhat\shim.efi -L rhel-redundant2
BootCurrent: 0012
Timeout: 0 seconds
BootOrder: 0011,0012,0002,0000,0003,0004,0005,0006,0007,0008,0009,000A,000B,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 LOM 1 Port 1 : HP Ethernet 1Gb Z-port 361i Adapter - NIC (PXE IPx6)
Boot000A* Embedded LOM 1 Port 1 : HP Ethernet 1Gb Z-port 361i Adapter - NIC (PXE IPx4)
Boot000B* Embedded SATA Port 2 HDD : ST500LT012-1DG14Z
Boot000C* Embedded SATA Port 1 HDD : ST500LT012-1DG14Z
Boot000D* iLO Virtual USB 2 : HPE iLO Virtual USB CD/DVD ROM
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* rhel-redundant
Boot0012* rhel-redundant2
root@localhost ~]# efibootmgr -o 0012,0011,0002,0000,0003,0004,0005,0006,0007,0008,0009,000C,000B
BootCurrent: 0012
Timeout: 0 seconds
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 Z-port 361i Adapter - NIC (PXE IPx6)
Boot000A* Embedded LOM 1 Port 1 : HP Ethernet 1Gb Z-port 361i Adapter - NIC (PXE IPx4)
Boot000B* Embedded SATA Port 2 HDD : ST500LT012-1DG14Z
Boot000C* Embedded SATA Port 1 HDD : ST500LT012-1DG14Z
Boot000D* iLO Virtual USB 2 : HPE iLO Virtual USB CD/DVD ROM
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* rhel-redundant
Boot0012* rhel-redundant2
root@localhost ~]#

```

## 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:

What type of devices will your installation involve?

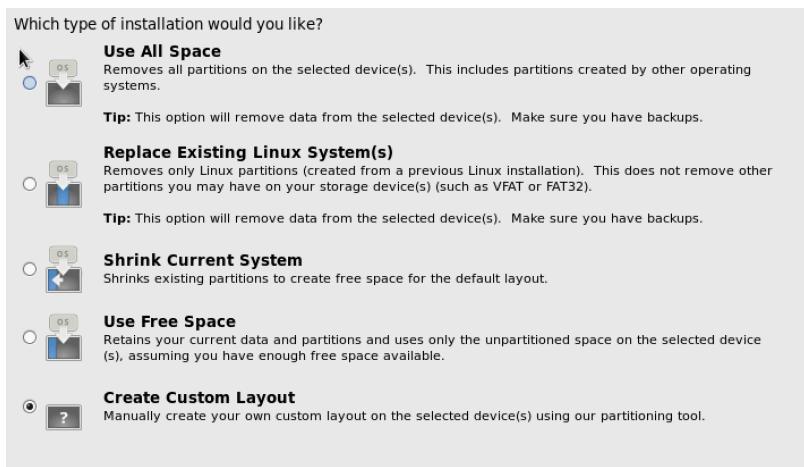
**Basic Storage Devices**

Installs or upgrades to typical types of storage devices. If you're not sure which option is right for you, this is probably it.

**Specialized Storage Devices**

Installs or upgrades to enterprise devices such as Storage Area Networks (SANs). This option will allow you to add FCoE / iSCSI / zFCP disks and to filter out devices the installer should ignore.

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



Then, the following is displayed:

Please Select A Device

Device	Size (MB)	Mount Point/ RAID/Volume	Type	Format
▼ Hard Drives				
▼ sda (/dev/sda)				
sda1	199		Unknown	
sda2	16184		Unknown	
Free	460556			
▼ sdb (/dev/sdb)				
sdb1	199		Unknown	
sdb2	16184		Unknown	
Free	460556			

Create    Edit    Delete    Reset

Back    Next

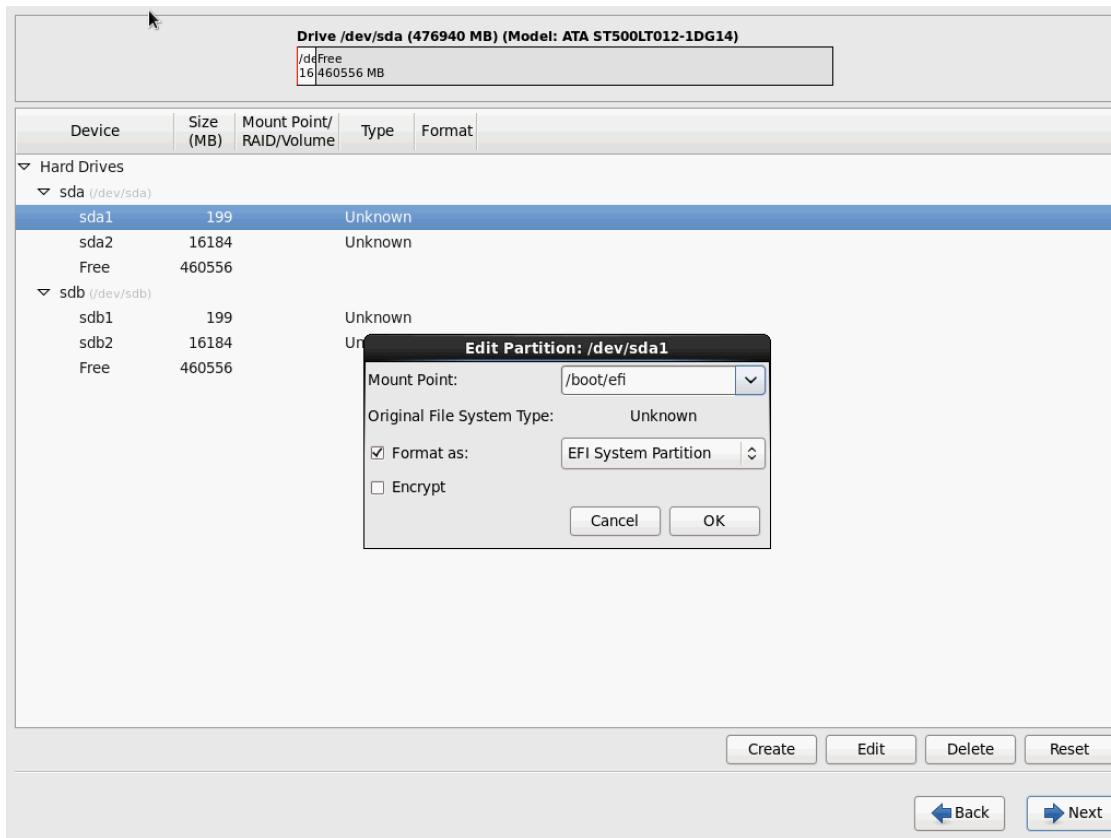
## Specifying the ESP

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**.

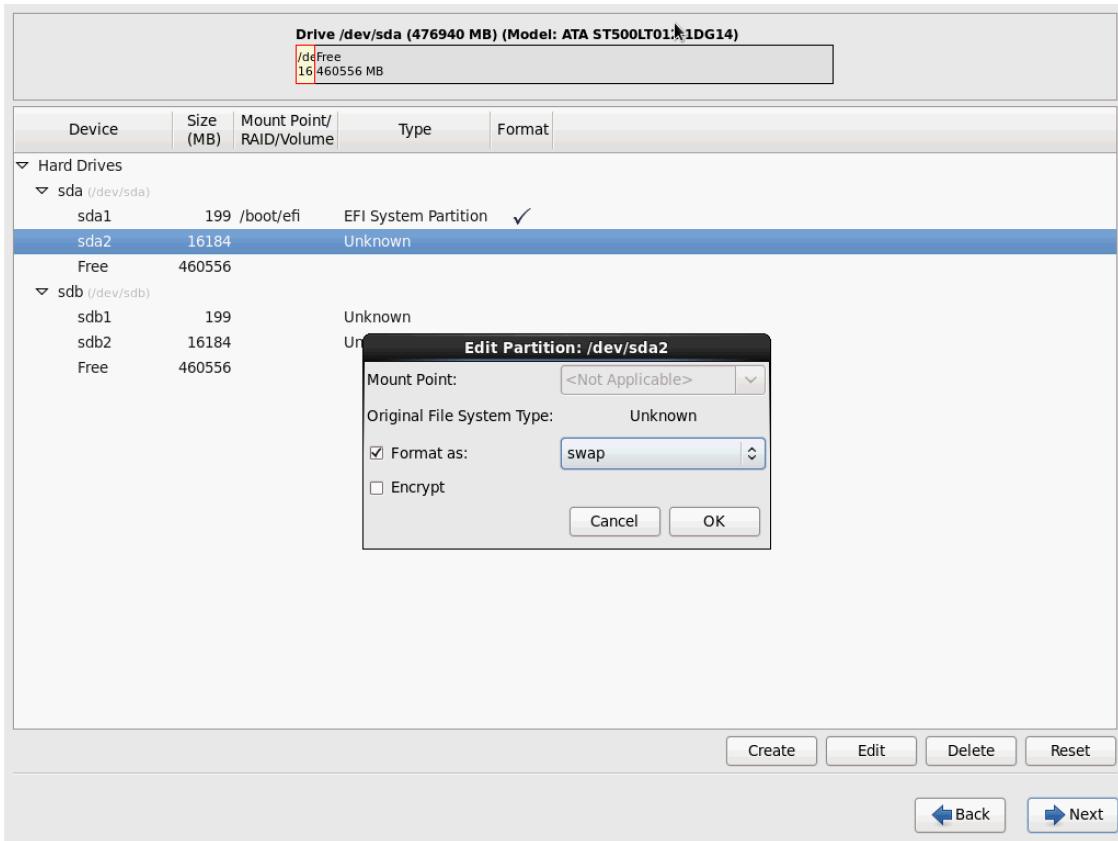


## Specifying the swap directory

4. Select **sda2** under sda, then click **Edit**.

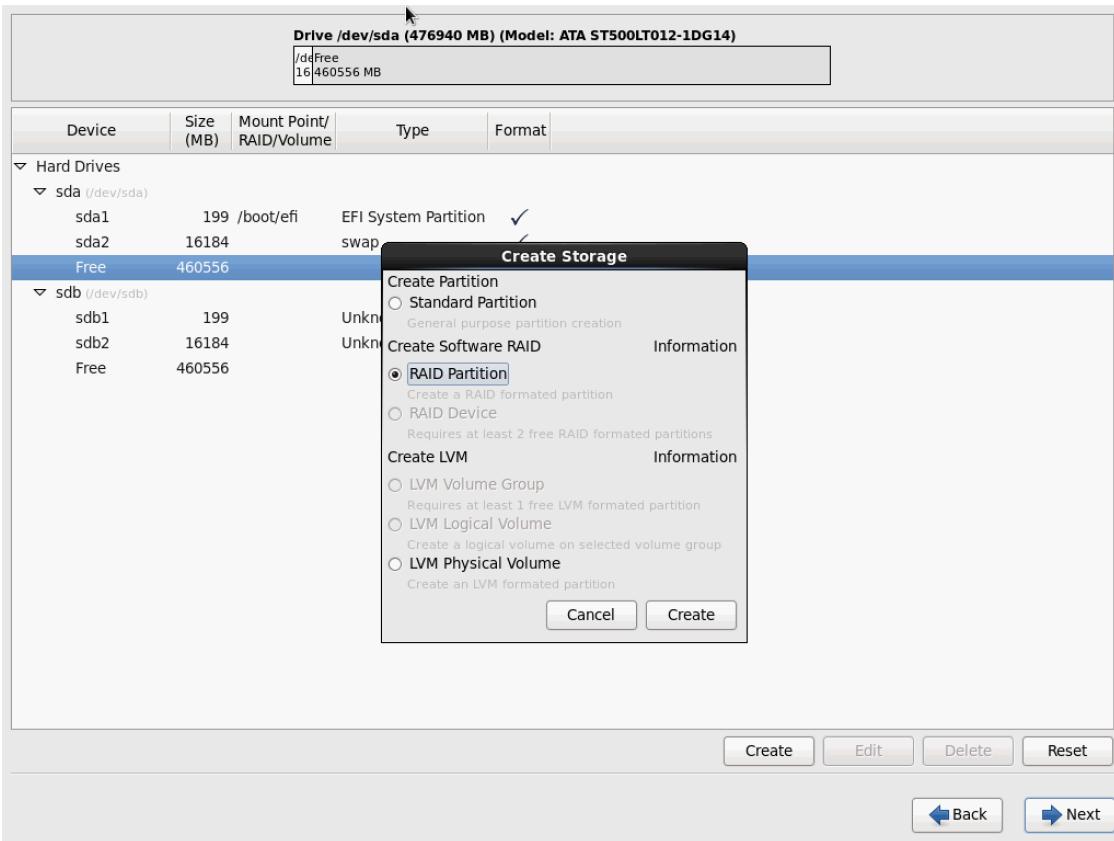
5. Click “Format as:” and select **swap**.

6. Click **OK**.

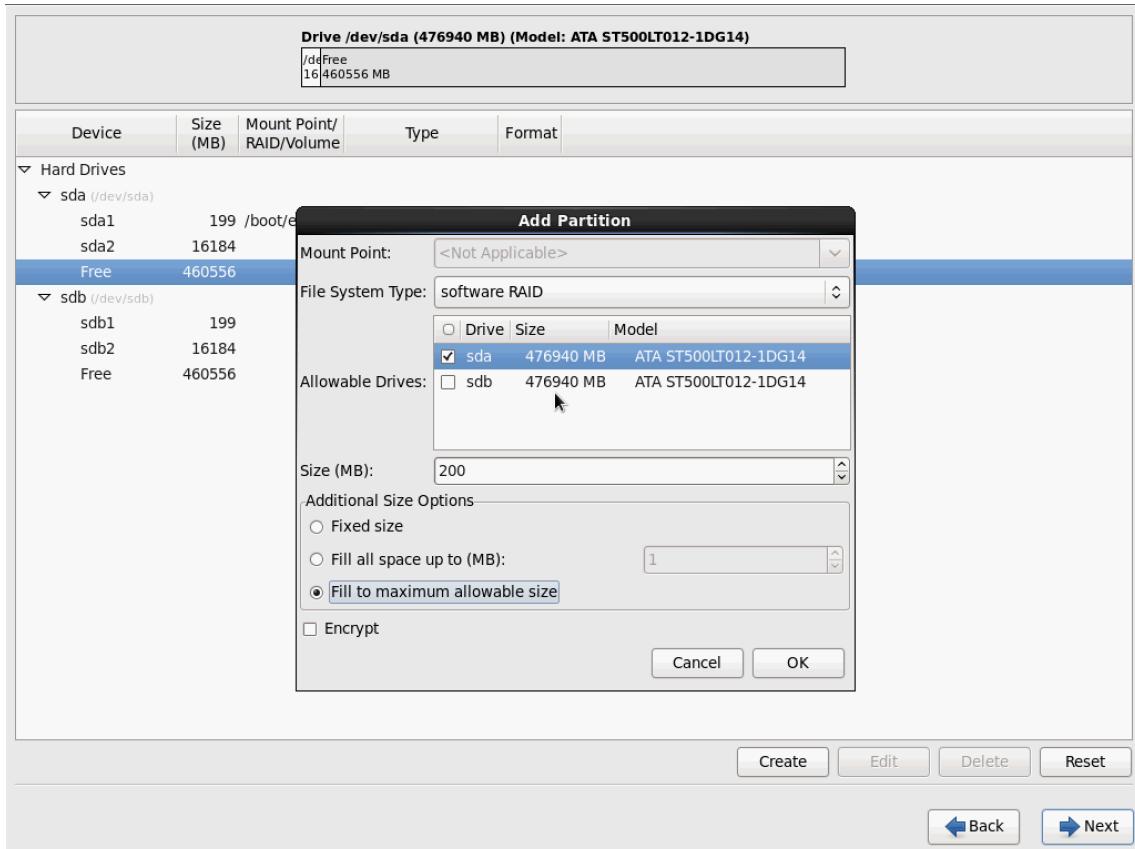


## Creating root disk as RAID1

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



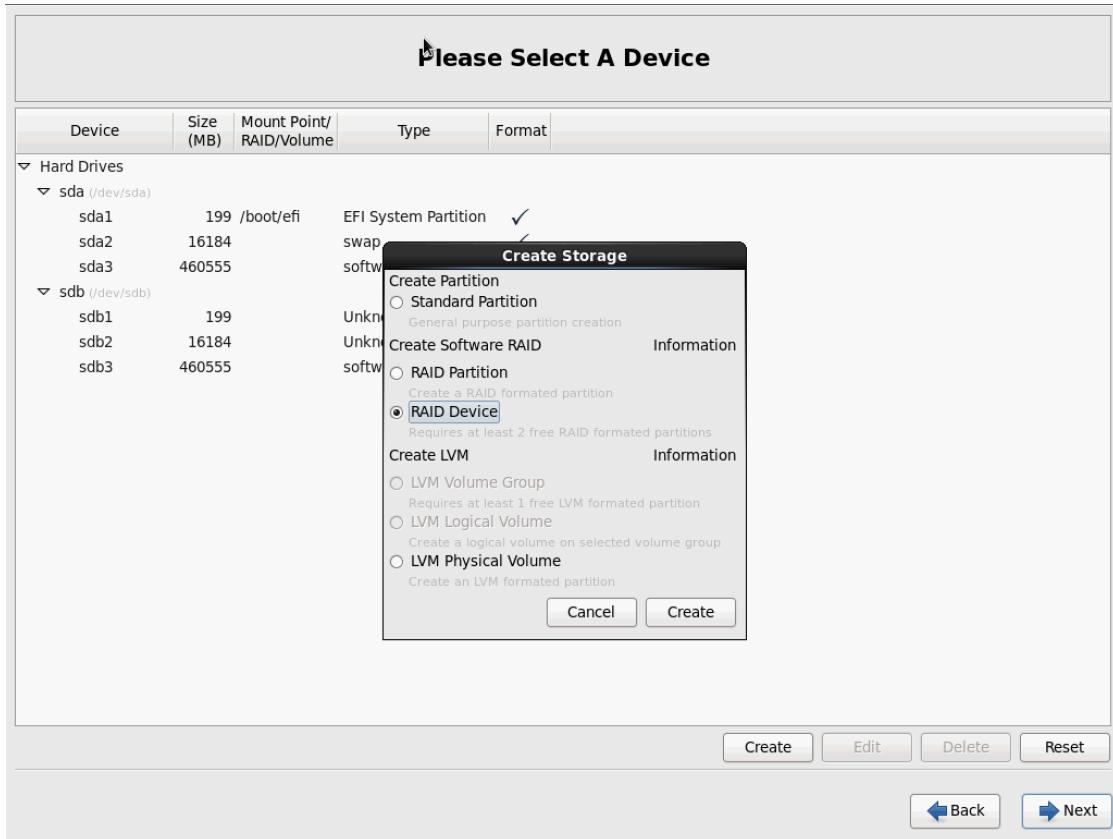
3. Check **sda** in the Add Partition screen, then click **Fill to maximum allowable size** in Additional Size Options. Then click **OK**.



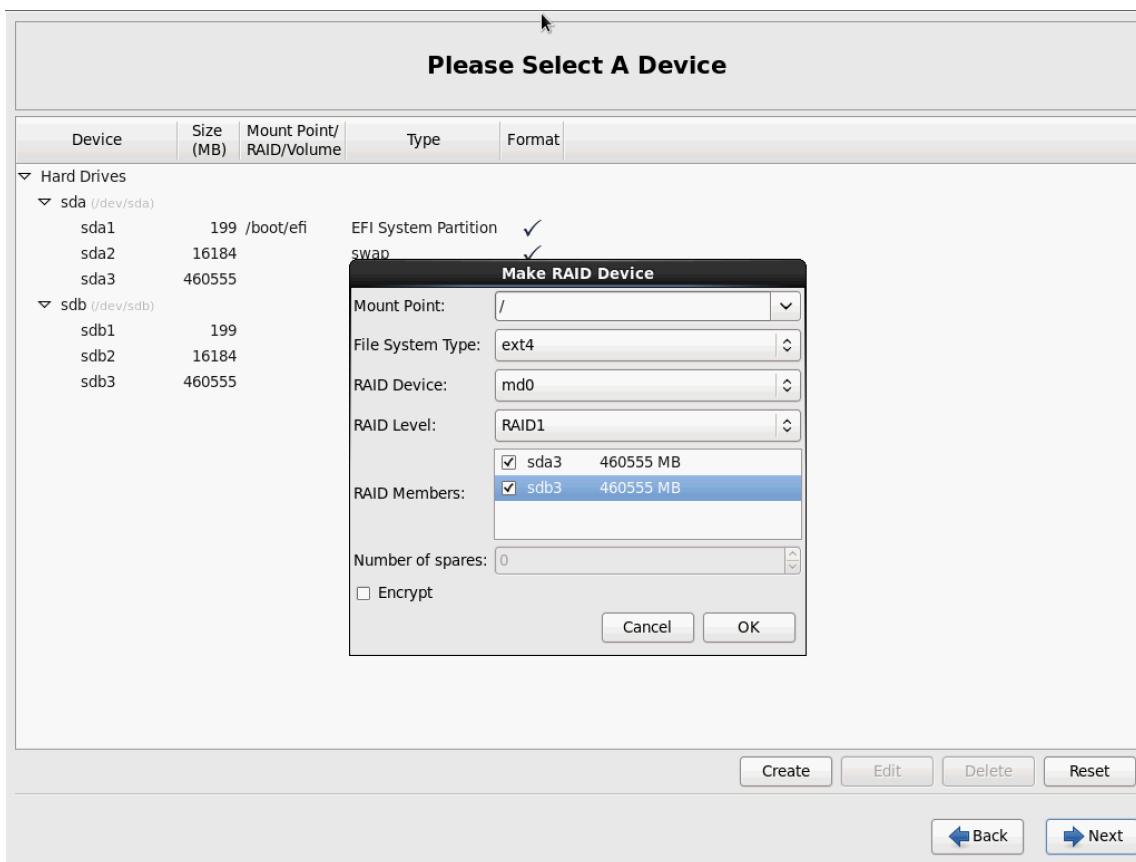
4. Repeat step 1, 2 and 3 for **sdb**.

## Create a RAID1 root partition

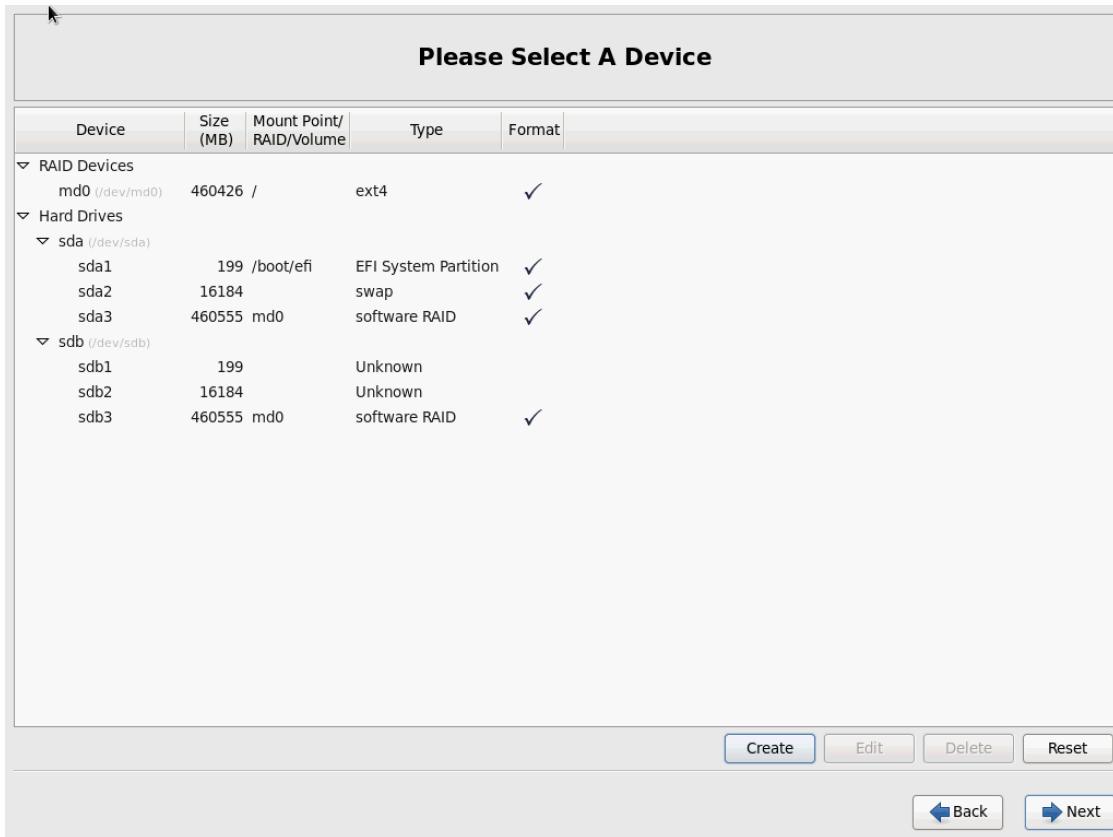
1. Click **Create** in the device selection screen.
2. Click **RAID Device** in the Create Storage screen, then click **Create**.



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 B148i - 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 B148i - LogVol (Lun:1 VolId:1) 931.48 Gi
Boot000F* rhel-redundant
Boot0010* Red Hat Enterprise Linux 6
[root@localhost ~]#

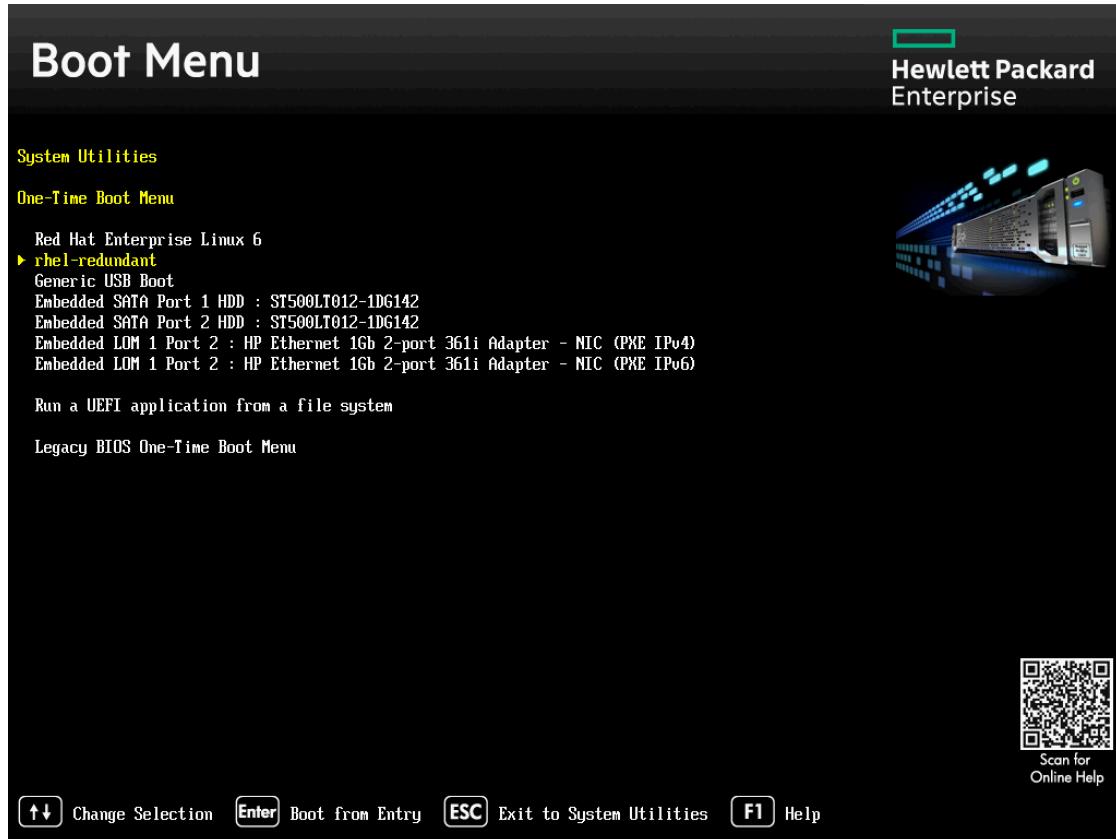
```

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.

```

[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 : 471689152 (449.76 GiB 482.93 GB)
      Used Dev Size : 471689152 (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 : c8cf8caa:8d8af3b4:624ed787:d013b8d1
                    Events : 1440

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

```

## 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.

```

[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 : 471689152 (449.76 GiB 482.93 GB)
      Used Dev Size : 471689152 (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 : c8cf8caa:8d8af3b4:624ed787:d013b8d1
                    Events : 1542

      Number  Major  Minor  RaidDevice State
          0      8       0        0     active sync  /dev/sda3
          1      8       3        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.

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
```

```
[root@localhost ~]# dd if=/dev/sdb1 of=/dev/sda1
499566+0 records in
499566+0 records out
293657792 bytes (210 MB) copied, 1.85419 s, 113 MB/s
[root@localhost ~]# efibootmgr -v
BootCurrent: 0012
Timeout: 0 seconds
BootOrder: 0011,0012,0002,0000,0003,0004,0005,0006,0007,0008,0009,000B,000C,000B
Boot0000  Embedded UEFI Shell Fx401(cdb)7b35-6033-4ed6-9ab2-57d2acddf6f8
Boot0001 Diagnose Error Fx401(cdb)7b35-6033-4ed6-9ab2-57d2acddf6f8
Boot0002 System Utilities Fx401(cdb)7b35-6033-4ed6-9ab2-57d2acddf6f8
Boot0003 Intelligent Provisioning Fx401(cdb)7b35-6033-4ed6-9ab2-57d2acddf6f8
Boot0004 Boot Menu Fx401(cdb)7b35-6033-4ed6-9ab2-57d2acddf6f8
Boot0005 Network Boot Fx401(cdb)7b35-6033-4ed6-9ab2-57d2acddf6f8
Boot0006 Embedded Diagnostics Fx401(cdb)7b35-6033-4ed6-9ab2-57d2acddf6f8
Boot0007 View Integrated Management Log Fx401(cdb)7b35-6033-4ed6-9ab2-57d2acddf6f8
Boot0008 Generic USB Boot
USBClass((ffff,ffff,ff,ff))
Boot0009* Embedded LOM 1 Port 1 : HP Ethernet 1Gb 2-port 361i Adapter - NIC (PXE IPo6) ACPI(a8341d,0)PCI(1c,4)PCI(0,0)MAC(MAC(S865f3e6f1bb,1))S3d3c800000000000
Boot000A* Embedded LOM 1 Port 1 : HP Ethernet 1Gb 2-port 361i Adapter - NIC (PXE IPo4) ACPI(a8341d,0)PCI(1c,4)PCI(0,0)MAC(MAC(S865f3e6f1bb,1))....YM...R,Y.
Boot000B* Embedded SATA Port 1 Port 2 HDD : ST500LTB12-1DG14Z ACPI(a8341d,0)PCI(1f,2)SATA(1,0,0N,...,YM...R,Y.
Boot000C* Embedded SATA Port 1 HDD : ST500LTB12-1DG14Z ACPI(a8341d,0)PCI(1f,2)SATA(0,0,0N,...,YM...R,Y.
Boot000D* ILO Virtual USB 2 : HPE ILO Virtual USB CD/DVD ROM ACPI(a8341d,0)PCI(1d,0)USB(0,0)....,YM...R,Y.
Boot000E* ILO Virtual USB 2 : HPE ILO Virtual USB CD/DVD ROM ACPI(a8341d,0)PCI(1d,0)USB(0,0)....,YM...R,Y.
Boot000F* ILO Virtual USB 2 : HPE ILO Virtual USB CD/DVD ROM ACPI(a8341d,0)PCI(1d,0)USB(0,0)....,YM...R,Y.
Boot0010* ILO Virtual USB 2 : HPE ILO Virtual USB CD/DVD ROM ACPI(a8341d,0)PCI(1d,0)USB(0,0)....,YM...R,Y.
Boot0011* Red Hat Enterprise Linux HD(1,22,63,de,a333hb2-02d0-46d2-b732-e02c4a96cd3c)File(\EFI\redhat\shim.efd)
Boot0012* rhel-redundant HD(1,22,63,de,52d22934-6627-4fb9-a5d0-71b305d1f05)File(\EFI\redhat\shim.efd)
[root@localhost ~]# efibootmgr -b 11 -B
BootCurrent: 0 seconds
BootOrder: 0012,0002,0000,0001,0003,0004,0005,0006,0007,0008,0009,000C,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 LOM 1 Port 1 : HP Ethernet 1Gb 2-port 361i Adapter - NIC (PXE IPo6)
Boot000A* Embedded LOM 1 Port 1 : HP Ethernet 1Gb 2-port 361i Adapter - NIC (PXE IPo4)
Boot000B* Embedded SATA Port 2 HDD : ST500LTB12-1DG14Z
Boot000C* Embedded SATA Port 1 HDD : ST500LTB12-1DG14Z
Boot000D* ILO Virtual USB 2 : HPE ILO Virtual USB CD/DVD ROM
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* rhel-redundant
```

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

```
efibootmgr -c -d /dev/sda -p 1 -l \\EFI\\redhat\\grub.efd -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
```

```

[root@localhost ~]# efibootmgr -c -d /dev/sda -p 1 -I \EFI\redhat\shim.efi -L rhel-redundant2
BootCurrent: 0012
Timeout: 0 seconds
BootOrder: 0011,0012,0002,0000,0003,0004,0005,0006,0007,0008,0009,000C,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 LOM 1 Port 1 : HP Ethernet 1Gb Z-port 361i Adapter - NIC (PXE IPo6)
Boot000A+ Embedded LOM 1 Port 1 : HP Ethernet 1Gb Z-port 361i Adapter - NIC (PXE IPo4)
Boot000B+ Embedded SATA Port 2 HDD : ST500LT012-1DG14Z
Boot000C+ Embedded SATA Port 1 HDD : ST500LT012-1DG14Z
Boot000D+ iLO Virtual USB 2 : HPE iLO Virtual USB CD/DVD ROM
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+ rhel-redundant
Boot0011+ rhel-redundant2
[root@localhost ~]# efibootmgr -o 0012,0011,0002,0000,0003,0004,0005,0006,0007,0008,0009,000C,000B
BootCurrent: 0012
Timeout: 0 seconds
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 Z-port 361i Adapter - NIC (PXE IPo6)
Boot000A+ Embedded LOM 1 Port 1 : HP Ethernet 1Gb Z-port 361i Adapter - NIC (PXE IPo4)
Boot000B+ Embedded SATA Port 2 HDD : ST500LT012-1DG14Z
Boot000C+ Embedded SATA Port 1 HDD : ST500LT012-1DG14Z
Boot000D+ iLO Virtual USB 2 : HPE iLO Virtual USB CD/DVD ROM
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+ rhel-redundant
Boot0012+ rhel-redundant2
[root@localhost ~]#

```

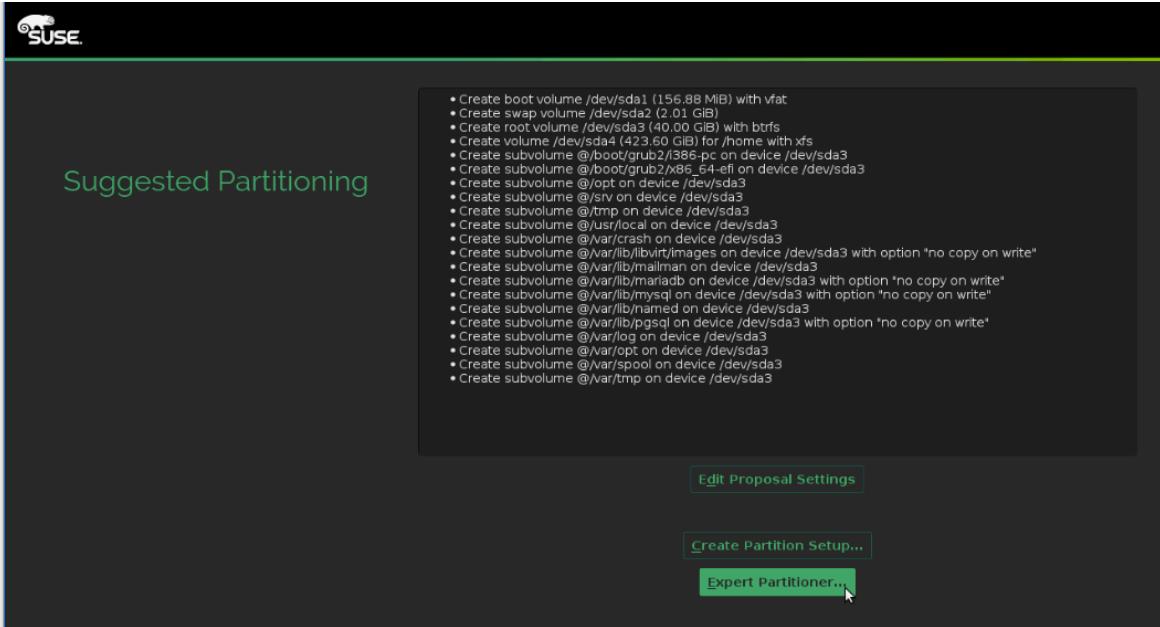
## SuSE Linux Enterprise Server (SLES) 12 SP2

### Installation process

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

### Partitioning drives for SLES

- From the Suggested Partitioning screen, select **Expert Partitioner...**



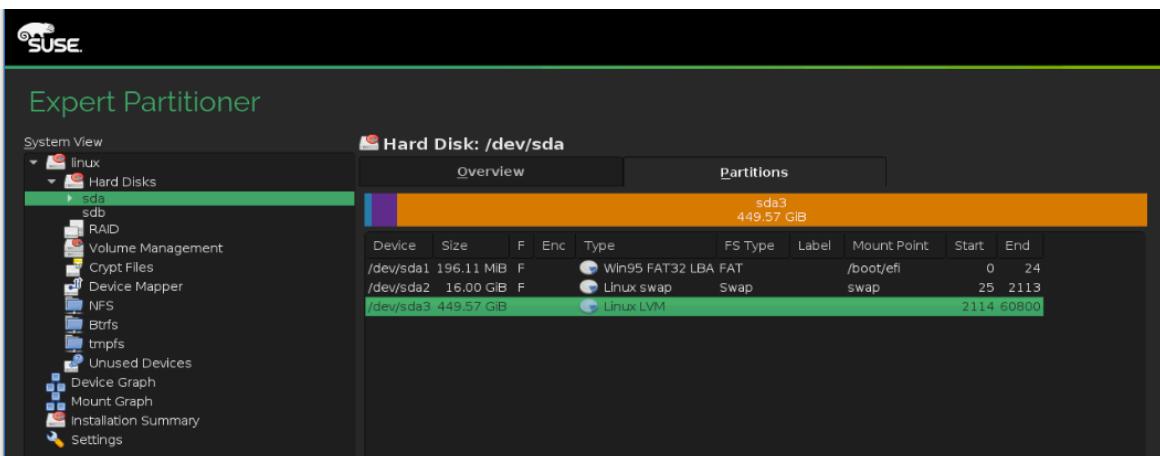
2. Delete the Expert Partitioner default partition scheme.

3. Partition /dev/sda as follows:

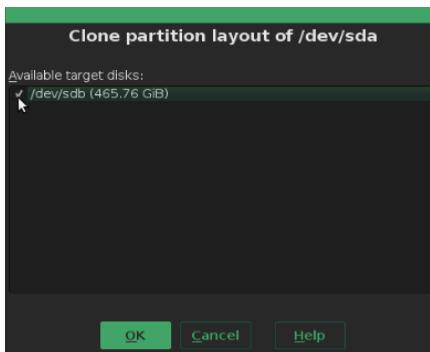
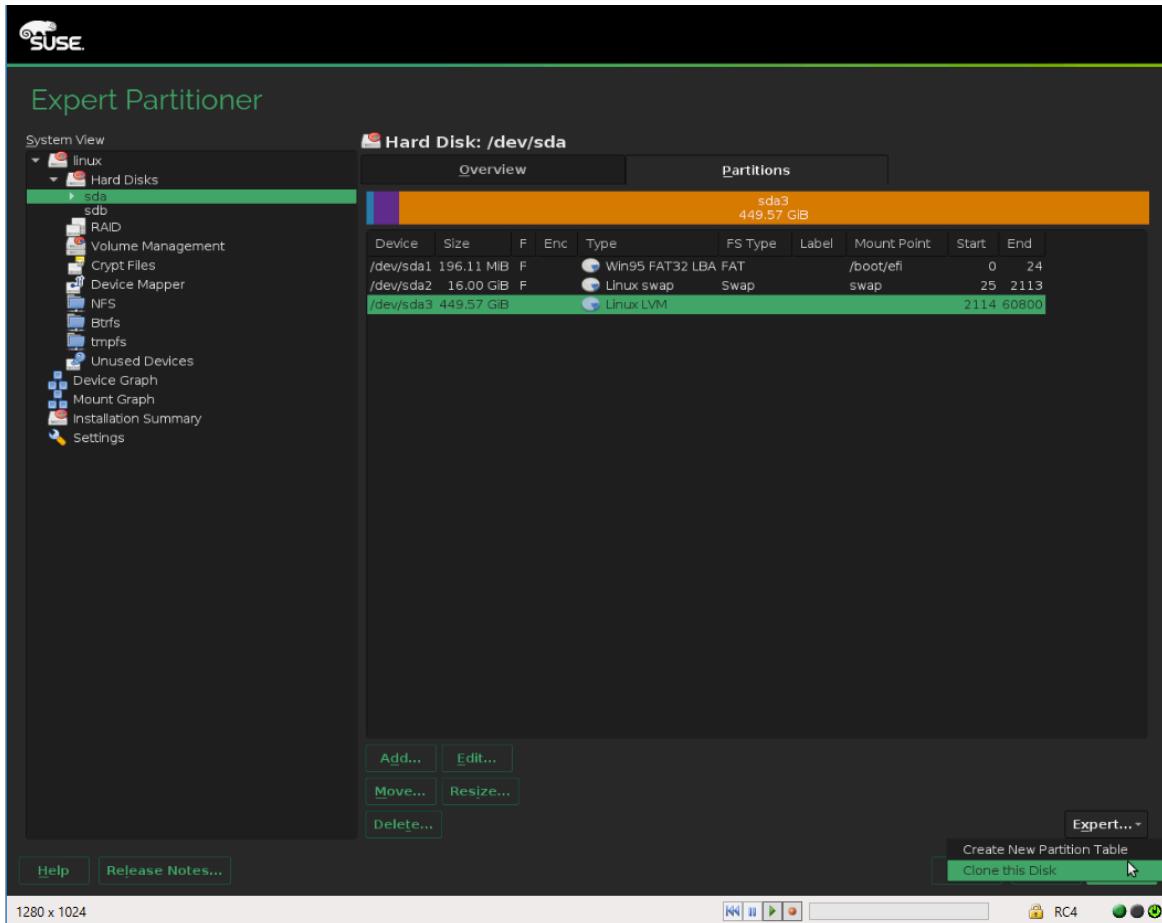
/dev/sda1, size = 200MB, mount point = /boot/efi, format as "FAT"

/dev/sda2, size = 16GB, format as "Swap"

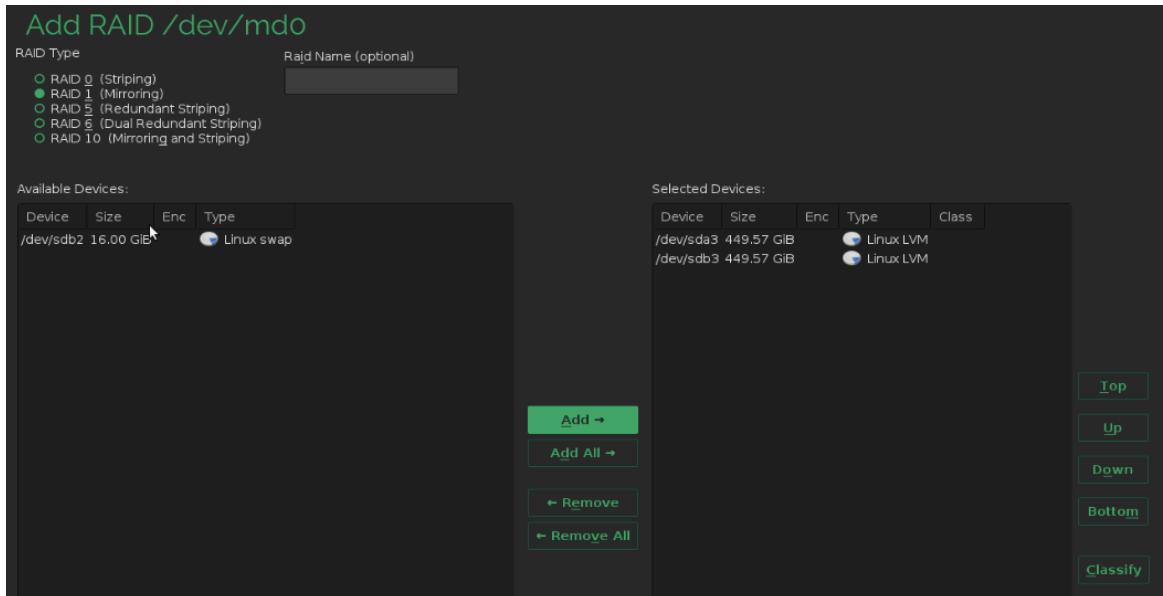
/dev/sda3, size = rest of the disk space.



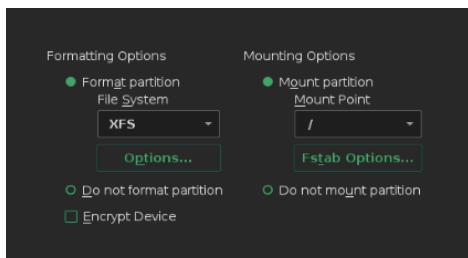
4. After successfully partitioning the first disk, use **Expert > Clone this disk...** function to clone the partition scheme to the second disk.



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.

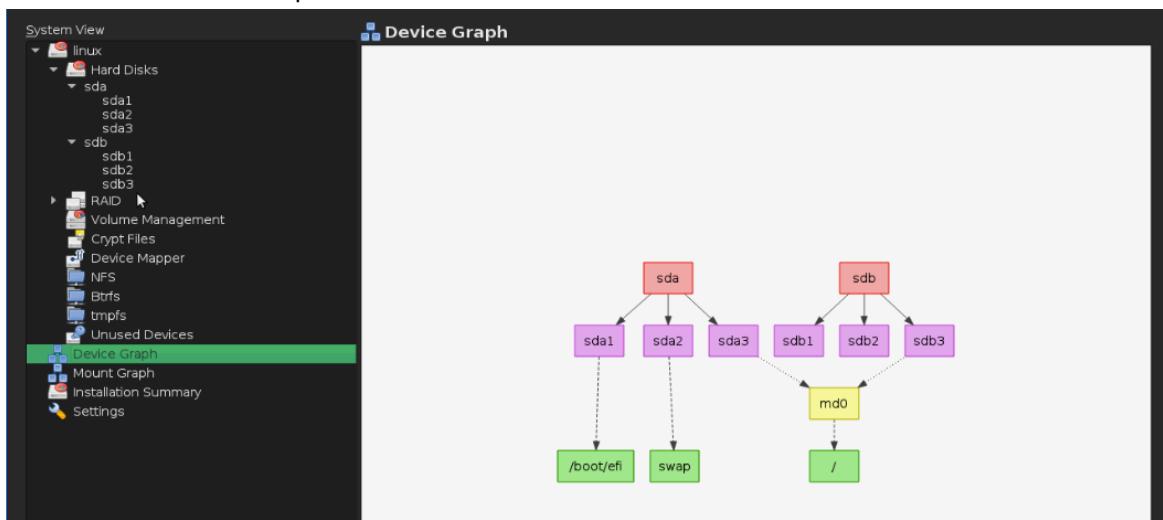


- Accept default setting such as 4KB Chunk Size, format as XFS and mount it to "/" (root).

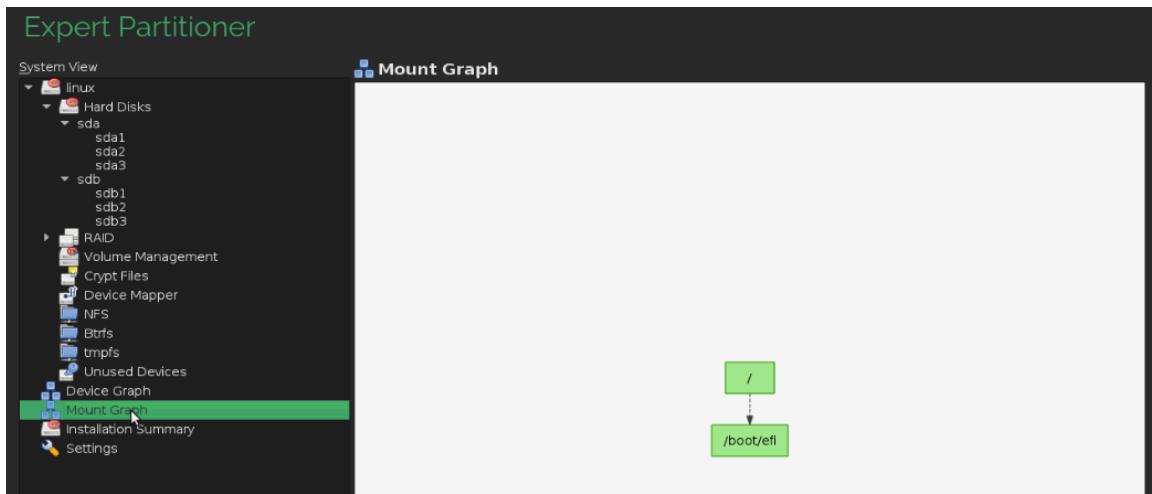


- Click **Finish**.

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

```

```

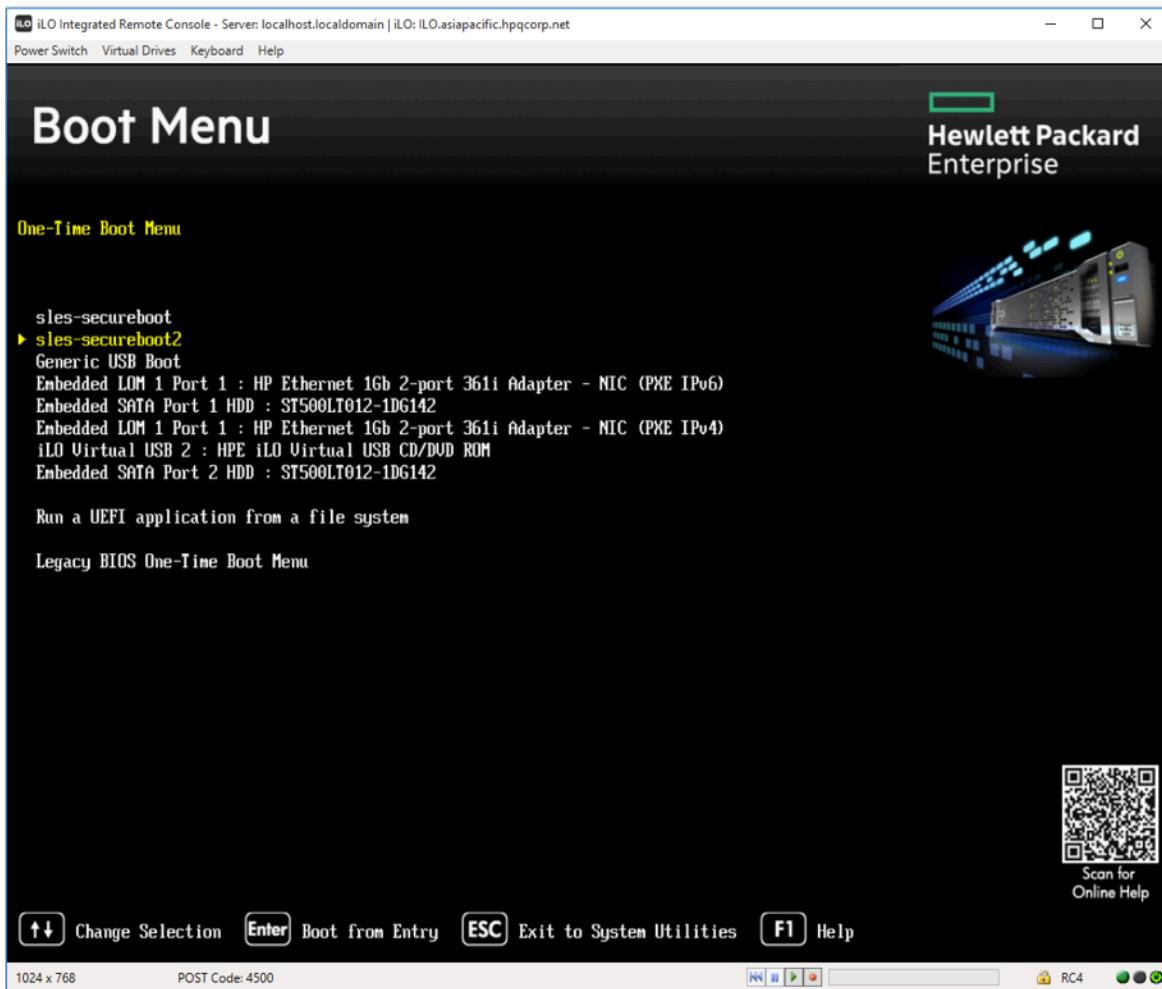
linux-9xde:~ # efibootmgr -o 0011,0012,0002,0000,0003,0004,0005,0006,0007,0008,0009,000C,0001,000A,000B,000D
BootCurrent: 0011
Timeout: 0 seconds
BootOrder: 0011,0012,0002,0000,0003,0004,0005,0006,0007,0008,0009,000C,0001,000A,000B,000D
Boot0000 Embedded UEFI Shell
Boot0001 Diagnose Error
Boot0002 System 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.

```

dracut:~# 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 : 1
        Persistence : Superblock is persistent

        Intent Bitmap : Internal

          Update Time : Wed Mar 30 03:57:15 2016
                      State : clean, degraded
        Active Devices : 1
       Working Devices : 1
         Failed Devices : 0
        Spare Devices : 0

              Name : any:0
              UUID : 824cc36d:607cf28b:2bbfaf68:a2d81425
            Events : 1692

      Number  Major  Minor  RaidDevice State
         0      8        0         0     removed
         1      8        3         1     active sync  /dev/sda3
dracut:~#

```

## 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 `crashkernel=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.

```

GNU GRUB  version 2.02^beta2

[GRUB boot menu]
load_video
set gfxpayload=keep
insmod gzio
insmod part_gpt gpt
insmod diskfilter mdraid1x
insmod xfs
set root='mduuid/824cc36d607cf28b2bbfaf68a2d81425'
if [ x$feature_platform_search_hint = xy ]; then
    search --no-floppy --fs-uuid --set=root --hint='mduuid/824cc36d607cf28b2b\
bfaf68a2d81425' 03d68659-23cf-423b-b1c6-c6a711aa9cfe
else
    search --no-floppy --fs-uuid --set=root 03d68659-23cf-423b-b1c6-c6a711aa9\
cfe
fi
echo      'Loading Linux 3.12.49-11-default ...'
linuxefi /boot/vmlinuz-3.12.49-11-default root=UUID=03d68659-23cf-423b-b1c6\
-c6a711aa9cfe ro resume=/dev/sda2 splash=silent quiet showopts crashkernel=103M,hi\
gh crashkernel=72M,low rd.shell rd.debug_
echo      'Loading initial ramdisk ...'
initrdefi /boot/initrd-3.12.49-11-default

[GRUB boot menu]
Minimum Emacs-like screen editing is supported. TAB lists completions.
Press Ctrl-x or F10 to boot, Ctrl-c or F2 for a command-line or ESC to
discard edits and return to the GRUB menu.

```

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

```

/lib/dracut-11b.sh#415(source_all): '[' -d //lib/dracut/hooks/emergency ']'
/lib/dracut-11b.sh#416(source_all): for f in "$_dir"/*.sh
//lib/dracut-11b.sh#416(source_all): '[' -e //lib/dracut/hooks/emergency/50-plymouth-emergency.sh ']'
/lib/dracut-11b.sh#416(source_all): . //lib/dracut/hooks/emergency/50-plymouth-emergency.sh
///lib/dracut/hooks/emergency/50-plymouth-emergency.sh#4(source): plymouth --hide-splash
///lib/dracut/hooks/emergency/50-plymouth-emergency.sh#4(source):
/lib/dracut-11b.sh#416(source_all): for f in "$_dir"/*.sh
//lib/dracut-11b.sh#416(source_all): '[' -e //lib/dracut/hooks/emergency/80->x2fdev<2fdisk<x2fbu-uid<x2f03d60659-23cf-423b-b1c6-c6a71aa9cfe.sh' ']'
/lib/dracut-11b.sh#416(source_all): . //lib/dracut/hooks/emergency/80-plymouth-emergency.sh
///lib/dracut/hooks/emergency/80->x2fdev<2fdisk<x2fbu-uid<x2f03d60659-23cf-423b-b1c6-c6a71aa9cfe.sh' ']'
/lib/dracut-11b.sh#416(source_all): -e /dev/disk/by-uid/03d60659-23cf-423b-b1c6-c6a71aa9cfe
//lib/dracut-11b.sh#416(source_all): for f in "$_dir"/*.sh
//lib/dracut-11b.sh#416(source_all): '[' -e //lib/dracut/hooks/emergency/80->x2fdev<2fdisk<x2fbu-uid<x2f3e880408-a786-49fb-989f-566378f0766.sh' ']'
/lib/dracut-11b.sh#416(source_all): . //lib/dracut/hooks/emergency/80->x2fdev<2fdisk<x2fbu-uid<x2f3e880408-a786-49fb-989f-566378f0766.sh
///lib/dracut/hooks/emergency/80->x2fdev<2fdisk<x2fbu-uid<x2f3e880408-a786-49fb-989f-566378f0766.sh' ']'
/lib/dracut-11b.sh#416(source_all): -e /dev/disk/by-uid/3e880408-a786-49fb-989f-566378f0766
does not exist
//lib/dracut-11b.sh#70(warn): echo 'Warning: /dev/disk/by-uid/3e880408-a786-49fb-989f-566378f0766 does not exist'
warning: /dev/disk/by-uid/3e880408-a786-49fb-989f-566378f0766 does not exist
//lib/dracut-11b.sh#416(source_all): for f in "$_dir"/*.sh
//lib/dracut-11b.sh#416(source_all): '[' -e //lib/dracut/hooks/emergency/80->x2fdev<2fdisk<x2fbu-uid<x2f806E-1882.sh' ']'
//lib/dracut-11b.sh#416(source_all): . //lib/dracut/hooks/emergency/80->x2fdev<2fdisk<x2fbu-uid<x2f806E-1882.sh
///lib/dracut/hooks/emergency/80->x2fdev<2fdisk<x2fbu-uid<x2f806E-1882.sh#1(source): '[' -e /dev/disk/by-uid/806E-1882 ']'
/bin/dracut-emergency@0: getarg rd.shell -d -g rdsshell
/lib/dracut-11b.sh#236(getargbool): local _b
/lib/dracut-11b.sh#237(getargbool): unset _b
/lib/dracut-11b.sh#238(getargbool): local _default
/lib/dracut-11b.sh#239(getargbool): _default=0
/lib/dracut-11b.sh#240(getargbool): shift
//lib/dracut-11b.sh#240(getargbool): getarg rd.shell -d -g rdsshell
//lib/dracut-11b.sh#108(debug): debug off
//lib/dracut-11b.sh#16(debug_off): set $x
//lib/dracut-11b.sh#210(debug): return 0
/lib/dracut-11b.sh#240(getargbool):
//lib/dracut-11b.sh#241(getargbool): '[' 0 -ne 0 -a -z '' ']'
//lib/dracut-11b.sh#242(getargbool): '[' -n 0 ']'
//lib/dracut-11b.sh#247(getargbool): return 0
/bin/dracut-emergency@ZIO: echo

/bin/dracut-emergency@ZIO: rdsosreport
Generating "/run/initramfs/rdsosreport.txt"
/bin/dracut-emergency@ZIO: echo

/bin/dracut-emergency@ZIO: echo

/bin/dracut-emergency@ZIO: echo 'Entering emergency mode. Exit the shell to continue.'
Entering emergency mode. Exit the shell to continue.
/bin/dracut-emergency@ZIO: echo 'Type "journalctl" to view system logs.'
Type "journalctl" to view system logs.
/bin/dracut-emergency@ZIO: echo 'You might want to save "/run/initramfs/rdsosreport.txt" to a USB stick or /boot'
You might want to save "/run/initramfs/rdsosreport.txt" to a USB stick or /boot
/bin/dracut-emergency@ZIO: echo 'after mounting them and attach it to a bug report.'
after mounting them and attach it to a bug report.
/bin/dracut-emergency@ZIO: echo

/bin/dracut-emergency@ZIO: echo

/bin/dracut-emergency@ZIO: '[' -f /etc/profile ']'
/bin/dracut-emergency@ZIO: ./etc/profile
/etc/profile@10: PS1='dracut:${PWD}# '
/bin/dracut-emergency@ZIO: '[' -z 'dracut:${PWD}# ' ']'
/bin/dracut-emergency@ZIO: exec sh -i -
dracut:@#

```

## 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 : 471495376 (449.57 GiB 482.72 GB)
      Used Dev Size : 471495376 (449.57 GiB 482.72 GB)
      Raid Devices : 2
      Total Devices : 2
      Persistence : Superblock is persistent

      Intent Bitmap : Internal

      Update Time : Wed Mar 30 05:40:11 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 : 02fc36d:607cf20b:2bbfaf60:a2d81425
                  Events : 174Z

      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: 0012,0002,0000,0003,0004,0005,0006,0007,0008,0009,0001,0000,000B,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 Z : 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 Z : HPE iLO Virtual USB CD/DVD ROM
Boot000F* iLO Virtual USB Z : HPE iLO Virtual USB CD/DVD ROM
Boot0010* iLO Virtual USB Z : 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
```

```
[root@9de: ~]# efibootmgr -c -d /dev/sda -p 1 -l \N{EFS}sles\shin.efi -L "sles-secureboot3"
BootCurrent: 0012
Timeout: 0 seconds
BootOrder: 0011,0012,0002,0000,0003,0004,0005,0006,0007,0008,0009,0001,000A,000B,0000,000C
Boot0009 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 : ST500LT012-1DG14Z
Boot000D Embedded SATA Port 2 HDD : ST500LT012-1DG14Z
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
Boot0012* sles-secureboot2
[root@9de: ~]#
```

# 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](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](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 <code>url -url "http://172.1.1.100/mrepo/RHEL-7.3Server-x86_64/dscl/"</code>
rootpw	The password for the root user <code>rootpw -plaintext "Passw0rd"</code>
%packages ... %end	Packages to install <code>%packages @base @core wget net-tools dhclient mdadm gdisk</code>

	<pre>smartmontools %end</pre>
part	<p>Disk partition information. This example creates a 256 MB ESP partition, a 16384MB swap partition, and a raid volume that takes the remaining space. (For NVMe disks, replace sda with nvme0n1p1 and sdb with nvme1n1p1)</p> <pre>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</pre>
raid	<p>RAID configuration</p> <pre>raid / --device=md0 --fstype=xfs --level=1 raid.01 raid.02</pre>
%post	<p>Specify the log path for the post-install scripts</p> <pre>%post --interpreter /bin/bash --log /var/log/ks.cfg.log</pre>
wget	<p>The path to get the RPM package</p> <pre>wget -P /tmp http://172.1.1.100/answers/mdsync/lsrrb-1.2.0-2.x86_64.rpm</pre>

## 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](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](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.

<b>Parameter Name</b>	<b>Description and Example</b>
url	The URL for the RHEL installation media <pre>url -url "http://172.1.1.100/mrepo/RHEL-7.3Server-x86_64/disc1/"</pre>
rootpw	The password for the root user <pre>rootpw -plaintext "Passw0rd"</pre>
%packages ... %end	Packages to install <pre>%packages @base @core wget net-tools dhclient mdadm gdisk smartmontools %end</pre>
part	Disk partition information. This example creates a 256 MB ESP partition, a 16384MB swap partition, and a raid volume that takes the remaining space. (For NVMe disks, replace sda with nvme0n1p1 and sdb with nvme1n1p1) <pre>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</pre>
raid	RAID configuration <pre>raid / --device=md0 --fstype=xfs --level=1 raid.01 raid.02</pre>
%post	Specify the log path for the post-install scripts <pre>%post --interpreter /bin/bash --log /var/log/ks.cfg.log</pre>
wget	The path to get the RPM package

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

## 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](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](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.  <code>wget -P /tmp http://172.1.1.100/answers/mdsync/lsrrb-1.2.0-2.x86_64.rpm</code>
<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 <code>/dev/md0</code> will be created to include <code>/dev/sda3</code> and <code>/dev/sdb3</code> .  <code>&lt;drive&gt; # Where to modify HD partitions. Default is for the two 500G HDs.</code> <code>&lt;device&gt;/dev/md&lt;/device&gt;</code> <code>&lt;disklabel&gt;msdos&lt;/disklabel&gt;</code> <code>&lt;enable_snapshots config:type="boolean"&gt;true&lt;/enable_snapshots&gt;</code> <code>&lt;initialize config:type="boolean"&gt;true&lt;/initialize&gt;</code> <code>&lt;partitions config:type="list"&gt;</code> <code>&lt;partition&gt;</code> <code>&lt;create config:type="boolean"&gt;true&lt;/create&gt;</code> <code>&lt;crypt_fs config:type="boolean"&gt;false&lt;/crypt_fs&gt;</code> <code>&lt;filesystem config:type="symbol"&gt;xfs&lt;/filesystem&gt;</code> <code>&lt;format config:type="boolean"&gt;true&lt;/format&gt;</code>

```

<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_superblock>
    <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>

```

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

# 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:

```

Starting installer, one moment...
anaconda 21.48.22.93-1 for Red Hat Enterprise Linux 7.3 started.
* installation log files are stored in /tmp during the installation
* shell is available on TTY2
* if the graphical installation interface fails to start, try again with the
  inst.text bootoption to start text installation
* when reporting a bug add logs from /tmp as separate text/plain attachments
=====
Rescue

The rescue environment will now attempt to find your Linux installation and
mount it under the directory : /mnt/sysimage. You can then make any changes
required to your system. Choose '1' to proceed with this step.
You can choose to mount your file systems read-only instead of read-write by
choosing '2'.
If for some reason this process does not work choose '3' to skip directly to a
shell.

1) Continue
2) Read-only mount
3) Skip to shell
4) Quit (Reboot)

Please make a selection from the above: 1
=====
Rescue Mount

You don't have any Linux partitions. The system will reboot automatically when
you exit from the shell.
Please press <return> to get a shell.
When finished, please exit from the shell and your system will reboot.
sh-4.2#

```

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:

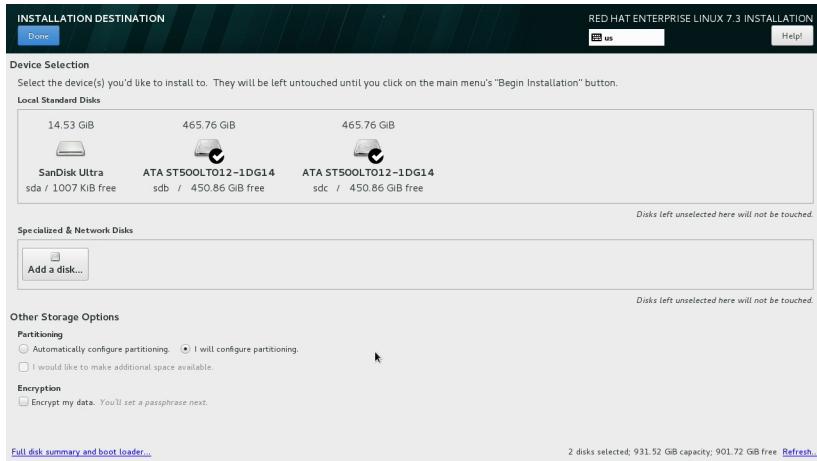
Number  Start   End     Size    File system   Name     Flags
 1      17.4kB  200MB   200MB   fat16         primary
 2      200MB    16.0GB   15.8GB

sh-4.2# _
```

9. Reboot to proceed with Red Hat installation.

### Normal Installation Process

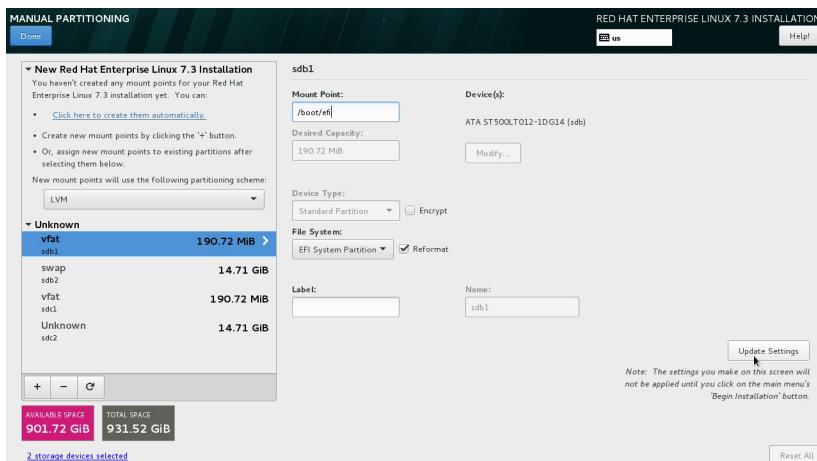
The software RAID installation differs from the normal installation process only in the “Installation Destination” step. In the “Installation Destination”, specify the ESP, swap and root partition respectively. In the “Installation Destination” step, make sure both disks are selected, and “I will configure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



## Specifying the ESP

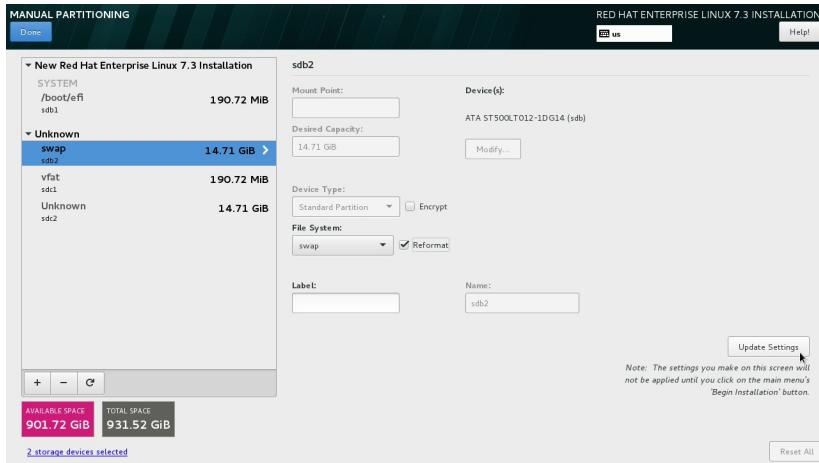
The ESP is the partition that contains the boot loaders used by the UEFI firmware.

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**.



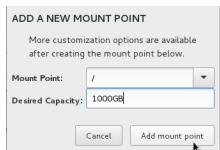
## Specifying the swap directory

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**.

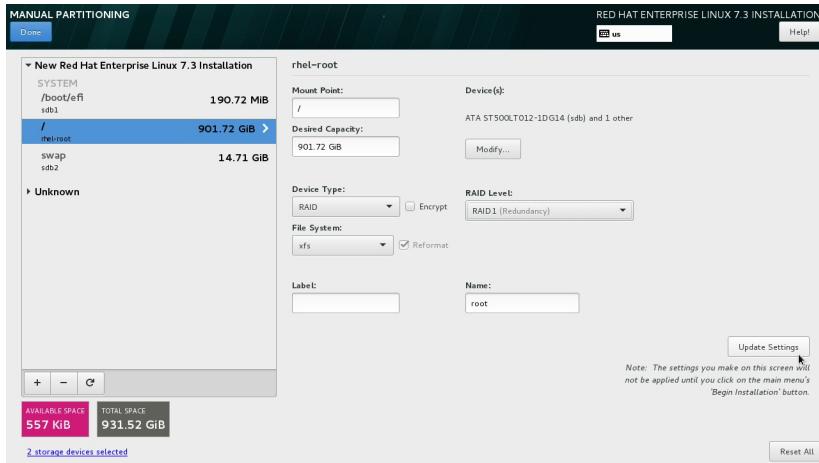


## Create a RAID1 root partition

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`.



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

The system will show a warning message.

This message can be ignored.



## Creating the Redundant ESP

- Log in to Red Hat Enterprise Linux 7.3.
- 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.
- For example output, see the following screenshot.

```
Red Hat Enterprise Linux Server 7.3 (Maipo)
Kernel 3.10.0-514.e17.x86_64 on an x86_64

localhost login: root
Password:
[root@localhost ~]# dd if=/dev/sda1 of=/dev/sdb1
390592+0 records in
390592+0 records out
1999983104 bytes (200 MB) copied, 9.23644 s, 21.7 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.

- 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.

```
[root@localhost ~]# efibootmgr -v
BootCurrent: 0000
Timeout: 9 seconds
BootOrder: 0000,0003,0004,0005,0001
Boot0000* Red Hat Enterprise Linux      HD(1,22,5f5c0,fefb9cb2-333c-4cde-8aa4-3bc2e9cd911f)File(\EFI\REDHAT\SHIM.EFI)
Boot0001* UEFI: Built-in EFI Shell    Vendor(5023b95c-db26-429b-a648-bd47664c0012)..BO
Boot0003* UEFI: SanDisk, Partition 1  ACPI(a0341d0,0)PCI(10,0)USB(3,0)HD(1,000,1d0cfdf,ea5b4ea2-3b33-48ce-bd2f-5dfe1ace042d)..BO
Boot0004* UEFI OS                  HD(1,22,5f5c0,fefb9cb2-333c-4cde-8aa4-3bc2e9cd911f)File(\EFI\BOOT\BOOTX64.EFI)..BO
Boot0005* UEFI OS                  HD(1,22,5f5c0,c515aeef-32bb-4aff-abda-58f8ef365d42)File(\EFI\BOOT\BOOTX64.EFI)..BO
[root@localhost ~]# -
```

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
```

```
[root@localhost ~]# efibootmgr -v
BootCurrent: 0000
Timeout: 9 seconds
BootOrder: 0000,0003,0004,0005,0001
Boot0000* Red Hat Enterprise Linux      HD(1,22,5f5c0,fefb9cb2-333c-4cde-8aa4-3bc2e9cd911f)File(\EFI\REDHAT\SHIM.EFI)
Boot0001* UEFI: Built-in EFI Shell    Vendor(5023b95c-db26-429b-a648-bd47664c0012)..BO
Boot0003* UEFI: SanDisk, Partition 1  ACPI(a0341d0,0)PCI(10,0)USB(3,0)HD(1,000,1d0cfdf,ea5b4ea2-3b33-48ce-bd2f-5dfe1ace042d)..BO
Boot0004* UEFI OS                  HD(1,22,5f5c0,fefb9cb2-333c-4cde-8aa4-3bc2e9cd911f)File(\EFI\BOOT\BOOTX64.EFI)..BO
Boot0005* UEFI OS                  HD(1,22,5f5c0,c515aeef-32bb-4aff-abda-58f8ef365d42)File(\EFI\BOOT\BOOTX64.EFI)..BO
[root@localhost ~]# efibootmgr -c -d /dev/sdb -p 1 -l \\\EFI\\\redhat\\shim.efi -L "Red Hat Enterprise Linux-redundant"
BootCurrent: 0000
Timeout: 9 seconds
BootOrder: 0002,0000,0003,0004,0005,0001
Boot0000* Red Hat Enterprise Linux
Boot0001* UEFI: Built-in EFI Shell
Boot0003* UEFI: SanDisk, Partition 1
Boot0004* UEFI OS
Boot0005* UEFI OS
Boot0002* Red Hat Enterprise Linux-redundant
[root@localhost ~]# efibootmgr -o 0000,0002,0003,0004,0005,0001
BootCurrent: 0000
Timeout: 9 seconds
BootOrder: 0000,0002,0003,0004,0005,0001
Boot0000* Red Hat Enterprise Linux
Boot0001* UEFI: Built-in EFI Shell
Boot0002* Red Hat Enterprise Linux-redundant
Boot0003* UEFI: SanDisk, Partition 1
Boot0004* UEFI OS
Boot0005* UEFI OS
[root@localhost ~]# -
```

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

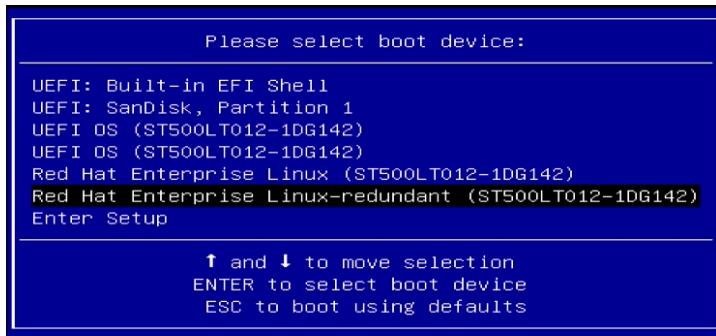
Check the system configuration by typing:

```
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.

```
[root@localhost ~]# mdadm --detail /dev/md/root
/dev/md/root:
      Version : 1.8
      Creation Time : Mon Mar 28 15:36:17 2016
      Raid Level : raid1
      Array Size : 471689152 (449.76 GiB 482.93 GB)
      Used Dev Size : 471689152 (449.76 GiB 482.93 GB)
      Raid Devices : 2
      Total Devices : 1
      Persistence : Superblock is persistent

      Intent Bitmap : Internal

      Update Time : Tue Mar 29 04:49:50 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 : 1410

      Number  Major  Minor  RaidDevice State
          0      8       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**.

- 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 .

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

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

- 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).

- Once the rebuild has completed, State will report as “clean”.

- 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 : 471689152 (449.76 GiB 482.93 GB)
      Used Dev Size : 471689152 (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 : c8ef0caa: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.

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

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

- 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"
```

- 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 -I \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
Boot0006* 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 ~]#
```

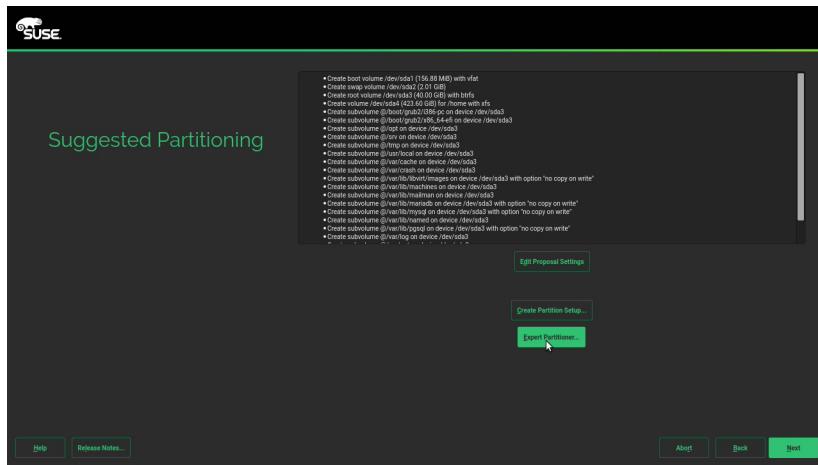
## SuSE Linux Enterprise Server (SLES) 12 SP2

### Installation process

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

### Partitioning drives for SLES

- From the Suggested Partitioning screen, select **Expert Partitioner...**

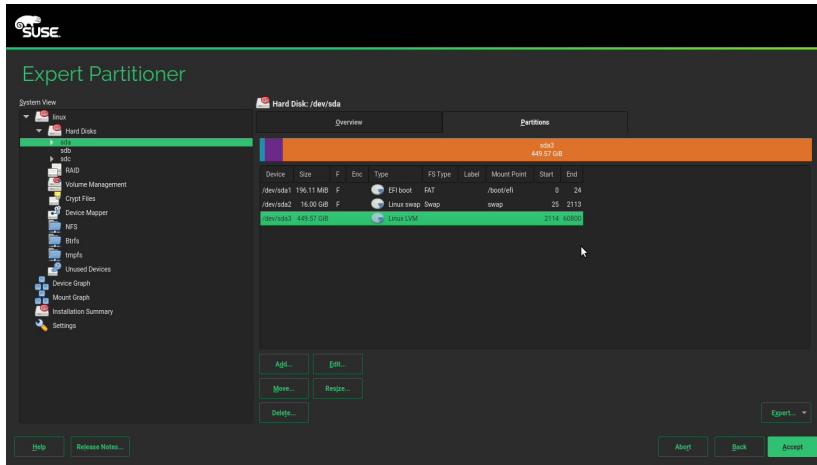


- Delete the Expert Partitioner default partition scheme.
- Partition /dev/sda as follows:

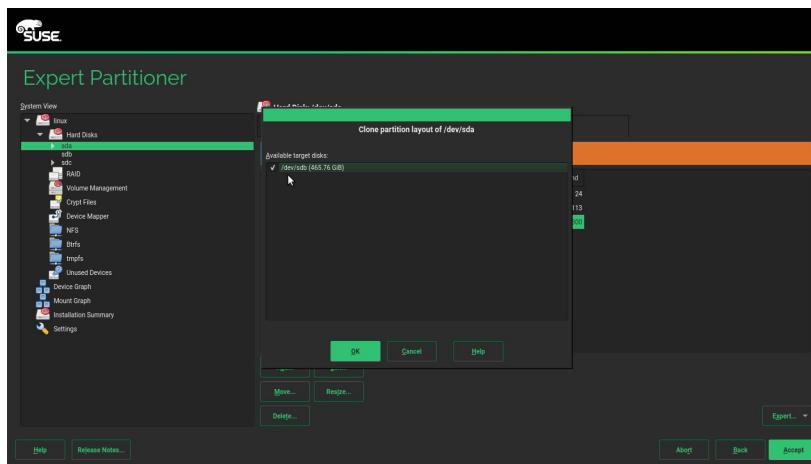
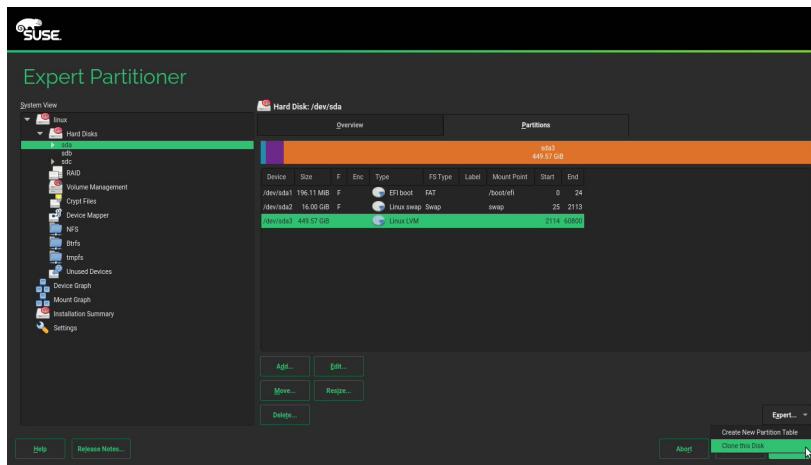
/dev/sda1, size = 200MB, role as “EFI Boot Partition”, mount point = /boot/efi, format as “FAT”

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

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

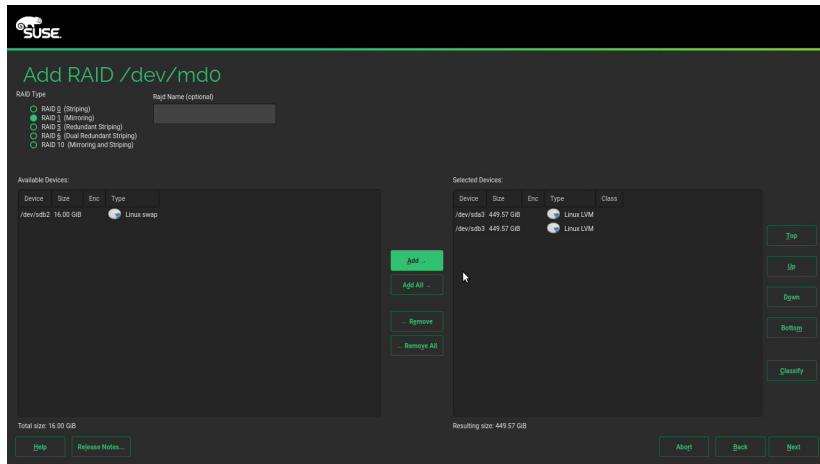


- After successfully partitioning the first disk, use **Expert > Clone this disk...** function to clone the partition scheme to the second disk.

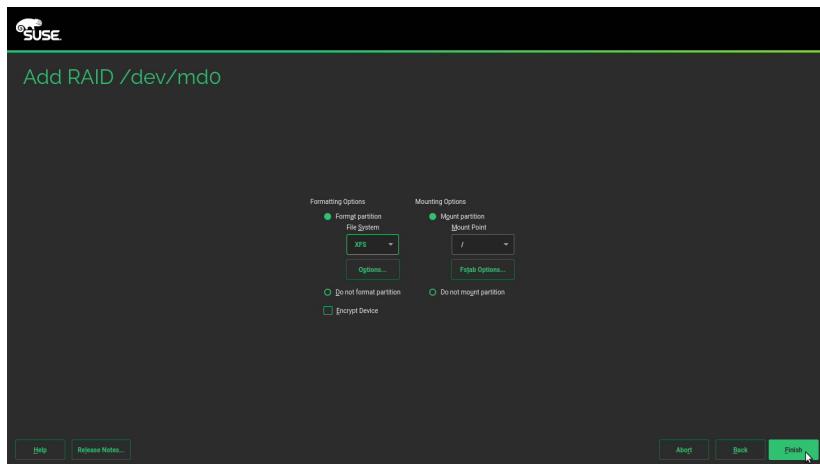


- In the RAID section, create a RAID1 that includes /dev/sda3 and /dev/sdb3:

- a. Click **RAID**.
- b. Choose RAID1 (mirroring).
- c. Select each partition and click **Add** to move them to Selected Devices.

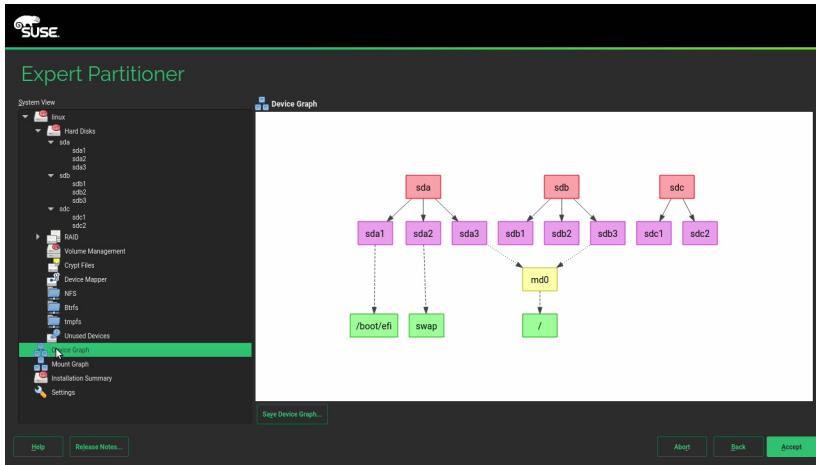


6. Set the following options: 4KB Chunk Size, role as “Operating System”, format as XFS and mount it to “/” (root).

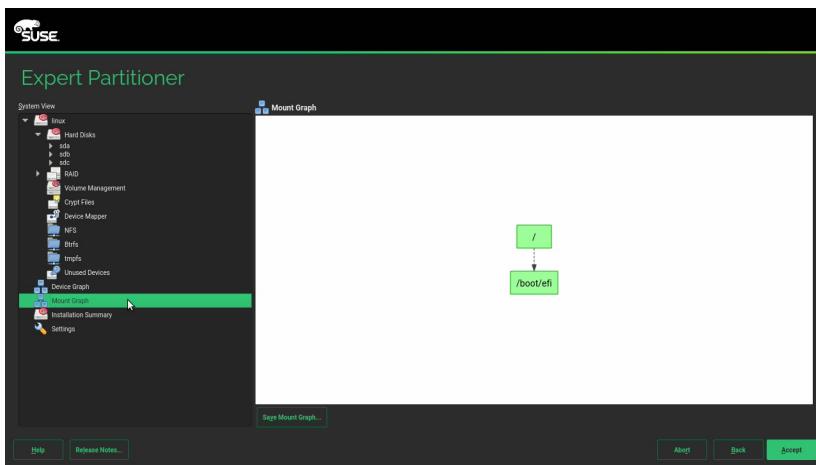


7. Click **Finish**.

Examine the Device Graph. It should match the screenshot.



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



- Proceed to finish the installation

## Creating the Redundant ESP

- Log in to SLES 12SP2 and open a Terminal.
- 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.
- You should see something like below screenshot:

```

root@linux-zhye:~#
File Edit View Search Terminal Help
linux-zhye:~ # dd if=/dev/sdal of=/dev/sdb1
399360+0 records in
399360+0 records out
204472320 bytes (204 MB, 195 MiB) copied, 9.35642 s, 21.9 MB/s
linux-zhye:~ #

```

## 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.

```

root@linux-zhye:~#
File Edit View Search Terminal Help
linux-zhye:~ # efibootmgr -v
BootCurrent: 0000
Timeout: 9 seconds
BootOrder: 0000,0003,0004,0001
Boot0000* sls-secureboot      HD(1,800,61800,6ff97237-175f-488d-a322-540c076e5f2e)File(\EFI\SLES\SHIM.EFI)
Boot0001* UEFI: Built-in EFI Shell    Vendor(5023b95c-db26-429b-a648-bd47664c8012,..)
BO
Boot0003* UEFI: SanDisk, Partition 1   ACPI(a0341d0,0)PCI(10,0)USB(2,0)HD(1,a14,2000,1
90ca130)..BO
Boot0004* UEFI OS      HD(1,800,61800,6ff97237-175f-488d-a322-540c076e5f2e)File(\EFI\B
OOT\BOOTX64.EFI)..BO
linux-zhye:~ #

```

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"
```

```

root@linux-zhye:~#
File Edit View Search Terminal Help
linux-zhye:~ # efibootmgr -c -d /dev/sdb -p 1 -l \\EFI\\sles\\shim.efi -L "sles-secureboot-redundant"
BootCurrent: 0000
Timeout: 9 seconds
BootOrder: 0002,0000,0003,0004,0001
Boot0000* sls-secureboot
Boot0001* UEFI: Built-in EFI Shell
Boot0003* UEFI: SanDisk, Partition 1
Boot0004* UEFI OS
Boot0002* sles-secureboot-redundant
linux-zhye:~ #

```

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.

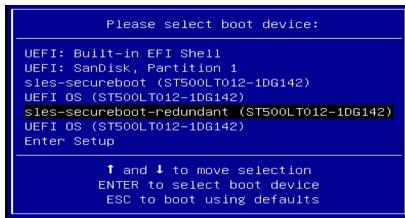
```
efibootmgr -o 0000,0002,0003,0004,0001
```

```

root@linux-zhye:~#
linux-zhye:~ # efibootmgr -c -d /dev/sdb -p 1 -l \\EFI\\sles\\shim.efi -L "sles-secureboot-redundant"
BootCurrent: 0000
Timeout: 9 seconds
BootOrder: 0002,0000,0003,0004,0001
Boot0000* sles-secureboot
Boot0001* UEFI: Built-in EFI Shell
Boot0003* UEFI: SanDisk, Partition 1
Boot0004* UEFI OS
Boot0002* sles-secureboot-redundant
linux-zhye:~ # efibootmgr -o 0000,0002,0003,0004,0001
BootCurrent: 0000
Timeout: 9 seconds
BootOrder: 0000,0002,0003,0004,0001
Boot0000* sles-secureboot
Boot0001* UEFI: Built-in EFI Shell
Boot0002* sles-secureboot-redundant
Boot0003* UEFI: SanDisk, Partition 1
Boot0004* UEFI OS
linux-zhye:~ #

```

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.

```

dracut:## 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 : 1
  Persistence : Superblock is persistent

  Intent Bitmap : Internal

  Update Time : Wed Mar 30 03:57:15 2016
  State : clean, degraded
  Active Devices : 1
  Working Devices : 1
  Failed Devices : 0
  Spare Devices : 0

    Name : any:0
    UUID : 824cc36d:607cf28b:2bbfaf68:a2d81425
    Events : 1692

      Number  Major  Minor  RaidDevice State
          0      8       0        0     removed
          1      8       3        1      active sync   /dev/sda3
dracut:##

```

### 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 `crashkernel=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.

```
/lib/dracut-11b.sh#415(source_a11): 'l' -d //lib/dracut/hooks/emergency '1'
/lib/dracut-11b.sh#416(source_a11): for f in "$_dir"/*.sh
/lib/dracut-11b.sh#416(source_a11): 'l' e //lib/dracut/hooks/emergency/50-plymouth-emergency.sh '1'
/lib/dracut-11b.sh#416(source_a11): //lib/dracut/hooks/emergency/50-plymouth-emergency.sh
///lib/dracut/hooks/emergency/50-plymouth-emergency.sh#4(source): plymouth --hide-splash
///lib/dracut/hooks/emergency/50-plymouth-emergency.sh#4(source): .
/lib/dracut-11b.sh#416(source_a11): for f in "$_dir"/*.sh
/lib/dracut-11b.sh#416(source_a11): for f in //lib/dracut/hooks/emergency/80~~x2fdev\x2fdisk\x2fbu~uid\x2f03d6b659-23cf-423b-b1c6-c6a711aa9cfe.sh '1'
/lib/dracut-11b.sh#416(source_a11): //lib/dracut/hooks/emergency/80~~x2fdev\x2fdisk\x2fbu~uid\x2f03d6b659-23cf-423b-b1c6-c6a711aa9cfe.sh'
///lib/dracut/hooks/emergency/80~~x2fdev\x2fdisk\x2fbu~uid\x2f03d6b659-23cf-423b-b1c6-c6a711aa9cfe '1' -e /dev/disk/by-uuid/03d6b659-23cf-423b-b1c6-c6a711aa9cfe
'1'
/lib/dracut-11b.sh#416(source_a11): for f in "$_dir"/*.sh
/lib/dracut-11b.sh#416(source_a11): 'l' e //lib/dracut/hooks/emergency/80~~x2fdev\x2fdisk\x2fbu~uid\x2f3e880408-a786-49fb-989f-566378fd0766.sh '1'
/lib/dracut-11b.sh#416(source_a11): //lib/dracut/hooks/emergency/80~~x2fdev\x2fdisk\x2fbu~uid\x2f3e880408-a786-49fb-989f-566378fd0766.sh'
///lib/dracut/hooks/emergency/80~~x2fdev\x2fdisk\x2fbu~uid\x2f3e880408-a786-49fb-989f-566378fd0766 '1' -e /dev/disk/by-uuid/3e880408-a786-49fb-989f-566378fd0766
'1'
///lib/dracut/hooks/emergency/80~~x2fdev\x2fdisk\x2fbu~uid\x2f3e880408-a786-49fb-989f-566378fd0766warn '/dev/disk/by-uuid/3e880408-a786-49fb-989f-566378fd0766
does not exist
/lib/dracut-11b.sh#70(warn): echo 'Warning: /dev/disk/by-uuid/3e880408-a786-49fb-989f-566378fd0766 does not exist'
Warning: /dev/disk/by-uuid/3e880408-a786-49fb-989f-566378fd0766 does not exist
/lib/dracut-11b.sh#416(source_a11): for f in "$_dir"/*.sh
/lib/dracut-11b.sh#416(source_a11): 'l' e //lib/dracut/hooks/emergency/80~~x2fdev\x2fdisk\x2fbu~uid\x2f0D6E-1982.sh '1'
/lib/dracut-11b.sh#416(source_a11): //lib/dracut/hooks/emergency/80~~x2fdev\x2fdisk\x2fbu~uid\x2f0D6E-1982.sh
///lib/dracut/hooks/emergency/80~~x2fdev\x2fdisk\x2fbu~uid\x2f0D6E-1982.sh#1(source): 'l' -e /dev/disk/by-uuid/0D6E-1982 '1'
/bin/dracut-emergency@210: getargbool 0 rd.shell -d -g rdshell
/lib/dracut-11b.sh#236(getargbool): local _1
/lib/dracut-11b.sh#237(getargbool): unset _b
/lib/dracut-11b.sh#238(getargbool): local _default
/lib/dracut-11b.sh#239(getargbool): _default=0
/lib/dracut-11b.sh#239(getargbool): shift
/lib/dracut-11b.sh#240(getargbool): getarg rd.shell -d -g rdshell
/lib/dracut-11b.sh#105(getarg): debug off
/lib/dracut-11b.sh#16(debug off): set --
/lib/dracut-11b.sh#210(getarg): return 0
/lib/dracut-11b.sh#240(getargbool): _b
/lib/dracut-11b.sh#241(getargbool): '_' 0 -ne 0 -a -z '' '1'
/lib/dracut-11b.sh#242(getargbool): '_' -n ''
/lib/dracut-11b.sh#247(getargbool): return 0
/bin/dracut-emergency@210: echo
/bin/dracut-emergency@210: rdsosreport
Generating "/run/inittrans/rdsosreport.txt"
/bin/dracut-emergency@210: echo
/bin/dracut-emergency@210: echo

/bin/dracut-emergency@210: echo
/bin/dracut-emergency@210: echo 'Entering emergency mode. Exit the shell to continue.'
Entering emergency mode. Exit the shell to continue.
/bin/dracut-emergency@210: echo 'Type "journalctl" to view system logs.'
Type "journalctl" to view system logs.
/bin/dracut-emergency@210: echo 'You might want to save "/run/inittrans/rdsosreport.txt" to a USB stick or /boot'
You might want to save "/run/inittrans/rdsosreport.txt" to a USB stick or /boot
/bin/dracut-emergency@210: echo 'after mounting them and attach it to a bug report.'
after mounting them and attach it to a bug report.
/bin/dracut-emergency@210: echo
/bin/dracut-emergency@210: echo
/bin/dracut-emergency@210: echo
/bin/dracut-emergency@210: f /etc/profile '1'
/bin/dracut-emergency@210: . /etc/profile
/etc/profile@10: PS1="#$dracut:$PWD#\` ' '1'
/bin/dracut-emergency@210: 'l' -z '$dracut:$PWD#\` ' '1'
/bin/dracut-emergency@210: exec sh -i -
dracut:@
```

## Recovering the failed partition

1. Prepare a new disk portioned as described in [“Partitioning a drive for SLES.”](#)
2. Boot from “sles-secureboot-redundant”.

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 : 471495376 (449.57 GiB 482.72 GB)
      Used Dev Size : 471495376 (449.57 GiB 482.72 GB)
      Raid Devices : 2
      Total Devices : 2
      Persistence : Superblock is persistent

      Intent Bitmap : Internal

      Update Time : Wed Mar 30 05:40:11 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 : 02fc36d:607cf20b:2bbfaf60:a2d81425
                  Events : 1742

      Number  Major  Minor  RaidDevice State
          2      8        3        0     spare rebuilding  /dev/sda3
          1      8        19       1     active sync   /dev/sdb3

```

## 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
```

```
linux-zhye:~ # efibootmgr -c -d /dev/sdc -p 1 -l \\EFI\\sles\\shim.efi -L "sles-secureboot-redundant2"
BootCurrent: 0000
Timeout: 9 seconds
BootOrder: 0000,0002,0004,0005,0001
Boot0001* UEFI: Built-in EFI Shell
Boot0002* sles-secureboot-redundant
Boot0004* UEFI OS
Boot0005* UEFI OS
Boot0006* sles-secureboot-redundant2
linux-zhye:~ # efibootmgr -o 0002,0000,0004,0005,0001
BootCurrent: 0000
Timeout: 9 seconds
BootOrder: 0002,0000,0004,0005,0001
Boot0000* sles-secureboot-redundant2
Boot0001* UEFI: Built-in EFI Shell
Boot0002* sles-secureboot-redundant
Boot0004* UEFI OS
Boot0005* UEFI OS
linux-zhye:~ #
```

## 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:

```
Starting installer, one moment...
anaconda 21.48.22.93-1 for Red Hat Enterprise Linux 7.3 started.
* installation log files are stored in /tmp during the installation
* shell is available on TTY2
* if the graphical installation interface fails to start, try again with the
  inst.text bootoption to start text installation
* when reporting a bug add logs from /tmp as separate text/plain attachments
=====
=====
Rescue

The rescue environment will now attempt to find your Linux installation and
mount it under the directory : /mnt/sysimage. You can then make any changes
required to your system. Choose '1' to proceed with this step.
You can choose to mount your file systems read-only instead of read-write by
choosing '2'.
If for some reason this process does not work choose '3' to skip directly to a
shell.

1) Continue
2) Read-only mount
3) Skip to shell
4) Quit (Reboot)

Please make a selection from the above: 1
=====
=====
Rescue Mount

You don't have any Linux partitions. The system will reboot automatically when
you exit from the shell.
Please press <return> to get a shell.
When finished, please exit from the shell and your system will reboot.
sh-4.2# _
```

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.

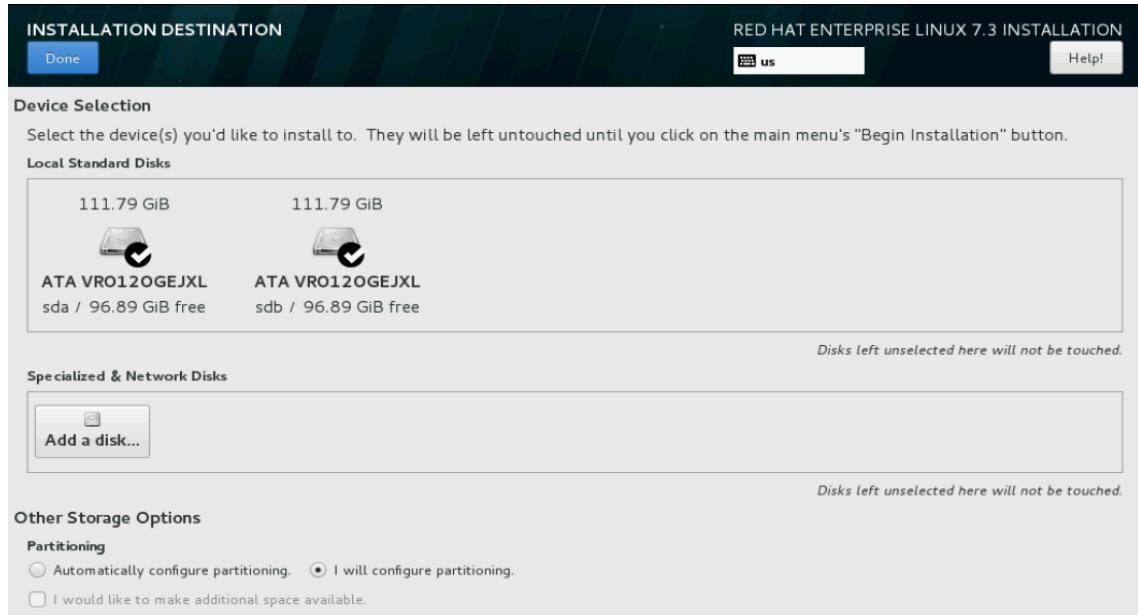
```
[anaconda root@localhost ~]# parted /dev/sdb print
Model: ATA VR0120GEJXL (scsi)
Disk /dev/sdb: 120GB
Sector size (logical/physical): 512B/4096B
Partition Table: gpt
Disk Flags:

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

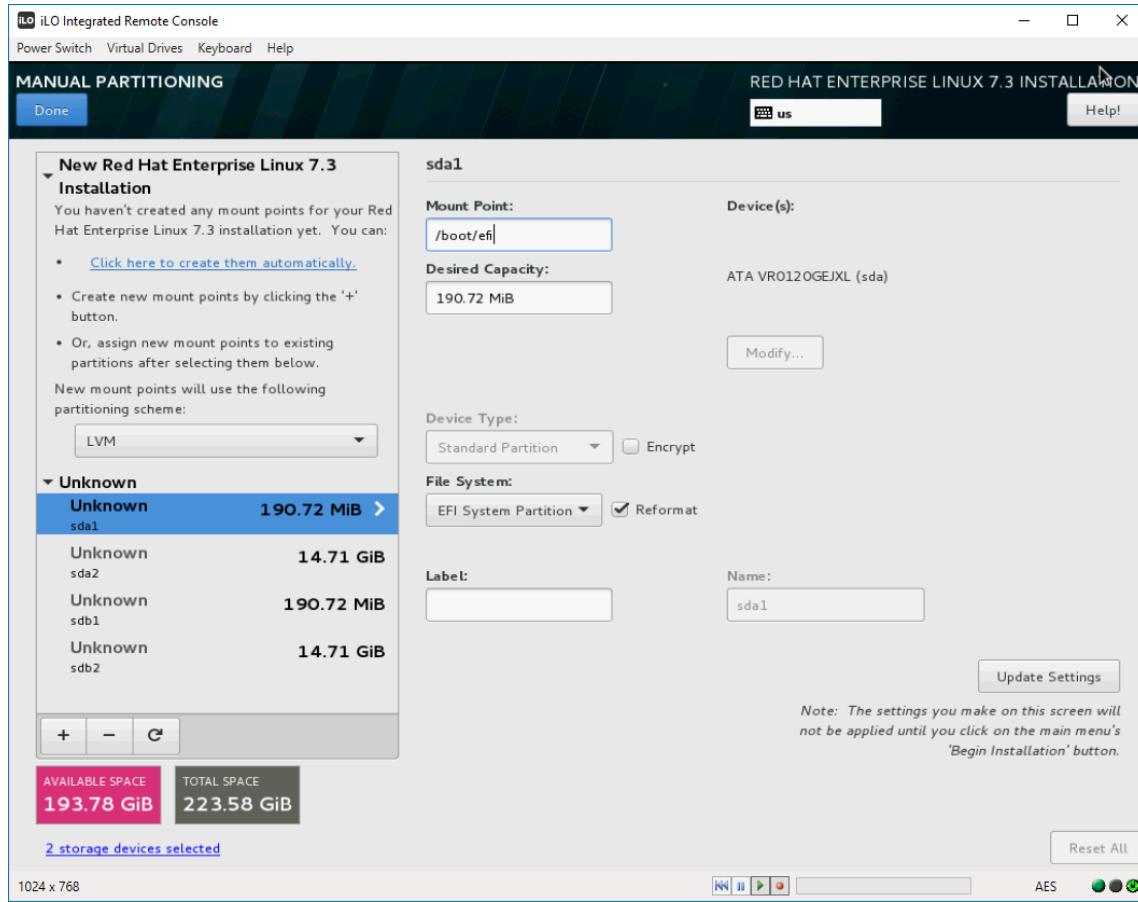
The software RAID installation differs from the normal installation process only in the “Installation Destination” step. In the “Installation Destination”, specify the ESP, swap and root partition respectively. In the “Installation Destination” step, make sure both disks are selected, and “I will configure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



## Specifying the ESP

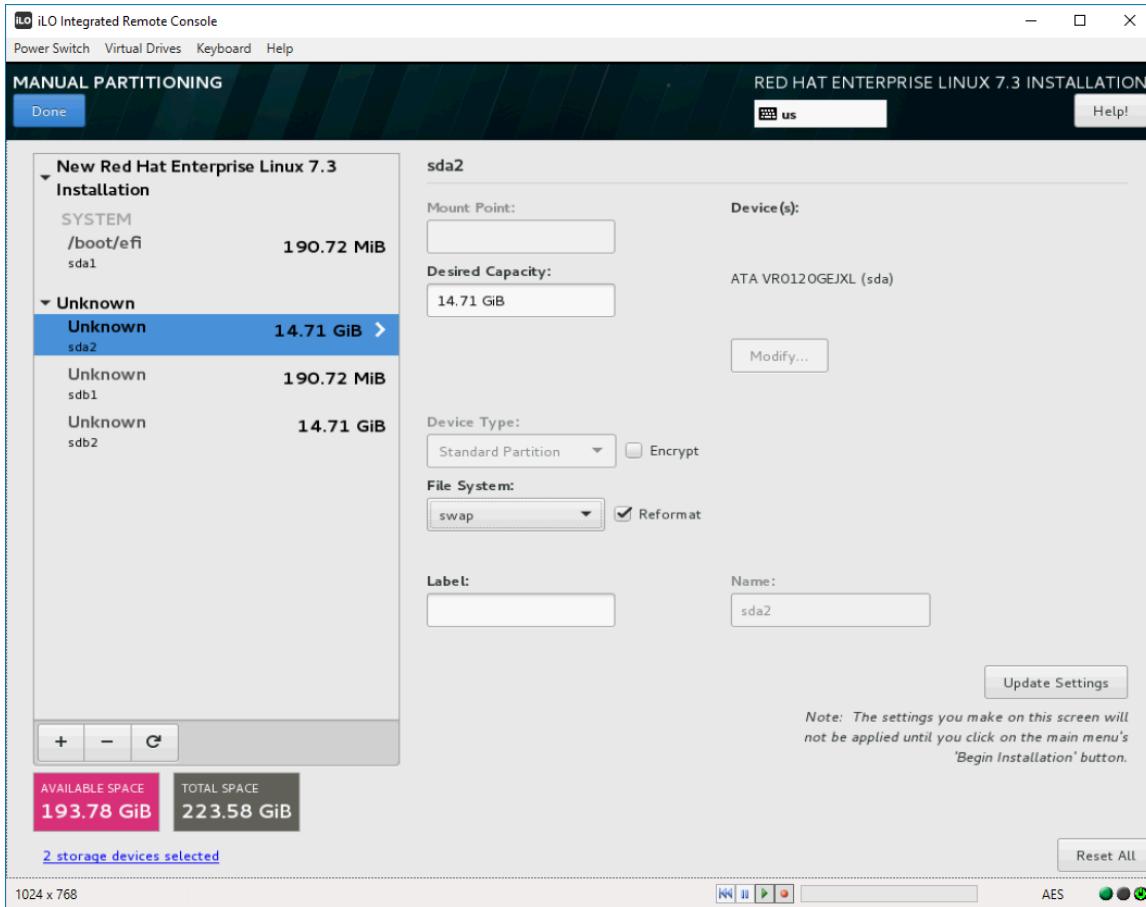
The ESP is the partition that contains the boot loaders used by the UEFI firmware.

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**.

**ADD A NEW MOUNT POINT**

More customization options are available after creating the mount point below.

Mount Point:	/
Desired Capacity:	1000GB

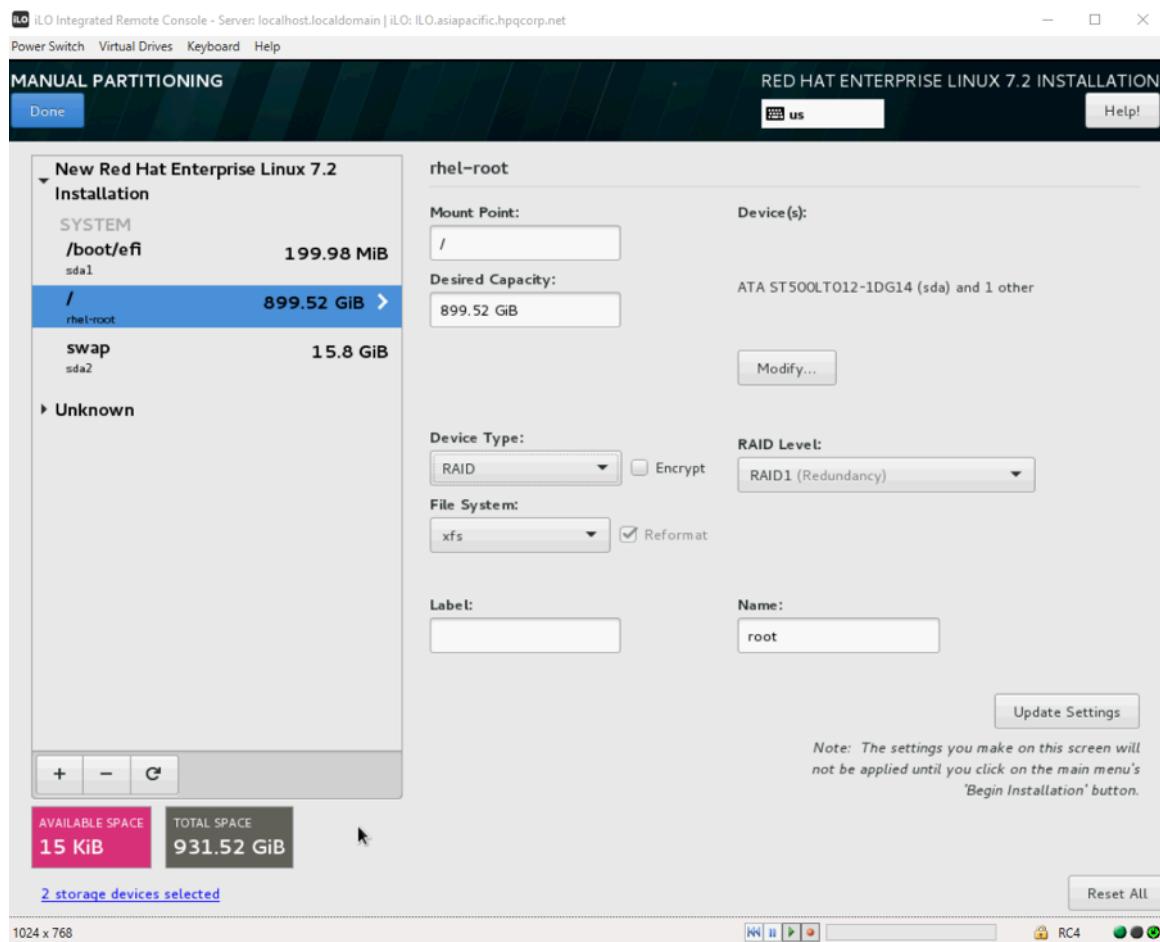
**Cancel** **Add mount point**

## 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.

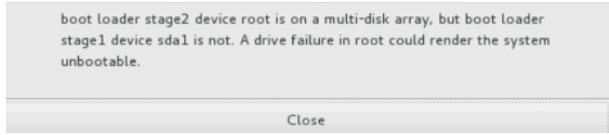
The system will create a new md device in `/dev/md/root`.



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.

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

localhost login: root
Password:
Last login: Mon Jan  2 22:57:01 on tty1
[root@localhost ~]# dd if=/dev/sda1 of=/dev/sdb1

390592+0 records in
390592+0 records out
199983104 bytes (200 MB) copied, 4.07844 s, 49.0 MB/s
[root@localhost ~]#
[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 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,0016,0018,0  
017,0002,0003,0004,0005,0006,0007,0008,0009,0013
```

```
[root@localhost ~]# efibootmgr -c -d /dev/sdb -p 1 -I NNEFIN\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,0016,0018,0017,0002,0003,0004,0005,0006,0007,0008,0009,0013
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)
Boot000* 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,0016,0018,0017,0002,0003,0004,0005,0006,0007,0008,0009,0013
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:

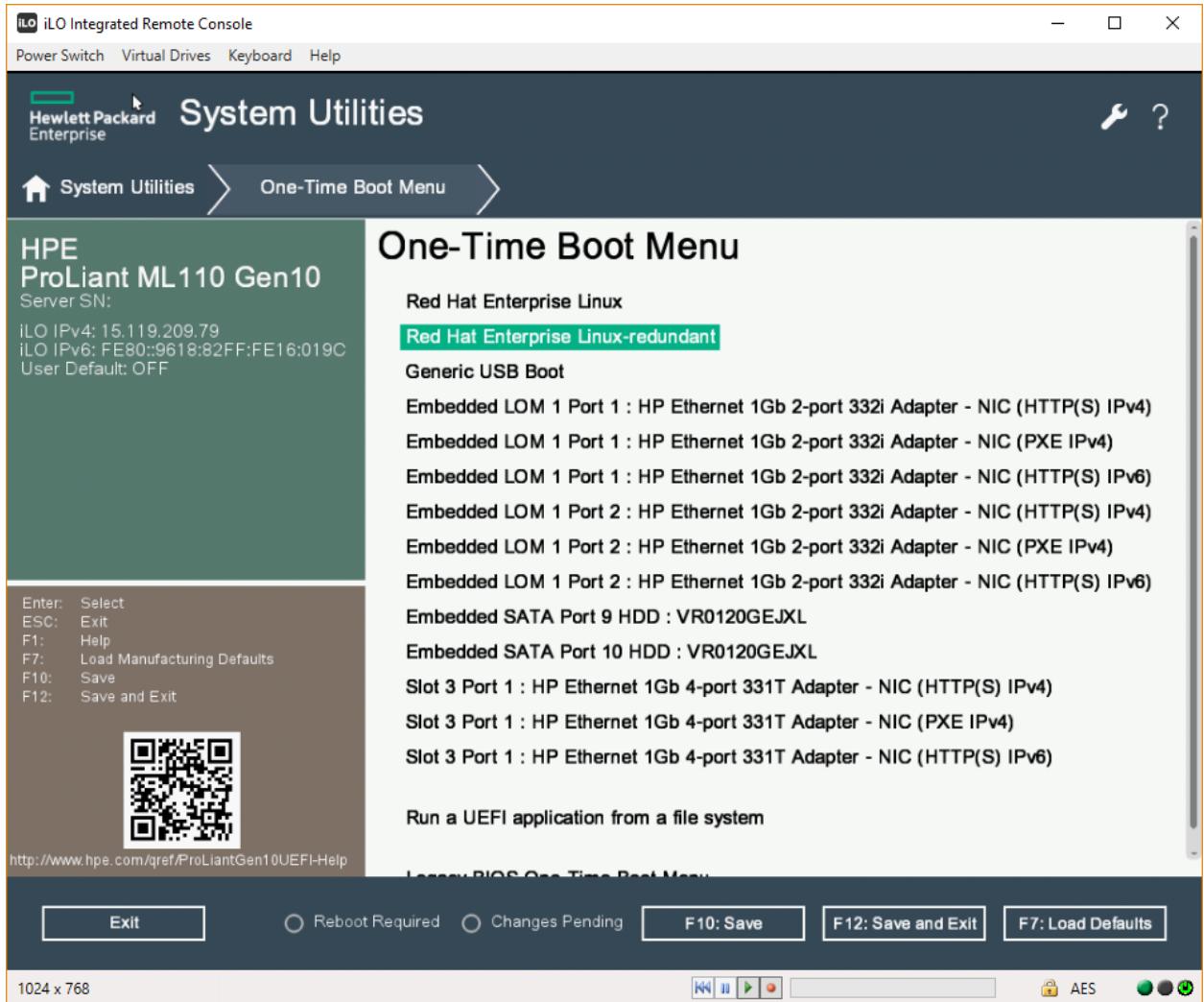
`efibootmgr -v`

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.

```

[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 : 471689152 (449.76 GiB 482.93 GB)
  Used Dev Size : 471689152 (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 : c8ef8caa:8d8af3b4:624ed707:d013b8d1
    Events : 1440

      Number  Major  Minor  RaidDevice State
        0      8       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/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.

```

[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 : 471689152 (449.76 GiB 482.93 GB)
  Used Dev Size : 471689152 (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 : c8ef8caa:8d8af3b4:624ed707:d013b8d1
    Events : 1542

      Number  Major  Minor  RaidDevice State
        0      8       0       0     active sync  /dev/sda3
        1      8       3       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/sdb1 back to /dev/sda1, enter the following command.

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

- 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

```

[root@localhost ~]# efibootmgr -c -d /dev/sda -p 1 -I \EFI\redhat\shim.efi -L rhel-redundant2
BootCurrent: 0012
Timeout: 0 seconds
BootOrder: 0011,0012,0002,0000,0003,0004,0005,0006,0007,0008,0009,000A,000B,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 LOM 1 Port 1 : HP Ethernet 1Gb Z-port 361i Adapter - NIC (PXE IPo6)
Boot000A* Embedded LOM 1 Port 1 : HP Ethernet 1Gb Z-port 361i Adapter - NIC (PXE IPo4)
Boot000B* Embedded SATA Port 2 HDD : ST500LT012-1DG14Z
Boot000C* Embedded SATA Port 1 HDD : ST500LT012-1DG14Z
Boot000D* iLO Virtual USB 2 : HPE iLO Virtual USB CD/DVD ROM
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* rhel-redundant
Boot0012* rhel-redundant2
[root@localhost ~]# efibootmgr -o 0012,0011,0002,0000,0003,0004,0005,0006,0007,0008,0009,000C,000B
BootCurrent: 0012
Timeout: 0 seconds
BootOrder: 0012,0011,0002,0000,0003,0004,0005,0006,0007,0008,0009,000C,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 LOM 1 Port 1 : HP Ethernet 1Gb Z-port 361i Adapter - NIC (PXE IPo6)
Boot000A* Embedded LOM 1 Port 1 : HP Ethernet 1Gb Z-port 361i Adapter - NIC (PXE IPo4)
Boot000B* Embedded SATA Port 2 HDD : ST500LT012-1DG14Z
Boot000C* Embedded SATA Port 1 HDD : ST500LT012-1DG14Z
Boot000D* iLO Virtual USB 2 : HPE iLO Virtual USB CD/DVD ROM
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* rhel-redundant
Boot0012* rhel-redundant2
[root@localhost ~]#

```

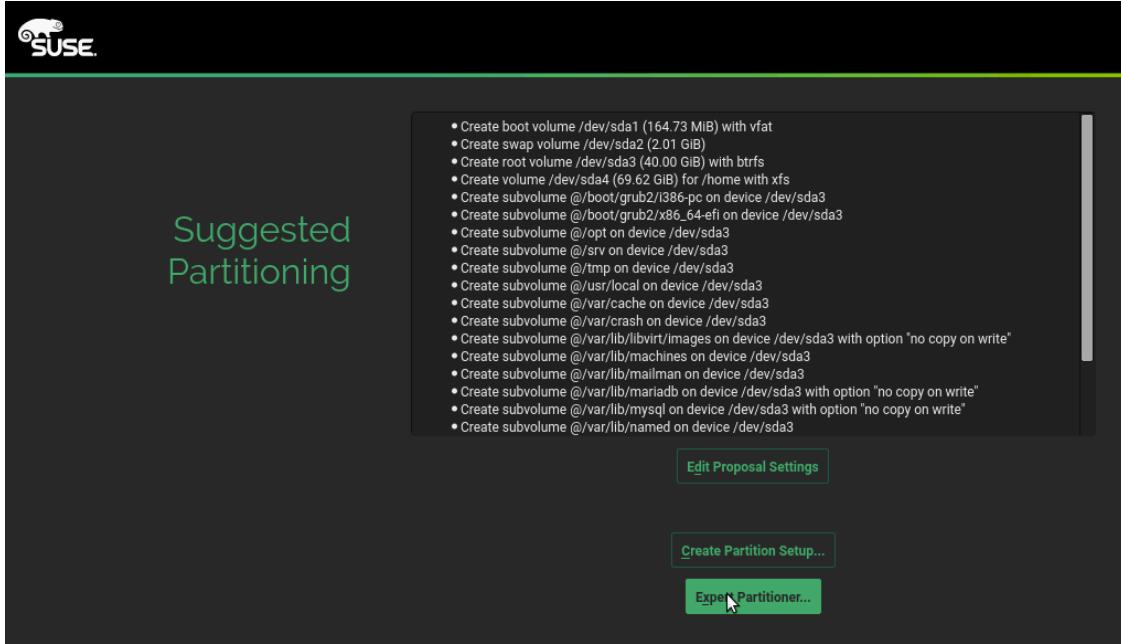
## SuSE Linux Enterprise Server (SLES) 12 SP2

### Installation process

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

### Partitioning drives for SLES

- From the Suggested Partitioning screen, select **Expert Partitioner...**

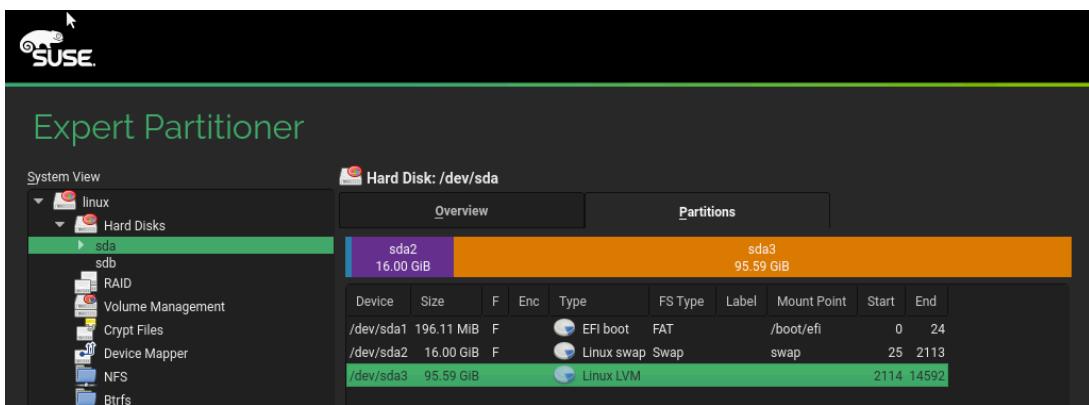


2. Delete the Expert Partitioner default partition scheme.
3. Partition /dev/sda as follows:

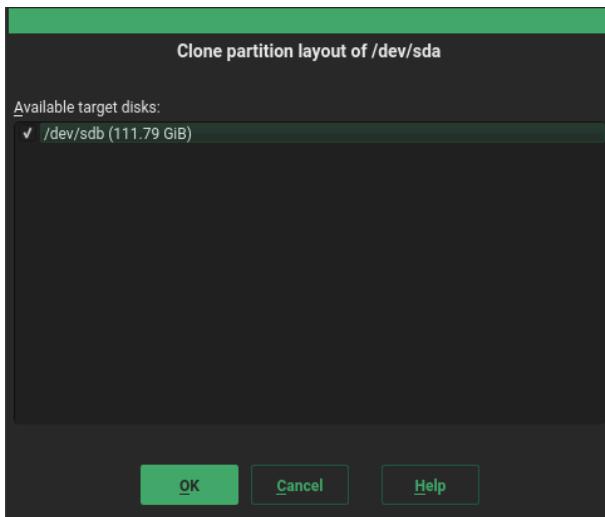
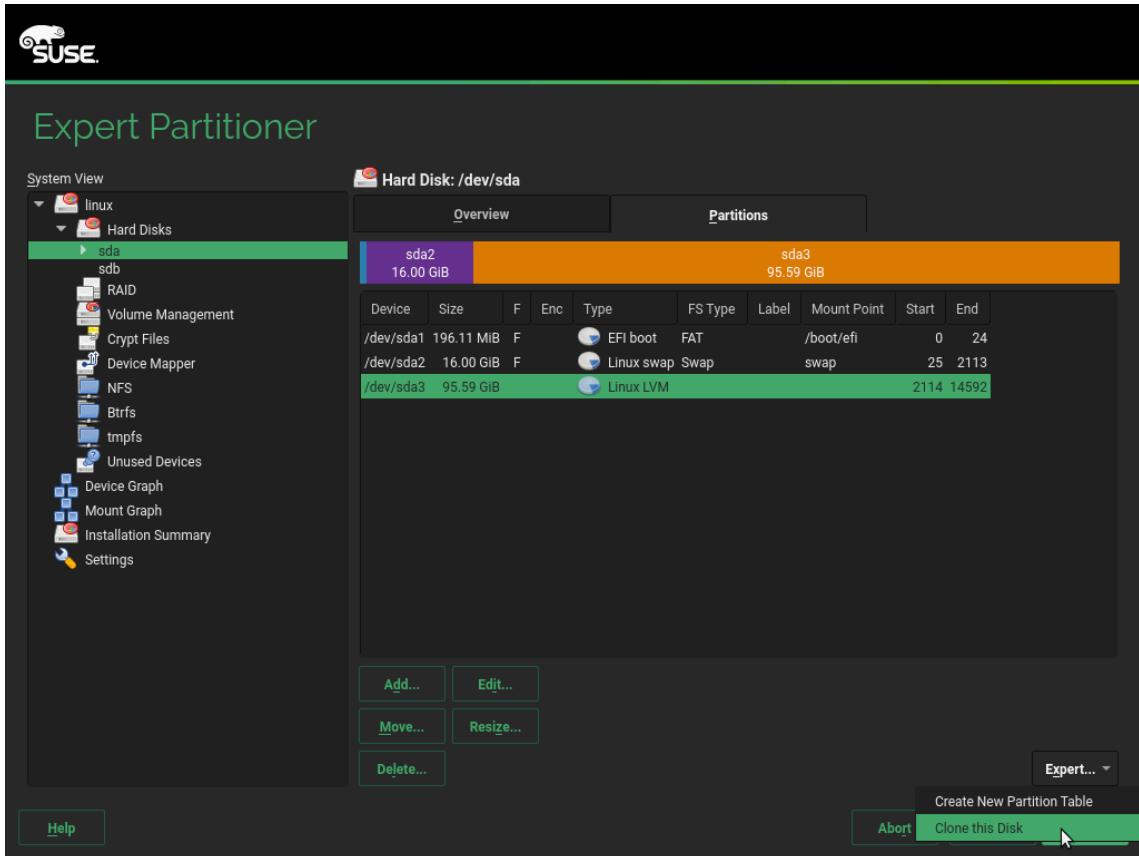
/dev/sda1, size = 200MB, role as “EFI Boot Partition”, mount point = /boot/efi, format as “FAT”

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

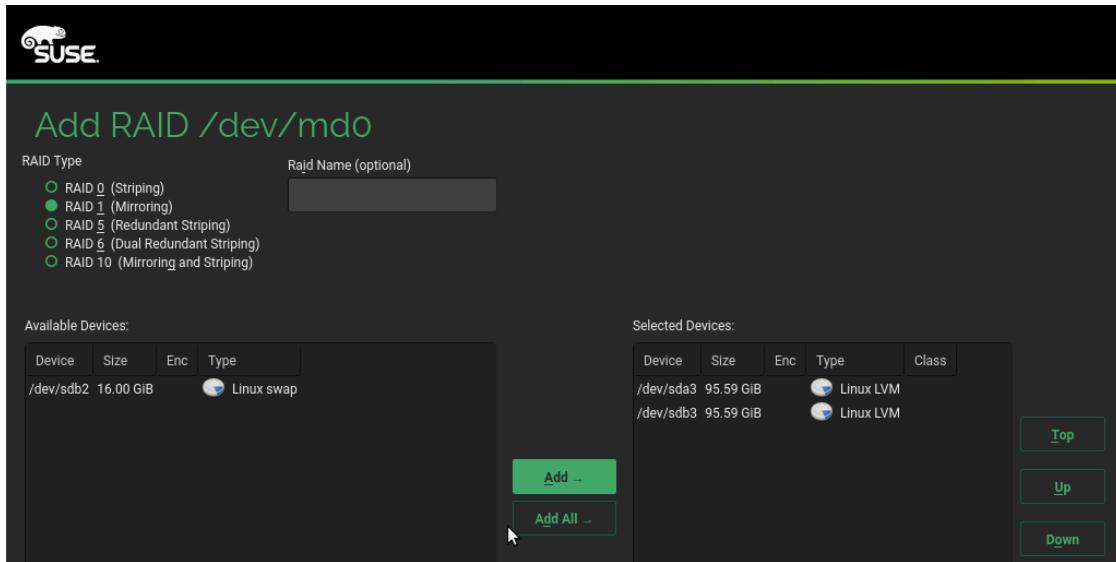
/dev/sda3, size = Maximum Size (rest of the disk space), role as “Raw Volume”.



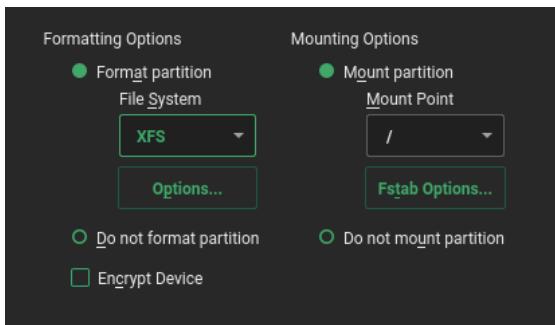
4. After successfully partitioning the first disk, use **Expert > Clone this disk...** function to clone the partition scheme to the second disk.



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.

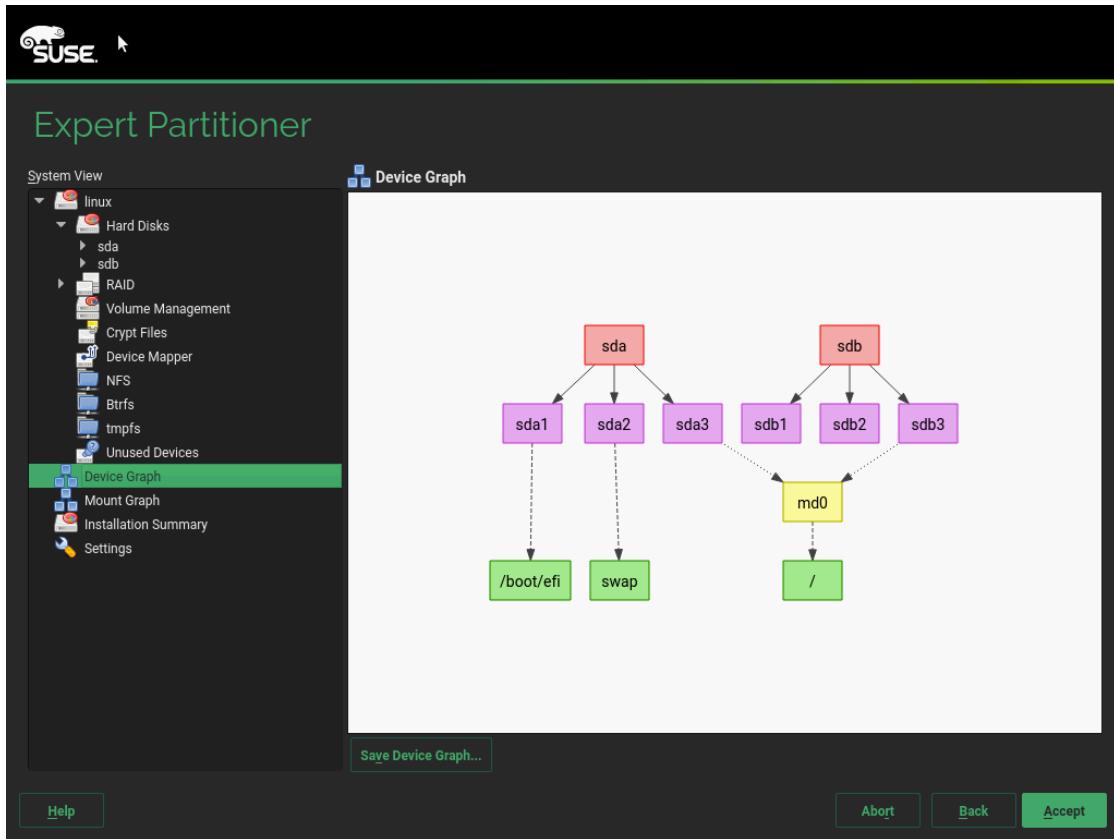


- Set the following options: 4KB Chunk Size, role as “Operating System”, format as XFS and mount it to “/” (root).

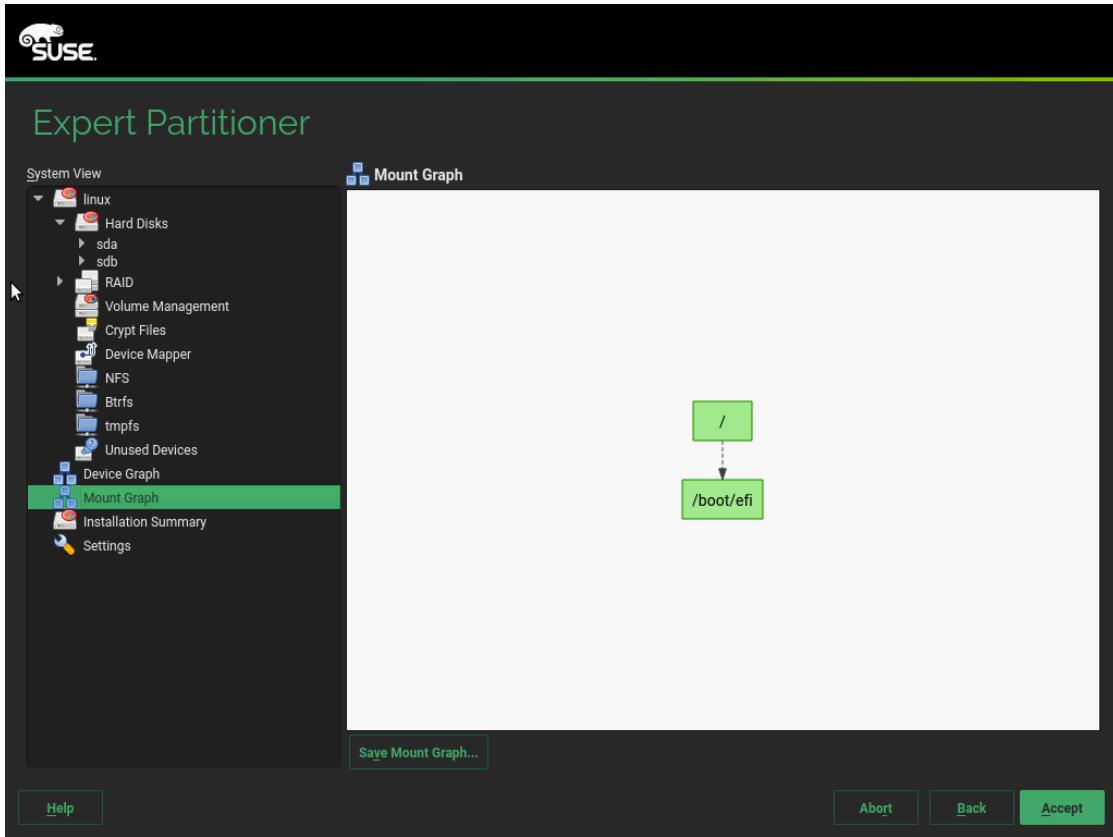


- Click **Finish**.

Examine the Device Graph. It should match the screenshot.



- 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"
```

```
linux-kymm:~ # efibootmgr -c -d /dev/sdb -p 1 -l \\EFI\\sles\\shim.efi -L "sles-secureboot-redundant"
BootCurrent: 0014
Timeout: 20 seconds
BootOrder: 0015,0014,0000,000A,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:~ #
```

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.

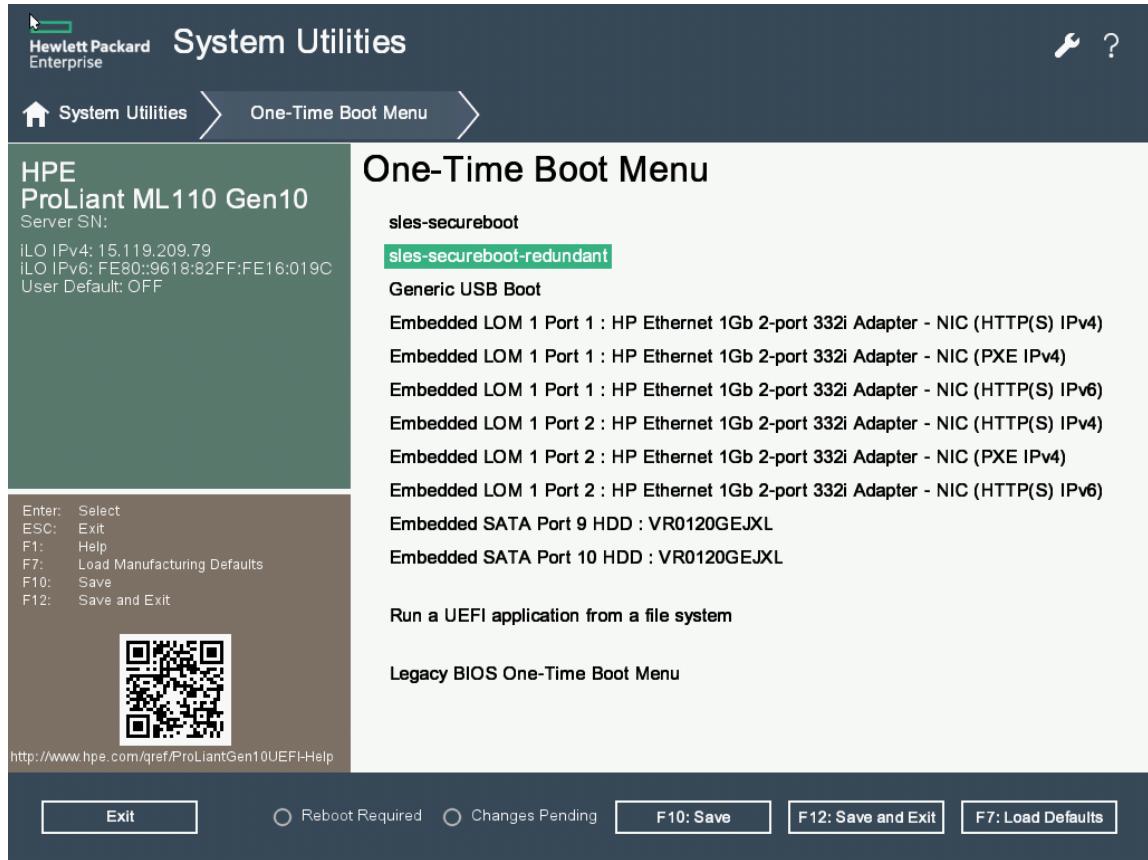
```
efibootmgr -o  
0014,0015,0000,000A,000D,000F,000E,0010,0012,0011,000B,000C,0001,0002,0003,0004,0005,0006,0007,0008,0009
```

```
linux-kymm:~ # efibootmgr -o 0014,0015,0000,000A,000D,000F,000E,0010,0012,0011,000B,000C,0001,0002,0003,0004,0005,0006,0007,0008,0009  
BootCurrent: 0014  
Timeout: 20 seconds  
BootOrder: 0014,0015,0000,000A,000D,000F,000E,0010,0012,0011,000B,000C,0001,0002,0003,0004,0005,0006,0007,0008,0009  
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* 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.

```

dracut:~# 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 : 1
  Persistence : Superblock is persistent

  Intent Bitmap : Internal

  Update Time : Wed Mar 30 03:57:15 2016
    State : clean, degraded
  Active Devices : 1
  Working Devices : 1
  Failed Devices : 0
  Spare Devices : 0

    Name : any:0
    UUID : 824cc36d:607cf28b:2bbfaf68:a2d81425
    Events : 1692

      Number  Major  Minor  RaidDevice State
         0       8       3          0     removed
         1       8       3          1     active sync   /dev/sda3
dracut:~#

```

### 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 `crashkernel=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.

```

/lib/dracut-lib.sh#415(source_all): '[' -d //lib/dracut/hooks/emergency ']'
/lib/dracut-lib.sh#416(source_all): for f in "$_dir"/*.sh
//lib/dracut-lib.sh#416(source_all): '[' -e //lib/dracut/hooks/emergency/50-plymouth-emergency.sh ']'
/lib/dracut-lib.sh#416(source_all): . //lib/dracut/hooks/emergency/50-plymouth-emergency.sh
///lib/dracut/hooks/emergency/50-plymouth-emergency.sh#4(source): plymouth --hide-splash
///lib/dracut/hooks/emergency/50-plymouth-emergency.sh#4(source):
/lib/dracut-lib.sh#416(source_all): for f in "$_dir"/*.sh
//lib/dracut-lib.sh#416(source_all): '[' -e //lib/dracut/hooks/emergency/80->x2fdev<2fdisk<x2fbu-uid<x2f03d60659-23cf-423b-b1c6-c6a71aa9cfe.sh' ']'
/lib/dracut-lib.sh#416(source_all): . //lib/dracut/hooks/emergency/80->x2fdev<2fdisk<x2fbu-uid<x2f03d60659-23cf-423b-b1c6-c6a71aa9cfe.sh'
///lib/dracut/hooks/emergency/80->x2fdev<2fdisk<x2fbu-uid<x2f03d60659-23cf-423b-b1c6-c6a71aa9cfe '[' -e /dev/disk/by-uid/03d60659-23cf-423b-b1c6-c6a71aa9cfe
']'
///lib/dracut/hooks/emergency/80->x2fdev<2fdisk<x2fbu-uid<x2f3e880408-a786-49fb-989f-566378f0766
does not exist
//lib/dracut-lib.sh#70(warn): echo 'Warning: /dev/disk/by-uid/3e880408-a786-49fb-989f-566378f0766 does not exist'
warning: /dev/disk/by-uid/3e880408-a786-49fb-989f-566378f0766 does not exist
//lib/dracut-lib.sh#416(source_all): for f in "$_dir"/*.sh
//lib/dracut-lib.sh#416(source_all): '[' -e //lib/dracut/hooks/emergency/80->x2fdev<2fdisk<x2fbu-uid<x2f3e880408-a786-49fb-989f-566378f0766.sh' ']'
//lib/dracut-lib.sh#416(source_all): . //lib/dracut/hooks/emergency/80->x2fdev<2fdisk<x2fbu-uid<x2f3e880408-a786-49fb-989f-566378f0766.sh'
///lib/dracut/hooks/emergency/80->x2fdev<2fdisk<x2fbu-uid<x2f3e880408-a786-49fb-989f-566378f0766 '[' -e /dev/disk/by-uid/3e880408-a786-49fb-989f-566378f0766
']'
//lib/dracut/hooks/emergency/80->x2fdev<2fdisk<x2fbu-uid<x2f3e880408-a786-49fb-989f-566378f0766warn '/dev/disk/by-uid/3e880408-a786-49fb-989f-566378f0766
/bin/dracut-emergency@Z0: echo
/bin/dracut-emergency@Z0(warn): echo 'Warning: /dev/disk/by-uid/3e880408-a786-49fb-989f-566378f0766 does not exist'
warning: /dev/disk/by-uid/3e880408-a786-49fb-989f-566378f0766 does not exist
//lib/dracut-lib.sh#416(source_all): for f in "$_dir"/*.sh
//lib/dracut-lib.sh#416(source_all): '[' -e //lib/dracut/hooks/emergency/80->x2fdev<2fdisk<x2fbu-uid<x2f806E-1882.sh' ']'
//lib/dracut-lib.sh#416(source_all): . //lib/dracut/hooks/emergency/80->x2fdev<2fdisk<x2fbu-uid<x2f806E-1882.sh'
///lib/dracut/hooks/emergency/80->x2fdev<2fdisk<x2fbu-uid<x2f806E-1882.sh@1(source): '[' -e /dev/disk/by-uid/806E-1882 '
/bin/dracut-emergency@Z0: getargbo1 rd.shell -d -g rdshe
//lib/dracut-lib.sh#236(getargbo1): local _b
//lib/dracut-lib.sh#237(getargbo1): unset _b
//lib/dracut-lib.sh#238(getargbo1): local _default
//lib/dracut-lib.sh#239(getargbo1): _default=0
//lib/dracut-lib.sh#240(getargbo1): shift
//lib/dracut-lib.sh#240(getargbo1): getarg rd.shell -d -g rdshe
//lib/dracut-lib.sh#241(getargbo1): debug off
//lib/dracut-lib.sh#242(getargbo1): set *
//lib/dracut-lib.sh#243(getargbo1): return 0
//lib/dracut-lib.sh#240(getargbo1):
//lib/dracut-lib.sh#241(getargbo1): '[' 0 -ne 0 -a -z '' ]'
//lib/dracut-lib.sh#242(getargbo1): '[' -n '' ]'
//lib/dracut-lib.sh#247(getargbo1): return 0
//bin/dracut-emergency@Z0: echo

/bin/dracut-emergency@Z0: rdsosreport
Generating "/run/initramfs/rdsosreport.txt"
/bin/dracut-emergency@Z0: echo

/bin/dracut-emergency@Z0: echo

```

## 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 : 471495376 (449.57 GiB 482.72 GB)
      Used Dev Size : 471495376 (449.57 GiB 482.72 GB)
      Raid Devices : 2
      Total Devices : 2
      Persistence : Superblock is persistent

      Intent Bitmap : Internal

      Update Time : Wed Mar 30 05:40:11 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 : 02fc36d:607cf20b:2bbfaf60:a2d81425
                  Events : 1742

      Number  Major  Minor  RaidDevice State
          2      8       3        0     spare rebuilding  /dev/sda3
          1      8       19       1     active sync   /dev/sdb3

```

## 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)
Boot0009* Embedded LOM 1 Port 1 : HP Ethernet 1Gb 2-port 361i Adapter - NIC (PXE IPv4)
Boot000A* ILO Virtual USB Z : 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 Z : HPE iLO Virtual USB CD/DVD ROM
Boot000F* ILO Virtual USB Z : HPE iLO Virtual USB CD/DVD ROM
Boot0010* ILO Virtual USB Z : HPE iLO Virtual USB CD/DVD ROM
Boot0012* sles-secureboot2

```

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
```

```
Linux-9xde:~ # efibootmgr -c -d /dev/sda -p 1 -1 --efiINs1es\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
Boot0001 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 36i Adapter - NIC (PXE IPv6)
Boot0009+ Embedded LOM 1 Port 1 : HP Ethernet 1Gb 2-port 36i Adapter - NIC (PXE IPv4)
Boot000B+ ILO Virtual USB 2 : HPE iLO Virtual USB CD/DVD ROM
Boot000C+ Embedded SATA Port 1 HDD : ST500LT012-1DG14Z
Boot000D+ Embedded SATA Port 2 HDD : ST500LT012-1DG14Z
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
Boot0008 Generic USB Boot
Boot0009+ Embedded LOM 1 Port 1 : HP Ethernet 1Gb 2-port 36i Adapter - NIC (PXE IPv6)
Boot0009+ Embedded LOM 1 Port 1 : HP Ethernet 1Gb 2-port 36i Adapter - NIC (PXE IPv4)
Boot000B+ ILO Virtual USB 2 : HPE iLO Virtual USB CD/DVD ROM
Boot000C+ Embedded SATA Port 1 HDD : ST500LT012-1DG14Z
Boot000D+ Embedded SATA Port 2 HDD : ST500LT012-1DG14Z
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:~ # -
```

# 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:

```
Starting installer, one moment...
anaconda 21.48.22.93-1 for Red Hat Enterprise Linux 7.3 started.
* installation log files are stored in /tmp during the installation
* shell is available on TTY2
* if the graphical installation interface fails to start, try again with the
  inst.text bootoption to start text installation
* when reporting a bug add logs from /tmp as separate text/plain attachments
=====
=====
Rescue

The rescue environment will now attempt to find your Linux installation and
mount it under the directory : /mnt/sysimage. You can then make any changes
required to your system. Choose '1' to proceed with this step.
You can choose to mount your file systems read-only instead of read-write by
choosing '2'.
If for some reason this process does not work choose '3' to skip directly to a
shell.

1) Continue
2) Read-only mount
3) Skip to shell
4) Quit (Reboot)

Please make a selection from the above: 1
=====
=====
Rescue Mount

You don't have any Linux partitions. The system will reboot automatically when
you exit from the shell.
Please press <return> to get a shell.
When finished, please exit from the shell and your system will reboot.
sh-4.2#
```

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:

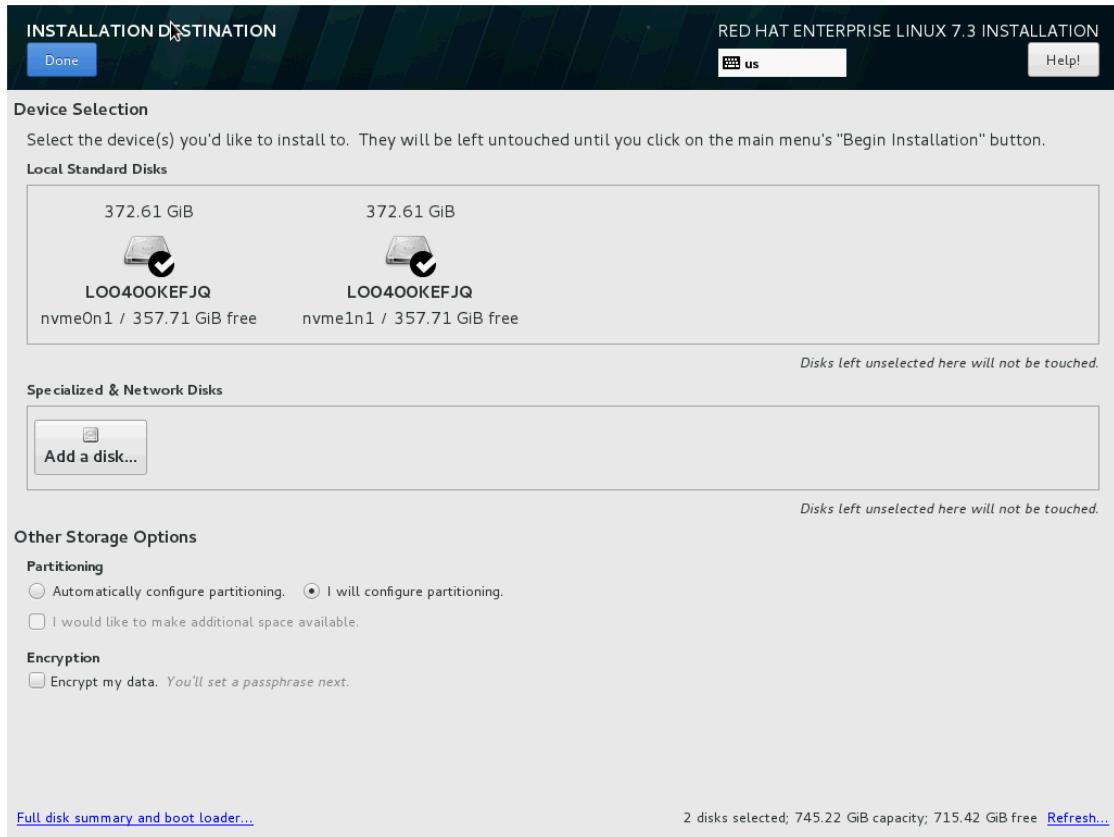
Number  Start   End     Size    File system  Name     Flags
 1      17.4kB  200MB   200MB   primary
 2      200MB   16.0GB   15.8GB  primary

sh-4.2#
```

9. Reboot to proceed with Red Hat installation.

### Normal Installation Process

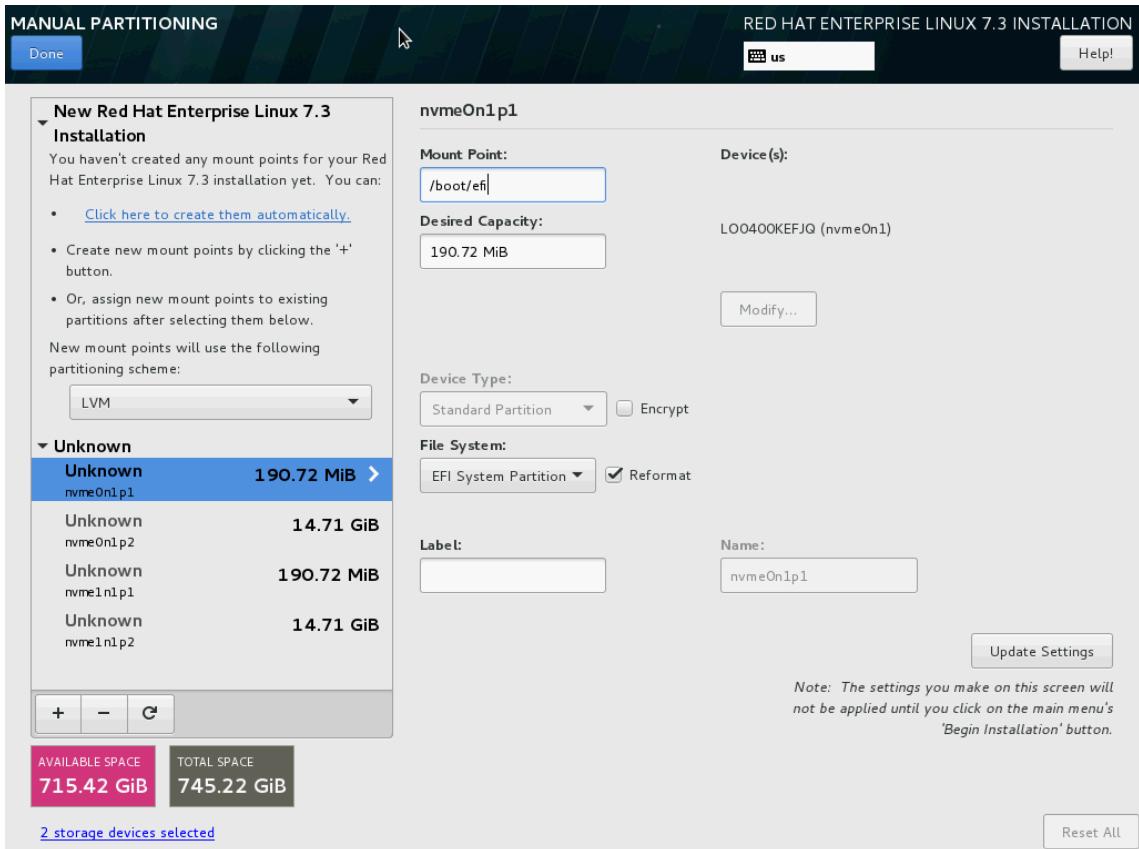
The software RAID installation differs from the normal installation process only in the “Installation Destination” step. In the “Installation Destination”, specify the ESP, swap and root partition respectively. In the “Installation Destination” step, make sure both disks are selected, and “I will configure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



## Specifying the ESP

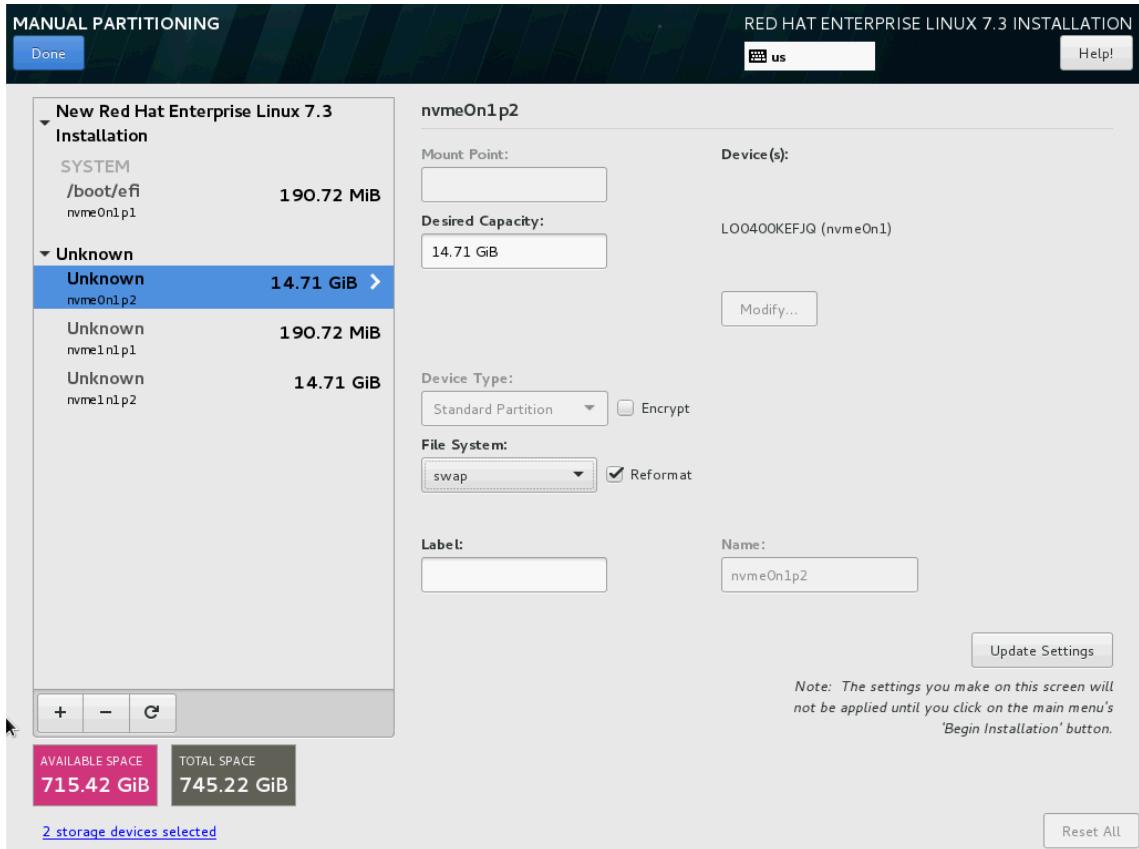
The ESP is the partition that contains the boot loaders used by the UEFI firmware.

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**.

**ADD A NEW MOUNT POINT**

More customization options are available after creating the mount point below.

Mount Point:	/
Desired Capacity:	1000GB

**Cancel** **Add mount point**

## Create a RAID1 root partition

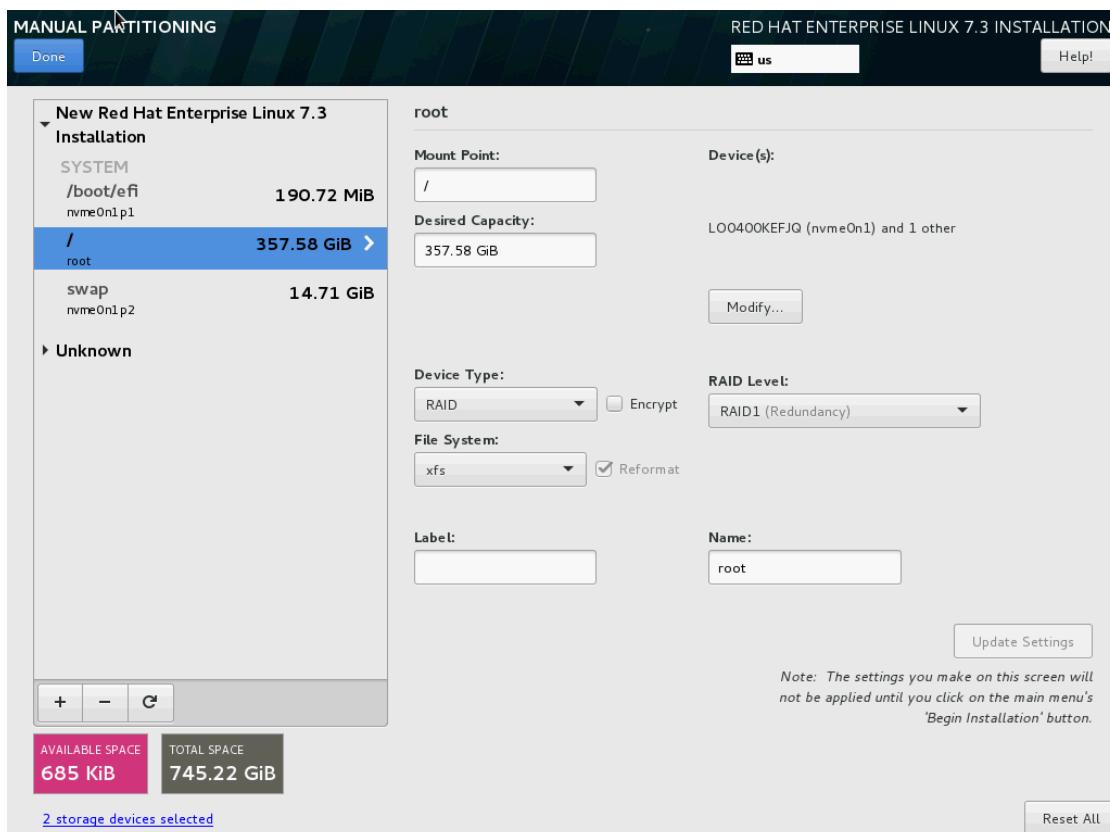
1. Select **/ rhel-root** in the left pane.
2. Select **RAID** in Device Type.

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`.

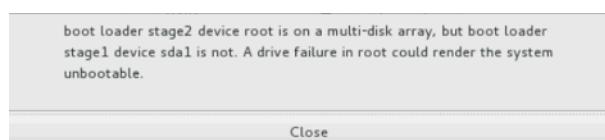
6. In the Name field, type “root”.



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
199983184 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.

- 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"
```

- 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,0011,0010,0001,0002,0003,0004,0
005,0006,0007,0008,0009,000D,000B,000C
```

```
[root@localhost ~]# efibootmgr -c -d /dev/nvme1n1 -p 1 -l \\EFI\\redhat\\shim.efi -L "Red Hat Enterprise Linux-redundant"
BootCurrent: 000E
Timeout: 20 seconds
BootOrder: 0012,000E,0000,000A,0015,0017,0016,000F,0011,0010,0001,0002,0003,0004,0
005,0006,0007,0008,0009,000D,000B,000C
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* NVMe Drive 15 : NUM Express Controller - CUMD6082001K400FGN-L00400KEFJQ-0
Boot000C* NVMe Drive 16 : NUM Express Controller - CUMD61100093400FGN-L00400KEFJQ-0
Boot000D* iLO Virtual USB 2 : HPE Virtual CD-ROM
Boot000E* Red Hat Enterprise Linux
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)
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)
Boot0012* Red Hat Enterprise Linux-redundant
** Warning ** : unrecognised version for memory mirror i/f
[root@localhost ~]#
[root@localhost ~]# efibootmgr -o 000E,0012,0000,000A,0015,0017,0016,000F,0011,0010,0001,0002,0003,0004,0005,0006,0007,0008,0009
,000D,000B,000C
BootCurrent: 000E
Timeout: 20 seconds
BootOrder: 000E,0012,0000,000A,0015,0017,0016,000F,0011,0010,0001,0002,0003,0004,0005,0006,0007,0008,0009,000D,000B,000C
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* NVMe Drive 15 : NUM Express Controller - CUMD6082001K400FGN-L00400KEFJQ-0
Boot000C* NVMe Drive 16 : NUM Express Controller - CUMD61100093400FGN-L00400KEFJQ-0
Boot000D* iLO Virtual USB 2 : HPE Virtual CD-ROM
Boot000E* Red Hat Enterprise Linux
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* Red Hat Enterprise Linux-redundant
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)
** Warning ** : unrecognised version for memory mirror i/f
[root@localhost ~]#
```

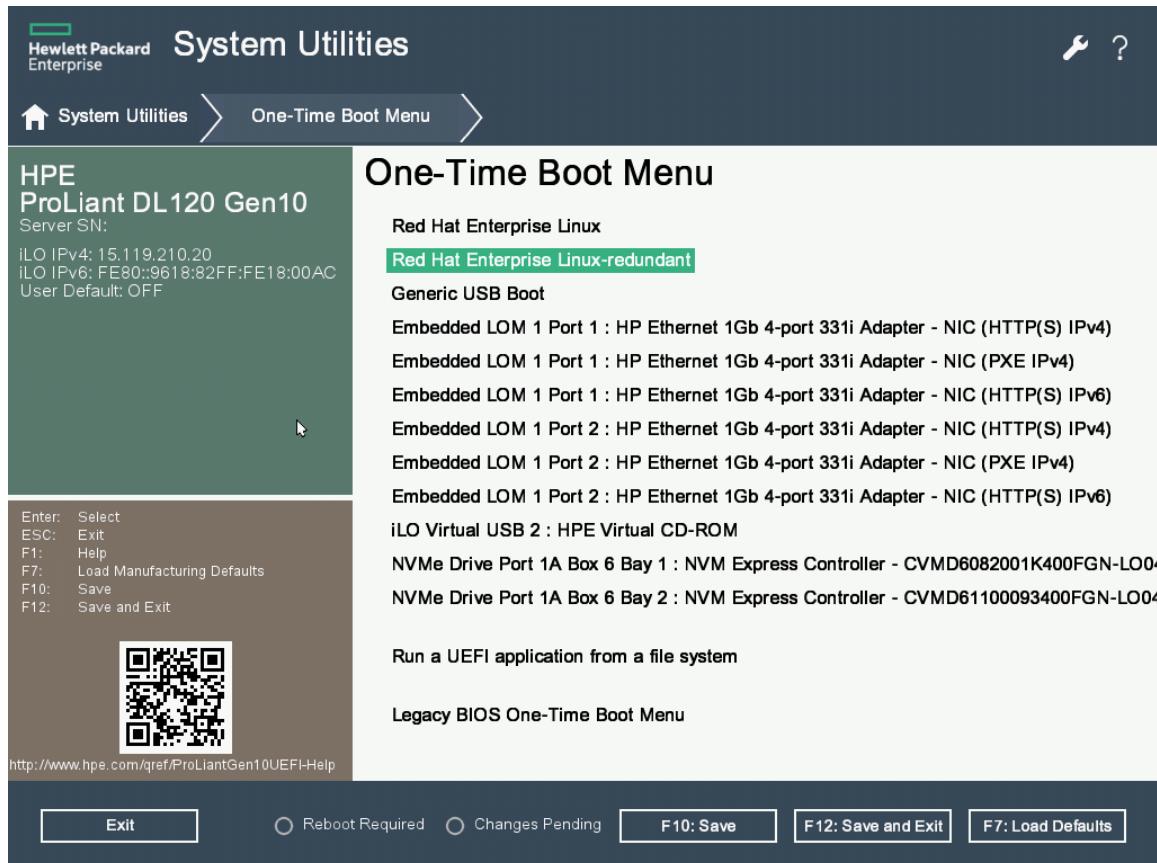
- The actual number for entries depends on the system configuration.

Check the system configuration by typing:

```
efibootmgr -v
```

- 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 : 471689152 (449.76 GiB 482.93 GB)
  Used Dev Size : 471689152 (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 : c8ef8caa:8d8af3b4:624ed707:d013b8d1
    Events : 1440

      Number  Major  Minor  RaidDevice State
         0      8       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 : 471689152 (449.76 GiB 482.93 GB)
  Used Dev Size : 471689152 (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 : c8ef8caa:8d8af3b4:624ed707:d013b8d1
    Events : 1542

      Number  Major  Minor  RaidDevice State
         0      8       0        0     active sync  /dev/sda3
         1      8       3        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
```

```
[root@localhost ~]# dd if=/dev/sdb1 of=/dev/sda1
499566+0 records in
499566+0 records out
293657792 bytes (210 MB) copied, 1.85419 s, 113 MB/s
[root@localhost ~]# efibootmgr -v
BootCurrent: 0012
Timeout: 0 seconds
BootOrder: 0011,0012,0002,0000,0001,0003,0004,0005,0006,0007,0008,0009,000A,000B,000C,000B
Boot0008 Embedded UEFI Shell Fx401(cdb7b35-6b33-4e6-9ab2-57d2acddf6f8)
Boot0001 Diagnose Error Fx401(cdb7b35-6b33-4e6-9ab2-57d2acddf6f8)
Boot0002 System Utilities Fx401(cdb7b35-6b33-4e6-9ab2-57d2acddf6f8)
Boot0003 Intelligent Provisioning Fx401(cdb7b35-6b33-4e6-9ab2-57d2acddf6f8)
Boot0004 Boot Menu Fx401(cdb7b35-6b33-4e6-9ab2-57d2acddf6f8)
Boot0005 Network Boot Fx401(cdb7b35-6b33-4e6-9ab2-57d2acddf6f8)
Boot0006 Embedded Diagnostics Fx401(cdb7b35-6b33-4e6-9ab2-57d2acddf6f8)
Boot0007 View Integrated Management Log Fx401(cdb7b35-6b33-4e6-9ab2-57d2acddf6f8)
Boot0008 Generic USB Boot
USBClass({ffff,ffff,ff,ff ff})
Boot0009 Embedded LOM 1 Port 1 : HP Ethernet 1Gb 2-port 361i Adapter - NIC (PXE IPv6) ACPI(a8341a0,0)PCI(1,4)PCI(0,0)MAC(MAC(S865f3e6f1bb,1)830d3c8000000000000
Boot000A Embedded SATA Port 2 HDD : ST500LTB12-1DG14Z ACPI(a8341a0,0)PCI(1,4)PCI(0,0)MAC(MAC(S865f3e6f1bb,1)M....YM...R,Y.
Boot000B Embedded LOM 1 Port 1 : HP Ethernet 1Gb 2-port 361i Adapter - NIC (PXE IPv4) ACPI(a8341a0,0)PCI(1,4)PCI(0,0)MAC(MAC(S865f3e6f1bb,1)M....YM...R,Y.
Boot000C Embedded SATA Port 2 HDD : ST500LTB12-1DG14Z ACPI(a8341a0,0)PCI(1,4)PCI(0,0)MAC(MAC(S865f3e6f1bb,1)M....YM...R,Y.
Boot000D ILO Virtual USB 2 : HPE iLO Virtual USB CD/DVD ROM ACPI(a8341a0,0)PCI(1,4)USB(0,0)N....YM...R,Y.
Boot000E ILO Virtual USB 2 : HPE iLO Virtual USB CD/DVD ROM ACPI(a8341a0,0)PCI(1,4)USB(0,0)N....YM...R,Y.
Boot000F ILO Virtual USB 2 : HPE iLO Virtual USB CD/DVD ROM ACPI(a8341a0,0)PCI(1,4)USB(0,0)N....YM...R,Y.
Boot0010 ILO Virtual USB 2 : HPE iLO Virtual USB CD/DVD ROM ACPI(a8341a0,0)PCI(1,4)USB(0,0)N....YM...R,Y.
Boot0011* Red Hat Enterprise Linux - HD(1,22,63)de,a333hb2-02d9-46d2-b732-e82c4a96cd3c)File(\EFI\redhat\shim.efd)
Boot0012* rhel-redundant - HD(1,22,63)de,52d22934-6627-4fb9-a5d0-7183b54d1f85)File(\EFI\redhat\shim.efd)
[root@localhost ~]# efibootmgr -b 11 -B
BootCurrent: 0012
Timeout: 0 seconds
BootOrder: 0012,0002,0000,0001,0003,0004,0005,0006,0007,0008,0009,000A,000B,000C,000B
Boot0008 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 Embedded SATA Port 2 HDD : ST500LTB12-1DG14Z
Boot000C Embedded SATA Port 1 HDD : ST500LTB12-1DG14Z
Boot000D ILO Virtual USB 2 : HPE iLO Virtual USB CD/DVD ROM
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* rhel-redundant
[root@localhost ~]
```

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

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

4. Reorder boot sequence by entering the following command:

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

```

[root@localhost ~]# efibootmgr -c -d /dev/sda -p 1 -I \EFI\redhat\shim.efi -L rhel-redundant2
BootCurrent: 0012
Timeout: 0 seconds
BootOrder: 0011,0012,0002,0000,0003,0004,0005,0006,0007,0008,0009,000A,000B,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 LOM 1 Port 1 : HP Ethernet 1Gb Z-port 361i Adapter - NIC (PXE IPo6)
Boot000A* Embedded LOM 1 Port 1 : HP Ethernet 1Gb Z-port 361i Adapter - NIC (PXE IPo4)
Boot000B* Embedded SATA Port 2 HDD : ST500LT012-1DG14Z
Boot000C* Embedded SATA Port 1 HDD : ST500LT012-1DG14Z
Boot000D* iLO Virtual USB 2 : HPE iLO Virtual USB CD/DVD ROM
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* rhel-redundant
Boot0011* rhel-redundant2
[root@localhost ~]# efibootmgr -o 0012,0011,0002,0000,0003,0004,0005,0006,0007,0008,0009,000C,000B
BootCurrent: 0012
Timeout: 0 seconds
BootOrder: 0012,0011,0002,0000,0003,0004,0005,0006,0007,0008,0009,000C,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 LOM 1 Port 1 : HP Ethernet 1Gb Z-port 361i Adapter - NIC (PXE IPo6)
Boot000A* Embedded LOM 1 Port 1 : HP Ethernet 1Gb Z-port 361i Adapter - NIC (PXE IPo4)
Boot000B* Embedded SATA Port 2 HDD : ST500LT012-1DG14Z
Boot000C* Embedded SATA Port 1 HDD : ST500LT012-1DG14Z
Boot000D* iLO Virtual USB 2 : HPE iLO Virtual USB CD/DVD ROM
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* rhel-redundant
Boot0012* rhel-redundant2
[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

- From the Suggested Partitioning screen, select **Expert Partitioner...**

The screenshot shows the SUSE Partitioner interface with the title "Suggested Partitioning". A large text box displays a list of proposed partition operations:

- Delete partition /dev/nvme1n1p3 (356.36 GiB)
- Create root volume /dev/nvme1n1p3 (40.00 GiB) with btrfs
- Create volume /dev/nvme1n1p4 (316.35 GiB) for /home with xfs
- Create subvolume @/boot/grub2/386-pc on device /dev/nvme1n1p3
- Create subvolume @/boot/grub2/x86\_64-efi on device /dev/nvme1n1p3
- Create subvolume @/opt on device /dev/nvme1n1p3
- Create subvolume @/srv on device /dev/nvme1n1p3
- Create subvolume @/tmp on device /dev/nvme1n1p3
- Create subvolume @/usr/local on device /dev/nvme1n1p3
- Create subvolume @/var/cache on device /dev/nvme1n1p3
- Create subvolume @/var/crash on device /dev/nvme1n1p3
- Create subvolume @/var/lib/lvibirt/images on device /dev/nvme1n1p3 with option "no copy on write"
- Create subvolume @/var/lib/machines on device /dev/nvme1n1p3
- Create subvolume @/var/lib/mailman on device /dev/nvme1n1p3
- Create subvolume @/var/lib/mariadb on device /dev/nvme1n1p3 with option "no copy on write"
- Create subvolume @/var/lib/mysql on device /dev/nvme1n1p3 with option "no copy on write"
- Create subvolume @/var/lib/named on device /dev/nvme1n1p3
- Create subvolume @/var/lib/pgsql on device /dev/nvme1n1p3 with option "no copy on write"

Below the list are two buttons: "Edit Proposal Settings" and "Create Partition Setup...". A third button, "Expert Partitioner...", is shown with a cursor hovering over it.

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”

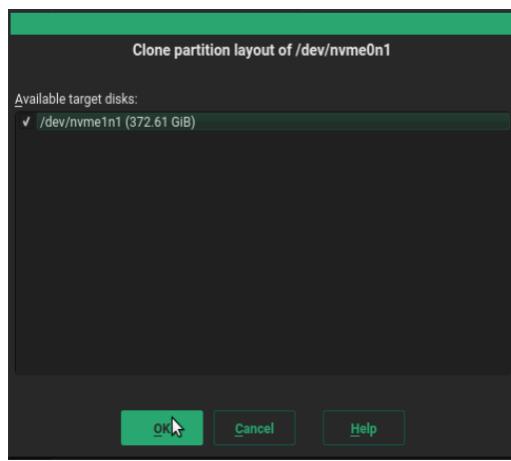
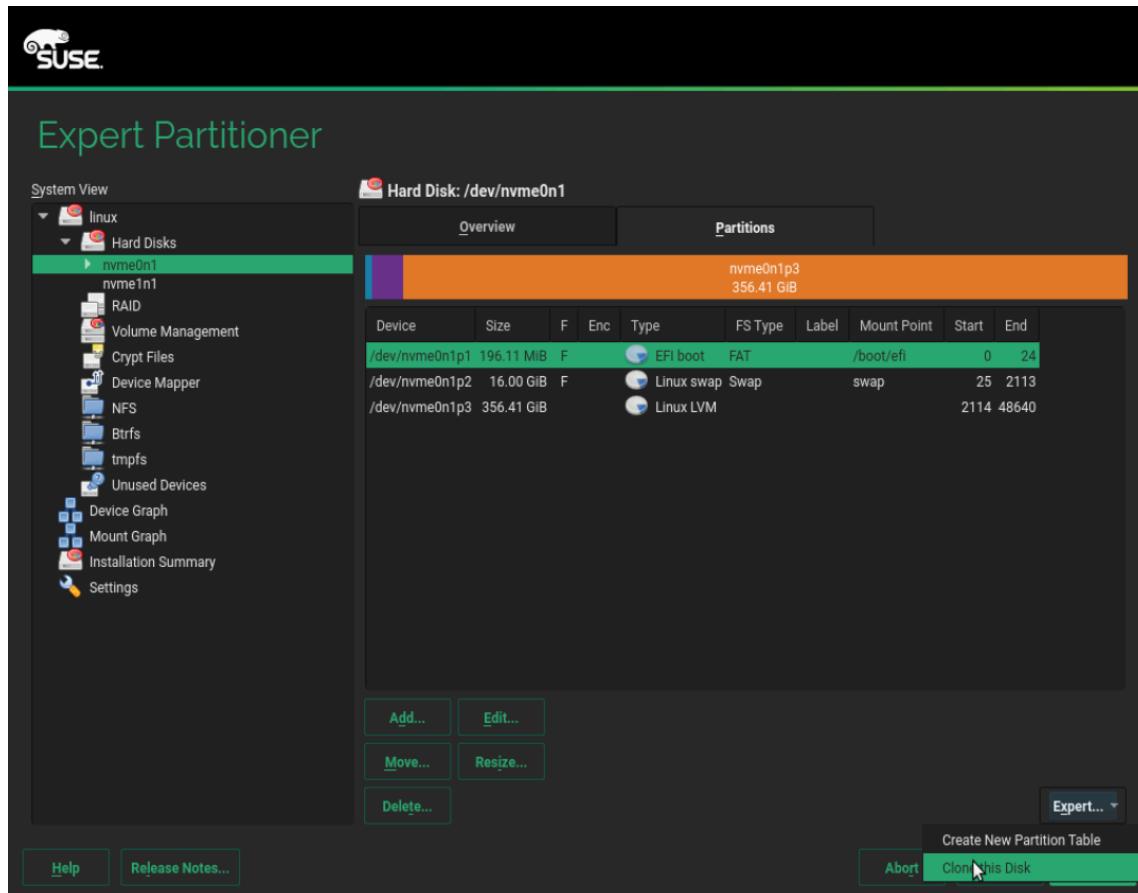
/dev/nvme0n1p2, size = 16GB, role as “Swap”

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

The screenshot shows the SUSE Expert Partitioner interface with the title "Expert Partitioner". The left sidebar shows "System View" with "Hard Disks" expanded, showing "nvme0n1" and "nvme1n1". The main area shows "Hard Disk: /dev/nvme0n1" with two partitions listed in the "Partitions" table:

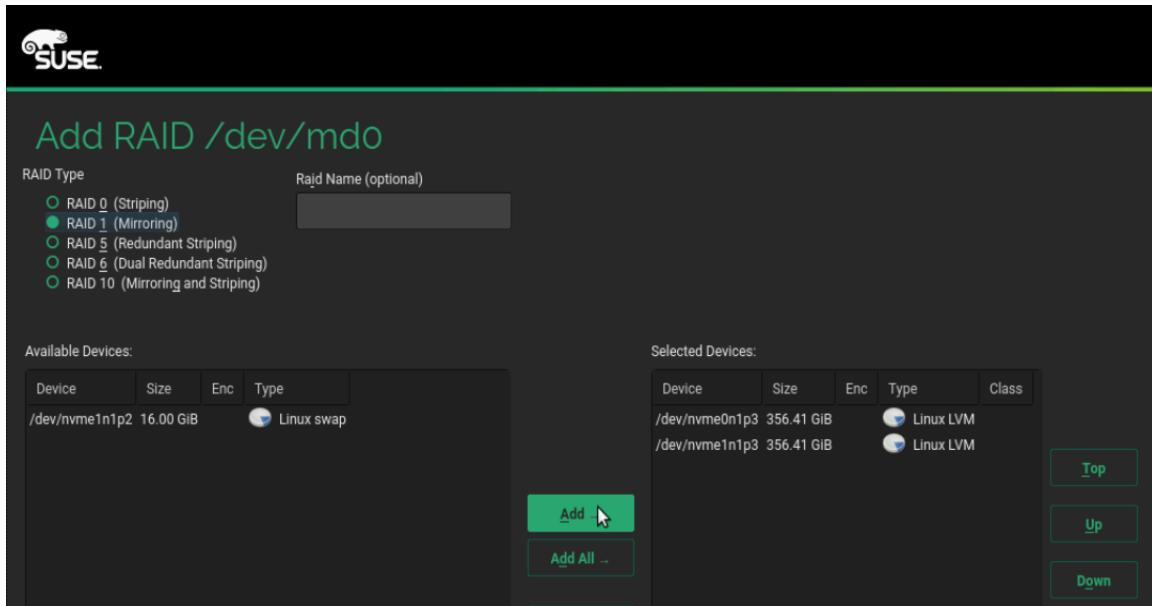
Device	Size	F	Enc	Type	FS Type	Label	Mount Point	Start	End
/dev/nvme0n1p1	196.11 MiB	F		EFI boot	FAT		/boot/efi	0	24
/dev/nvme0n1p2	16.00 GiB	F		Linux swap	Swap	swap		25	2113
/dev/nvme0n1p3	356.41 GiB			Linux LVM				2114	48640

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

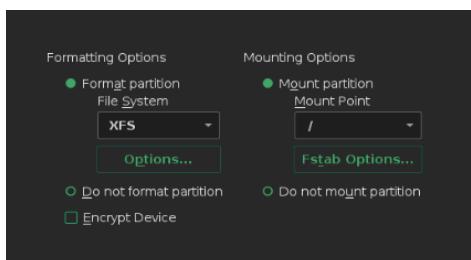


- In the RAID section, create a RAID1 that includes `/dev/nvme0n1p3` and `/dev/nvme1n1p3`:

- a. Click **RAID**.
- b. Choose **RAID1 (mirroring)**.
- c. Select each partition and click **Add** to move them to Selected Devices.

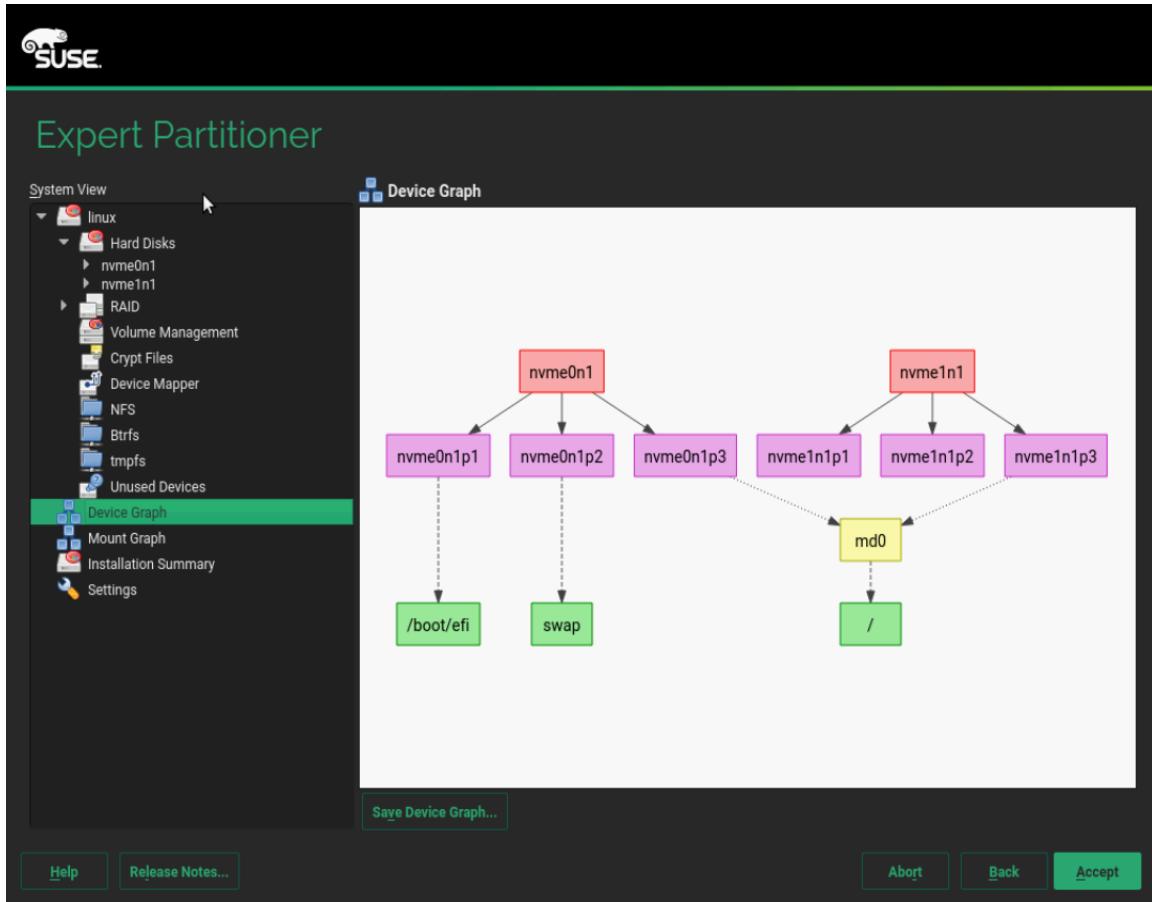


6. Set the following options: 4KB Chunk Size, role as “Operating System”, format as XFS and mount it to “/” (root).

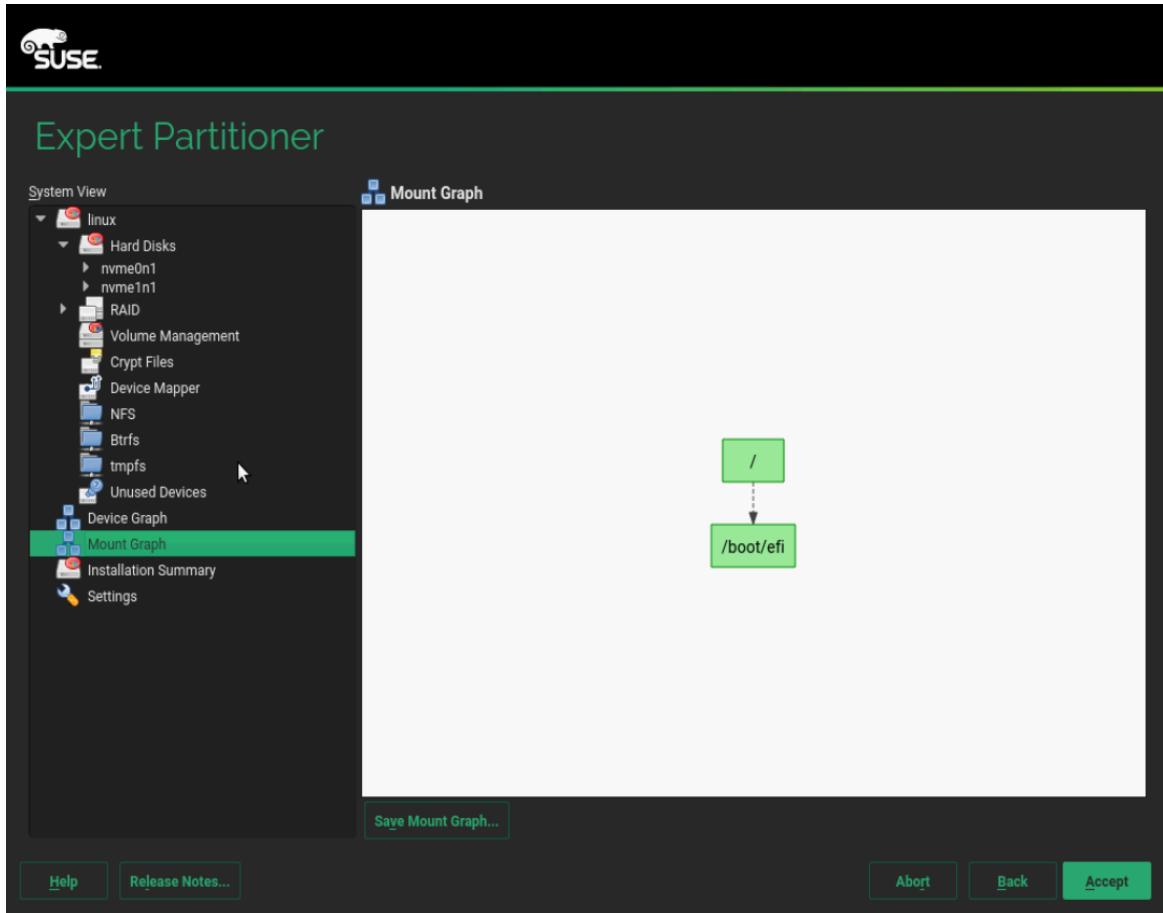


7. Click **Finish**.

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.

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/nvme0n1 -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-L00400KEFJQ-0
Boot0013* NVMe Drive 16 : NVM Express Controller - CVMD61100093400FGN-L00400KEFJQ-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

```

```

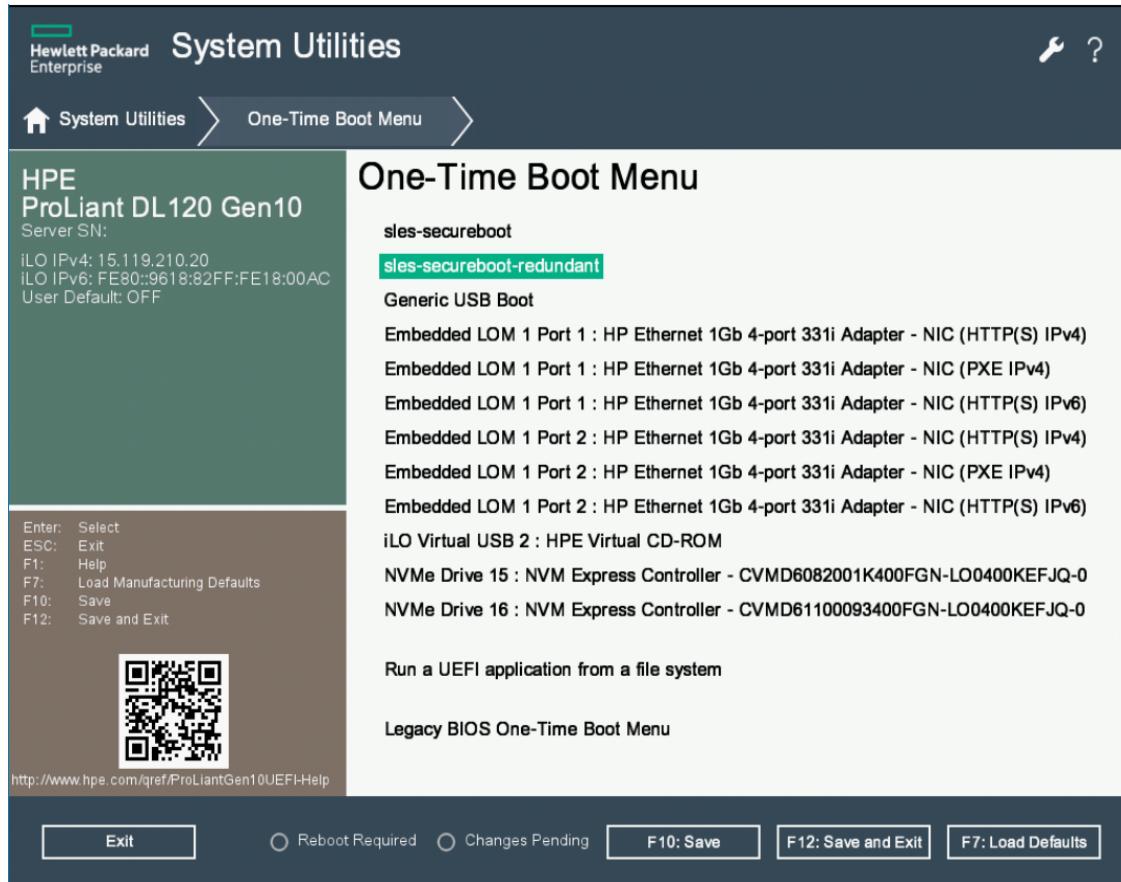
linux-nrdo:~ # efibootmgr -o 000C,000D,0000,000A,0015,0017,0016,000F,0011,0010,000B,0012,0013,0001,0002,0003,000
4,0005,0006,0007,0008,0009
BootCurrent: 000C
Timeout: 20 seconds
BootOrder: 000C,000D,0000,000A,0015,0017,0016,000F,0011,0010,000B,0012,0013,0001,0002,0003,0004,0005,0006,0007,0
008,0009
Boot0000* 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-L00400KEFJQ-0
Boot0013* NVMe Drive 16 : NVM Express Controller - CVMD61100093400FGN-L00400KEFJQ-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.

```
dracut:/# mdadm --detail /dev/md0
/dev/md0:
      Version : 1.0
Creation Time : Tue Mar 29 16:43:01 2016
     Raid Level : raid1
       Array Size : 47195376 (449.57 GiB 462.72 GB)
   Used Dev Size : 47195376 (449.57 GiB 462.72 GB)
    Raid Devices : 2
   Total Devices : 1
        Persistence: Superblock is persistent

        Intent Bitmap : Internal

          Update Time : Wed Mar 30 03:57:15 2016
                        State : clean, degraded
        Active Devices : 1
       Working Devices : 1
         Failed Devices : 0
        Spare Devices : 0

              Name : any:0
              UUID : 824cc36d:607cf2b6:2bbfaf68:a2d81425
            Events : 1692

      Number  Major  Minor  RaidDevice State
         0      8       0        0     removed
         1      8       3        1     active sync  /dev/sda3
dracut:/#
```

### 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 `crashkernel=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.

```
/lib/dracut-11b.sh#415(source_a11): 'l' -d //lib/dracut/hooks/emergency ' '
/lib/dracut-11b.sh#416(source_a11): for f in "$_dir"/*.sh
/lib/dracut-11b.sh#416(source_a11): 'l' e //lib/dracut/hooks/emergency/50-plumouth-emergency.sh '
/lib/dracut-11b.sh#416(source_a11): //lib/dracut/hooks/emergency/50-plumouth-emergency.sh
//lib/dracut/hooks/emergency/50-plumouth-emergency.sh#4(source): plmouth --hide-splash
/lib/dracut-11b.sh#416(source_a11): for f in "$_dir"/*
/lib/dracut-11b.sh#416(source_a11): for f in //lib/dracut/hooks/emergency/80-->2fdev/x2fdisk/x2fbu-uidx2f03d6b659-23cf-423b-b1c6-c6a711aa9cfe.sh ' '
/lib/dracut-11b.sh#416(source_a11): //lib/dracut/hooks/emergency/80-->2fdev/x2fdisk/x2fbu-uidx2f03d6b659-23cf-423b-b1c6-c6a711aa9cfe.sh'
//lib/dracut/hooks/emergency/80-->2fdev/x2fdisk/x2fbu-uidx2f03d6b659-23cf-423b-b1c6-c6a711aa9cfe ' -e /dev/disk/by-uuid/03d6b659-23cf-423b-b1c6-c6a711aa9cfe
/lib/dracut-11b.sh#416(source_a11): for f in "$_dir"/*
/lib/dracut-11b.sh#416(source_a11): 'l' e //lib/dracut/hooks/emergency/80-->2fdev/x2fdisk/x2fbu-uidx2f3e880408-a786-49fb-989f-566378fd0766.sh ' '
/lib/dracut-11b.sh#416(source_a11): //lib/dracut/hooks/emergency/80-->2fdev/x2fdisk/x2fbu-uidx2f3e880408-a786-49fb-989f-566378fd0766.sh'
//lib/dracut/hooks/emergency/80-->2fdev/x2fdisk/x2fbu-uidx2f3e880408-a786-49fb-989f-566378fd0766 ' -e /dev/disk/by-uuid/3e880408-a786-49fb-989f-566378fd0766
'
//lib/dracut/hooks/emergency/80-->2fdev/x2fdisk/x2fbu-uidx2f3e880408-a786-49fb-989f-566378fd0766warn '/dev/disk/by-uuid/3e880408-a786-49fb-989f-566378fd0766
does not exist'
/lib/dracut-11b.sh#70(warn): echo 'Warning: /dev/disk/by-uuid/3e880408-a786-49fb-989f-566378fd0766 does not exist'
Warning: /dev/disk/by-uuid/3e880408-a786-49fb-989f-566378fd0766 does not exist
/lib/dracut-11b.sh#416(source_a11): for f in "$_dir"/*
/lib/dracut-11b.sh#416(source_a11): 'l' e //lib/dracut/hooks/emergency/90-->2fdev/x2fdisk/x2fbu-uidx2f0d6e-1982.sh ' '
/lib/dracut-11b.sh#416(source_a11): //lib/dracut/hooks/emergency/90-->2fdev/x2fdisk/x2fbu-uidx2f0d6e-1982.sh@1(source): 'l' -e /dev/disk/by-uuid/0d6e-1982 '
/bin/dracut-emergency@20(): getargbool 0 rd.shell -d -g rdshell
/lib/dracut-11b.sh#236(getargbool): local _1
/lib/dracut-11b.sh#237(getargbool): unset _b
/lib/dracut-11b.sh#238(getargbool): local _default
/lib/dracut-11b.sh#239(getargbool): _default=0
/lib/dracut-11b.sh#239(getargbool): shift
/lib/dracut-11b.sh#240(getargbool): getarg rd.shell -d -g rdshell
/lib/dracut-11b.sh#105(getarg): debug off
/lib/dracut-11b.sh#16(debug off): set --
/lib/dracut-11b.sh#210(getarg): return 0
/lib/dracut-11b.sh#240(getargbool): _b
/lib/dracut-11b.sh#241(getargbool): '_ 0 -ne 0 -a -z ' ' '
/lib/dracut-11b.sh#242(getargbool): '_ -n ' '
/lib/dracut-11b.sh#247(getargbool): return 0
/bin/dracut-emergency@21(): echo
/bin/dracut-emergency@21(): echo

/bin/dracut-emergency@22(): rdsosreport
Generating "/run/initrafs/rdsosreport.txt"
/bin/dracut-emergency@23(): echo
/bin/dracut-emergency@24(): echo

/bin/dracut-emergency@25(): echo 'Entering emergency mode. Exit the shell to continue.'
Entering emergency mode. Exit the shell to continue.
/bin/dracut-emergency@26(): echo 'Type "journalctl" to view system logs.'
Type "journalctl" to view system logs.
/bin/dracut-emergency@27(): echo 'You might want to save "/run/initrafs/rdsosreport.txt" to a USB stick or /boot'
You might want to save "/run/initrafs/rdsosreport.txt" to a USB stick or /boot
/bin/dracut-emergency@28(): echo 'after mounting them and attach it to a bug report.'
after mounting them and attach it to a bug report.
/bin/dracut-emergency@29(): echo

/bin/dracut-emergency@30(): echo

/bin/dracut-emergency@31(): 'l' -f /etc/profile '
/bin/dracut-emergency@31(): . /etc/profile
/etc/profile@10: PS1='dracut:$PWD# '
/bin/dracut-emergency@32(): 'l' -z 'dracut:$PWD# ' '
/bin/dracut-emergency@33(): exec sh -i -
dracut:@
```

## 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 : 471495376 (449.57 GiB 482.72 GB)
      Used Dev Size : 471495376 (449.57 GiB 482.72 GB)
      Raid Devices : 2
      Total Devices : 2
      Persistence : Superblock is persistent

      Intent Bitmap : Internal

      Update Time : Wed Mar 30 05:40:11 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 : 02fc36d:607cf20b:2bbfaf60:a2d81425
                  Events : 1742

      Number  Major  Minor  RaidDevice State
          2      8       3        0     spare rebuilding  /dev/sda3
          1      8       19       1     active sync   /dev/sdb3

```

## 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/nvme0n1p1 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
20472320 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)
Boot0009+ Embedded LOM 1 Port 1 : HP Ethernet 1Gb 2-port 361i Adapter - NIC (PXE IPv4)
Boot000B+ ILO Virtual USB Z : 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 Z : HPE iLO Virtual USB CD/DVD ROM
Boot000F+ ILO Virtual USB Z : HPE iLO Virtual USB CD/DVD ROM
Boot0010+ ILO Virtual USB Z : HPE iLO Virtual USB CD/DVD ROM
Boot0012+ sles-secureboot2

```

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-0xde:~]# 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
Boot0009 Embedded UEFI Shell
Boot0001 Diagnose Error
Boot0002 System Utilities
Boot0003 Intelligent Provisioning
Boot0004 Boot Menu
Boot0005 Network Boot
Boot0006 Embedded Diagnostics
Boot0007 Uicu Integrated Management Log
Boot0008 Generic USB Boot
Boot0009* Embedded LOM 1 Port 1 : HP Ethernet 1Gb 2-port 361i Adapter - NIC (PXE IPv6)
Boot0009* Embedded LOM 1 Port 1 : HP Ethernet 1Gb 2-port 361i Adapter - NIC (PXE IPv4)
Boot000B* ILO Virtual USB Z : 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 Z : HPE iLO Virtual USB CD/DVD ROM
Boot000F* ILO Virtual USB Z : HPE iLO Virtual USB CD/DVD ROM
Boot0010* ILO Virtual USB Z : HPE iLO Virtual USB CD/DVD ROM
Boot0011* sles-secureboot2
Boot0012* sles-secureboot3
Boot0011* sles-secureboot3
Boot0012* sles-secureboot2
[Linux-0xde:~]# 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
Boot0009 Embedded UEFI Shell
Boot0001 Diagnose Error
Boot0002 System Utilities
Boot0003 Intelligent Provisioning
Boot0004 Boot Menu
Boot0005 Network Boot
Boot0006 Embedded Diagnostics
Boot0007 Uicu Integrated Management Log
Boot0008 Generic USB Boot
Boot0009* Embedded LOM 1 Port 1 : HP Ethernet 1Gb 2-port 361i Adapter - NIC (PXE IPv6)
Boot0009* Embedded LOM 1 Port 1 : HP Ethernet 1Gb 2-port 361i Adapter - NIC (PXE IPv4)
Boot000B* ILO Virtual USB Z : 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 Z : HPE iLO Virtual USB CD/DVD ROM
Boot000F* ILO Virtual USB Z : HPE iLO Virtual USB CD/DVD ROM
Boot0010* ILO Virtual USB Z : HPE iLO Virtual USB CD/DVD ROM
Boot0011* sles-secureboot3
Boot0012* sles-secureboot2
[Linux-0xde:~]#

```

# 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](http://www.hpe.com/support/hpesc)
- Hewlett Packard Enterprise Support Center: Software downloads  
[www.hpe.com/support/downloads](http://www.hpe.com/support/downloads)
- Software Depot

[www.hpe.com/support/softwaredepot](http://www.hpe.com/support/softwaredepot)

- To subscribe to eNewsletters and alerts:  
[www.hpe.com/support/e-updates](http://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](http://www.hpe.com/support/AccessToSupportMaterials)

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**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.

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## 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](http://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](http://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](http://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](http://www.hpe.com/info/environment)

## **Documentation feedback**

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