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Lab Overview -
HOL-1851-06-ADV -
Horizon 7 for Linux
Hosted Desktops
Lab Guidance

Note: It will take more than 90 minutes to complete this lab. You will need to extend your time if you expect to finish all of the modules during your time. In this lab, modules 2-5 are dependent on each other! (You can start on module 2, if you have limited time)

The Table of Contents can be accessed in the upper right-hand corner of the Lab Manual.

Lab Abstract: In this lab you will learn how to Deliver, manage and access Linux virtual desktops with Horizon 7 for Linux. You will configure a Linux desktop for use with Horizon including installing the Horizon Agent and joining an CentOS 7.2 desktop to Active Directory for single sign-on.

Lab Module List:

- **Module 1 - Introduction to Horizon for Linux** (30 minutes) (Basic) Learn what, why and how in Horizon for Linux.
- **Module 2 - Linux Desktop Master Image** (30 minutes) (Advanced) Learn how to prepare a maser image and configure single sign-on.
- **Module 3 - Install Horizon Agent** (15 minutes) (Basic) Install and configure the Horizon Agent.
- **Module 4 - Create Linux Desktop Pool** (15 minutes) (Basic) Create a Desktop Pool for Linux desktops in Horizon Administrator.
- **Module 5 - Connecting to Horizon for Linux Desktop** (30 minutes) (Basic) Connect to the Linux desktop via the Horizon client and learn about advanced features.
- **Module 6 - Horizon for Linux Advance Concepts** (15 minutes) (Advanced) Learn about advanced concepts like 3D graphics and bulk deployment.

Lab Captains:

- **Mark Richards, Staff Systems Engineer, US**

This lab manual can be downloaded from the Hands-on Labs Document site found here:

[http://docs.hol.vmware.com](http://docs.hol.vmware.com)

This lab may be available in other languages. To set your language preference and have a localized manual deployed with your lab, you may utilize this document to help guide you through the process:

Location of the Main Console

1. The area in the RED box contains the Main Console. The Lab Manual is on the tab to the Right of the Main Console.
2. A particular lab may have additional consoles found on separate tabs in the upper left. You will be directed to open another specific console if needed.
3. Your lab starts with 90 minutes on the timer. The lab cannot be saved. All your work must be done during the lab session. But you can click the **EXTEND** to increase your time. If you are at a VMware event, you can extend your lab time twice, for up to 30 minutes. Each click gives you an additional 15 minutes. Outside of VMware events, you can extend your lab time up to 9 hours and 30 minutes. Each click gives you an additional hour.

Alternate Methods of Keyboard Data Entry

During this module, you will input text into the Main Console. Besides directly typing it in, there are two very helpful methods of entering data which make it easier to enter complex data.
Click and Drag Lab Manual Content Into Console Active Window

You can also click and drag text and Command Line Interface (CLI) commands directly from the Lab Manual into the active window in the Main Console.

Accessing the Online International Keyboard

You can also use the Online International Keyboard found in the Main Console.

1. Click on the Keyboard Icon found on the Windows Quick Launch Task Bar.
Click once in active console window

In this example, you will use the Online Keyboard to enter the "@" sign used in email addresses. The "@" sign is Shift-2 on US keyboard layouts.

1. Click once in the active console window.
2. Click on the **Shift** key.

Click on the @ key

1. Click on the "@ key".

Notice the @ sign entered in the active console window.
**Activation Prompt or Watermark**

When you first start your lab, you may notice a watermark on the desktop indicating that Windows is not activated.

One of the major benefits of virtualization is that virtual machines can be moved and run on any platform. The Hands-on Labs utilizes this benefit and we are able to run the labs out of multiple datacenters. However, these datacenters may not have identical processors, which triggers a Microsoft activation check through the Internet.

Rest assured, VMware and the Hands-on Labs are in full compliance with Microsoft licensing requirements. The lab that you are using is a self-contained pod and does not have full access to the Internet, which is required for Windows to verify the activation. Without full access to the Internet, this automated process fails and you see this watermark.

This cosmetic issue has no effect on your lab.

**Look at the lower right portion of the screen**
Please check to see that your lab is finished all the start-up routines and is ready for you to start. If you see anything other than "Ready", please wait a few minutes. If after 5 minutes your lab has not changed to "Ready", please ask for assistance.
Module 1 - Introduction to Horizon for Linux (30 minutes)
Introduction

This Module contains the following lessons:

• **Introduction to Linux Desktop:** Learn what the key uses cases are for Linux desktops and why Linux desktops are a viable solution
• **Blast Extreme Protocol:** Learn about the desktop protocol leveraged in Horizon for Linux
Introduction to Linux Desktop

Horizon for Linux Overview

Why Linux Desktop's

In a predominantly Windows world, the use of Linux desktops is becoming more pervasive. Organizations rely on Linux for a variety of reasons:

- Support access to the many design applications and engineering development applications that run only on Linux-based operating systems
- Move away from Windows and drive down costs
- Ensure security and facilitate greater customization

However, supporting Linux desktops in a physical world comes with its own set of challenges. Linux desktops can be complex and cumbersome to manage. They offer little or no intellectual property protection especially when it comes to remote, outsourced, or offshored workers. And the endpoints required to run Linux typically are pricey and drive up costs. To overcome these challenges, many organizations have looked to desktop and application virtualization. But this solution has been largely reserved for Windows users. That is until now...

Horizon 7 for Linux

With Horizon 7 for Linux, organizations can now extend the benefits of desktop and application virtualization to Linux users.
• Centralizes desktop management
• Secures data in the data center while supporting end users with seamless access to Linux services across devices, locations, mediums, and connections.
• Allows organizations to move away from costly Windows licensing and to embrace low-cost endpoints to deliver the best possible total cost of ownership.

Streamline Desktop Management

Horizon 7 for Linux allows IT administrators to leverage a single platform to entitle users and set policy for Linux and Windows desktops. This intuitive management interface allows IT to provision and manage desktops with a few easy clicks.

Support Greater Productivity

Horizon for Linux supports a broad range of Linux options including Ubuntu, Red Hat Enterprise Linux (RHEL), CentOS, and NeoKylin, ensuring that end users have easy access to all the Linux office applications they need to remain as productive as possible. Together with NVIDIA, Horizon for Linux additionally supports rich 3D graphics for developers and designers—to support even the most powerful and intensive use cases.

Provide Fast, Easy Access

Leveraging the Linux operating system is inherently more secure, and by centrally managing the Linux image, apps, and files, Horizon for Linux ensures that organizations can better secure data and manage user access across devices and locations. With Horizon for Linux, end users can quickly and easily log in to their virtual session and enjoy a consistently great experience every single time.

Linux Drives Cost Savings

Moving organizations beyond Windows, Horizon for Linux enables customers to reduce capital and operational expenditures by as much as 60 percent. Customers can lower costs by leveraging thin clients versus expensive laptops or workstations and by moving away from Microsoft licensing. They can also save when it comes to day-to-day operations.
What are the key use cases of Horizon 7 for Linux?

The use cases for using a Linux desktop can vary from educational labs to engineering development and Horizon can support those use cases. The key use cases that VMware continues to see are:

- Software development requiring intellectual property protection
- CAD/CAM/CAE designer who need enhanced support for 3D applications
- Government institutions requiring the security and customization of Linux
- Customers looking for a Windows replacement
## Supported Distributions

<table>
<thead>
<tr>
<th>Supported Linux Distribution</th>
<th>Architecture</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ubuntu 12.04, 14.04 and 16.04</td>
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<td>x64</td>
</tr>
<tr>
<td>CentOS 6.6, 6.7, 6.8, 6.9, 7.2, and 7.3 x64</td>
<td></td>
</tr>
<tr>
<td>NeoKylin 6 Update 1</td>
<td>x64</td>
</tr>
<tr>
<td>SLED 11 SP3/SP4, SLED 12 SP1/SP2</td>
<td>x64</td>
</tr>
<tr>
<td>SLES 12 SP1/SP2</td>
<td>x64</td>
</tr>
</tbody>
</table>

## Requirements

- VMware Horizon 6.1.1 or higher
- vSphere* 5.5 U1 or higher (6.5 or higher recommended)
  - 3D Graphics with physical GPU requires vSphere 6.0 or higher
- Horizon Client for Windows, Mac or Linux 3.3 or higher
- Horizon Linux agent
Supported Features

Horizon 7 for Linux supports the following key features:

- 3D supports with vSGA, vDGA, vGPU on RHEL
- Copy & Paste between client and remote Linux desktop
- Audio In / Audio out
- Single Sign-On on RHEL, SLED, CentOS, Ubuntu
- Multiple Monitors
  - Up to 4 monitors with 2560*1600 displays
  - Auto Fit
- Kerberos authentication
- Open LDAP integration
- Blast Extreme Protocol
  - JPEG/PNG
  - H.264 software encoding
- HTML Access
- Multiple networks
- Smart Card Redirection with SSO
- Client Drive Redirection (CDR)
- USB Redirection support
- Audio output support for HTML Access
- Support for FIPS 140-2 mode
- Support for K Desktop Environment (KDE) on CentOS 6 x64 and RHEL 6 x64
Supported Horizon Clients and Devices

- Windows
- Linux
- MAC
- Thin Client
- iOS
- Android
- Chromebook
- HTML
Horizon for Linux - Blast Extreme Protocol

What is Blast Extreme Protocol?

Note: Horizon for Linux only supports the Blast protocols.

Blast Extreme

Optimized for the mobile cloud, VMware Blast Extreme supports the broadest range of client devices that are H.264 capable. Of the display protocols, VMware Blast offers the lowest CPU consumption for longer battery life on mobile devices. VMware Blast Extreme can compensate for an increase in latency or a reduction in bandwidth and can leverage both TCP and UDP network transports.

The VMware Blast display protocol can be used for remote applications and for remote desktops that use virtual machines or shared-session desktops on an RDS host. The RDS host can be a physical machine or a virtual machine. The VMware Blast display protocol does not operate on a single-user physical computer.
VMware Blast Extreme Features

Key features of VMware Blast Extreme include the following:

• Users outside the corporate firewall can use this protocol with the corporate virtual private network (VPN), or users can make secure, encrypted connections to a security server or Access Point appliance in the corporate DMZ.
• Advanced Encryption Standard (AES) 128-bit encryption is supported and is turned on by default. You can, however, change the encryption key cipher to AES-256.
• Connections from all types of client devices.
• Optimization controls for reducing bandwidth usage on the LAN and WAN.
• 32-bit color is supported for virtual displays.
• ClearType fonts are supported.
• Audio redirection with dynamic audio quality adjustment for LAN and WAN.
• Real-Time Audio-Video for using webcams and microphones on some client types.
• Copy and paste of text and, on some clients, images between the client operating system and a remote application or desktop. For other client types, only copy and paste of plain text is supported. You cannot copy and paste system objects such as folders and files between systems.
• Multiple monitors are supported for some client types. On some clients, you can use up to four monitors with a resolution of up to 2560 x 1600 per display or up to three monitors with a resolution of 4K (3840 x 2160) for Windows 7 remote desktops with Aero disabled. Pivot display and autofit are also supported.

1. When the 3D feature is enabled, up to two monitors are supported with a resolution of up to 1920 x 1200, or one monitor with a resolution of 4K (3840 x 2160).
• USB redirection is supported for some client types.
• MMR redirection is supported for some Windows client operating systems and some remote desktop operating systems (with Horizon Agent installed).
• Connections to physical machines that have no monitors attached are supported with NVIDIA graphics cards. For best performance, use a graphics card that supports H.264 encoding. This is a technical preview feature for Horizon 7 version 7.1.

1. If you have an add-in discrete GPU and an embedded GPU, the operating system might default to the embedded GPU. To fix this problem, you can disable or remove the device in Device Manager. If the problem persists, you can install the WDDM graphics driver for the embedded GPU, or disable the embedded GPU in the system BIOS. Refer to your system documentation on how disable the embedded GPU.

Blast Extreme Encoding and Decoding Technologies

Horizon for Linux Blast Extreme leverages H.264 and JPG/PNG codecs for the best user experience.

Depending on circumstances and configuration used, Blast Extreme uses either an H.264 codec or a JPG/PNG codec. A codec is a computer program that can encode or decode a digital data stream for transmission. The word codec is a blend of the words coder-decoder. By default, Blast Extreme uses the H.264 codec if the client device supports that codec.
H.264 or MPEG-4 Part 10, Advanced Video Coding (MPEG-4 AVC) is a block-oriented motion compensation-based video compression standard that is currently one of the most commonly used formats for the recording, compression, and distribution of video content.

The intent of the H.264/AVC project was to create a standard capable of providing good video quality at substantially lower bit rates than previous standards (i.e., half or less the bit rate of MPEG-2, H.263, or MPEG-4 Part 2), without increasing the complexity of design so much that it would be impractical or excessively expensive to implement. An additional goal was to provide enough flexibility to allow the standard to be applied to a wide variety of applications on a wide variety of networks and systems, including low and high bit rates, low and high resolution video, broadcast, DVD storage, RTP/IP packet networks, and ITU-T multimedia telephony systems.

The JPG/PNG codec performs software encoding and decoding of video and images. The JPG/PNG codec supports lossless compression and can be used with multiple-monitor displays.

It is the best choice for:

- Images that require lossless compression
- Applications such as word processors or spreadsheets, which are composed of static content
- Multiple monitors

### Blast Extreme: JPG/PNG Codec

<table>
<thead>
<tr>
<th>Overview</th>
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<tbody>
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<td>Proprietary codec</td>
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<td>Default codec for Multi-Monitor Support</td>
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<tr>
<td>Default codec for Linux VDI</td>
</tr>
<tr>
<td>Supports both TCP and UDP</td>
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<table>
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<tr>
<th>Benefit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Can be tuned with Group Policy</td>
</tr>
<tr>
<td>Lossless compression support</td>
</tr>
<tr>
<td>Better for static content delivery</td>
</tr>
</tbody>
</table>
With Blast Extreme, H.264 provides software encoding and hardware decoding on supported devices. Tablets and phones can perform H.264 hardware decoding, as can computers manufactured in 2013 or later.

When users use Blast Extreme on one of these devices and enable H.264 hardware decoding, the graphics processor on the device does the work involved in playing back video and images. In contrast, when users use the JPG/PNG software codec, the CPU on the device, rather than the GPU, does the work. When users use H.264 hardware decoding and thereby offload the work to the GPU, CPU consumption is reduced, resulting in less device power consumed, for longer battery life.
Blast Extreme Security

Blast Extreme: Security

Overview

- IPv6 Support (TCP only)
  - Only Supported with Security Server
- FIPS ready libraries
  - Only Supported with Security Server
- TCP connections over encrypted SSL web sockets
- UDP connections use DTLS encrypted sessions
- TLS 1.1, 1.2
- AES Encryption
- Common Criteria (In process)

Blast Extreme is secure out of the box and encrypted from Horizon Client to Virtual Desktops or Applications

Blast Extreme Network Adaptation

Blast Extreme: Adaptation

Network Adaptation

- TCP is initial default connection
- Tries to connect via UDP – *if enabled*
  - Automatically falls back to TCP if unable to connect on UDP

Codec Adaptation

- Use hardware encode with NVIDIA GRID if available
- Use software H.264 if client can decode H.264
- Use JPG/PNG if client can’t decode H.264
- Multi-Monitor will default to JPG/PNG

Protocol Adaptation

- If a pool is forced to Blast Extreme
  - Zero client will connect with PCoIP
  - Pre 4.x Horizon clients will connect with PCoIP/RDP
VMware Blast Extreme can compensate for an increase in latency or a reduction in bandwidth and can leverage both TCP and UDP network transports.
Conclusion

What you learned in this module:

You have learned that

• Why Linux desktops
• What are the key use cases
• Supported Distributions
• Supported Features
• What is the Blast Extreme Protocol

Congratulations on completing Module 1

Please continue to the next module or scan the QR code to learn more.

Please continue to the next module or click a module below to review.

Lab Module List:

• **Module 1 - Introduction to Horizon for Linux** (30 minutes) (Basic) Learn what, why and how in Horizon for Linux.
• **Module 2 - Linux Desktop Master Image** (30 minutes) (Advanced) Learn how to prepare a master image and configure single sign-on.
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• **Module 6 - Horizon for Linux Advance Concepts** (15 minutes) (Advanced) Learn about advanced concepts like 3D graphics and bulk deployment.
Module 2 - Linux Desktop Master Image (30 minutes)
Introduction

This Module contains the following lessons:

- **Linux Desktop Master Image:** Learn about supported Linux distributions, supported desktop environments and enhancements for the users experience during the Hands-On-Labs
- **Configure CentOS for Single Sign On:** Join the Linux Desktop to Active Directory using System Security Services Daemon for Single Sign-On
- **Required Linux Packages:** Install the required packages
Linux Desktop Master Image Preparation

Horizon for Linux uses vCenter managed virtual machines. The same concept that you use for Windows desktops applies to Linux for a master image. The master image needs to be a supported distribution using the supported desktop environment listed below and must be able to communicate with Connection Server. You must configure networking on the Linux machine so that the Linux machine can ping the Connection Server instance using its FQDN (fully qualified domain name).

Open VMware Tools (OVT) are pre-installed on RHEL 7, CentOS 7, SLED 12, and SLES 12 machines. If you are using an Ubuntu16.04 machine, install OVT on it.

You should also customize the desktop environment to your use case. In this lab, I utilized http://bit.ly/GnomeLogin to help customize the logon screen for Gnome.

Supported Linux Distributions

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Supported Desktop Environments

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<th>Linux Distribution</th>
<th>Default Desktop Environment</th>
<th>Supported Desktop Environment in Horizon for Linux</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ubuntu 14.04/16.04</td>
<td>Unity</td>
<td>Gnome Fallback/Flashback (Metacity)</td>
</tr>
<tr>
<td>Ubuntu 12.04</td>
<td>Unity</td>
<td>Unity</td>
</tr>
<tr>
<td>RHEL/CentOS 6</td>
<td>Gnome</td>
<td>Gnome, KDE</td>
</tr>
<tr>
<td>RHEL/CentOS 7</td>
<td>Gnome</td>
<td>Gnome</td>
</tr>
</tbody>
</table>
Linux Distribution | Default Desktop Environment | Supported Desktop Environment in Horizon for Linux
---|---|---
SLED 11 SP4, SLED 12 SP1/SP2 | Gnome | Gnome
SLES 12 SP1/SP2 | Gnome | Gnome
NeoKylin 6 Update 1 | Mate | Mate

HzLinux-01a Customizations

Several changes have been made to enhance the users experience during the Hands-On-Labs use of the HzLinux-01a desktop.

The login screen was modified to disable the user list, added a banner message and a logo as an example.

[https://wiki.centos.org/TipsAndTricks/DisableGDMUserlist](https://wiki.centos.org/TipsAndTricks/DisableGDMUserlist)

- [org/gnome/login-screen]
  - disable-user-list=true
  - banner-message-enable=true
  - banner-message-test='YOUR TEXT HERE'
  - logo='/usr/share/pixmaps/VMware-HOL-Logo.png'

All of the modifications can be found using Google to search for how to make the changes.

Power on the Linux VM
Start Google Chrome

1. Make sure you are on the **Main Console**
2. Double-Click the **Google Chrome** icon
Login to vCenter

1. In Chrome, Click on the **HOL-1851 Admin** bookmark folder
2. Click **vCenter HTML5 Client**
3. Login as **Corp\Administrator**
4. Password is **VMware1!**
5. Click on **Login**
1. Expand **vcsa-01a.corp.local**
2. Expand **RegionA01**
3. Expand **RegionA01-COMP01**
4. Find **HzLinux-01a** and Right Click
5. Click on **Power**
6. Click on **Power On**
Launch Remote Console for HzLinux-01a

1. Click the **Launch Remote Console** link to open the console

Note: The VMware Remote Console application will open and connect to the HzLinux-01a desktop
Login to HzLinux-01a Desktop

1. Enter hol as the username
2. Click Next
Enter Password

1. Enter **VMware1!** for the password
2. Click **Sign In**

Configure Linux for Single Sign-On

The single-sign-on (SSO) feature allows end users to supply Active Directory login credentials only once.

If you do not use the single-sign-on feature, end users must log in twice. They are first prompted for Active Directory credentials to log in to Horizon Connection Server and then are prompted log in to their remote desktop. If smart cards are also used, end users must sign in three times because users must also log in when the smart card reader prompts them for a PIN.
The following solutions are known to work in a Horizon 7 for Linux Desktop environment:

- OpenLDAP Server Pass-through Authentication
- System Security Services Daemon (SSSD) LDAP Authentication against the Microsoft Active Directory
- Winbind Domain Join

**Join the Linux Desktop to Active Directory using System Security Services Daemon**

In the following steps you will complete several tasks to enable SSO. Note that SSO is NOT required in Horizon for Linux, but this greatly enhances the users experience.

To enable SSO for CentOS you need to locate the Active Directory domain, configure the Kerberos realm and join the desktop to the domain.

You will configure the desktop using System Security Services Daemon or SSSD.
1. Double Click on **Terminal**

**Discover the Domain**

In terminal enter
```
realm discover controlcenter.corp.local
```
Realm Results

After you enter the command you should see the following results:

The HOL environment is setup to support Kerberos with a realm name of CORP.LOCAL and the Active Directory domain name of corp.local.

You will also notice that several Linux packages are required to be installed before we can proceed and the CentOS is not configured.
Install Required Packages

1. To install the required packages please enter the following command: `sudo yum install sssd-tools sssd adcli samba-common pam_ldap pam_krb5 samba-client krb5-workstation samba-common-tools`

2. Enter `VMware1` when prompted to `sudo`
Confirm the installation

1. Enter \( y \) to continue the installation
Complete

Validate the installation was **complete**
Join the Linux Desktop to the AD Domain

You need to join the HzLinux-01a desktop to the corp.local Active Directory domain. In this step you need to login to the AD domain with an user that has the correct permissions to join a computer to AD.

1. Enter the following command into the terminal: `sudo realm join --verbose corp.local -U administrator`
2. Enter `VMware1!` if prompted for [sudo]

NOTE:
• Please note that you may not get prompted for the [sudo] password
• sudo has a time out and you may need to re-enter the password after a few minutes.

1. Enter the **VMware1!** for the Administrator

**Domain Join Results**
You should see * Successfully enrolled machine in realm, if not please backup one step and validate the command.

**Modify Linux PAM (Pluggable Authentication Module) for SSO**

We need to modify the authentication settings.

Start by clearing the terminal

1. Enter `clear`

Note: In a Redhat or CentOS 7.2 desktop you need to modify the authentication module.

**Copy the modified file**

1. In terminal Enter `cd Downloads`
2. Enter `ls` (list information)

You will see the modified password-auth-ac file

3. In terminal enter `sudo cp -av password-auth-ac /etc/pam.d/`
4. Enter `VMware1!` for the [sudo] password
5. File is copied to correct path
Note: The modifications of the /etc/pam.d/password-auth file are shown below in bold.

Original file:
auth    required pam_env.so
auth    [default=1 success=ok] pam_localuser.so
auth    [success=done ignore=ignore default=die] pam_unix.so nullok try_first_pass
auth    requisite pam_succeed_if.so uid >= 1000 quiet_success
auth    sufficient pam_sss.so forward_pass
auth    required  pam_deny.so

Modified File:
auth    required pam_env.so
auth    sufficient pam_unix.so nullok try_first_pass
auth    requisite pam_succeed_if.so uid >= 1000 quiet_success
auth    sufficient pam_sss.so use_first_pass
auth    required  pam_deny.so

Modify the Permissions of the PAM file

Since you copied the modified file from the user HOL, you need to modify the ownership of the file.

You will use the Change Owner command

1. In terminal Enter `sudo chown root:root /etc/pam.d/password-auth-ac`
2. Enter `VMware1!` for the [sudo] password if prompted
Restart the SSSD service

1. In terminal Enter `sudo service sssd restart`
2. Enter `VMware1!` for the [sudo] password if prompted

Modify SSSD.conf

Since Horizon for Linux SSO leverages your AD user name and by default SSSD is configured for UPN. You need to modify the configuration file to allow username format and become case insensitive.
Launch gedit to modify the file

1. In terminal Enter `sudo gedit /etc/sssd/sssd.conf` to modify the file
2. Enter `VMware1!` for the [sudo] password if prompted
Modify sssd.conf

1. Change the line to `use_fully_qualified_names = False` for username format
2. Add the line `case_sensitive = False` to ensure authentication ignores mixed case user names
3. Click on **Save**
4. Click on **X** to exit
Restart the SSSD service

1. In terminal Enter `sudo service sssd restart`
2. Enter `VMware1!` for the [sudo] password if prompted
Restart HzLinux-01a

1. Click the **Power icon** in the upper right hand corner
2. Click the **Power icon** in the drop down
Confirm Restart

1. Click **Restart**
Conclusion

What you learned in this module:

You have learned that

- Horizon for Linux uses vCenter managed virtual machines.
- The master image needs to be a supported distribution using the supported desktop environment
- Master images for Linux leverage the same concept that you use for Windows desktops
- How to use SSSD for Single Sign-On to Active Directory
- Sample configuration changes for end user usability enhancements

Congratulations on completing Module 2

Please continue to the next module or scan the QR code to learn more.

Lab Module List:

- **Module 1 - Introduction to Horizon for Linux** (30 minutes) (Basic) Learn what, why and how in Horizon for Linux.
- **Module 2 - Linux Desktop Master Image** (30 minutes) (Advanced) Learn how to prepare a master image and configure single sign-on.
- **Module 3 - Install Horizon Agent** (15 minutes) (Basic) Install and configure the Horizon Agent,
- **Module 4 - Create Linux Desktop Pool** (15 minutes) (Basic) Create a Desktop Pool for Linux desktops in Horizon Administrator.
- **Module 5 - Connecting to Horizon for Linux Desktop** (30 minutes) (Basic) Connect to the Linux desktop via the Horizon client and learn about advanced features.
• **Module 6 - Horizon for Linux Advance Concepts** (15 minutes) (Advanced)
  Learn about advanced concepts like 3D graphics and bulk deployment.
Module 3 - Install Horizon Agent (15 minutes)
Introduction

This Module contains the following lessons:

- **Horizon Agent Prerequisites:** Learn about the prerequisites for the Horizon Agent.
- **Horizon Agent installer extraction:** Extract the installer from the tarball.
- **Horizon Agent install:** Install the Horizon Agent
Install Horizon Agent on Linux

Horizon Linux Agent Install

In the following steps you will extract and install the Horizon agent.

Note that Single Sign-On is NOT a requirement in Horizon for Linux, but greatly enhances the users experience.

Single sign-on is supported on the following Linux versions:

- RHEL 6/7 Workstation x64
- CentOS 6/7 x64
- SLED 11 SP3/SP4 x64
- Ubuntu 14.04/16.04 x64

To enable SSO in the Hands-On-Labs, please see the article [Linux Desktop Master Image Preparation](http://bit.ly/2smJCR2) in this lab manual.

Pre-Requisites

For a list of dependent packages please see [http://bit.ly/2smJCR2](http://bit.ly/2smJCR2)

Java Runtime Edition (JRE)

- 7 update 75 (Update 76 for Ubuntu)

DNS & Hostname

- /etc/resolv.conf
- /etc/hosts
- /etc/hostname

VMware Tools

- Latest version or open vm-tools

Windows Active Directory

- Join to AD domain

Power on the Linux VM [if needed]
Start Google Chrome

1. Make sure you are on the **Main Console**
2. Double-Click the **Google Chrome** icon
Login to vCenter

1. In Chrome, Click on the **HOL-1851 Admin** bookmark folder
2. Click **vCenter HTML5 Client**
3. Login as **Corp\Administrator**
4. Password is **VMware1!**
5. Click on **Login**
Power On HzLinux-01a

1. Expand vcsa-01a.corp.local
2. Expand RegionA01
3. Expand RegionA01-COMP01
4. Find HzLinux-01a and Right Click
5. Click on Power
6. Click on Power On
1. Click the Launch Remote Console link to open the console

Note: The VMware Remote Console application will open and connect to the HzLinux-01a desktop
Login to HzLinux-01a Desktop

1. Enter hol as the username
2. Click Next
Enter Password

1. Enter **VMware1!** for the password
2. Click **Sign In**

Install the Horizon Agent

You must install Horizon Agent on a Linux virtual machine before you can deploy the machine as a remote desktop.

Beginning with Horizon 7.0.1 release, Horizon Agent for Linux uses vCenter managed virtual machines. The managed virtual machines provide the following enhancements.

- vCenter is a mandatory requirement for Linux desktop deployment.
- Horizon Agent installation on Linux does not require registration.
• For a large number of Linux desktop deployment, you can install the Horizon Agent on the base virtual machine.

Prerequisites

• Verify that the Linux guest operating system is prepared for desktop use
• Prepare a Linux Machine for Remote Desktop Deployment
• You must perform certain tasks to prepare a Linux machine for use as a desktop in a Horizon 7 deployment.

Before a Linux machine can be managed by Horizon 7, the machine must be able to communicate with Connection Server. You must configure networking on the Linux machine so that the Linux machine can ping the Connection Server instance using its FQDN (fully qualified domain name).

Open VMware Tools (OVT) are pre-installed on RHEL 7, CentOS 7, SLED 12, and SLES 12 machines. If you are using an Ubuntu 16.04 machine, install OVT on it.
Open Terminal

1. Double Click on Terminal
Extract the Horizon agent for install

1. In terminal Enter: `cd Downloads`
2. Enter: `ls` (list information)
3. Here you will see the Horizon Agent tarball `VMware-horizonagent-linux-x86_64-7.2.0-5603763.tar.gz`
4. In terminal enter: `tar -xzvf VMware-horizonagent-linux-x86_64-7.2.0-5603763.tar.gz` to extract the installer
Change Present Working Directory

1. In terminal Enter `cd VMware-horizonagent-linux-x86_64-7.2.0-5603763`
2. Enter `ls` (list information)
3. Notice the executable bash script `install_viewagent.sh`
Run the Install Agent Script

1. In terminal enter `sudo ./install_viewagent.sh` to start the installer
2. Enter `VMware1!` for the [sudo] password

Accept the EULA

1. Enter `y` to accept the EULA
Reboot to Finish Agent Install

1. After the Installation is complete you must restart
2. In terminal enter `sudo reboot`
3. Enter `VMware1!` if prompted for the [sudo] password

Close the VMware Remote Console

1. Click on the X

Conclusion

The Horizon Agent is now installed in your Linux Desktop.

You are now ready to create a Horizon View Desktop Pool.
Conclusion

*What you learned in this module:*

You have learned that

- Horizon Agent Prerequisites
- How to extract the agent installer
- How to install the Horizon Agent on a Linux desktop

**Congratulations on completing Module 3**

Please continue to the next module or scan the QR code to learn more.

Please continue to the next module or click a module below to review.

**Lab Module List:**

- **Module 1 - Introduction to Horizon for Linux** (30 minutes) (Basic) Learn what, why and how in Horizon for Linux.
- **Module 2 - Linux Desktop Master Image** (30 minutes) (Advanced) Learn how to prepare a maser image and configure single sign-on.
- **Module 3 - Install Horizon Agent** (15 minutes) (Basic) Install and configure the Horizon Agent,
- **Module 4 - Create Linux Desktop Pool** (15 minutes) (Basic) Create a Desktop Pool for Linux desktops in Horizon Administrator.
- **Module 5 - Connecting to Horizon for Linux Desktop** (30 minutes) (Basic) Connect to the Linux desktop via the Horizon client and learn about advanced features.
- **Module 6 - Horizon for Linux Advance Concepts** (15 minutes) (Advanced) Learn about advanced concepts like 3D graphics and bulk deployment.
Module 4 - Create Linux Desktop Pool (15 minutes)
Introduction

This Module contains the following lessons:

- **Create Desktop Pool**: [How to create a desktop pool for Linux
- **Entitle Users**: How to entitle users to a desktop pool
- **Validate Linux Pool**: How to validate the Linux desktop is part a member of the pool
Create Horizon Linux Desktop Pool

Horizon View Administrator

Start Google Chrome

1. Make sure you are on the **Main Console**
2. Double-Click the **Google Chrome** icon
Login to Horizon Administrator

1. In Chrome, Click on the View-01A Admin bookmark
2. Login as Administrator
3. Password is VMware1!
4. Click on Login
Create Desktops Pools

1. Expand the **Catalog**
2. Click on **Desktop Pools**
3. Click **Add...**
Desktop Pool Type

1. Click on **Manual Desktop Pool**
2. Click **Next**
User Assignment

1. Choose **Floating**
2. Click **Next**
Machine Source

1. Choose **vCenter virtual machines**
2. Click **Next**
vCenter Server

Click Next
Desktop Pool ID

1. In the ID: enter **Linux**
2. In Display name enter: **Linux Desktop**
3. Click **Next**
Desktop Pool Settings

1. Scroll down
2. Click **HTML Access: Enabled**
3. Click **Next**
Virtual Machine

1. Enter **Hz** in the filter
2. Click **Find**
3. Choose the **HzLinux-01a**
4. Click **Add**

Confirm

1. Click **Next**
Advanced Storage Options

1. Click **Next**
Ready to Complete

1. Click the Entitle users after this wizard finishes
2. Click Finish
Entitlements

On the Entitlements pop-up page

1. Click **Add**

In the Find User or Group pop-up

2. Enter **lab**
3. Click **Find**
4. Select All **Lab [1-5] Users**
5. Click **Ok**
Close Window

1. Click **Close**
Validate Desktop Pool

1. Click on Desktop Pools
2. Double-Click on Linux

Go back to the Horizon View Administrator

1. Click on Desktop Pools
2. Double-Click on Linux

Linux Pool Inventory
1. Click on **Inventory** tab
2. Validate the **Status is Available** if not move to step 3
3. You may need to Click on the **Refresh icon**

**Minimize Horizon View Administrator**

1. Click on the **Minimize** button on Google Chrome
Conclusion

What you learned in this module:

You have learned that

- How to create a desktop pool for Linux
- How to entitle users to a desktop pool
- How to validate the Linux desktop is part a member of the pool

Congratulations on completing Module 4

Please continue to the next module or scan the QR code to learn more.

Please continue to the next module or click a module below to review.

Lab Module List:

- **Module 1 - Introduction to Horizon for Linux** (30 minutes) (Basic) Learn what, why and how in Horizon for Linux.
- **Module 2 - Linux Desktop Master Image** (30 minutes) (Advanced) Learn how to prepare a maser image and configure single sign-on.
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- **Module 4 - Create Linux Desktop Pool** (15 minutes) (Basic) Create a Desktop Pool for Linux desktops in Horizon Administrator.
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- **Module 6 - Horizon for Linux Advance Concepts** (15 minutes) (Advanced) Learn about advanced concepts like 3D graphics and bulk deployment.
Module 5 - Connecting to Horizon for Linux Desktop (30 minutes)
Introduction

This Module contains the following lessons:

- **Connecting to Horizon for Linux**: Connect to Linux desktop pool using single sign-on from the Horizon client and web browser as well as learn about desktop features like Client Drive Redirection
Connect to Horizon for Linux

Connect using the Horizon Client

1. Make sure you are on the Main Console
2. Double-Click the **VMware Horizon Client** icon
Connect to View-01a.corp.local

1. Double-Click the **view-01a.corp.local** cloud
Login as Lab1User

1. Enter the User name: **lab1user**
2. Enter the Password: **VMware1!**
3. Click **Login**
Now that you are logged in as Lab User 1 you will see the Linux Desktop pool that was created in Module 4. Review the desktop pool settings and change the Display size.

1. Right Click on the **Linux Desktop**
2. Click **Display**
3. Choose **Window - Small**
Launch Linux Desktop

1. Double-Click on the Linux Desktop pool
You're Connected via SSO Horizon for Linux Desktop

1. **Expand** the desktop settings in the taskbar  
2. Notice you're logged in as Lab 1 User  
3. Click on the desktop to close the window

### Horizon for Linux Desktop Features

Horizon 7 features for Linux desktops.

The following features are supported for Horizon 7 version 7.2 release

- The Keyboard Layout and Locale Synchronization feature is supported for Horizon Client for Windows and only for English, French, German, Japanese, Korean, Spanish, Simplified Chinese, and Traditional Chinese locales
- Client Drive Redirection (CDR)
- Bi-directional audio with Ubuntu, RHEL and CentOS
- Blast Extreme - software H.264 Encoder to support multiple monitors
• Clipboard redirection support on all distributions
• USB Redirection support
• Audio output support for HTML Access
• Support for smart card redirection with SSO
• Multiple Monitors
• 3D Graphics
• FIPS 140-2 Mode for Multiple RHEL 6/7

Note: Due to the Hands-On-Labs environment you will not be able to experience all of the features

Client Drive Redirection (CDR)

Client Drive Redirection is a feature in Horizon that will redirect your endpoint folders to the Horizon Desktop or Applications.

1. On the desktop, Double-Click the tsclient disk
The Main Console administrator folders are available in Files

1. Double-Click on the **Administrator** folder
Open Folder

Notice the administrator's folders.

1. Double-Click the **Documents** folder

Select Document

You will see all the files from the Main Console available on the Linux desktop.
1. Double-Click the Horizon for Linux Overview, End User Computing Design and D.pptx file

Libre Office Slide Show

In Libre Office Impress

1. Click on the Slide Show tab
2. Click Start from first Slide
Review the presentation [Optional]

Press ESC on the keyboard when finished reviewing the slides
Close Libre Office Impress

1. Click the X to close Impress

Exit Files to close CDR

1. Click the X to close Files applications
Disconnect from Horizon for Linux

On the Horizon Client

1. Click **Options**
2. Choose **Disconnect**
3. Click **OK** when prompted
Close the Horizon Client

1. Click on the X to close the client

Connect using Google Chrome
1. Make sure you are on the Main Console
2. Double-Click the Google Chrome icon
Login to Horizon WebClient Portal

1. Click on the **Horizon** bookmark
2. Enter the username: **lab1user**
3. Enter the password: **VMware1!**
4. Click **Login**
Launch the Linux Desktop

1. Click on the **Linux Desktop** to connect
HTML5 Access to Horizon for Linux

Navigate the desktop at your leisure

1. Click on the Horizon Unity tab
Log off Linux Desktop

1. Click on the hamburger
2. Click on Log off
3. Click OK when prompted

Close Google Chrome
1. In Chrome, Click the X to close the browser
Conclusion

What you learned in this module:

You have learned that

- Horizon for Linux desktop features like Client Drive Redirection
- Connect to Linux desktop pool using single sign-on from the Horizon client and web browser

Congratulations on completing Module 5

Please continue to the next module or scan the QR code to learn more.

Please continue to the next module or click a module below to review.

Lab Module List:

- **Module 1 - Introduction to Horizon for Linux** (30 minutes) (Basic) Learn what, why and how in Horizon for Linux.
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- **Module 6 - Horizon for Linux Advance Concepts** (15 minutes) (Advanced) Learn about advanced concepts like 3D graphics and bulk deployment.
Module 6 - Horizon for Linux Concepts (15 minutes)
Introduction

This Module contains the following lessons:

- **Linux Desktop Deployment Concepts**: Bulk deployment options for desktop provisioning
- **Linux 3D Desktop Graphics Concepts**: 3D graphics in Horizon for Linux
Linux Desktop Deployment Concepts

It is important to understand the possibilities of creating a Linux pool in an automated fashion, at the moment Instant Clones and auto-provisioning built-in to the product.

Provisioning

![PowerShell scripts](EASY)

![vRealize Orchestrator](MEDIUM)

![PXE boot with Kickstart](HARD)

You have the ability to create an automated pool in three different ways by using different tools. Depending on what you consider to use, the diagram above gives you indication on the level of complexity.

Note: Horizon 7 has increased the functionality using PowerCLI commandlets and vCenter managed Linux machines. This allows for a much easier bulk deployment and less scripting.
Steps to Prepare a Template

1. Create Master Virtual Machine Template
2. Create Customization Specification
3. Clone From Template
4. Guest Customization
5. Install Agent for Linux

1. Create your master Linux desktop template
2. Create a Customization Specification file for Linux in the vSphere environment
3. Clone the Virtual Machine
4. Guest Customization including domain join commands with example scripts or use option RunOnce Script in/etc/vmware/viewagent-custom.conf, configured in the template virtual machine
5. Install the Horizon Agent
Power shell scripts are the easiest way to automate the pool cloning for Linux virtual machines.

**Benefits**

- Automate the cloning of multiple (hundreds) of Linux virtual machines
- No prior PowerShell knowledge is necessary using supplied scripts
- Use kickstart (.ks) scripts to customize your master images (optional)
- Use PowerCLI to add Linux desktops to pool
- Get creative and create your own scripts!

**Note:** PowerShell Scripts and CSV can be found in DeployLinuxAgents.zip
vRealize Orchestrator - [Medium]

To automate the pool creating with vRealize Orchestrator is a medium easy way to manage your Linux desktop pool creation.

Benefits

- vRealize Orchestrator (vRO) is already included with vCenter Server
- Horizon vRO plugin allows for further integration like adding desktops into the pool, as well as management of the user entitlement
- Self-service for end user enablement by integration with vRealize Automation (requires vRA license)
To automate the pool creating with Kickstart / PXE Boot is a harder way to manage your Linux desktop pool creation as it requires more backend components like the PXE server and Kickstart or AutoYast knowledge.

**Benefits**

- Use Kickstart Configurator to create or modify scripts
- Graphical interface allowing full customization
- Use PXE boot for automated installation

```bash
yum install system-config-kickstart
```

or

```bash
apt-get install system-config-kickstart
```
Preparing the Linux Virtual Machine

VMware Tools can be installed using `apt-get install open-vm-tools` which will stay up-to-date with Linux updates (apt-get update).

Name resolution and a working DNS is critical for successfully creating a Linux pool.

Virtual Machine Display Settings

- Configure the video memory and number of displays
- Configure the .vmx for **RHEL, Ubuntu, or CentOS** multi-display
  
  svga.maxWidth="8192"
  svga.maxHeight="2048"

Note: It is important to understand the cause and effects of the number of displays and video RAM. Leaving this as the default (4MB) will result in low screen resolutions and the VM being unable to resize to the Horizon Client's display resolution.
Installing the Horizon Agent

This topic is covered in Module 3 Install the Horizon Agent.

Create a Linux Desktop Pool

This topic is covered in Module 4 - Create Linux Desktop Pool
Linux 3D Desktop Graphics Concepts

This Module contains the following lessons:

- Lesson 1: An overview of 3D technologies supported in Horizon 7
- Lesson 2: 3D Graphics support in Horizon for Linux

Horizon 3D Overview

VMware vSphere servers with Horizon 7 hosted in enterprise data centers enable users to access virtual desktops running 3D applications from a wide range of client devices. This solution provides users with graphics performance roughly equivalent to high-end graphics workstations, using lower-cost clients or re-purposed devices.

For detailed information on, please see the VMware Horizon 3D Engineering Workloads Reference Architecture

Horizon 7 offers four types of 3D graphics acceleration: software-based Soft 3D, and hardware-based vSGA, vGPU, and vDGA.

The picture above illustrates how the 3D technologies map to the main use case categories: task workers, knowledge workers, power users, and designers.

**Use Case Categories**
Task workers often require only Soft 3D, a software-based 3D renderer suitable for less graphics-intensive applications. They do not need, or realize a noticeable benefit from, hardware-based 3D acceleration. For that reason, the task worker use case is not considered in this paper. Soft 3D is a standard component of Horizon 7.

Knowledge Workers
Office workers and executives fall into this category, typically using applications such as Microsoft Office, Adobe Photoshop, and other non-specialized end-user applications. A vSGA solution can improve performance for this use case by providing high levels of consolidation of users across GPUs.

However, vSGA does not provide a wide range of graphics API support, so it is often worthwhile to consider a vGPU-based solution for knowledge workers.

**Power Users**

These users consume more complex visual data, but their requirements for manipulations of large datasets and specialized software are less intense than for designers. Their needs can typically be served more than adequately with access to a shared vGPU.
Designers and advanced engineering and scientific users often create and work with large, complex datasets and require graphics-intensive applications such as 3D design, molecular modeling, and medical diagnostics software from companies such as Dassault Systèmes, Enovia, Siemens NX, and Autodesk. These users typically require either a vGPU- or vDGA-based solution.

Choosing a 3D Graphics Acceleration Technology

The three types of hardware-based graphics acceleration available for View virtual desktops in Horizon 7 map well to the three major use cases considered here. However, vGPU provides the greatest performance and compatibility trade-off.
The table compares the main features of these technologies.

<table>
<thead>
<tr>
<th>vDGA</th>
<th>vGPU</th>
<th>vSGA</th>
</tr>
</thead>
<tbody>
<tr>
<td>GPU dedicated to one user</td>
<td>GPUs shared among users but can be dedicated</td>
<td>GPUs shared among users</td>
</tr>
<tr>
<td>1:1 consolidation ratio (1 user per physical GPU)</td>
<td>Good consolidation ratio (8 users per physical GPU)</td>
<td>High consolidation ratio (limited by video memory on graphics card)</td>
</tr>
<tr>
<td>Workstation-level performance</td>
<td>Entry-level workstation performance under load</td>
<td>Solid performance for lightweight applications, but no driver certification</td>
</tr>
<tr>
<td>Maximum compatibility with all 3D GPU rendering and computation applications</td>
<td>Full compatibility with all 3D and GPU rendering applications; requires certification</td>
<td>Compatibility limited by API support and virtual machine video RAM capacity</td>
</tr>
<tr>
<td>DirectX 9, 10, or 11</td>
<td>DirectX 9, 10, or 11</td>
<td>DirectX 9.0 SM3 only</td>
</tr>
<tr>
<td>OpenGL 2.1, 3.x, or 4.x</td>
<td>OpenGL 2.1, 3.x, or 4.x</td>
<td>OpenGL 2.1 only</td>
</tr>
<tr>
<td>Hardware video playback</td>
<td>Hardware video playback</td>
<td>Software video playback only</td>
</tr>
<tr>
<td>Compute APIs with CUDA or OpenCL</td>
<td>Does not support compute APIs, CUDA, or OpenCL</td>
<td>Does not support compute APIs, CUDA, or OpenCL</td>
</tr>
<tr>
<td>Not compatible with VMware vSphere vMotion® and vSphere High Availability</td>
<td>Not compatible with vSphere vMotion and HA</td>
<td>vSphere vMotion, HA, and VMware vSphere Distributed Resource Scheduler™ compatible—automatically falls back to software renderer as needed</td>
</tr>
</tbody>
</table>
Virtual Dedicated Graphics Acceleration (vDGA)

This technology provides a user with unrestricted, fully dedicated access to a single vGPU. Although consolidation and management trade-offs are associated with dedicated access, vDGA offers the highest level of performance for users with the most intensive graphics computing needs. It enables the use of applications that run OpenGL 4.4, Microsoft DirectX 9, 10, or 11, and NVIDIA CUDA 5.0.

With vDGA, the hypervisor passes the GPUs directly to guest virtual machines, so the technology is also known as GPU pass-through. No special drivers are required in the hypervisor. However, to enable graphics acceleration, the appropriate NVIDIA driver needs to be installed on the guest virtual machines. The installation procedures are the same as for physical machines.
Because the GPU is passed through to the guest OS, which uses native graphics drivers, vDGA fully supports everything the chosen driver can do natively, including but not limited to all versions of DirectX, OpenGL, and CUDA.

<table>
<thead>
<tr>
<th>BENEFITS</th>
<th>PROS</th>
<th>CONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enables dedicated access to physical GPU hardware for 3D and high-performance graphical workloads.</td>
<td>Outstanding performance</td>
<td>1:1 consolidation ratio</td>
</tr>
<tr>
<td>Uses native NVIDIA drivers</td>
<td>Performance equivalent to dedicated GPU in physical desktop</td>
<td></td>
</tr>
<tr>
<td>CUDA available to virtual machine</td>
<td>Supports the entire API stack</td>
<td></td>
</tr>
<tr>
<td>Best for super high-performance needs</td>
<td>Direct driver support for GPU</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Vendor certification—technology is direct pass-through</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Could be a true workstation replacement option</td>
<td></td>
</tr>
</tbody>
</table>

Virtual Graphics Processing Unit (vGPU)
Horizon 7 and vSphere 6.0 include vGPU support. Like vDGA, vGPU brings the benefit of wide API support and native NVIDIA drivers but with greater scalability.

vGPU is essentially vDGA with multiple users instead of one user. As with vDGA, a user or administrator needs to install the appropriate NVIDIA driver on the guest virtual machine, and all graphics commands are passed directly to the GPU without having to be translated by the hypervisor. Up to eight virtual machines can share a GPU. Calculating the exact number of desktops or users per GPU depends on application requirements, screen resolution, number of displays, and frame rate measured in frames per second (FPS).

The vGPU technology provides better performance than vSGA and higher consolidation ratios than vDGA. It is a good technology to use for low-, mid-, or even advanced-level engineers and designers as well as for power users with 3D application requirements. One drawback of vGPU, however, is that it might require applications be re-certified in order to be supported.

Choosing a vGPU Profile

Each physical GPU can support several virtual GPU types, or profiles. Each vGPU profile has a fixed amount of frame buffer memory, number of supported display heads, and maximum resolutions, and is targeted at different classes of workload.
The GPU profiles (ending in Q, as shown in the images) undergo the same application certification process as the NVIDIA Quadro workstation-class processors.

### Virtual GPU Types Available for NVIDIA GRID M60 vGPU on Linux Virtual Machines

<table>
<thead>
<tr>
<th>Virtual GPU Type</th>
<th>Physical Board</th>
<th>Physical GPUs</th>
<th>FB Per Virtual GPU</th>
<th>Display Heads</th>
<th>Maximum Resolution</th>
<th>Maximum Virtual GPUs Per Physical GPU</th>
<th>Maximum Virtual GPUs Per Physical Board</th>
</tr>
</thead>
<tbody>
<tr>
<td>GRID M60-0q</td>
<td>GRID M60</td>
<td>two</td>
<td>512M</td>
<td>2</td>
<td>2560x1600</td>
<td>16</td>
<td>32</td>
</tr>
<tr>
<td>GRID M60-1q</td>
<td>GRID M60</td>
<td>two</td>
<td>1G</td>
<td>2</td>
<td>2560x1600</td>
<td>8</td>
<td>16</td>
</tr>
<tr>
<td>GRID M60-2q</td>
<td>GRID M60</td>
<td>two</td>
<td>2G</td>
<td>4</td>
<td>2560x1600</td>
<td>4</td>
<td>8</td>
</tr>
<tr>
<td>GRID M60-4q</td>
<td>GRID M60</td>
<td>two</td>
<td>4G</td>
<td>4</td>
<td>3840x2160</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>GRID M60-8q</td>
<td>GRID M60</td>
<td>two</td>
<td>8G</td>
<td>4</td>
<td>3840x2160</td>
<td>1</td>
<td>2</td>
</tr>
</tbody>
</table>

### Virtual GPU Types Available for NVIDIA GRID M6 vGPU on Linux Virtual Machines

<table>
<thead>
<tr>
<th>Virtual GPU Type</th>
<th>Physical Board</th>
<th>Physical GPUs</th>
<th>FB Per Virtual GPU</th>
<th>Display Heads</th>
<th>Maximum Resolution</th>
<th>Maximum Virtual GPUs Per Physical GPU</th>
<th>Maximum Virtual GPUs Per Physical Board</th>
</tr>
</thead>
<tbody>
<tr>
<td>GRID M6-0q</td>
<td>GRID M6</td>
<td>one</td>
<td>512M</td>
<td>2</td>
<td>2560x1600</td>
<td>16</td>
<td>16</td>
</tr>
<tr>
<td>GRID M6-1q</td>
<td>GRID M6</td>
<td>one</td>
<td>1G</td>
<td>2</td>
<td>2560x1600</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>GRID M6-2q</td>
<td>GRID M6</td>
<td>one</td>
<td>2G</td>
<td>4</td>
<td>2560x1600</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>GRID M6-4q</td>
<td>GRID M6</td>
<td>one</td>
<td>4G</td>
<td>4</td>
<td>3840x2160</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>GRID M6-8q</td>
<td>GRID M6</td>
<td>one</td>
<td>8G</td>
<td>4</td>
<td>3840x2160</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>
Virtual Shared Graphics Acceleration (vSGA)

This technology allows a GPU to be shared across multiple virtual desktops. It is an attractive solution for users who require the full potential of the GPU’s capability during brief periods. However, vSGA can create bottlenecks, depending on which applications are used and resources needed from the GPU. vSGA is generally used for knowledge workers and occasionally for power users, but it is restricted in its support for OpenGL and DirectX versions.
With vSGA, the physical GPUs in the host are virtualized and shared across multiple guest virtual machines. An NVIDIA driver needs to be installed in the hypervisor. Each guest virtual machine uses a proprietary VMware vSGA 3D driver that communicates with the NVIDIA driver in vSphere.

<table>
<thead>
<tr>
<th>BENEFITS</th>
<th>PROS</th>
<th>CONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enables shared access to physical GPU hardware for 3D and high-performance graphical workloads</td>
<td>Mature technology with appropriate number of ISVs supporting this type of configuration</td>
<td>Not suitable for high-end or compute-intensive workloads</td>
</tr>
<tr>
<td>Desktops still see abstracted VMware SVGA device for maximum virtual machine compatibility and portability</td>
<td>Scales well and provides good performance</td>
<td>Shared environment, shared problems</td>
</tr>
<tr>
<td>Cost effective with multiple virtual machines sharing single GPU resource</td>
<td>Full compatibility with hosts lacking physical GPUs (for vSphere vMotion, DRS, and so on)</td>
<td>Limited API support (Microsoft)</td>
</tr>
<tr>
<td>Local SSD, VMware vSAN, or all-flash-based storage arrays are a good choice for workloads typical in a 3D environment. Storage suffers the biggest performance impact when bandwidth is shared directly by all virtual machines. Virtual machine placement across available storage is critical for maximum performance.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

If using linked or instant clones, consider the impact of applications that load large datasets from the network and store locally. You may want to look at using App Volumes writable volumes to redirect the data to a separate storage tier.

CPU is a critical component for a 3D workload. Operations, such as update, clash detection, drawing, and weight analysis, are especially CPU-intensive. Because most operations, including CAD operations, are mono-threaded, a higher CPU clock frequency increases performance more than an increase in CPU cores (or vCPUs). Multithreaded applications, however, which are the exception, can benefit from running application threads across multiple CPU cores (or vCPUs).

3D requires more memory then a virtual desktop that is running traditional graphics. Consider using the highest frequency memory available in the host to produce the best results.
You will want to confirm there is sufficient bandwidth between the location of the graphics card and the end users device along with sufficient processing power on the client device itself. 3D applications typically have fast-changing graphics that can require considerable bandwidth that flows between the two devices.

Once configured, a user can access their virtual desktop from Workspace One or Utilizing the Horizon Client. These clients to access their virtual desktop on anything from a smart phone to a the hardiest MAC or PC and everything in between. That being said, It is important not to underestimate the amount of CPU and memory that the end user device needs to decode the display protocol. It is possible that a lower end client may not have the CPU processing power decode the data fast enough for a positive user experience. The amount of end user device resource will be dependent on configuration, application workload, and how the virtual desktop is being accessed. Testing will be required in order to validate end user experience in your environment.

**Horizon for Linux 3D Graphics Support**

Horizon for Linux supports the use of graphics accelerated desktops with NVIDIA Grid cards for the following:

- vGPU
- vDGA
- vSGA


3D graphics is supported with the following combinations of Linux versions and graphics cards:

- vSGA: supported on RHEL 7 Workstation x64 with NVIDIA GRID K1 or K2 graphics cards.
- vDGA: supported on RHEL 6 Workstation x64 with NVIDIA GRID K1 or K2 graphics cards.
- vGPU: supported on RHEL 6/7 Workstation x64 with NVIDIA Maxwell M60 or M6 graphics cards.

**Graphics for Linux Desktops**

You can configure the currently supported RHEL distributions to take advantage of NVIDIA capabilities on ESXi host or on a guest operating system.

**VM Clone Requirements for Setting Up 3D Graphics**

You must consider the following requirements for VM Clone before setting up 3D graphics.
• For vGPU and vSGA, complete the graphic setup in the base VM. Clone the VMs. The graphic settings work for cloned VMs and no further settings are required.
• For vDGA, complete the graphic setup in the base VM. Clone the VMs. However before you power on the cloned VMs, you must remove the existing NVIDIA pass-through PCI device from the cloned VM and add the new NVIDIA pass-through PCI device to the cloned VM. NVIDIA pass-through PCI device cannot be shared between VMs. Each VM uses a dedicated NVIDIA pass-through PCI device.

Note: To learn how to configure NVIDIA grid cards please see modules 2 and modules 3 in HOL-1851-10-ADV in the Hands-On-Labs catalog.

Configure Linux for vGPU

You can set up a supported RHEL distribution to take advantage of NVIDIA vGPU (shared GPU hardware acceleration) capabilities on the ESXi host.

You must use the NVIDIA Linux VM display driver that matches the ESXi host GPU driver(.vib). See the NVIDIA Web site for information about driver packages.

Important:

NVIDIA vGPU is supported on NVIDIA Maxwell M60 graphics cards and NVIDIA M6 graphics cards. This feature does not work on other NVIDIA graphics cards such as GRID K1 or K2.

Caution:

Before you begin, verify that Horizon Agent is not installed on the Linux virtual machine. If you install Horizon Agent before you configure the machine to use NVIDIA vGPU, required configuration parameters in the xorg.conf file are overwritten, and NVIDIA vGPU does not work. You must install Horizon Agent after the NVIDIA vGPU configuration is completed.

Required Steps

1. Install the VIB for the NVIDIA GRID vGPU Graphics Card on the ESXi Host
2. Configure a Shared PCI Device for vGPU on the Linux Virtual Machine
3. Install the NVIDIA GRID vGPU Display Driver
   ◦ To install the NVIDIA GRID vGPU display driver, you must disable the default NVIDIA driver, download the NVIDIA display drivers, and configure the PCI device on the virtual machine.
Configure Linux for vDGA

You can set up an RHEL guest operating system so that Horizon 7 for Linux desktop can take advantage of vDGA capabilities on the ESXi host.

Caution:

Before you begin, verify that Horizon Agent is not installed on the Linux virtual machine. If you install Horizon Agent before you configure the machine to use vDGA, required configuration parameters in the xorg.conf file are overwritten, and vDGA does not work. You must install Horizon Agent after the vDGA configuration is completed.

Required Steps

1. Enable DirectPath I/O for NVIDIA GRID on a Host
2. Add vDGA Pass-Through Device to a Virtual Machine
3. Install the NVIDIA Display Driver for vDGA
   ○ To install the NVIDIA display driver for vDGA, you must disable the default NVIDIA driver, download the NVIDIA display drivers, and configure the PCI device on the virtual machine.

Configure Linux for vSGA

You can set up an RHEL guest operating system so that a Horizon 7 for Linux desktop can take advantage of vSGA capabilities.

Required Steps

1. Install the VIB for the NVIDIA Graphics Card for vSGA on the ESXi Host
2. Configure 3D Capabilities for vSGA on the Linux Virtual Machine
Conclusion

What you learned in this module:

You have learned that

- Horizon for Linux bulk deployment options
- 3D graphics in Horizon for Linux

Congratulations on completing Module 6

Please continue to the next module or scan the QR code to learn more.

Please continue to the next module or click a module below to review.

Lab Module List:

- **Module 1 - Introduction to Horizon for Linux** (30 minutes) (Basic) Learn what, why and how in Horizon for Linux.
- **Module 2 - Linux Desktop Master Image** (30 minutes) (Advanced) Learn how to prepare a master image and configure single sign-on.
- **Module 3 - Install Horizon Agent** (15 minutes) (Basic) Install and configure the Horizon Agent,
- **Module 4 - Create Linux Desktop Pool** (15 minutes) (Basic) Create a Desktop Pool for Linux desktops in Horizon Administrator.
- **Module 5 - Connecting to Horizon for Linux Desktop** (30 minutes) (Basic) Connect to the Linux desktop via the Horizon client and learn about advanced features.
- **Module 6 - Horizon for Linux Advance Concepts** (15 minutes) (Advanced) Learn about advanced concepts like 3D graphics and bulk deployment
What you learned

This concludes the module on Horizon for Linux

During this lab you learned why to use Linux Desktops, the features and Linux distributions supported in Horizon for Linux.

You walked though joining a Linux desktop to Active Directory using SSSD, installing the Horizon Agent and creating a manual desktop pool.

You also learned about advanced concepts around bulk deployment and 3D graphics with physical GPUs.

You've finished the Horizon for Linux HOL-1851-06-ADV Lab

To learn more about the Horizon for Linux please scan the QR Code or go to https://www.vmware.com/products/horizon/horizon-linux.html
To end your lab click on the **END** button.
Conclusion

Thank you for participating in the VMware Hands-on Labs. Be sure to visit http://hol.vmware.com/ to continue your lab experience online.

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