Implementing Linux Software RAID1 on HPE ProLiant Servers with RHEL 6, RHEL 7, SLES 11, or SLES 12

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 6, 7; SuSE Linux Enterprise Server 11 and 12.
Table of Contents

Table of Contents ........................................................................................................................................ 3
Introduction ................................................................................................................................................. 5
   Prerequisites ........................................................................................................................................... 5
LSRRB Software .......................................................................................................................................... 7
   OS specific installation scripts ............................................................................................................. 7
   LSRRB Value Added software ............................................................................................................... 7
OS Deployment ........................................................................................................................................... 9
   Single machine deployment .................................................................................................................. 9
Checking system status ........................................................................................................................... 12
   LSRRB Service Status .......................................................................................................................... 12
   Hard drive thermal information ......................................................................................................... 13
   Checking RAID status ......................................................................................................................... 13
   Faulty disk replacement ....................................................................................................................... 14
   Verification ............................................................................................................................................ 16
   Known Issues and Limitations ............................................................................................................ 17
Appendix A: Creating redundant boot strategy for software RAID1 in Linux .................................... 19
   Basic configuration .............................................................................................................................. 19
   Red Hat Enterprise Linux (RHEL) 7 .................................................................................................... 21
   Red Hat Enterprise Linux (RHEL) 6 .................................................................................................... 33
   SuSE Linux Enterprise Server (SLES) 12 ........................................................................................... 47
   SuSE Linux Enterprise Server (SLES) 11 ........................................................................................... 58
Appendix B: Example server configurations ......................................................................................... 68
   PXE server configuration ...................................................................................................................... 68
   TFTP server configuration .................................................................................................................... 69
   DHCP server configuration .................................................................................................................. 70
Appendix C: Example OS-specific installation scripts ......................................................................... 72
   KickStart Script for RHEL 7 ................................................................................................................. 72
   KickStart Script for RHEL 6 ................................................................................................................. 73
   AutoYast Script for SLES 12 ............................................................................................................... 75
   AutoYast Script for SLES 11 ............................................................................................................... 79
<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Appendix D Support for Gen10 and AMD Platform</td>
<td>84</td>
</tr>
<tr>
<td>AMD Platform with AMD FCH AHCI Controller</td>
<td>84</td>
</tr>
<tr>
<td>SATA-based PCI-e M.2 SSD</td>
<td>102</td>
</tr>
<tr>
<td>NVMe PCI-e Disk</td>
<td>126</td>
</tr>
<tr>
<td>Support and other resources</td>
<td>150</td>
</tr>
<tr>
<td>Accessing Hewlett Packard Enterprise Support</td>
<td>150</td>
</tr>
<tr>
<td>Accessing updates</td>
<td>150</td>
</tr>
<tr>
<td>Regulatory information</td>
<td>151</td>
</tr>
<tr>
<td>Documentation feedback</td>
<td>151</td>
</tr>
</tbody>
</table>
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.

LSRRB is now an open-source project on GitHub. You can find the latest code and scripts on https://github.com/HewlettPackard/lsrrb. Errata to this document or other supplementary materials can be found on the GitHub link as well.

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.

- Prepare a PXE server.
- Prepare a TFTP server.
- Prepare a DHCP server.

PXE server information

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

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

For an example PXE server configuration, see “PXE server configuration.”
**TFTP server information**

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

Reference to [https://wiki.centos.org/HowTos/PXE/PXE_Setup](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/](http://downloads.linux.hpe.com/SDR/project/lsrrb/current/).

<table>
<thead>
<tr>
<th>File Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>RHEL6_RAID1_ks.cfg</td>
<td>Installation script for RHEL 6 unattended mode</td>
</tr>
<tr>
<td>RHEL7_RAID1_ks.cfg</td>
<td>Installation script for RHEL 7 unattended mode</td>
</tr>
<tr>
<td>RHEL7_RAID1_ks_nvme.cfg</td>
<td>Installation script for RHEL 7 unattended mode (with NVMe disks)</td>
</tr>
<tr>
<td>SLES11_RAID1_autoinst.xml</td>
<td>Installation script for SLES 11 unattended mode</td>
</tr>
<tr>
<td>SLES12_RAID1_autoinst.xml</td>
<td>Installation script for SLES 12 unattended mode</td>
</tr>
<tr>
<td>SLES12_RAID1_autoinst_nvme.xml</td>
<td>Installation script for SLES 12 unattended mode (with NVMe disks)</td>
</tr>
</tbody>
</table>

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:

<table>
<thead>
<tr>
<th>File Name</th>
<th>Location</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>10-lsrrb.rules</td>
<td>/etc/udev/rules.d</td>
<td>The udev rule file that directs the udev subsystem to invoke LSRRB md_auto_resync.py script when a replacement disk is inserted.</td>
</tr>
<tr>
<td>lsrrb.service</td>
<td>/etc/systemd/system</td>
<td>LSRRB systemd service for RHEL 7 and SLES 12</td>
</tr>
<tr>
<td>lsrrbd</td>
<td>/etc/init.d</td>
<td>LSRRB init service for RHEL 6</td>
</tr>
<tr>
<td>File Name</td>
<td>Location</td>
<td>Description</td>
</tr>
<tr>
<td>----------------------</td>
<td>---------------------------</td>
<td>----------------------------------------------------------------------------</td>
</tr>
<tr>
<td>HPEsdtemplog</td>
<td>/etc/logrotate.d</td>
<td>The logrotate config file for advanced thermal reporting</td>
</tr>
<tr>
<td>HPEtemp.sh</td>
<td>/opt/hpe/lsrrb/bin</td>
<td>Script for advanced thermal reporting</td>
</tr>
<tr>
<td>md_auto_resync.py</td>
<td>/opt/hpe/lsrrb/bin</td>
<td>The script that periodically checks the existence of the recovery key file. If there is a key file, the recovery process will be executed.</td>
</tr>
<tr>
<td>md_resync_trigger.py</td>
<td>/opt/hpe/lsrrb/bin</td>
<td>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.</td>
</tr>
<tr>
<td>lsrrb.sh</td>
<td>/opt/hpe/lsrrb/bin</td>
<td>Script for executing LSRRB scripts</td>
</tr>
</tbody>
</table>
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 6/7 and SUSE 11/12 are described below.
RHEL 7

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 single machine deploy
image=/RHEL/RHEL-7.4Server-x86_64/vmlinuz
label=RHEL-7Server-x86_64_ks
description = "RHEL 7 Server RAID1 kickstart"
initrd=/RHEL/RHEL-7.4Server-x86_64/initrd.img
append="ipv6.disable=1
inst.ks=http://172.1.1.100/answers/RHEL7_RAID1_ks.cfg" #The place to change file path.
```

In the above example, the RHEL7_RAID1_ks.cfg file is placed on the TFTP server (172.1.1.100), in the folder ‘answer’.

The RHEL 7.4 installation files are in the mrepo/RHEL-7.4Server-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

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 RHEL6 single machine deploy
image=/RHEL/RHEL-6.8Server-x86_64/vmlinuz
label=RHEL-6Server-x86_64_ks
description = "RHEL 6 Server RAID1 kickstart"
initrd=/RHEL/RHEL-6.9Server-x86_64/initrd.img
append="ipv6.disable=1
inst.ks=http://172.1.1.100/answers/RHEL6_RAID1_ks.cfg" #The place to change file path.
```

In the above example, the RHEL6_RAID1_ks.cfg file is placed on the TFTP server (172.1.1.100), in the folder ‘answer’.

The RHEL 6.9 installation files are in the mrepo/RHEL-6.9Server-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

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 single machine deploy
image=/SLE/SLE-12-SP3-Server-x86_64/linux
label=SLE-12-Server-x86_64_ks
description = "SLES 12 RAID1 AutoYast"
initrd=/SLE/SLE-12-SP3-Server-x86_64/initrd
append="vga=normal netdev=eth1
autoyast=http://172.1.1.100/answers/SLES12_RAID1_autoinst.xml
install=http://172.1.1.100/mrepo/SLE-12-SP3-Server-x86_64/disc1" #The place to change file path.
```

In the above example, the SLES12_RAID1_autoinst.xml file is placed on the TFTP server (172.1.1.100), in the folder ‘answer’. The SLES12 installation files are in the mrepo/SLE-12-SP3-Server-x86_64/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.

SLES 11

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 11 single machine deploy
image=/SLE/SLES-11-SP4-x86_64/linux
label=SLE-11-Server-x86_64_ks
description = "SLES 11 RAID1 AutoYast"
initrd=/SLE/SLES-11-SP4-x86_64/initrd
append="vga=normal netdev=eth1
autoyast=http://172.1.1.100/answers/SLES11_RAID1_autoinst.xml
install=http://172.1.1.100/mrepo/SLES-11-SP4-x86_64/disc1" #The place to change file path.
```

In the above example, the SLES11_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/SLES-11-SP4-x86_64/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-4.
LSRRB Service Status

LSRRB is a systemd service on RHEL7 and SLES 12. 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 and SLES 12

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 2015-10-13 18:55:10 CDT; 1min 50s ago
     Process: 871 ExecStart=/opt/hpe/minnow/bin/minnow.sh (code=exited, status=0/SUCCESS)
     Main PID: 875 (bash)
   CGroup: /system.slice/minnow.service
            874 /usr/bin/python /opt/hpe/minnow/bin/md_auto_resync.py
            875 /bin/bash -c "/opt/hpe/minnow/bin/HPEtemp.sh"
            876 /bin/sleep 600
[...]
```

On RHEL 6 or SLES 11

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 or SLES 12

- 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 or SLES 11
• Use the following command to start the service.
  `/etc/init.d/lsrrbd start`

• Use the following command to stop the service.
  `/etc/init.d/lsrrbd stop`

**Hard drive thermal information**

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

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

To find the drive thermal information, type the command:
  `cat /var/log/HPEsdtemp.log`

**Checking RAID status**

To check the RAID device on the system, type the command:
  `cat /proc/mdstat`

The above screenshot indicates there is only one RAID device in the system. To check the RAID status for `md0`, type the command:
  `mdadm --detail /dev/md0`

Here `/dev/md0` is the RAID device on the system.
The above screenshot reports the State as "clean". This is the normal state of the RAID system. If State reports as "degraded", the RAID system is degraded, and one of the disk became faulty.

**Faulty disk replacement**

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

**Replacing a faulty disk using the hot-swap method**

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

Type the following command to check the rebuild program.

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

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

**Replacing a faulty disk using the cold-swap method**

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

Type the following command to check the rebuild progress:

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

Here `md0` is the RAID device on the system.
The screenshot indicates the progress of the rebuild, which is 1%. The time to complete a rebuild depends on the size of the hard drive. Once it reaches 100%, the rebuild process completes and the State indicates “clean”.

**Verification**

Type the following command to verify the RAID system:

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

Here `md0` is the RAID device on the system.
The above screenshot shows State reporting "clean". It is the normal state of the RAID system.

Known Issues and Limitations

The LED on the hard drive tray doesn't work

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

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

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

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

The RAID metadata or partition information on the replacement hard drive should be wiped before inserting to the system.
LSRRB service should not be stopped or restarted before RAID is fully recovered and status is clean

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

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

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

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

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

    ls -la /boot/efi

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

Hot-swap of failure NVMe disk is currently not supported.
Appendix A: Creating redundant boot strategy for software RAID1 in Linux

Introduction

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

- Red Hat Enterprise Linux
- SuSE Linux Enterprise Server

It covers the following topics:

- Installation
- Configuration
- Recovery steps when a disk fails

Basic configuration

This procedure will be completed using HPE iLO. For more information, see the HPE iLO 5 User Guide in the Hewlett Packard Enterprise Information Library (www.hpe.com/info/docs).

Setting AHCI mode in Gen9

a. In RBSU > System Options > SATA Controller Options > Embedded SATA Configuration.
b. Make sure that “Enable SATA AHCI Support” is enabled.
Setting AHCI mode in Gen10

AHCI mode is a default setting in Gen10.

UEFI partitioning scheme

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

<table>
<thead>
<tr>
<th>Name</th>
<th>Size</th>
<th>File System Type</th>
<th>Mount Point</th>
</tr>
</thead>
<tbody>
<tr>
<td>First disk</td>
<td>/dev/sda1</td>
<td>200MB</td>
<td>/boot/efi</td>
</tr>
<tr>
<td>Name</td>
<td>Size</td>
<td>File System Type</td>
<td>Mount Point</td>
</tr>
<tr>
<td>----------</td>
<td>----------</td>
<td>------------------</td>
<td>-------------</td>
</tr>
<tr>
<td>/dev/sda2</td>
<td>16GB</td>
<td>Swap</td>
<td>Swap</td>
</tr>
<tr>
<td>/dev/sda3</td>
<td>Rest of the disk</td>
<td>Ext4</td>
<td>None</td>
</tr>
<tr>
<td><strong>Second Disk</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>/dev/sdb1</td>
<td>200MB</td>
<td>FAT</td>
<td>None</td>
</tr>
<tr>
<td>/dev/sdb2</td>
<td>16GB</td>
<td>Swap</td>
<td>None</td>
</tr>
<tr>
<td>/dev/sdb3</td>
<td>Rest of the disk</td>
<td>Ext4</td>
<td>None</td>
</tr>
</tbody>
</table>

* 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**

**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 7.4 DVD image.
   a. Select Troubleshooting > Rescue a Red Hat Enterprise Linux system from the GRUB boot menu.
   b. Select 1) Continue.

   The following prompt is displayed:
To create partitions on the first disk (/dev/sda), type the following commands.

1. parted /dev/sda mklabel gpt
   
   a. Type “Yes” to confirm changes are made to the existing disk label.

2. The following is displayed:

3. parted /dev/sda mkpart primary fat32 0 200MiB
   
   a. Type “Ignore” to ignore the size mismatch.

4. The following is displayed:

5. parted /dev/sda mkpart primary ext2 200MiB 16GiB

6. parted /dev/sda print

   a. Refer to the screenshot for detail partitioning instruction and information for /dev/sda.
b. Repeat step 5 for the second disk (/dev/sdb).

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

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

![ADD A NEW MOUNT POINT](image)

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. Click Update Settings.
13. The system will calculate the final size for the RAID partition.
14. The system will create a new md device in /dev/md/root.
15. In the Name field, type “root”.

Page 26
16. Continue the installation by clicking **Done**.
17. The system will show a warning message.
18. This message can be ignored.

Creating the Redundant ESP

1. Log in to Red Hat.
2. To clone the ESP partition from `/dev/sda1` to `/dev/sdb1`, enter the following command.
   ```
   dd if=/dev/sda1 of=/dev/sdb1
   ```
   “if” means the input and “of” is the output.

Creating a New Entry in UEFI Boot Manager

Before creating a new entry for the Redundant ESP for `/dev/sdb1`, examine the current EFI boot manager. Make sure the contents of the new entry match the existing entry for RHEL.
1. To list the entries in the EFI boot manager, type the following command.
   ```
   efibootmgr -v
   ```
   The screenshot shows that entry Boot000C 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\shimx64.efi -L “rhel-redundant"
   ```
   The “rhel-redundant” entry is created as Boot0013.
   It is selected as the first boot option. It should be moved to second boot option.
   ```
   efibootmgr -o 000C,0013,000A,000B,000D,000E,000F,0011,0010,0012,0009,0000,0001,0002,0003,0004,0005,0006,0007,0008
   ```
   The actual number for entries depends on the system configuration.

5. Check the system configuration by typing:
   ```
   efibootmgr -v
   ```

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

7. 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.

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

   Total Devices report “1”.

   State reports as “clean, degraded”.

   /dev/sdb3 has become /dev/sda3

   It is the only available disk.
Recover the RAID system

1. Prepare a new disk, partitioned as previously described.
2. From the boot menu, choose `rhel-redundant`.
3. The new disk is shown as `/dev/sda`.
4. The original second disk will appear as `/dev/sdb`.
5. Type the following command to add the new `/dev/sda3` to rebuild the RAID.
   ```bash
   mdadm --add /dev/md/root /dev/sda3
   ```
6. Enter the following command:
   ```bash
   mdadm --detail /dev/md/root
   ```
7. The State will change to “clean, degraded, recovering” and the Rebuild Status will report “75% complete” (or other progress number).
8. Once the rebuild has completed, State will report as “clean”.
9. The recovery is complete.
Complete the recovery process

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

1. To replicate the ESP from /dev/sdb1 back to /dev/sda1, enter the following command.
   ```
   dd -if=/dev/sdb1 -of=/dev/sda1
   ```
2. To remove the existing RHEL boot entry, enter the following command.
   ```
   efibootmgr -b 0C -B
   ```
3. Create new entry for the replicated ESP by entering the following command:

   efibootmgr -c -d /dev/sda -p 1 -l \EFI\redhat\shimx64.efi -L rhel-redundant2

4. Reorder boot sequence by entering the following command:

   efibootmgr -o

   00013,000C,000A,000B,000D,000E,000F,0011,0010,0012,0009,0000,0001,0002,0004,0005,0006,0007,0008,0003
Red Hat Enterprise Linux (RHEL) 6

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 6.9 DVD image.
   a. Select rescue from the GRUB boot menu.

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

   Select “Continue”, then start the shell.

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

   parted /dev/sda mklabel gpt

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

8. The following is displayed:

9. parted /dev/sda mkpart primary fat32 0 200MiB
   a. Type “Ignore” to ignore the size mismatch.

10. The following is displayed:

11. parted /dev/sda mkpart primary ext2 200MiB 16GiB

12. parted /dev/sda print
   a. Refer to the screenshot for detail partitioning instruction and information for /dev/sda.
b. Repeat step 5 for the second disk (/dev/sdb).

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

c. 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.

1. Select “Basic Storage Device” in the installation device selection menu:
2. Select “Create Custom Layout” in the installation type selection menu:

The following is displayed:

<table>
<thead>
<tr>
<th>Device</th>
<th>Size (MB)</th>
<th>Mount Point/ Filesystem</th>
<th>Type</th>
<th>Format</th>
</tr>
</thead>
<tbody>
<tr>
<td>sda1</td>
<td>199</td>
<td>Unknown</td>
<td></td>
<td></td>
</tr>
<tr>
<td>sda2</td>
<td>16184</td>
<td>Unknown</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Free</td>
<td>460556</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>sdb1</td>
<td>199</td>
<td>Unknown</td>
<td></td>
<td></td>
</tr>
<tr>
<td>sdb2</td>
<td>16184</td>
<td>Unknown</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Free</td>
<td>460556</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
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

1. Select sda2 under sda, then click Edit.
2. Click “Format as:” and select swap.
3. 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 \texttt{ext4}, RAID Device is \texttt{md0} and RAID Level is \texttt{RAID1}. Check \texttt{sda} and \texttt{sdb}, then click \texttt{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/sdal` to `/dev/sdb1`, enter the following command.

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

   “if” means the input and “of” is the output.
Creating a New Entry in UEFI Boot Manager

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

1. To list the entries in the EFI boot manager, type the following command:
   ```
   efibootmgr -v
   ```

2. The screenshot shows that entry Boot000C is the RHEL entry created by the installer.

3. 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"
   ```

4. The “rhel-redundant” entry is created as Boot0017.

5. It is selected as the first boot option. It should be moved to second boot option.
   ```
   efibootmgr -o 000C,0017,0000,0001,0003,0004,0005,0006,0007,0008,0009,000A,000B,000D,000E,000F,0010,0011,0012,0013,0014,0015,0016
   ```
6. The actual number for entries depends on the system configuration.
7. Check the system configuration by typing:
   ```bash
   efibootmgr -v
   ```
8. Verify the boot entry by rebooting the system.
9. Press **F11** to go to the boot menu.
10. Choose **rhel-redundant** from the boot menu.
11. 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.
Examine the status of the RAID configuration using the following command.

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

- Total Devices report “1”.
- State reports as “clean, degraded”.
- /dev/sdb3 has become /dev/sda3
  
  It is the only available disk.

Recover the RAID system

1. Prepare a new disk, partitioned as previously described.
2. From the boot menu, choose `rhel-redundant`.
   
   The new disk is shown as `/dev/sda`.
   
   The original second disk will appear as `/dev/sdb`.
3. Type the following command to add the new `/dev/sda3` to rebuild the RAID.

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

   ```
   mdadm --detail /dev/md/root
   ```
   
   The State will change to “clean, degraded, recovering” and the Rebuild Status will report “75% complete” (or other progress number).
5. Once the rebuild has completed, State will report as “clean”.
6. The recovery is complete.
Complete the recovery process

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

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

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

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

   ```bash
efibootmgr -b 0C -B
   ```

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

   ```bash
efibootmgr -c -d /dev/sda -p 1 -l \EFI\redhat\grub.efi -L rhel-redundant2
   ```
19. Reorder boot sequence by entering the following command:

```
efibootmgr -o 0017,000C,0000,0001,0002,0003,0004,0005,0006,0007,0008,0009,000A,000B,000D,000E,000F,0010,0012,0013,0014,0015,0016
```

SuSE Linux Enterprise Server (SLES) 12

Installation process

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

Partitioning drives for SLES

1. From the Suggested Partitioning screen, select **Expert Partitioner**...
2. Delete the Expert Partitioner default partition scheme.

3. Partition /dev/sda as follows:
   
   /dev/sda1, size = 200MB, mount point = /boot/efi, format as “FAT”

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

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

4. After successfully partitioning the first disk, use **Expert > Clone this disk**... function to clone the partition scheme to the second disk.
5. In the RAID section, create a RAID1 that includes `/dev/sda3` and `/dev/sdb3`:
   a. Click RAID.
   b. Choose RAID1 (mirroring).
   c. Select each partition and click Add to move them to Selected Devices.
6. Accept default setting such as 4KB Chunk Size, format as XFS and mount it to "/" (root).

7. Click Finish.

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

9. Proceed to finish the installation

Creating the Redundant ESP

1. Log in to SLES.
2. To clone the ESP partition from /dev/sda1 to /dev/sdb1, type the following command.
   ```
   dd if=/dev/sda1 of=/dev/sdb1
   ```
3. "If" means the input, and "of" is the output.

Creating a New Entry in the UEFI Boot Manager

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

1. To list the entries in the EFI boot manager, type the following command.
   ```
   efibootmgr -v
   ```
2. The following screenshot shows that entry Boot0011 is the SLES entry created by the installer.
3. Create a new entry and name it `sles-secureboot2`.

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

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 into the system to verify it works.

8. 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.

Examine the RAID status

1. To examine the status of the RAID configuration, enter the following:
   
   ```bash
   mdadm --detail /dev/md0
   ```
   
   - Total Devices became “1”.
   - State changed to “clean, degraded”.
   - Disk /dev/sdb3 has become /dev/sda3.

2. It is the only available disk.
Add two additional kernel parameters to allow booting from the second disk

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

1. From the GRUB menu, press the e key to edit the kernel parameter.
2. Find the line ending with crashkernel=72M,low
3. Append rd.shell rd.debug
4. Press Ctrl-x or F10 to boot with the new setting.
5. This is a one-time setting only. It will not impact subsequent boots.

6. After a few minutes, the screen will enter a rescue shell.
Recovering the failed partition

1. Prepare a new disk portioned as described in “Partitioning a drive for SLES.”
2. Boot from the “sles-secureboot2”.
3. Make sure proper kernel parameters (rd.shell rd.debug) were added to enter the rescue shell.
4. The new disk will be shown as /dev/sda, and the original second disk will appear as /dev/sdb.
5. To add the new /dev/sda3 to rebuild the RAID, type the following command in the rescue shell.

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

6. Enter the following command.

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

7. The State will change to “clean, degraded, recovering” and the Rebuild Status “75% complete” (or other progress number).
8. Once the rebuild has completed, the State will change to “clean”,
9. The recovery is complete.
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.
2. `dd –if=/dev/sdb1 –of=/dev/sda1`
3. Remove the existing SLES boot entry:
4. `efibootmgr –b 11 –B`

1. Create new entry for the replicated ESP:
   ```
   efibootmgr –c –d /dev/sda –p 1 –l \EFI\sles\shim.efi -L “sles-secureboot2”
   ```
2. Reorder the boot sequence:
   ```
   efibootmgr –o
   0012,0011,0002,0000,0003,0004,0005,0006,0007,0008,0009,0001,0001,0000
   A,000B,000D,000C
   ```
SuSE Linux Enterprise Server (SLES) 11

Installation process

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

Partitioning drives for SLES

1. From the Installation Settings screen, select Partitioning...
2. In the Preparing Hard Disk screen, select **Custom Partitioning (for experts)**

3. Delete the Expert Partitioner default partition scheme.

4. 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.
5. After successfully partitioning the first disk, use **Expert > Clone this disk...** function to clone the partition scheme to the second disk.
6. 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.

7. Format as XFS and mount it to "/" (root).
8. Click Finish.

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 Boot0013 is the SLES entry created by the installer.
3. Create a new entry and name it ‘sles-secureboot2’.
   ```bash
efibootmgr -c -d /dev/sdb -p 1 -l \"efi\SuSE\elilo.efi\" -L “sles-secureboot2”
   ```

4. The “sles-secureboot2” entry will be created as Boot000C.

5. This process will place it as the first boot option. Move it to the second boot option.
   ```bash
efibootmgr -o 0013,000C,000A,000B,000D,000E,0011,0010,0012,0009,0000,0001,0002,0004,0005,0006,0007,0008,0003
   ```
6. The actual number of entries depends on the system configuration. Check the entries by entering:
   efibootmgr -v

7. Verify the boot entry by rebooting the system, press F11 to the boot menu. "sles-secureboot2" should be in the boot menu.

8. Boot into the system to verify it works.

9. 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.

![RAID status command output](Image)

Recovering the failed partition

1. Prepare a new disk portioned as described in “Partitioning a drive for SLES.”
2. Boot from the “sles-secureboot2”.
3. Make sure proper kernel parameters (rd.shell rd.debug) were added to enter the rescue shell.
4. The new disk will be shown as `/dev/sda`, and the original second disk will appear as `/dev/sdb`.
5. To add the new `/dev/sda3` to rebuild the RAID, type the following command in the rescue shell.
   
   `mdadm --add /dev/md0 /dev/sda3`

6. Enter the following command.
   
   `mdadm --detail /dev/md0`

7. The State will change to “clean, degraded, recovering” and the Rebuild Status “75% complete” (or other progress number).
8. Once the rebuild has completed, the State will change to “clean”.
9. The recovery is complete.
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.
   
   \[ \text{dd -if=/dev/sdb1 -of=/dev/sda1} \]

2. Remove the existing SLES boot entry:
   
   \[ \text{efibootmgr -b 11 -B} \]

3. Create new entry for the replicated ESP:
   
   \[ \text{efibootmgr -c -d /dev/sda -p 1 -l \\
   /efi\SuSE\elilo.efi -L "sles-secureboot3"} \]

4. Reorder the boot sequence:
   
   \[ \text{efibootmgr -o 0012,0011,0002,0000,0003,0004,0005,0006,0007,0008,0009,0001,0002,0003,0004,0005,0006,0007,0008,0009,0010,000A,000B,000D,000C} \]
Appendix B: Example server configurations

PXE server configuration

The PXE configuration file is located in `/data/tftpboot/EFI/elilo.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=RHEL-7Server-x86_64_ks #The default boot entry.
```

# For RHEL 7.4 Single Machine Deployment
```
image=/RHEL/RHEL-7.4Server-x86_64/vmlinuz
label=RHEL-7Server-x86_64_ks
description = "RHEL 7.x Server RAID1 kickstart"
initrd=/RHEL/RHEL-7.4Server-x86_64/initrd.img
append="ipv6disable=1
inst.ks=http://172.1.1.100/answers/RHEL7_RAID1_ks.cfg" #The place to change file path.
```

# For RHEL 6.9 Single Machine Deployment
```
image=/RHEL/RHEL-6.9Server-x86_64/vmlinuz
label=RHEL-6Server-x86_64_ks
description = "RHEL 6.x Server RAID1 kickstart"
initrd=/RHEL/RHEL-6.9Server-x86_64/initrd.img
append="ipv6disable=1
inst.ks=http://172.1.1.100/answers/RHEL6_RAID1_ks.cfg" #The place to change file path.
```

# For SLES 12 SP3 Single Machine Deployment
TFTP server configuration

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

```plaintext
# 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
```

# For SLES 11 SP4 Single Machine Deployment

```plaintext
image=/SLE/SLES-11-SP4-x86_64/linux
label=SLES-11-SP4-x86_64
description = "SLES 11 RAID1 AutoYast"
initrd=/SLE/SLES-11-SP4-x86_64/initrd
append="vga=normal netdev=eth1
autoyast=http://172.1.1.100/answers/SLES11_RAID1_autoinst.xml install=http://172.1.1.100/mrepo/SLES-11-SP4-x86_64/disc1" #The place to change file 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

For the example KickStart script, see http://downloads.linux.hpe.com/SDR/project/lsrb/current/RHEL7_RAID1_ks.cfg

Place the script in your local TFTP server where your PXE installation can connect to it. In RHEL 7, you will need one extra package, which is can be downloaded from: http://downloads.linux.hpe.com/SDR/project/lsrb/current/lsrrb-latest.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

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

<table>
<thead>
<tr>
<th>Parameter Name</th>
<th>Description and Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>url</td>
<td>The URL for the RHEL installation media</td>
</tr>
<tr>
<td></td>
<td>url -url “<a href="http://172.1.1.100/mrepo/RHEL-7.4Server-x86_64/disc1/%E2%80%9D">http://172.1.1.100/mrepo/RHEL-7.4Server-x86_64/disc1/”</a></td>
</tr>
<tr>
<td>rootpw</td>
<td>The password for the root user</td>
</tr>
<tr>
<td></td>
<td>rootpw -plaintext “Passw0rd”</td>
</tr>
<tr>
<td>%packages … %end</td>
<td>Packages to install</td>
</tr>
<tr>
<td></td>
<td>%packages</td>
</tr>
<tr>
<td></td>
<td>@base</td>
</tr>
<tr>
<td></td>
<td>@core</td>
</tr>
<tr>
<td></td>
<td>wget</td>
</tr>
<tr>
<td></td>
<td>net-tools</td>
</tr>
<tr>
<td></td>
<td>dhcp</td>
</tr>
<tr>
<td></td>
<td>mdadm</td>
</tr>
<tr>
<td></td>
<td>gdisk</td>
</tr>
</tbody>
</table>
part Disk partition information. This example creates a 256 MB ESP partition, a 16384 RAID MB swap partition, and a raid volume that takes the remaining space. (For NVMe disks, replace sda with nvme0n1p1 and sdb with nvme1n1p1)

```bash
part /boot/efi --fstype=efi --ondisk=sda --size=256
part swap --fstype=swap --ondisk=sda -size=16384
part raid.01 --fstype=raid --ondisk=sda --size=1 --grow
part none.01 --fstype=efi --ondisk=sdb --size=256
part none.02 --fstype=vfat --ondisk=sdb --size=16384
part raid.02 --fstype=raid
```

raid RAID configuration

```bash
raid / --device=md0 --fstype=xfs --level=1 raid.01
raid.02
```

%post Specify the log path for the post-install scripts

```bash
%post --interpreter /bin/bah --log /var/log/ks.cfg.log
```

wget The path to get the RPM package

```bash
wget -P /tmp http://172.1.1.100/answers/mdsync/lsrrb-latest.x86_64.rpm
```

KickStart Script for RHEL 6

For the example KickStart script, see http://downloads.linux.hpe.com/SDR/project/lsrrb/current/RHEL6_RAID1_ks.cfg

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

In RHEL 6, you will need one extra package, which is can be downloaded from: http://downloads.linux.hpe.com/SDR/project/lsrrb/current/lsrrb-latest.rhel6.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

In the KickStart script, there are configurable parameters that user should adjust to fit the deployment environments.
<table>
<thead>
<tr>
<th>Parameter Name</th>
<th>Description and Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>url</td>
<td>The URL for the RHEL installation media</td>
</tr>
<tr>
<td></td>
<td>url -url &quot;<a href="http://172.1.1.100/mrepo/RHEL-6.9Server-x86_64/disc1/">http://172.1.1.100/mrepo/RHEL-6.9Server-x86_64/disc1/</a>&quot;</td>
</tr>
<tr>
<td>rootpw</td>
<td>The password for the root user</td>
</tr>
<tr>
<td></td>
<td>rootpw -plaintext &quot;Passw0rd&quot;</td>
</tr>
<tr>
<td>%packages ... %end</td>
<td>Packages to install</td>
</tr>
<tr>
<td></td>
<td>%packages @base @core wget net-tools dhcp mdadm gdisk smartmontools %end</td>
</tr>
<tr>
<td>part</td>
<td>Disk partition information. This example creates a 256 MB ESP partition, a 16384RAID MB swap partition, and a raid volume that takes the remaining space. (For NVMe disks, replace sda with nvme0n1p1 and sdb with nvme1n1p1)</td>
</tr>
<tr>
<td></td>
<td>part /boot/efi --fstype=efi --ondisk=sda --size=256</td>
</tr>
<tr>
<td></td>
<td>part swap --fstype=swap --ondisk=sda -size=16384</td>
</tr>
<tr>
<td></td>
<td>part raid.01 --fstype=raid --ondisk=sda --size=1 --grow</td>
</tr>
<tr>
<td></td>
<td>part none.01 --fstype=efi --ondisk=sdb --size=256</td>
</tr>
<tr>
<td></td>
<td>part none.02 --fstype=vmfat --ondisk=sdb --size=16384</td>
</tr>
<tr>
<td></td>
<td>part raid.02 --fstype=raid</td>
</tr>
<tr>
<td>raid</td>
<td>RAID configuration</td>
</tr>
<tr>
<td></td>
<td>raid / --device/md0 --fstype=xfs --level=1 raid.01 raid.02</td>
</tr>
<tr>
<td>%post</td>
<td>Specify the log path for the post-install scripts</td>
</tr>
<tr>
<td></td>
<td>%post --interpreter /bin/bah --log /var/log/ks.cfg.log</td>
</tr>
</tbody>
</table>
Parameter Name | Description and Example
---|---
wget | The path to get the RPM package.

```
wget -P /tmp http://172.1.1.100/answers/mdsync/lsrrb-latest.rhel6.x86_64.rpm
```

AutoYast Script for SLES 12

For the example AutoYast script, see (use wget to retrieve the file)
[http://downloads.linux.hpe.com/SDR/project/lsrrb/current/SLES12_RAID1_autoinst.xml](http://downloads.linux.hpe.com/SDR/project/lsrrb/current/SLES12_RAID1_autoinst.xml)

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

In SLES 12, you will need one extra package, which can be downloaded from:
[http://downloads.linux.hpe.com/SDR/project/lsrrb/current/lsrrb-latest.x86_64.rpm](http://downloads.linux.hpe.com/SDR/project/lsrrb/current/lsrrb-latest.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

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

<table>
<thead>
<tr>
<th>Parameter Name</th>
<th>Description and Example</th>
</tr>
</thead>
</table>
wget | The path to get the RPM package.

```
wget -P /tmp http://172.1.1.100/answers/mdsync/lsrrb-latest.x86_64.rpm
```
Hard drive configuration. Check the AutoYast file. This example is for two identical 500GB hard drives. Each drive is partitioned as 1) 187 MB ESP partition; 2) 16 GB of swap partition; 3) remaining 482 GB for data. (For NVMe disks, replace sda with nvme0n1p1 and sdb with nvme1n1p1)

The RAID device /dev/md0 will be create to include /dev/sda3 and /dev/sdb3.

<drive>  # Where to modify HD partitions. Default is for the two 500G HDs.
<device>/dev/md0</device>
<disklabel>msdos</disklabel>
<enable_snapshots config:type="boolean">true</enable_snapshots>
<initialize config:type="boolean">true</initialize>
<partitions config:type="list">
    <partition>
        <create config:type="boolean">true</create>
        <crypt_fs config:type="boolean">false</crypt_fs>
        <filesystem config:type="symbol">xfs</filesystem>
        <format config:type="boolean">true</format>
        <loop_fs config:type="boolean">false</loop_fs>
        <mount>/</mount>
        <mountby config:type="symbol">uuid</mountby>
        <partition_nr config:type="integer">0</partition_nr>
        <raid_options>
            <device_order config:type="list">
                <device>/dev/sda3</device>
                <device>/dev/sdb3</device>
            </device_order>
            <persistent_superblock config:type="boolean">false</persistent_superblock>
            <raid_type>raid1</raid_type>
        </raid_options>
    </partition>
</partitions>
</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>
    </partition>
</partitions>
</drive>
<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>
</partition>
</partitions>
</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>
</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>
</partition>
</partitions>
</drive>
<table>
<thead>
<tr>
<th>Parameter Name</th>
<th>Description and Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;size&gt;196247040&lt;/size&gt;</td>
<td>&lt;/partition&gt;</td>
</tr>
<tr>
<td>&lt;partition&gt;</td>
<td>&lt;/partition&gt;</td>
</tr>
<tr>
<td>&lt;create config:type=&quot;boolean&quot;&gt;true&lt;/create&gt;</td>
<td>&lt;/create&gt;</td>
</tr>
<tr>
<td>&lt;crypt_fs config:type=&quot;boolean&quot;&gt;false&lt;/crypt_fs&gt;</td>
<td>&lt;/crypt_fs&gt;</td>
</tr>
<tr>
<td>&lt;filesystem config:type=&quot;symbol&quot;&gt;swap&lt;/filesystem&gt;</td>
<td>&lt;/filesystem&gt;</td>
</tr>
<tr>
<td>&lt;format config:type=&quot;boolean&quot;&gt;true&lt;/format&gt;</td>
<td>&lt;/format&gt;</td>
</tr>
<tr>
<td>&lt;loop_fs config:type=&quot;boolean&quot;&gt;false&lt;/loop_fs&gt;</td>
<td>&lt;/loop_fs&gt;</td>
</tr>
<tr>
<td>&lt;mount&gt;swap&lt;/mount&gt;</td>
<td>&lt;/mount&gt;</td>
</tr>
<tr>
<td>&lt;mountby config:type=&quot;symbol&quot;&gt;uuid&lt;/mountby&gt;</td>
<td>&lt;/mountby&gt;</td>
</tr>
<tr>
<td>&lt;partition_id config:type=&quot;integer&quot;&gt;130&lt;/partition_id&gt;</td>
<td>&lt;/partition_id&gt;</td>
</tr>
<tr>
<td>&lt;partition_nr config:type=&quot;integer&quot;&gt;2&lt;/partition_nr&gt;</td>
<td>&lt;/partition_nr&gt;</td>
</tr>
<tr>
<td>&lt;resize config:type=&quot;boolean&quot;&gt;false&lt;/resize&gt;</td>
<td>&lt;/resize&gt;</td>
</tr>
<tr>
<td>&lt;size&gt;17174789632&lt;/size&gt;</td>
<td>&lt;/size&gt;</td>
</tr>
<tr>
<td>&lt;/partition&gt;</td>
<td>&lt;/partition&gt;</td>
</tr>
<tr>
<td>&lt;partition&gt;</td>
<td>&lt;/partition&gt;</td>
</tr>
<tr>
<td>&lt;create config:type=&quot;boolean&quot;&gt;true&lt;/create&gt;</td>
<td>&lt;/create&gt;</td>
</tr>
<tr>
<td>&lt;crypt_fs config:type=&quot;boolean&quot;&gt;false&lt;/crypt_fs&gt;</td>
<td>&lt;/crypt_fs&gt;</td>
</tr>
<tr>
<td>&lt;format config:type=&quot;boolean&quot;&gt;false&lt;/format&gt;</td>
<td>&lt;/format&gt;</td>
</tr>
<tr>
<td>&lt;loop_fs config:type=&quot;boolean&quot;&gt;false&lt;/loop_fs&gt;</td>
<td>&lt;/loop_fs&gt;</td>
</tr>
<tr>
<td>&lt;mountby config:type=&quot;symbol&quot;&gt;device&lt;/mountby&gt;</td>
<td>&lt;/mountby&gt;</td>
</tr>
<tr>
<td>&lt;partition_id config:type=&quot;integer&quot;&gt;253&lt;/partition_id&gt;</td>
<td>&lt;/partition_id&gt;</td>
</tr>
<tr>
<td>&lt;partition_nr config:type=&quot;integer&quot;&gt;3&lt;/partition_nr&gt;</td>
<td>&lt;/partition_nr&gt;</td>
</tr>
<tr>
<td>&lt;raid_name&gt;/dev/md0&lt;/raid_name&gt;</td>
<td>&lt;/raid_name&gt;</td>
</tr>
<tr>
<td>&lt;resize config:type=&quot;boolean&quot;&gt;false&lt;/resize&gt;</td>
<td>&lt;/resize&gt;</td>
</tr>
<tr>
<td>&lt;size&gt;482711076352&lt;/size&gt;</td>
<td>&lt;/size&gt;</td>
</tr>
<tr>
<td>&lt;/partition&gt;</td>
<td>&lt;/partition&gt;</td>
</tr>
<tr>
<td>&lt;/partitions&gt;</td>
<td>&lt;/partitions&gt;</td>
</tr>
<tr>
<td>&lt;pesize/&gt;</td>
<td>&lt;/pesize/&gt;</td>
</tr>
<tr>
<td>&lt;type config:type=&quot;symbol&quot;&gt;CT_DISK&lt;/type&gt;</td>
<td>&lt;/type&gt;</td>
</tr>
<tr>
<td>&lt;use&gt;all&lt;/use&gt;</td>
<td>&lt;/use&gt;</td>
</tr>
<tr>
<td>&lt;/drive&gt;</td>
<td>&lt;/drive&gt;</td>
</tr>
</tbody>
</table>

**<http_proxy>**
... 
**</http_proxy>**

The http proxy used in the deployment environment.

**<http_proxy>http://proxy:port</http_proxy>**
<table>
<thead>
<tr>
<th>Parameter Name</th>
<th>Description and Example</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>&lt;software&gt;</code></td>
<td>The software packages to install.</td>
</tr>
<tr>
<td>...</td>
<td></td>
</tr>
<tr>
<td><code>&lt;/software&gt;</code></td>
<td></td>
</tr>
<tr>
<td><code>&lt;users&gt;</code></td>
<td>The users described in this section will be created. In the example, user 'hpe' will be created with password 'Passw0rd'.</td>
</tr>
<tr>
<td><code>&lt;/users&gt;</code></td>
<td></td>
</tr>
</tbody>
</table>

### AutoYast Script for SLES 11

For the example AutoYast script, see (use wget to retrieve the file)

http://downloads.linux.hpe.com/SDR/project/lsrrb/current/SLES11_RAID1_autoinst.xml

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

In SLES 11, you will need one extra package, which can be downloaded from:

http://downloads.linux.hpe.com/SDR/project/lsrrb/current/lsrrb-latest.sles11.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

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

<table>
<thead>
<tr>
<th>Parameter Name</th>
<th>Description and Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>wget</td>
<td>The path to get the RPM package.</td>
</tr>
<tr>
<td></td>
<td><code>wget -P /tmp http://172.1.1.100/answers/mdsync/lsrrb-latest.sles11.x86_64.rpm</code></td>
</tr>
<tr>
<td>&lt;drive&gt;</td>
<td>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)</td>
</tr>
<tr>
<td></td>
<td>The RAID device <code>/dev/md0</code> will be create to include <code>/dev/sda3</code> and <code>/dev/sdb3</code>.</td>
</tr>
<tr>
<td>&lt;drive&gt; #</td>
<td># Where to modify HD partitions. Default is for the two 500G HDs.</td>
</tr>
<tr>
<td>&lt;device&gt;/dev/md0 device&gt;</td>
<td></td>
</tr>
<tr>
<td>&lt;disklabel&gt;msdos disklabel&gt;</td>
<td></td>
</tr>
<tr>
<td>&lt;enable_snapshots config:type=&quot;boolean&quot;&gt;true&lt;enable_snapshots&gt;</td>
<td></td>
</tr>
<tr>
<td>&lt;initialize config:type=&quot;boolean&quot;&gt;true&lt;initialize&gt;</td>
<td></td>
</tr>
<tr>
<td>&lt;partitions config:type=&quot;list&quot;&gt;</td>
<td></td>
</tr>
<tr>
<td>&lt;partition&gt;</td>
<td></td>
</tr>
<tr>
<td>&lt;create config:type=&quot;boolean&quot;&gt;true&lt;create&gt;</td>
<td></td>
</tr>
<tr>
<td>&lt;crypt_fs config:type=&quot;boolean&quot;&gt;false&lt;crypt_fs&gt;</td>
<td></td>
</tr>
<tr>
<td>&lt;filesystem config:type=&quot;symbol&quot;&gt;xfs&lt;filesystem&gt;</td>
<td></td>
</tr>
<tr>
<td>&lt;format config:type=&quot;boolean&quot;&gt;true&lt;format&gt;</td>
<td></td>
</tr>
<tr>
<td>&lt;loop_fs config:type=&quot;boolean&quot;&gt;false&lt;loop_fs&gt;</td>
<td></td>
</tr>
<tr>
<td>&lt;mount&gt;/&lt;/mount&gt;</td>
<td></td>
</tr>
<tr>
<td>&lt;mountby config:type=&quot;symbol&quot;&gt;uuid&lt;mountby&gt;</td>
<td></td>
</tr>
<tr>
<td>&lt;partition_nr config:type=&quot;integer&quot;&gt;0&lt;partition_nr&gt;</td>
<td></td>
</tr>
<tr>
<td>&lt;raid_options&gt;</td>
<td></td>
</tr>
<tr>
<td>&lt;device_order config:type=&quot;list&quot;&gt;</td>
<td></td>
</tr>
<tr>
<td>&lt;device&gt;/dev/sda3&lt;device&gt;</td>
<td></td>
</tr>
<tr>
<td>&lt;device&gt;/dev/sdb3&lt;device&gt;</td>
<td></td>
</tr>
<tr>
<td>&lt;/device_order&gt;</td>
<td></td>
</tr>
<tr>
<td>&lt;persistent_superblock config:type=&quot;boolean&quot;&gt;false&lt;persistent_superblock&gt;</td>
<td></td>
</tr>
<tr>
<td>&lt;raid_type&gt;raid1&lt;/raid_type&gt;</td>
<td></td>
</tr>
<tr>
<td>&lt;/raid_options&gt;</td>
<td></td>
</tr>
<tr>
<td>&lt;resize config:type=&quot;boolean&quot;&gt;false&lt;resize&gt;</td>
<td></td>
</tr>
<tr>
<td>&lt;/partition&gt;</td>
<td></td>
</tr>
<tr>
<td>&lt;/partitions&gt;</td>
<td></td>
</tr>
<tr>
<td>&lt;pesize/&gt;</td>
<td></td>
</tr>
<tr>
<td>&lt;type config:type=&quot;symbol&quot;&gt;CT_MD&lt;/type&gt;</td>
<td></td>
</tr>
<tr>
<td>&lt;use&gt;all&lt;/use&gt;</td>
<td></td>
</tr>
<tr>
<td>&lt;/drive&gt;</td>
<td></td>
</tr>
</tbody>
</table>
<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>
      <filesystem config:type="boolean">false</filesystem>
      <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>
    <filesystem config:type="symbol">swap</filesystem>
    <format config:type="boolean">true</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>
<type config:type="symbol">CT_DISK</type>
<use>all</use>
</drive>

<http_proxy>
... http://proxy:port ...
</http_proxy>

The http proxy used in the deployment environment.

<http_proxy>http://proxy:port</http_proxy>
The software packages to install.

```
<software>
  <image/>
  <instsource/>

  <packages config:type="list">
    <package>xfsprogs</package>
    <package>sles-release</package>
    <package>shim</package>
    <package>mokutil</package>
    <package>mdadm</package>
    <package>numactl</package>
    <package>blkid</package>
    <package>kexec-tools</package>
    <package>kdump</package>
    <package>irgbalance</package>
    <package>grub2-x86_64-efi</package>
    <package>glibc</package>
    <package>efibootmgr</package>
    <package>dosfstools</package>
    <package>perl-Bootloader-YAML</package>
  </packages>

  <patterns config:type="list">
    <pattern>apparmor</pattern>
    <pattern>x11</pattern>
    <pattern>documentation</pattern>
    <pattern>base</pattern>
    <pattern>gnome-basic</pattern>
    <pattern>Minimal</pattern>
    <pattern>32bit</pattern>
  </patterns>
</software>
```

The users described in this section will be created. In the example, user 'hpe' will be created with password 'Passw0rd'.
Appendix D Support for Gen10 and AMD Platform

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

The following platforms are covered:

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

The operating systems covered in this section are:

- Red Hat Enterprise Linux 7
- SuSE Linux Enterprise Server 12

AMD Platform with AMD FCH AHCI Controller

Red Hat Enterprise Linux (RHEL) 7

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 7.4 DVD image.
   a. Select Troubleshooting > Rescue a Red Hat Enterprise Linux system.
   b. Select 1) Continue.

   The following prompt is displayed:
c. 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


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

   The following is displayed:

   parted /dev/sdb mkpart primary fat32 0 200MB


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

   The following is displayed:

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

   Refer to the screenshot for detail partitioning instruction and information for /dev/sdb.
f. Repeat step 5 for the second disk (/dev/sdc).

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

g. Reboot to proceed with Red Hat installation.

**Normal Installation Process**

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

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

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

Specifying the swap directory

1. Select sda2 in the “Unknown” section.
2. In the File System dropdown, select **swap** and check **Reformat**.
3. Click Update Settings.
Creating root disk as RAID1

1. Click +.
2. To choose the root directory, enter “/” as mount point.
3. Enter “1000GB” in Desired Capacity.
   The system will calculate the correct size.
4. Click Add mount point.

Create a RAID1 root partition

1. Select / rhel-root in the left pane.
2. Select RAID in Device Type.
3. Choose xfs or other desired file system.
4. Make sure RAID1 (Redundancy) in RAID Level is selected.
5. In the Name field, type “root”.
6. Click Update Settings.
   The system will calculate the final size for the RAID partition.
   The system will create a new md device in /dev/md/root.
7. Continue the installation by clicking Done. The system will show a warning message. This message can be ignored.

Creating the Redundant ESP

1. Log in to Red Hat Enterprise Linux 7.4.
2. To clone the ESP partition from /dev/sda1 to /dev/sdb1, enter the following command.
   
   ```
   dd if=/dev/sda1 of=/dev/sdb1
   ```
   where “if” is the input file, and “of” is the output file.
3. For example output, see the following screenshot.

Creating a New Entry in UEFI Boot Manager

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

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

   ```
   efibootmgr -v
   ```
21. 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: 0000,0002,0003,0004,0005,0001
Boot0000= Red Hat Enterprise Linux 6B(1,22,5f5c0,fe0f9c92-333c-4cde-8aa4-3be2999c9f11)\EFI\redhat\shim.efi
Boot0001= EFI: Built-in EFI Shell Vendor:6e23295c-e326-423c-9d48-b467f66c8812
Boot0002= SanDisk, Partition 1 Path:1866350400f00a2,0004,0005,0001
Boot0003= EFI: SanDisk, Partition 1 Path:1866350400f00a2,0004,0005,0001
Boot0004= Red Hat Enterprise Linux-redundant
Boot0005= Red Hat Enterprise Linux-redundant
```

22. 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"
```

23. 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: 0000,0002,0003,0004,0005,0001
Boot0000= Red Hat Enterprise Linux 6B(1,22,5f5c0,fe0f9c92-333c-4cde-8aa4-3be2999c9f11)\EFI\redhat\shim.efi
Boot0001= EFI: Built-in EFI Shell Vendor:6e23295c-e326-423c-9d48-b467f66c8812
Boot0002= SanDisk, Partition 1 Path:1866350400f00a2,0004,0005,0001
Boot0003= EFI: SanDisk, Partition 1 Path:1866350400f00a2,0004,0005,0001
Boot0004= Red Hat Enterprise Linux-redundant
Boot0005= Red Hat Enterprise Linux-redundant
```

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

Check the system configuration by typing:

```
efibootmgr -v
```

25. 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.

26. Log in to the system.
Recovering a failed disk and repairing Software RAID

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

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

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

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

   It is the only available disk.

Recover the RAID system

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

   The new disk is shown as /dev/sda.
The original second disk will appear as /dev/sdb.

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

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

5. The recovery is complete.

---

Complete the recovery process

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

1. To replicate the ESP from /dev/sdb1 back to /dev/sda1, enter the following command.
   
   ```bash
   dd if=/dev/sdb1 of=/dev/sda1
   ```

2. Create new entry for the replicated ESP by entering the following command:
   
   ```bash
   efibootmgr -c -d /dev/sda -p 1 -l \EFI\redhat\shim.efi -L “Red Hat Enterprise Linux-redundant2”
   ```

3. Reorder the boot sequence by entering the following command:
   
   ```bash
   efibootmgr -o 0002,0000,0004,0005,0001
   ```
SuSE Linux Enterprise Server (SLES) 12 SP3

Installation process

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

Partitioning drives for SLES

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

2. Delete the Expert Partitioner default partition scheme.

3. Partition /dev/sda as follows:

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

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

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

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

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

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 SP3 and open a Terminal.

2. To clone the ESP partition from /dev/sda1 to /dev/sdb1, type the following command.
   
   ```bash
   dd if=/dev/sda1 of=/dev/sdb1
   ```
   
   where “If” is the input file, and “of” is the output file.

3. You should see something like below screenshot:
Creating a New Entry in the UEFI Boot Manager

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

1. To list the entries in the EFI boot manager, type the following command.
   
   `efibootmgr -v`

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

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

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

4. The "sles-secureboot-redundant" entry will be created as Boot0002.
   
   This process will place it as the first boot option. Move it to the second boot option.

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

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

   `efibootmgr -v`
6. Verify the boot entry by rebooting the system, press **F11** to the boot menu. “sles-secureboot-redundant” should be in the boot menu.

7. Boot in to the system to verify it works.

8. Log in the system.

![Boot Menu](image)

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.

![RAID Status](image)

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.
Recovering the failed partition

1. Prepare a new disk portioned as described in "Partitioning a drive for SLES."
2. Boot from "sles-secureboot-redundant".
3. Make sure the proper kernel parameters (rd.shell rd.debug) were added to enter the rescue shell.
4. The new disk will be shown as /dev/sda, and the original second disk will appear as /dev/sdb.
5. To add the new /dev/sda3 to rebuild the RAID, type the following command in the rescue shell.
   
   ```bash
   mdadm --add /dev/md0 /dev/sda3
   ```
6. Enter `mdadm --detail /dev/md0`

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

   Once the rebuild has completed, the State will change to "clean",
7. The recovery is complete.
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
   ```

3. Create new entry for the replicated ESP:
   
   ```
   efibootmgr -c -d /dev/sda -p 1 -l \EFI\sles\shim.efi -L “sles-secureboot-redundant2”
   ```

4. Reorder the boot sequence:
   
   ```
   efibootmgr -o 0002,0000,0004,0005,0001
   ```
SATA-based PCI-e M.2 SSD

Red Hat Enterprise Linux (RHEL) 7

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 7.4 DVD image.
   a. Select **Troubleshooting > Rescue a Red Hat Enterprise Linux system**.
   b. Select **1) Continue**.

   The following prompt is displayed:

```
Starting installer: one moment ...
anaconda 21.04.22.121-1 for Red Hat Enterprise Linux 7.4 started.
- installation key 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.textboot option 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
```

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

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

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

   The following is displayed:

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

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

   The following is displayed:

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

parted /dev/sda print
f. Refer to the screenshot for detail partitioning instruction and information for /dev/sda.

![Partitions on /dev/sda](image)

```
[anaconda root@localhost ~]# parted /dev/sda print
Model: ATA V80120GEJXL (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     primary
 2 200MB 16.0GB 15.8GB  primary     primary
```

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

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

![Partitions on /dev/sdb](image)

```
[anaconda root@localhost ~]# parted /dev/sdb print
Model: ATA V80120GEJXL (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     primary
 2 200MB 16.0GB 15.8GB  primary     primary
```

i. 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.
7. The ESP is the partition that contains the boot loaders used by the UEFI firmware.
8. Select sda1 under Unknown in the left pane.
9. Under File System, select **EFI System Partition** and check **Reformat**.
10. In the Mount Point field, enter `/boot/efi`.
11. 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

27. Select `/rhel-root` in the left pane.
28. Select RAID in Device Type.
29. Choose xfs or other desired file system.
30. Make sure RAID1 (Redundancy) in RAID Level is selected.
31. In the Name field, type "root".
32. Click Update Settings.
33. The system will calculate the final size for the RAID partition.
34. The system will create a new md device in `/dev/md/root`.

35. Continue the installation by clicking Done.
36. The system will show a warning message.
37. This message can be ignored.
Creating the Redundant ESP

1. Log in to Red Hat Enterprise Linux 7.4.
2. To clone the ESP partition from /dev/sda1 to /dev/sdb1, enter the following command.
   
   ```bash
   dd if=/dev/sda1 of=/dev/sdb1
   ```

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

Creating a New Entry in UEFI Boot Manager

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

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

   ```bash
   efibootmgr -v
   ```

   The screenshot shows that entry Boot0014 is the “Red Hat Enterprise Linux” entry created by the installer.
2. Create a new entry and name it “Red Hat Enterprise Linux-redundant” using the following command.

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

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

   efibootmgr -o

   0014,0000,0001,000A,000D,000F,000E,0010,0012,0011,000B,000C,0016,0018,0017,0002,0003,0004,0005,0006,0007,0008,0009,0013
The actual number for entries depends on the system configuration.

4. Check the system configuration by typing:
   ```
   efibootmgr -v
   ```

5. Verify the boot entry by rebooting the system.
   a. Press **F11** to go to the boot menu.
   b. Choose Red Hat Enterprise Linux-redundant from the boot menu.

6. Log in to the system.
Recovering a failed disk and repairing Software RAID

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

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

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

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

   It is the only available disk.
Recover the RAID system

1. Prepare a new disk, partitioned as previously described.
2. From the boot menu, choose Red Hat Enterprise Linux-redundant.
   The new disk is shown as /dev/sda.
   The original second disk will appear as /dev/sdb.
3. Type the following command to add the new /dev/sda3 to rebuild the RAID.
   ```bash
   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).
   Once the rebuild has completed, State will report as “clean”.
5. The recovery is complete.

Complete the recovery process
Repeat the process described in “Creating the Redundant ESP” to make a redundant copy of the ESP, and add a new entry to EFI Boot Manager to complete the recovery process.
1. To replicate the ESP from /dev/sdb1 back to /dev/sda1, enter the following command.
   
   ```
   dd if=/dev/sdb1 of=/dev/sda1
   ```

2. To remove the existing RHEL boot entry, enter the following command.
   
   ```
   efibootmgr -b 11 -B
   ```

3. Create new entry for the replicated ESP by entering the following command:
   
   ```
   efibootmgr -c -d /dev/sda -p 1 -l \EFI\redhat\shim.efi -L "Red Hat Enterprise Linux-redundant2"
   ```

4. Reorder boot sequence by entering the following command:
   
   ```
   efibootmgr -o
   ```

   ```
   0012,0011,0002,0000,0001,0003,0004,0005,0006,0007,0008,000A,0009,000C,000B
   ```
SuSE Linux Enterprise Server (SLES) 12 SP3

Installation process

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

Partitioning drives for SLES

1. From the Suggested Partitioning screen, select Expert Partitioner...
2. Delete the Expert Partitioner default partition scheme.

3. Partition /dev/sda as follows:
   /dev/sda1, size = 200MB, role as “EFI Boot Partition”, mount point = /boot/efi, format as “FAT”
   /dev/sda2, size = 16GB, role as “Swap”
   /dev/sda3, size = Maximum Size (rest of the disk space), role as “Raw Volume”.

4. After successfully partitioning the first disk, use **Expert > Clone this disk**... function to clone the partition scheme to the second disk.
5. In the RAID section, create a RAID1 that includes `/dev/sda3` and `/dev/sdb3`:
   a. Click RAID.
   b. Choose RAID1 (mirroring).
   c. Select each partition and click Add to move them to Selected Devices.
6. Set the following options: 4KB Chunk Size, role as “Operating System”, format as XFS and mount it to “/” (root).

7. Click Finish.

Examine the Device Graph. It should match the screenshot.
8. Examine the Mount Graph. It should match the screenshot.
9. Proceed to finish the installation

Creating the Redundant ESP

1. Log in to SLES 12 SP3 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:
   
   ```
   399360+0 records in
   399360+0 records out
   284472320 bytes (289 MB, 195 MiB) copied, 3.22669 s, 63.4 MB/s
   ```

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.

```
linux-kvm:~ # efibootmgr -v
BootCurrent: 0014
Timeout: 20 seconds
BootOrder: 0014,0000,000A,0000,000F,000E,0010,0012,0011,0008,000C,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 : VR0128EJXL
Boot000C* Embedded SATA Port 10 HDD : VR0128EJXL
Boot0010* Embedded LOM 1 Port 1 : HP Ethernet 1Gb 2-port 332i Adapter - NICS (HTTP(S) IPv4)
Boot0011* Embedded LOM 1 Port 2 : HP Ethernet 1Gb 2-port 332i Adapter - NICS (HTTP(S) IPv4)
Boot0012* Embedded LOM 1 Port 3 : HP Ethernet 1Gb 2-port 332i Adapter - NICS (HTTP(S) IPv4)
Boot0013* Embedded LOM 1 Port 4 : HP Ethernet 1Gb 2-port 332i Adapter - NICS (HTTP(S) IPv4)
Boot0014* Embedded LOM 1 Port 5 : HP Ethernet 1Gb 2-port 332i Adapter - NICS (HTTP(S) IPv4)
Boot0015* Embedded LOM 1 Port 6 : HP Ethernet 1Gb 2-port 332i Adapter - NICS (HTTP(S) IPv4)
Boot0016* Embedded LOM 1 Port 7 : HP Ethernet 1Gb 2-port 332i Adapter - NICS (HTTP(S) IPv4)
Boot0017* Embedded LOM 1 Port 8 : HP Ethernet 1Gb 2-port 332i Adapter - NICS (HTTP(S) IPv4)
Boot0018* Embedded LOM 1 Port 9 : HP Ethernet 1Gb 2-port 332i Adapter - NICS (HTTP(S) IPv4)
Boot0019* Embedded LOM 1 Port 10 : HP Ethernet 1Gb 2-port 332i Adapter - NICS (HTTP(S) IPv4)
Boot001A* Embedded LOM 1 Port 11 : HP Ethernet 1Gb 2-port 332i Adapter - NICS (HTTP(S) IPv4)
Boot001B* Embedded LOM 1 Port 12 : HP Ethernet 1Gb 2-port 332i Adapter - NICS (HTTP(S) IPv4)
Boot001C* Embedded LOM 1 Port 13 : HP Ethernet 1Gb 2-port 332i Adapter - NICS (HTTP(S) IPv4)
Boot001D* Embedded LOM 1 Port 14 : HP Ethernet 1Gb 2-port 332i Adapter - NICS (HTTP(S) IPv4)
Boot001E* Embedded LOM 1 Port 15 : HP Ethernet 1Gb 2-port 332i Adapter - NICS (HTTP(S) IPv4)
```

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

```
efibootmgr -c -d /dev/sdb -p 1 -l \\
```

```efi\sles\\shim.efi```

```
“sles-secureboot-redundant”
```

```
linux-kvm:~ # efibootmgr -v
BootCurrent: 0014
Timeout: 20 seconds
BootOrder: 0015,0014,0000,000A,0000,000F,000E,0010,0012,0011,0008,000C,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 : VR0128EJXL
Boot000C* Embedded SATA Port 10 HDD : VR0128EJXL
Boot0010* Embedded LOM 1 Port 1 : HP Ethernet 1Gb 2-port 332i Adapter - NICS (HTTP(S) IPv4)
Boot0011* Embedded LOM 1 Port 2 : HP Ethernet 1Gb 2-port 332i Adapter - NICS (HTTP(S) IPv4)
Boot0012* Embedded LOM 1 Port 3 : HP Ethernet 1Gb 2-port 332i Adapter - NICS (HTTP(S) IPv4)
Boot0013* Embedded LOM 1 Port 4 : HP Ethernet 1Gb 2-port 332i Adapter - NICS (HTTP(S) IPv4)
Boot0014* Embedded LOM 1 Port 5 : HP Ethernet 1Gb 2-port 332i Adapter - NICS (HTTP(S) IPv4)
Boot0015* Embedded LOM 1 Port 6 : HP Ethernet 1Gb 2-port 332i Adapter - NICS (HTTP(S) IPv4)
Boot0016* Embedded LOM 1 Port 7 : HP Ethernet 1Gb 2-port 332i Adapter - NICS (HTTP(S) IPv4)
Boot0017* Embedded LOM 1 Port 8 : HP Ethernet 1Gb 2-port 332i Adapter - NICS (HTTP(S) IPv4)
Boot0018* Embedded LOM 1 Port 9 : HP Ethernet 1Gb 2-port 332i Adapter - NICS (HTTP(S) IPv4)
Boot0019* Embedded LOM 1 Port 10 : HP Ethernet 1Gb 2-port 332i Adapter - NICS (HTTP(S) IPv4)
Boot001A* Embedded LOM 1 Port 11 : HP Ethernet 1Gb 2-port 332i Adapter - NICS (HTTP(S) IPv4)
Boot001B* Embedded LOM 1 Port 12 : HP Ethernet 1Gb 2-port 332i Adapter - NICS (HTTP(S) IPv4)
Boot001C* Embedded LOM 1 Port 13 : HP Ethernet 1Gb 2-port 332i Adapter - NICS (HTTP(S) IPv4)
Boot001D* Embedded LOM 1 Port 14 : HP Ethernet 1Gb 2-port 332i Adapter - NICS (HTTP(S) IPv4)
Boot001E* Embedded LOM 1 Port 15 : HP Ethernet 1Gb 2-port 332i Adapter - NICS (HTTP(S) IPv4)
```

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.
5. The actual number of entries depends on the system configuration. Check the entries by entering:
   
   ```
   efibootmgr -o
   0014,0015,0000,000A,000D,000F,000E,0010,0012,0011,000B,000C,0001,000
   2,0003,0004,0005,0006,0007,0008,0009
   ```

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 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.

Examine the RAID status

1. To examine the status of the RAID configuration, enter the following:
   
   ```bash
   mdadm --detail /dev/md0
   ```

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

   It is the only available disk.
Add two additional kernel parameters to allow booting from the second disk

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

1. From the GRUB menu, press the **e** key to edit the kernel parameter.
2. Find the line ending with `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.
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.
3. The new disk will be shown as /dev/sda, and the original second disk will appear as /dev/sdb.
4. To add the new /dev/sda3 to rebuild the RAID, type the following command in the rescue shell.
   ```bash
   mdadm --add /dev/md0 /dev/sda3
   ```
5. Enter `mdadm --detail /dev/md0`
   The State will change to "clean, degraded, recovering" and the Rebuild Status "75% complete" (or other progress number).
   Once the rebuild has completed, the State will change to "clean",
6. The recovery is complete.
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
   ```

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
   0012,0011,0002,0000,0003,0004,0005,0006,0007,0008,0009,0001,0001,000 A,000B,000D,000C
   ```
NVMe PCI-e Disk

Red Hat Enterprise Linux (RHEL) 7

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 7.4 DVD image.
   a. Select Troubleshooting > Rescue a Red Hat Enterprise Linux system.
   b. Select 1) Continue.

   The following prompt is displayed:
2. To create partitions on the first disk (/dev/nvme0n1), type the following commands.

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

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

The following is displayed:

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

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

5. The following is displayed:

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

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

```
sh-4.2m 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 17.1KB 200MB 200MB primary
2 200MB 16.8GB 15.8GB primary
```

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

a. Repeat step 5 for the second disk (/dev/nvme1n1).
7. 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.
8. Select `nvme0n1p1` under Unknown in the left pane.
9. Under File System, select **EFI System Partition** and check **Reformat**.
10. In the Mount Point field, enter `/boot/efi`.
11. Click Update Settings.

**Specifying the swap directory**

1. Select `nvme0n1p2` in the “Unknown” section.
2. In the File System dropdown, select **swap** and check **Reformat**.
3. Click Update Settings.
Creating root disk as RAID1

1. Click +.
2. To choose the root directory, enter “/” as mount point.
3. Enter “1000GB” in Desired Capacity.
   The system will calculate the correct size.
4. Click Add mount point.

Create a RAID1 root partition

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

5. Click Update Settings.

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

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

6. In the Name field, type “root”.

![Partitioning screen](image)

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 7.4.

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.

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.

```bash
efibootmgr -v
```

The screenshot shows that entry Boot000E 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.

```bash
efibootmgr -c -d /dev/nvme1n1 -p 1 -l \EFI\redhat\shim.efi -L "Red Hat Enterprise Linux-redundant"
```
3. The “Red Hat Enterprise Linux-redundant” entry is created as Boot0012. It is selected as the first boot option. It should be moved to second boot option.

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

   The actual number for entries depends on the system configuration.

4. Check the system configuration by typing:

   efibootmgr -v

5. Verify the boot entry by rebooting the system.
   a. Press F11 to go to the boot menu.
   b. Choose Red Hat Enterprise Linux-redundant from the boot menu.

6. Log in to the system.
Recovering a failed disk and repairing Software RAID

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

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

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

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

   It is the only available disk.
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.
   
   ```bash
   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.

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.

   \texttt{dd \textasciitilde if=/dev/nvme1n1p1 of=/dev/nvme0n1p1}

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

   \texttt{efibootmgr -b 11 -B}

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

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

4. Reorder boot sequence by entering the following command:

   \texttt{efibootmgr \-o \n   0012,0011,0002,0000,0001,0003,0004,0005,0006,0007,0008,000A,0009,000C,000B}
SuSE Linux Enterprise Server (SLES) 12 SP3

Installation process

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

Partitioning drives for SLES

1. From the Suggested Partitioning screen, select Expert Partitioner...
2. Delete the Expert Partitioner default partition scheme.

3. Partition /dev/sda as follows:
   
   - /dev/nvme0n1p1, size = 200MB, role as “EFI Boot Partition”, mount point = /boot/efi, format as “FAT”
   
   - /dev/nvme0n1p2, size = 16GB, role as “Swap”
   
   - /dev/nvme0n1p3, size = Maximum Size (rest of the disk space), role as “Raw Volume”.

4. After successfully partitioning the first disk, use **Expert > Clone this disk**… function to clone the partition scheme to the second disk.
5. In the RAID section, create a RAID1 that includes /dev/nvme0n1p3 and /dev/nvme1n1p3:
   a. Click RAID.
   b. Choose RAID1 (mirroring).
   c. Select each partition and click Add to move them to Selected Devices.
6. Set the following options: 4KB Chunk Size, role as “Operating System”, format as XFS and mount it to “/” (root).

7. Click **Finish**.

Examine the Device Graph. It should match the screenshot.
8. Examine the Mount Graph. It should match the screenshot.
9. Proceed to finish the installation

Creating the Redundant ESP

1. Log in to SLES 12 SP3 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.

   ![Screenshot of efibootmgr output]

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"
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,0000,00A,0015,0017,0016,000F,0011,000B,0012,0013,0001,000
2,0003,0004,0005,0006,0007,0008,0009
```

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

6. Verify the boot entry by rebooting the system, press F11 to the boot menu. “sles-secureboot-redundant” should be in the boot menu.

7. Boot in to the system to verify it works.

8. Log in the system.

Recovering a failed disk and repairing Software RAID

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

Examine the RAID status

1. To examine the status of the RAID configuration, enter the following:
   
   ```
   mdadm --detail /dev/md0
   ```

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

   It is the only available disk.
Add two additional kernel parameters to allow booting from the second disk

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

1. From the GRUB menu, press the **e** key to edit the kernel parameter.
2. Find the line ending with `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.
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.

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

   ```
   mdadm --add /dev/md0 /dev/nvme0n1p3
   ```

4. Enter `mdadm --detail /dev/md0`

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

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

5. The recovery is complete.
Complete the recovery process

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

1. Add a new entry to EFI Boot Manager to complete the recovery process.
2. Replicate the ESP from /dev/sdb1 back to /dev/sda1.
   ```
   dd if=/dev/nvme1n1p1 of=/dev/nvme0n1p1
   ```
3. Remove the existing SLES boot entry:
   ```
   efibootmgr -b 11 -B
   ```
4. Create new entry for the replicated ESP:
   ```
   efibootmgr -c -d /dev/nvme0n1 -p 1 -l \EFI\sles\shim.efi -L "sles-secureboot-redundant2"
   ```
5. Reorder the boot sequence:
   ```
   efibootmgr -o
   0012,0011,0002,0000,0003,0004,0005,0006,0007,0008,0009,0001,0001,0000
   A,000B,000D,000C
   ```
Support and other resources

Accessing Hewlett Packard Enterprise Support

- For live assistance, go to the Contact Hewlett Packard Enterprise Worldwide website:
  http://www.hpe.com/assistance
- To access documentation and support services, go to the Hewlett Packard Enterprise Support Center website:
  http://www.hpe.com/support/hpesc

Information to collect

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

Accessing updates

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

To download product updates:

- Hewlett Packard Enterprise Support Center
  www.hpe.com/support/hpesc
- Hewlett Packard Enterprise Support Center: Software downloads
  www.hpe.com/support/downloads
- Software Depot
  www.hpe.com/support/softwaredepot
- To subscribe to eNewsletters and alerts:
www.hpe.com/support/e-updates

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

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

### Regulatory information

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

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

### Additional regulatory information

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

www.hpe.com/info/reach

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www.hpe.com/info/ecodata

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

www.hpe.com/info/environment

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the product name, product version, help edition, and publication date located on the legal notices page.