Installing SLES on a ThinkSystem Server using kISO and PXE Boot

Describes how to use Preboot eXecution Environment (PXE) to remote boot a server

Provides instructions on how to set up a PXE Server

Shows how to install SLES from remote ISO images

Explains how to integrate a kISO customized kernel image with a Golden Master SLES image

Huaisheng Ye

Abstract

Preboot eXecution Environment (PXE) is an efficient way to boot Lenovo® servers without local media or storage. With the PXE protocol, the server boots from an image stored elsewhere on the network.

This document describes how to use PXE boot when performing a fresh installation of SUSE Linux Enterprise Server (SLES) 11 SP4 or SLES 12 SP2 on a Lenovo ThinkSystem™ server. The installation uses both the standard golden master (GM) ISO image plus a custom kISO (Kernel Update ISO) image, developed specifically for ThinkSystem servers, which include updated kernel, drivers and libraries.

The paper is for IT specialists and architects looking for ways to install SLES onto ThinkSystem servers. It assumes that the reader has some experience with Linux commands and with installing SLES using normal installation processes.

At Lenovo Press, we bring together experts to produce technical publications around topics of importance to you, providing information and best practices for using Lenovo products and solutions to solve IT challenges.

See a list of our most recent publications at the Lenovo Press web site:

http://lenovopress.com

> **Do you have the latest version?** We update our papers from time to time, so check whether you have the latest version of this document by clicking the **Check for Updates** button on the front page of the PDF. Pressing this button will take you to a web page that will tell you if you are reading the latest version of the document and give you a link to the latest if needed. While you're there, you can also sign up to get notified via email whenever we make an update.

Contents

Introduction

Preboot eXecution Environment (PXE) is an efficient way to boot Lenovo servers without local media or a boot drive. With the PXE protocol, the server boots from an image stored elsewhere on the network.

This document describes how to use PXE boot to perform a fresh installation of SUSE Linux Enterprise Server (SLES) 11.4 or 12.2 on a Lenovo ThinkSystem server. The installation uses both the standard golden master (GM) ISO image plus a custom kISO (Kernel Update ISO) image, developed specifically for ThinkSystem servers, which include updated kernel, drivers and libraries.

With the procedures describes in this document, when the server is booted via PXE, the kISO image is installed first, and then SLES ISO image is installed, thereby resulting in a fresh SLES installation that includes all the necessary kernel and drive updates needed for the ThinkSystem server.

This paper is split into two main sections:

1. Configure a server to act as the PXE server
2. Set up the kISO and ISO images on the PXE server for use with target ThinkSystem servers

The paper describes the use of PXE boot with the system BIOS set in both in UEFI mode and Legacy mode. Both modes are described because the method to install an operating system via PXE Boot is slightly different depending on the mode used.

Building a PXE server

The PXE server is a server on the network that responds to PXE boot requests from other systems on the network and provides the appropriate boot images to those systems.

The PXE server is a relatively low-function server and does not require a large hardware configuration. In our lab environment, our PXE Server is a Lenovo ThinkServer® TS440 running CentOS 6.4, however you can choose another server and OS environment if so desired.

Install and set up DHCP service to get IP address for target server

Make sure that the following two packages have been correctly installed on PXE server.

► dhcp-common-4.1.1-34.P1.el6.x86_64
► dhcp-4.1.1-34.P1.el6.x86_64

If these two packages have not been installed, use the following command:

```
[root@localhost]# yum install dhcp dhcp-common -y
```

Figure 1   Install DHCP packages

After the installation of the two packages, perform these steps:

1. Locate configuration file dhcpd.conf in the /etc directory.

2. Modify its subnet range to proper address. For example, we set it from 192.168.9.10 to 192.168.9.245.

3. Modify next-server to 192.168.9.245 as TFTP server IP.

4. Replace the default filename mboot.efi with BOOTX64.efi.

   The changes are highlighted in Figure 2.

```
#
# DHCP Server Configuration file.
#    see /usr/share/doc/dhcp*/dhcpd.conf.sample
#    see 'man 5 dhcpd.conf'
#

option space pxelinux;
option pxelinux.magic code 208 = string;
option pxelinux.configfile code 209 = text;
option pxelinux.pathprefix code 210 = text;
option pxelinux.reboottime code 211 = unsigned integer 32;
option arch code 93 = unsigned integer 16;
allow booting;

ddns-update-style interim;

log-facility local7;

subnet 192.168.9.0 netmask 255.255.255.0
{
        range 192.168.9.10 192.168.9.245;
        option subnet-mask 255.255.255.0;
        option domain-name "linuxOS";

#        default-lease-time 3600;
#
#       max-lease-time 7200;
        class "pxeclients"
        {
        match if substring (option vendor-class-identifier, 0, 9) = "PXEClient";
        next-server 192.168.9.254;
        if option arch = 00:07
                {
#               filename "mboot.efi";
                filename "BOOTX64.efi";
                }
        else
                {
                filename "pxelinux.0";
                }
        }
}
```

Figure 2   Changes to /etc/dhcpd.conf

5. Save this file and exit

6. Use the following command to restart DHCP:

```
[root@ip10-245-200-125 xinetd.d]# service dhcpd restart
Shutting down dhcpd:                                    [  OK  ]
Starting dhcpd:                                         [  OK  ]
```

Figure 3   Restart DHCP

Install and set up TFTP service

TFTP service has been installed to CentOS 6 by default, if it is not installed correctly, you can use the following command to install it.

```
[root@localhost]# yum install tftp-server -y
```

Figure 4   Install TFTP

After installation of TFTP service, do the following steps:

1. Edit the default configuration file /etc/xinetd.d/tftp.

2. Modify parameter `disable` to `no`, then modify `server args` to `-s /tftpboot`. The parameter `/tftpboot` means the root directory of PXE server's TFTP service. You can change it to other location based on actual requirement.

   The changes are highlighted in Figure 5.

```
# 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
{
disable = no
socket_type             = dgram
protocol                = udp
wait                    = yes
user                    = root
server                  = /usr/sbin/in.tftpd
server_args             = -s /tftpboot
per_source              = 11
cps                     = 100 2
instances               = 30
flags                   = IPv4
}


}
```

Figure 5   Configuration file /etc/xinetd.d/tftp

3. Save and close this file,

4. Restart the TFTP service with the following commands:

```
[root@ip10-245-200-125 xinetd.d]# service xinetd restart
Stopping xinetd:                                          [  OK  ]
Starting xinetd:                                          [  OK  ]
```

Figure 6   Restart TFTP

Install and set up NFS service

The PXE server also needs NFS installed, as follows:

1. Use the following command to check whether NFS packages have been installed or not.

```
[root@ip10-245-200-125 xinetd.d]# rpm -qa | grep nfs-utils
nfs-utils-lib-1.1.5-6.el6.x86_64
nfs-utils-1.2.3-36.el6.x86_64
```

Figure 7   Listing installed NFS packages

2. If they have not been installed, use the following command to install them.

```
[root@ip10-245-200-125 xinetd.d]# yum install nfs-utils* -y
```

Figure 8   Install NFS

3. Create NFS directory /install/nfs_share to mount kISO and ISO images
4. Edit the file /etc/exports as highlighted in Figure 9.

```
/ISO *(ro,sync)
#/ISO *(rw,no_root_squash,sync)
#/ISO/RHEL6.9Alpha *(rw,no_root_squash,sync)
/opt/nfs *(rw,sync,no_root_squash,no_subtree_check)
/install/nfs_share    *(ro,async,no hide,crossmnt)  localhost(ro,async,nohide,crossmnt)
/mnt/part1 *(ro,sync)
```

Figure 9   File /etc/exports

5. Use the following command to restart NFS service.

```
[root@localhost ~]# service nfs restart
Shutting down NFS daemon:                                 [  OK  ]
Shutting down NFS mountd:                                 [  OK  ]
Shutting down NFS quotas:                                 [  OK  ]
Shutting down NFS services:                               [  OK  ]
Starting NFS services:                                    [  OK  ]
Starting NFS quotas:                                      [  OK  ]
Starting NFS mountd:                                      [  OK  ]
Stopping RPC idmapd:                                      [  OK  ]
Starting RPC idmapd:                                      [  OK  ]
Starting NFS daemon:                                      [  OK  ]
```

Figure 10   Restart NFS

Installing SLES from kISO and GM images with PXE boot

In this section, we describe how to install SLES on a server by using PXE to boot from kISO and Golden Master (GM) ISO images on the PXE server.

In our lab environment, we used the following images:

► kISO image: lenovo_servers_thinksystem-sle11sp4-x86_64-2.1.iso

► GM standard ISO image: sles11.4 as SLES-11-SP4-DVD-x86_64-GM-DVD1.iso

You can obtain the latest kISO image from the SUSE SolidDriver web site:

https://drivers.suse.com/index.php?vendor=Lenovo&SLE=none&name=%25

In our lab, we installed SLES 11.4; the process to install SLES 12.2 is the same.

UEFI and Legacy Modes

In ThinkSystem servers, there are two different boot modes can be used, the one is Legacy Boot and the other is UEFI Boot. The difference between them is the process that the firmware uses to find the boot target.

► Legacy Boot is the boot process used by BIOS firmware. The firmware maintains a list of installed storage devices that may be bootable (diskette drive, hard disk drive, optical drive, tape drive, etc) and enumerates them in a configurable order of priority. When the POST procedure has completed, the firmware loads the first sector of each of the storage targets into memory and scans it for a valid Master Boot Record (MBR). If a valid MBR is found, the firmware passes execution to the boot loader code found in the MBR which allows the user to select a partition to boot from.

► UEFI boot is the boot process used by UEFI firmware. The firmware maintains a list of valid boot volumes called EFI Service Partitions. During the POST procedure the UEFI firmware scans all of the bootable storage devices that are connected to the system for a valid GUID Partition Table (GPT). Unlike a MBR, a GPT does not contain a boot loader. The firmware itself scans the GPTs to find an EFI Service Partition to boot from. If no EFI bootable partition is found, the firmware can fall back on the Legacy Boot method.

In general, UEFI Boot is more desirable with modern servers such as ThinkSystem, however Legacy Boot is still more commonly used and is equally supported.

Setting up the PXE server

In this section, we describe how to install SLES 11.4 with kISO and GM images in Legacy mode.

Follow these steps to set up PXE server for preparation of installation:

1. Download SLES 11.4 kISO and GM ISO images to the PXE server from SUSE SolidDriver web site. In our lab, we downloaded these images:

   — kISO: lenovo_servers_thinksystem-sle11sp4-x86_64-2.1.iso

   — GM standard iso image of SLES 11.4: SLES-11-SP4-DVD-x86_64-GM-DVD1.iso.

2. Create corresponding directories for NFS share location as shown in Figure 11. The directories are used to mount respective images.

```
[root@ip10-245-200-125 ISO]# ls /install/nfs_share/ -lh
total 60K
...
drwxr-xr-x 2 root root 4.0K Aug  1 22:15 sles11.4kiso
dr-xr-xr-x 7 root root 4.0K Jul  1  2015 sles11.4gm
```

Figure 11   ISO Image locations

3. Use the following commands to mount the images individually:

```
# mount -o loop /ISO/lenovo_servers_thinksystem-sle11sp4-x86_64-2.1.iso
/install/nfs_share/sles11.4kiso/

# ls /install/nfs_share/sles11.4kiso/
ARCHIVES.gz  boot  ChangeLog  content  content.asc  content.key  directory.yast  docu
EFI  gpg-pubkey-c2bea7e6-4c2de264.asc  INDEX.gz  ls-lR.gz  media.1  pubring.gpg
README  suse

# mount -o loop /ISO/SLES-11-SP4-DVD-x86_64-GM-DVD1.iso
/install/nfs_share/sles11.4gm/

# ls /install/nfs_share/sles11.4gm/
ARCHIVES.gz  content.asc  COPYING.de      docu gpg-pubkey-3d25d3d9-36e12d04.asc
INDEX.gz      NEWS boot content.key COPYRIGHT EFI  gpg-pubkey-50a3dd1c-50f35137.asc
license.tar.gz  pubring.gpg
ChangeLog control.xml COPYRIGHT.degpg-pubkey-307e3d54-53287cdc.asc
gpg-pubkey-9c800aca-53287d18.asc ls-lR.gz  README content  COPYING  directory.yast
gpg-pubkey-39db7c82-510a966b.asc gpg-pubkey-b37b98a9-5328792f.asc media.1  suse
```

Figure 12   Commands to mount ISO images

4. Go to TFTP boot directory to create a subdirectory for storing kernel and initrd images of kISO. We created folder sles11.4kiso_2.1.

5. Copy the kernel and initrd images from the installation kit ISO image to the appropriate location on the tftpboot directory. The initrd and kernel image can be found under the ./install/boot/x86_64/loader directory.

   The commands we used are shown below.

```
# pwd
/tftpboot/sles11.4kiso_2.1
# cp /install/nfs_share/sles11.4kiso/boot/x86_64/loader/linux ./
# cp /install/nfs_share/sles11.4kiso/boot/x86_64/loader/initrd ./
# ls
```

Figure 13   Copy images to the tftpboot directory

6. Modify your access authority to 755 to ensure you have the correct permissions, using the following commands.

```
[root@localhost sles11.4kiso_2.1]# ls
initrd  linux
[root@localhost sles11.4kiso_2.1]# chmod 755 initrd linux
[root@localhost sles11.4kiso_2.1]# ll -h
total 46M
-rwxr-xr-x 1 root root  42M Jan 25 18:53 initrd
-rwxr-xr-x 1 root root 3.9M Jan 25 18:53 linux
```

Figure 14   Modifying permissions

7. Edit the file /tftpboot/pxelinux.cfg/default as highlighted in Figure 15. Save and exit the file.

```
label SLES11.4KISO_2.1
menu label ^Install SLES11.4KISO_2.1(Legacy)
kernel /sles11.4kiso_2.1/linux
initrd /sles11.4kiso_2.1/initrd
append ip=dhcp splash=silent vga=0x317 showopts
install=nfs://192.168.9.254/install/nfs_share/sles11.4gm/
addon=nfs://192.168.9.254/install/nfs_share/sles11.4kiso
```

Figure 15   Configuration file /tftpboot/pxelinux.cfg/default

Performing the installation

Now that PXE Boot and the installation images are prepared, we can now proceed with the actual remote install. We are using a ThinkSystem ST550 server as our target server where SLES is to be installed.

Follow these steps to enable PXE Boot on the target server and perform the OS installation:

1. Reboot target server.
2. During boot, press F1 when prompted to enter UEFI (System Setup) as shown in Figure 16 on page 10
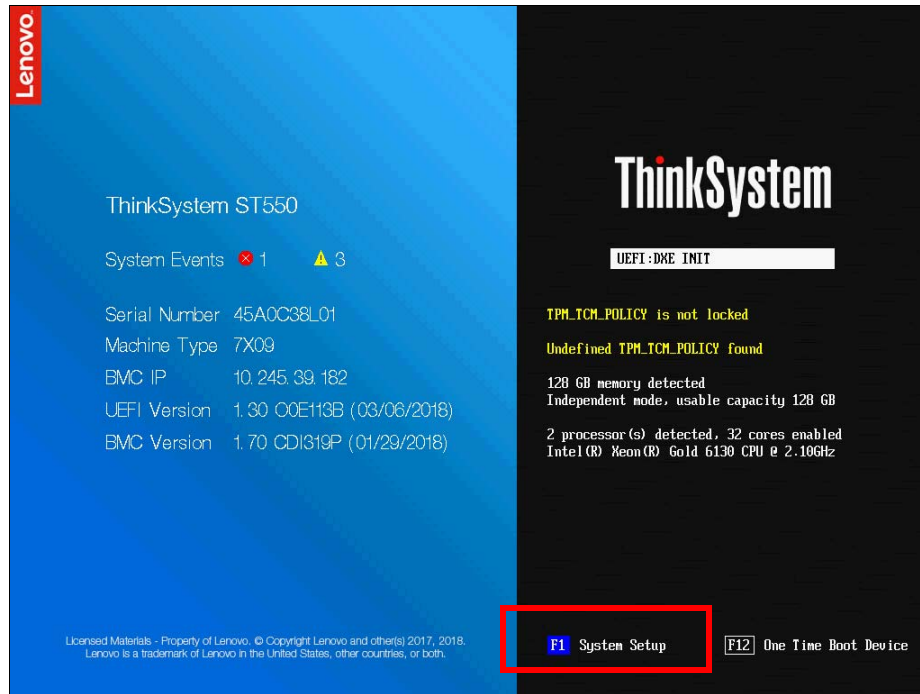
Figure 16   ThinkSystem ST550 boot screen - Press F1 to enter System Setup (UEFI)

3. From the System Summary page, select **UEFI Setup** from the left-hand navigation, Figure 17.
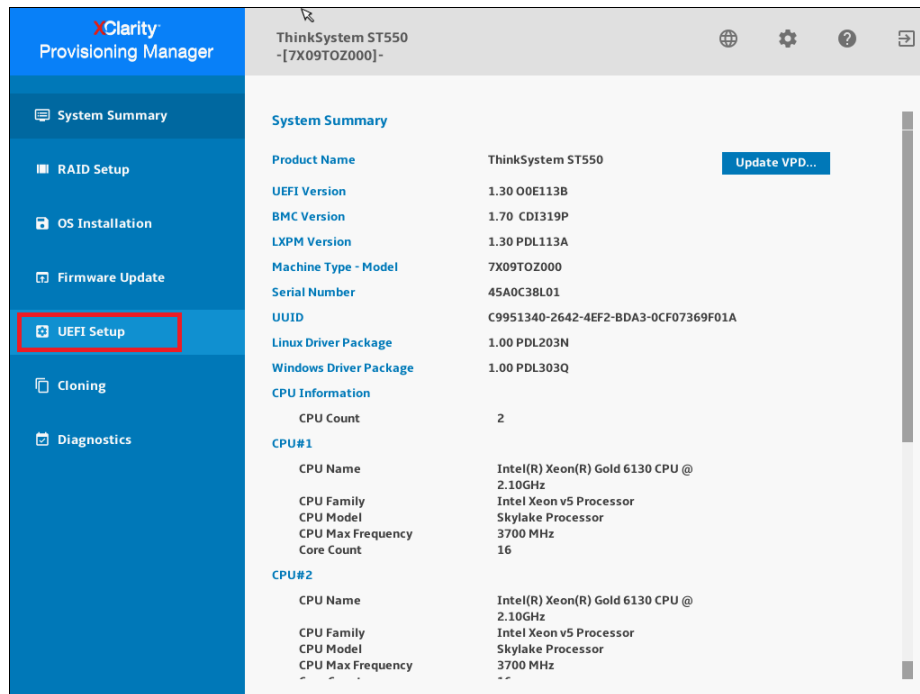

Figure 17   System Summary page in UEFI

4. From the UEFI Setup page, select **Boot Manager** from the left, and the select **Boot Modes** as highlighted. Figure 18.
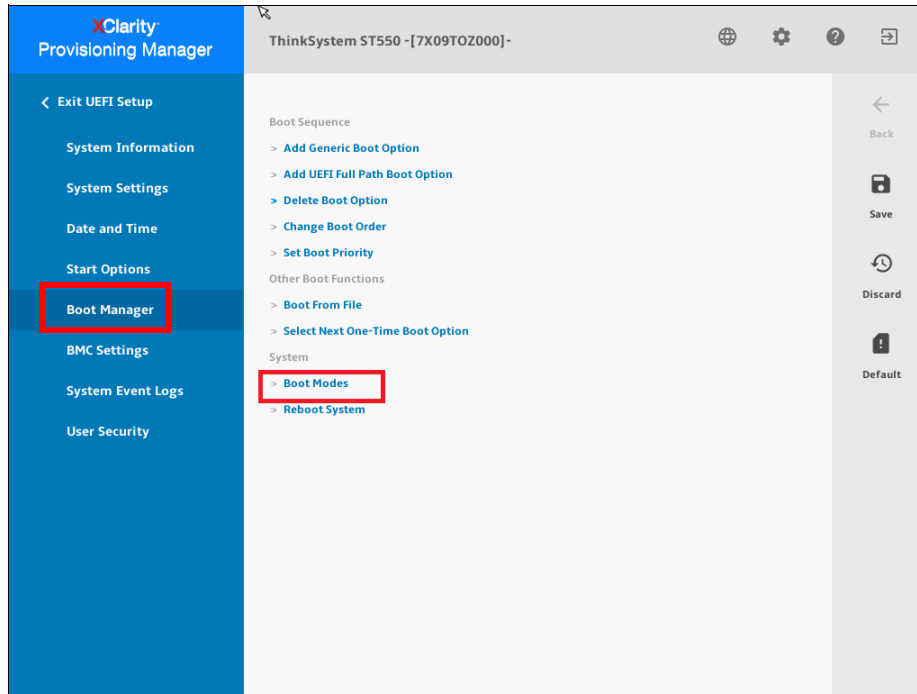

Figure 18   Boot Manager page in UEFI

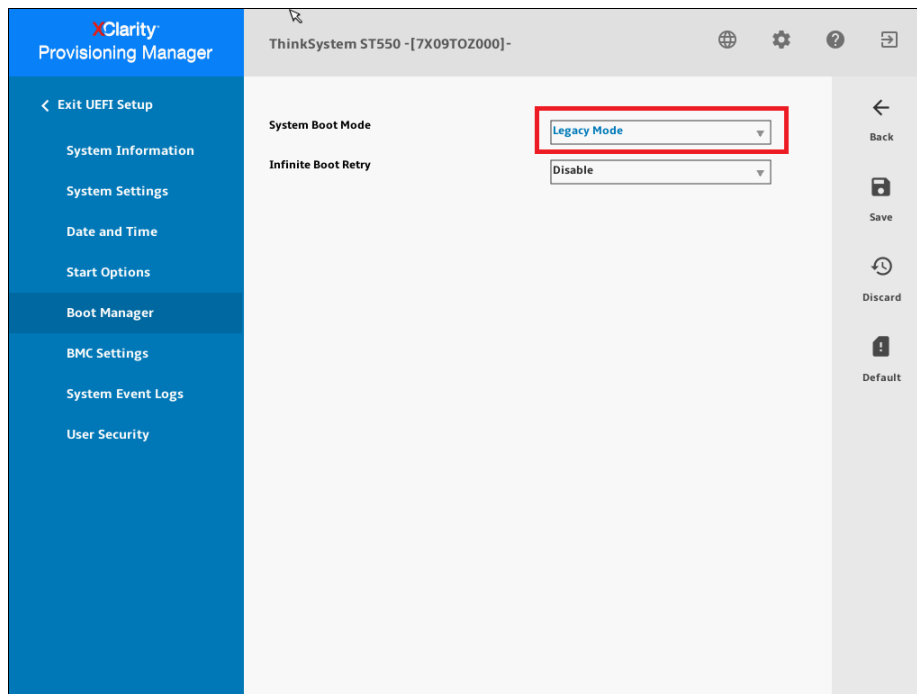5. Change System Boot Mode to **Legacy Mode** as shown in Figure 19.

Figure 19   Setting Boot Mode to Legacy

6. Save and reboot target server.

7. Press F12 when prompted to select a One Time Boot Device (see Figure 16 on page 10) and select **Network** as shown in Figure 20. The menu selection instructions the server to search for PXE Servers on the local network.
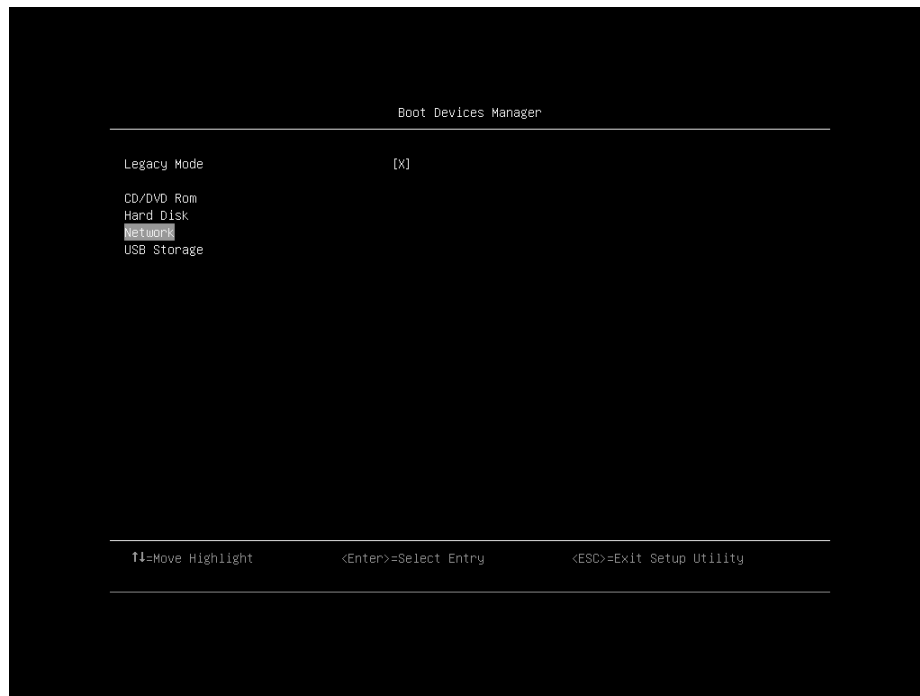
Figure 20   Boot from Network

8. Our PXE server responds and presents to the target server the available boot images, Figure 21. This list comes from the /tftpboot/pxelinux.cfg/default file on the PXE server.
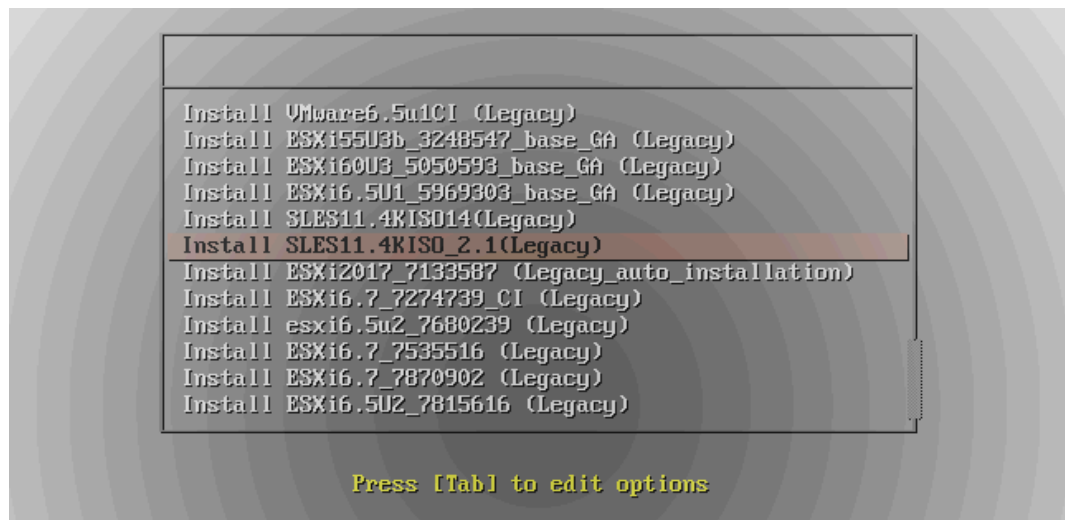
9. To install SLES 11.4 kISO, we selected **SLES11.4KISO_2.1(Legacy)**.

Figure 21   PXE boot list

10.The target server is now booted using the updated kernel and initrd images from the PXE Server. You can see the drivers being loaded in Figure 22.

```
Loading basic drivers... ok
Starting hardware detection... ok
(If a driver is not working for you, try booting with brokenmodules=driver_name.)

Intel SATA controller
  drivers: ahci*
Intel SATA controller
  drivers: ahci*
Marvell 88SE9230 PCIe SATA 6Gb/s Controller
  drivers: ahci*
Activating usb devices... ok
IBM XClarity Controller
  drivers: cdc_ether*
Intel Ethernet controller
  drivers: i40e*
Intel Ethernet controller
  drivers: i40e*
IBM XClarity Controller
  drivers: cdc_ether*
Driver Update: Lenovo_Servers_ThinkSystem
Sending DHCP request to eth0...
Loading Installation System (1/6) (26432 kB) - 100%
Loading Installation System (2/6) (53056 kB) - 100%
Loading Installation System (3/6) (3689 kB) - 100%
Loading Installation System (4/6) (1920 kB) - 100%
Loading Installation System (5/6) (2752 kB) - 100%
Loading Installation System (6/6) (129 kB) - 100%
Starting haveged daemon haveged: haveged starting up
haveged: arch:        x86

vendor:      intel
starting hald...generic:     0
i_cache:     32
d_cache:     32
loop_idx:    30
loop_idxmax: 40
loop_sz:     31836
loop_szmax:  124334
etime:       9241
havege_ndpt  0


 ok
starting syslogd (logging to /dev/tty4)... ok
starting klogd... ok
starting yast...
Probing connected terminal...
```

Figure 22   Target Server Boots with KISO kernel and initrd

13

11. You are now presented with the SLES Welcome Screen, as shown in Figure 23. Proceed as normal to install SLES.
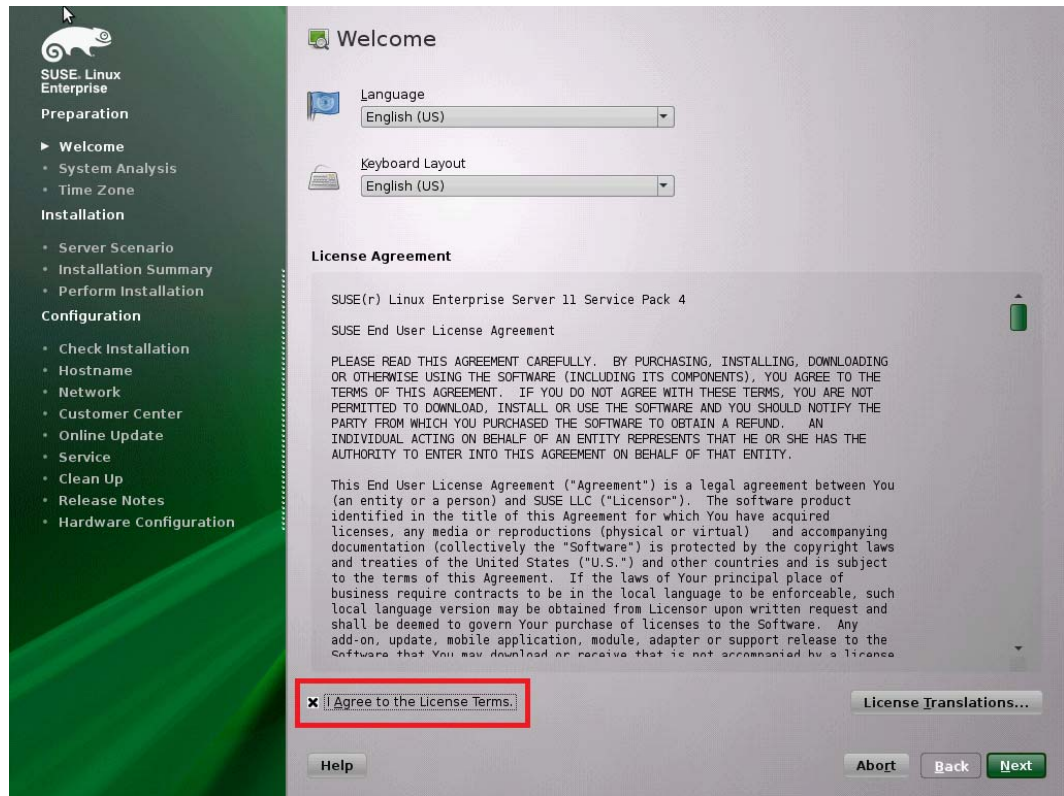

Figure 23   Default Welcome Interface of SLES 11.4

Install SLES using UEFI Mode

The steps to install SLES in UEFI mode are the same as with Legacy mode, with the following differences:

► In step 7 on page 9, you should instead edit file /tftpboot/efidefault as highlighted in Figure 24.

```
title install SLES11.4KISO_2.1(UEFI)
root (nd)
kernel /SLES11.4KISO_2.1/linux ip=dhcp splash=silent vga=0x317 showopts
install=nfs://192.168.9.254/install/nfs_share/sles11.4gm/
addon=nfs://192.168.9.254/install/nfs_share/sles11.4kiso
initrd /SLES11.4KISO_2.1/initrd
```

Figure 24   Configuration file /tftpboot/efidefault

► In the UEFI settings in the target server, select **UEFI Mode** in step 5 on page 11.

Resources

For more information, see these resources:

https://en.opensuse.org/SDB:PXE_boot_installation#tftpd-hpa_config

https://www.suse.com/c/setting-pxe-boot-server/

Author

Huaisheng Ye is a Linux Engineer at the Lenovo Data Center Group in Beijing, China. He has experience with Linux kernel power and memory management subsystems, and kernel drm scope. Before joining Lenovo, he worked for AMD as a graphics driver engineer. He has over nine years work experience, and currently focuses on Linux kernel memory, storage and power management subsystems.

Thanks to the following people for their contributions to this project:

- ► Song Shang, Lenovo Test Engineer for Linux Enablement
- ► David Watts, Lenovo Press

Notices

Lenovo may not offer the products, services, or features discussed in this document in all countries. Consult your local Lenovo representative for information on the products and services currently available in your area. Any reference to a Lenovo product, program, or service is not intended to state or imply that only that Lenovo product, program, or service may be used. Any functionally equivalent product, program, or service that does not infringe any Lenovo intellectual property right may be used instead. However, it is the user's responsibility to evaluate and verify the operation of any other product, program, or service.

Lenovo may have patents or pending patent applications covering subject matter described in this document. The furnishing of this document does not give you any license to these patents. You can send license inquiries, in writing, to:

Lenovo (United States), Inc.
1009 Think Place - Building One
Morrisville, NC 27560
U.S.A.
Attention: Lenovo Director of Licensing

LENOVO PROVIDES THIS PUBLICATION "AS IS" WITHOUT WARRANTY OF ANY KIND, EITHER EXPRESS OR IMPLIED, INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTIES OF NON-INFRINGEMENT, MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. Some jurisdictions do not allow disclaimer of express or implied warranties in certain transactions, therefore, this statement may not apply to you.

This information could include technical inaccuracies or typographical errors. Changes are periodically made to the information herein; these changes will be incorporated in new editions of the publication. Lenovo may make improvements and/or changes in the product(s) and/or the program(s) described in this publication at any time without notice.

The products described in this document are not intended for use in implantation or other life support applications where malfunction may result in injury or death to persons. The information contained in this document does not affect or change Lenovo product specifications or warranties. Nothing in this document shall operate as an express or implied license or indemnity under the intellectual property rights of Lenovo or third parties. All information contained in this document was obtained in specific environments and is presented as an illustration. The result obtained in other operating environments may vary.

Lenovo may use or distribute any of the information you supply in any way it believes appropriate without incurring any obligation to you.

Any references in this publication to non-Lenovo Web sites are provided for convenience only and do not in any manner serve as an endorsement of those Web sites. The materials at those Web sites are not part of the materials for this Lenovo product, and use of those Web sites is at your own risk.

Any performance data contained herein was determined in a controlled environment. Therefore, the result obtained in other operating environments may vary significantly. Some measurements may have been made on development-level systems and there is no guarantee that these measurements will be the same on generally available systems. Furthermore, some measurements may have been estimated through extrapolation. Actual results may vary. Users of this document should verify the applicable data for their specific environment.

This document was created or updated on March 27, 2018.

Send us your comments via the **Rate & Provide Feedback** form found at
http://lenovopress.com/lp0864

Trademarks

Lenovo, the Lenovo logo, and For Those Who Do are trademarks or registered trademarks of Lenovo in the United States, other countries, or both. These and other Lenovo trademarked terms are marked on their first occurrence in this information with the appropriate symbol (® or ™), indicating US registered or common law trademarks owned by Lenovo at the time this information was published. Such trademarks may also be registered or common law trademarks in other countries. A current list of Lenovo trademarks is available on the Web at http://www.lenovo.com/legal/copytrade.html.

The following terms are trademarks of Lenovo in the United States, other countries, or both:

Lenovo®   ThinkServer®
Lenovo(logo)®   ThinkSystem™

The following terms are trademarks of other companies:

Linux is a trademark of Linus Torvalds in the United States, other countries, or both.

Other company, product, or service names may be trademarks or service marks of others.