The *Unofficial* Fusion for Apple Silicon Companion Guide

The manual that VMware didn't publish…
and the one that you <u>will</u> need.

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1   Introduction

Knowledge is good.

– Inscription on the statue of Emil Faber at Faber College,
from the film "Animal House"

The Unofficial Fusion for Apple Silicon Companion Guide (the "Companion Guide") is an unofficial addition to the VMware Fusion documentation. It contains a collection of useful tips and techniques for building and running virtual machines under Fusion 13.5 on Apple Silicon (M1/M2) Macs. These tips were submitted by users on the VMware Fusion Discussions forums.

The Companion Guide may contain hyperlinks to external web sites. It is best viewed in Adobe Reader or any other PDF viewer. It can be printed for reference if desired (URLs to external web sites are visible in their entirety).

1.1   This guide is an unofficial publication

The Companion Guide is not a VMware official publication and is not endorsed by VMware. Its content is sourced from user posts in the VMware Community forums for VMware Fusion.

While every effort has been made to ensure the accuracy of content contained in the Companion Guide, no guarantees or warranties of accuracy are offered by either the editor or VMware. The editor's intent is to keep the Companion Guide as accurate as possible so that it is useful to the broader community. Any inaccuracies should be reported to the Fusion forums, and they will be addressed in future versions of this document.

1.2   This guide requires Fusion 13.5 for Apple Silicon Macs

The Companion Guide is written to be used with Fusion 13.5 on Apple Silicon Macs. Users of older versions of Fusion need to install or update to Fusion 13.5 before using this Guide.

The Companion Guide does not cover Fusion running on Intel Macs.

1.3   "Some assembly is required" when using this guide

Some of the procedures in this Guide can be categorized as "some assembly required". They require system administration or other "command line" (non-GUI) operations to complete the tasks. The Companion Guide tries to walk you through the procedures in as straight-forward a manner as possible without the need to be an expert programmer or system administrator to complete the tasks.

If you are unsure about how to perform these tasks, please post a question in the VMware Fusion Discussions forum. You are also encouraged to search the web for documentation and tutorials on your operating system environment.

1.4   Document conventions

Any references to "Fusion" in this document refer to Fusion 13.5 or later running on Apple Silicon Macs, unless otherwise noted.

Command input to a command prompt or "shell" (macOS Terminal/zsh shell, Linux bash shell, Windows cmd.exe or PowerShell) appears as follows

```
command arg1 arg2¬
```

The "¬" character represents the "return" or "enter" key. If copying and pasting the command into a command prompt, do not include the "¬" character, but press "Return" or "Enter" where it appears.

Commands that are too long to fit on one line, appear with the "\¬" at the end of each line of the command to indicate it is continued on the next line:

```
command this command is too long\¬
 and continues here¬
```

Such a multi-line command can be entered by either

- manually typing the command on a single line into the "shell" (and leaving out the "\¬" and "¬" characters). Press the "Enter" or "Return" key when the complete command is entered.
- copying and pasting each line into the "shell" (leaving out the "¬" character but including the "\" character). Press "Return" or "Enter" after pasting each part of the command. Leave in in any spaces at the beginning of continuation line(s) if present.

Example:

Copying and pasting the multiple line command

```
command this command is too long\¬
 and continues here¬
```

should result in the following command line:

```
command this command is too long and continues here
```

Command output or text that a procedure asks to be included in files will appear as follows:

```
Output line 1
Output line 2
```

1.5   Acknowledgements

The content of the Companion Guide is the work of the many Fusion community members that have contributed these valuable tips. Many thanks go out to those whose efforts make it possible. Apologies to anyone that I may have missed.

Special thanks go out to:

- @Mikero (Michael Roy, VMware Fusion/Workstation product manager) – for providing the Tech Preview, its documentation, and for keeping watch over the Discussions forum.

- @ColoradoMarmot – For comments and experiences on using prior versions of the Tech Preview, a heads-up on running multiple virtualization products at the same time.

- @palter – for noting that UTM 4.0 now enables virtualization of macOS Monterey and Ventura.

- @JamesRule – for reporting issues with resizing Kali Linux windows

- @adf43r3rfe – for reporting issues in booting a newly installed Kali Linux VM

- @mvreijn – for pointing out an omission of instructions for installing openSUSE Leap

- @toce – for pointing out an error in earlier versions of the commands used to install a Debian backport kernel that results in installation failures,

- @treee – for pointing out inaccuracies in revision 2 of this document, and suggesting changes for clarity

- @itris666 – for pointing out that Fusion Player does not have the ability to change Secure Boot state in the GUI once a Windows 11 ARM VM is created, and suggesting that the Windows Insider VHDX conversion procedures be returned to the Companion

- @gnttz79xro – for a solution to stuttering sound on Linux virtual machines.

- @maxmori – for another solution for stuttering sound on Linux virtual machines.

- @neanti – for a procedure to manually convert a Parallels VM to Fusion

- @joedec – for solution to Windows 11 screen flickering/black display problem.

- @gringley – for reporting the availability of updated VMware Tools that address 2 security issues.

- @coolryg – for the explanation of devices that have no drivers in Windows 11 ARM VMs.

- @parhom and @brad-x – for the workaround to GNOME 46 display issues when 3D is enabled.

1.6   Changes from Version 25

Cosmetic/Formatting Changes

- Commands that were too long to fit on one line were proving to be difficult to copy/paste from the pdf form of the Companion. The display of commands in general have been changed to make copy/paste from the pdf document easier and more reliable.

- Known Issues sections have been introduced to organize items that aren't tips and techniques, but rather are problems/gotchas that have been found by the community.
- Miscellaneous other cosmetic/formatting changes to cross-references within the Companion document. Readers will note the addition of page numbers for cross-references and more prominent numbering of figures/screen shots in the document.

Updated content

- GNOME 46 is now appearing in Linux distributions and is introducing issues with 3D acceleration on Fusion. Discussions have been added with workarounds for users that are experiencing these issues.
- The Companion has been updated to reflect the release of VMware Tools 12.4.0. This new Tools release introduces OpenGL support for Windows 11 ARM VMs.
- A workaround to the DPC_WATCHDOG_VIOLATION crash and other hangs on Windows 11 ARM VMs is provided.
- An expanded discussion on 3D capabilities for Windows ARM VMs is now available.
- Updates to reflect the release of Fusion 13.5.1. This includes:
  o A discussion of the security content of the release, which contains fixes to a critical vulnerability.
  o Fixes to the "Get Windows from Microsoft" tool in the Fusion GUI when running a non-English version of macOS.
- Updates to reflect the release of macOS Sonoma 14.4, which fixes the issue of Fusion crashing when macOS VoiceOver or Full Keyboard Access features are enabled.
- Because of the number of posts seen in the discussion forums about the GNS3 and EVE-NG network simulation software not working on Apple Silicon, a new topic has been added.

2   General Notes

2.1   Getting help

If you need help, the first place to start is the Fusion documentation. The topic Location of Fusion documentation on page 6 will guide you to where you can find the available documentation.

If you can't find an answer in the documentation, take a look in the VMware Fusion Community forum: https://communities.vmware.com/t5/VMware-Fusion/ct-p/3005-home. The forum is a user-to-user forum where users try to help each other out. Your question may have already been answered; if not, then the forum is a good place to ask for help.

> **Tip**:   Be wary of posts in the "Fusion 2023 Tech Preview" or the "Fusion TP 22H2" forums. Those forums were for public beta test versions of the software that have long since expired. They are not monitored for new content. Discussions in those forums may not be relevant to the current versions of Fusion. Instead, look at the VMware Fusion Community forum and ask a new question if you need to.
>
> **Tip**:   To help forum members to help you better, please provide as much information as possible about what you are experiencing. That includes:
>
> - the Mac hardware and macOS version that you're using
> - the Fusion version you're running on
> - the operating system (with version/build information) you're running in the VM
> - a detailed description on what has happened (including how you got to the point of failure)
> - the vmware.log file from the impacted VM

About the VMware Community forums

The VMware Community forums are user-to-user forums. People participating are end-users just like you. They respond based on their available time and expertise. Knowledgeable and helpful people do frequent the forum and are happy to assist – but remember that there are no guarantees on when or if someone responds to your question or that anyone knows an answer to your question.

Also remember that the forums are not an official VMware support site. VMware employees and technical support do not actively monitor the forums as part of their jobs. You shouldn't expect that any problems with Fusion reported to the forums will be investigated by VMware. You may get the attention of a VMware engineer with a forum post but consider yourself lucky if that happens.

To get a problem officially reported to VMware so that it can be fixed, open a Service Request through the VMware Customer Connect portal. You are entitled to open a Service request if :

- You have purchased a Fusion product license (full or upgrade) within the last 30 days. (VMware offers complimentary Service Requests for 30 days after a Fusion license purchase), or
- You have a VMware support contract for Fusion (uncommon for non-business users), or
- You have purchased Fusion Pro per-incident support vouchers from the VMware Online Store.

2.2   Location of Fusion documentation

2.2.1   Release notes

It is strongly recommended that you review the release notes for Fusion before installing or upgrading Fusion. The release notes for all Fusion versions can be found on the VMware Fusion Documentation site at https://docs.vmware.com/en/VMware-Fusion/index.html.

2.2.2   Fusion documentation

The documentation for Fusion is available in-product, in HTML format on the Internet, and as a PDF document. To find the Fusion documentation:

- In-product - Select **Help > VMware Fusion Help** from the Fusion menu bar
- HTML format on the web - browse to the VMware Fusion Documentation site at https://docs.vmware.com/en/VMware-Fusion/index.html
- PDF format - https://docs.vmware.com/en/VMware-Fusion/13/fusion-13-user-guide.pdf

2.3   VMware KB article 90364 contains important information

VMware KB article "**Compatibility considerations for Arm guest operating systems in Fusion VMs on Apple silicon**" https://kb.vmware.com/s/article/90364. This article describes in more detail:

- The generic requirements and limitations for all ARM guest operating systems
- Detailed information on the virtual hardware devices for officially supported ARM guest operating systems, and
- Operating systems that are NOT supported by Fusion on Apple Silicon Macs. This includes a statement that NO x86 (Intel) operating systems and NO macOS versions are supported.

The information in this KB article is an important addition to the official Fusion documentation.

2.4 Obtaining installation media for guest operating systems

VMware does not provide pre-built virtual machine images for any guest operating system. You must download installation media and install it into a Fusion VM like you would for a physical machine. Here's how to obtain installation media.

2.4.1 Windows 11 ARM

Starting with Fusion 13.5, VMware provides a tool that downloads Windows 11 ARM installation media directly from Microsoft. See Obtaining Windows 11 ARM ISO installation media on page 48 for more details.

2.4.2 All other operating systems

Download arm64 ISO installation media from the distribution's web site.

> **Tip**: Make sure any installation ISOs that you download are for arm64 or aarch64 processor architectures. ISOs for other processor architectures such as x86, x86_64, amd64, IBM Power, RISC-V etc. will not work.
>
> **Tip**: Do not use any arm64 downloads that are system images for single board ARM computers such as the Raspberry Pi. In most cases, these images will not work with a Fusion virtual machine. Most of these images only have drivers for the devices present in the single board computer, and do not have drivers for the devices that Fusion provides to a virtual machine.

2.5 Update to Fusion 13.5.1

Fusion 13.5.1 is a free update to Fusion 13 users. It is recommended for Apple Silicon Mac users. It includes the following features that are not present in Fusion 13.0 through 13.0.3:

- macOS 14 Sonoma support
- Dramatically improved copy/paste/drag/drop speed for all guest operating systems
- Improved VMware Tools Setup installer for Windows 11 ARM (goodbye to the Powershell script to install VMware Tools)
- Copy/paste/drag/drop for Windows 11 ARM guests
- 3D graphics acceleration with DirectX 11 support for Windows 11 ARM guests
- Soft power operations (including suspend) for Windows 11 ARM guests
- Tool to download Windows 11 ARM installation media directly from Microsoft.
- Bug and security fixes

Please stop using the Tech Previews

Why?

- Tech Previews are designed for users to test pre-release versions of software and provide feedback to VMware. The 21H1, 22H2, and 2023 Tech Preview releases are obsolete as their testing periods are over.

- Fusion 13.5 and later contain all the features that were found in all of the Tech Preview releases. Plus some.

- Tech Previews have known bugs and security vulnerabilities that are fixed in the released versions.

- Tech Previews are totally unsupported software.

- You won't get community help for Tech Previews by posting in the Tech Preview discussion forums. Nobody's monitoring those forums.

There's no reason to continue to use Tech Previews. Use Fusion 13.5 or later.

2.6 Run your VMs on local APFS or HFS+ volumes

You should save and run your VMs on disk volumes formatted with macOS Extended (HFS+) or APFS file systems. You will have problems trying to run Fusion virtual machines stored on other types of file system such as:

- Read-write NTFS formatted file systems using third-party file systems such as Paragon NTFS

- FAT (MS/DOS) formatted USB sticks or hard drives

- Media formatted with ExFAT file systems

These file systems either don't provide the file system operations that Fusion needs, or the third party file system drivers are problematic. The reported issues range from Fusion errors to corrupted virtual machines to macOS crashes.

It's also not recommended to run virtual machines from networked (NAS) storage. Aside from potential performance issues, one network interruption on your Mac and *poof* you may be faced with a virtual machine crash and a potentially corrupted virtual machine.

Just because you can't run a VM on NTFS, FAT, ExFAT, or networked file systems doesn't mean you can't use them. All available read-write file system types on the Mac can be used to transport VMs to/from another system or to provide a backup copy of your VM[1].

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[1] Note that FAT formatted volumes have a maximum file size of 4 GB. You won't be able to use them to transport virtual machines with any virtual disk piece of 4 GB or larger. Use ExFAT instead.

2.7 Don't sync your VMs to the cloud

Avoid storing and running your VMs in locations that are configured to sync to cloud storage. This includes but is not limited to:

- Microsoft OneDrive
- Dropbox
- iCloud Drive
- Google Drive

Running your VMs from folders that use cloud storage may result in errors or corrupted virtual machines. Most of these cloud storage solutions use Apple's File Provider services, and Fusion has no knowledge of where the files are stored or when they may be synchronized or evicted to the cloud. Some file system operations that Fusion wants to use may not work as expected, resulting in errors. You may also be waiting for the cloud to restore a multi-gigabyte file over the network that has been evicted from your disk without Fusion's knowledge.

> **Be wary of iCloud Drive**
>
> You may be syncing your Desktop and Documents folders to the cloud and not realizing it.
>
> Check the macOS **System Settings/System Preferences > Apple ID > iCloud > iCloud Drive**. If iCloud Drive is enabled, you should check the option for "**Desktop & Documents Folders**". If that's enabled, you are syncing your Desktop and Documents folders to iCloud.
>
> You should not store your VMs in your Desktop or Documents folder (or their subfolders) if this is enabled. Choose another folder for your VMs or disable Desktop & Documents Folder syncing.

2.8 Do not disable macOS security features

System Integrity Protection (SIP) and Apple Mobile File Integrity (AMFI) are two features that macOS provides to protect against malware. They are both is enabled by default and never recommended[2] to be disabled by Apple.

Do not disable either of these features and expect Fusion to run properly. VMware does not test and will not address problems with configurations where these features are disabled.

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[2] Well, almost never. Apple only recommends disabling SIP when testing operating system device drivers and only for limited amounts of time. Which is a task that only operating system device driver developers perform, not ordinary users.

2.9   Fusion on Apple Silicon does not run Intel virtual machines

As stated in KB article https://kb.vmware.com/s/article/90364, virtual machines built with Intel 32- or 64-bit operating systems will not run on Fusion on Apple Silicon Macs.[3] Parallels running on Apple Silicon Macs has the same behavior.

Intel Mac users with VMs other than macOS (including versions of Windows client before Windows 11 and all Windows Server versions) should consider:

- Continuing to run VMs on an Intel Mac.
- Using an Intel/AMD PC to run VMs with VMware Workstation[4]
- Using an Intel CPU emulator such as QEMU or UTM. Be aware that the performance of emulated Intel CPUs may not be acceptable.

Intel Mac users with macOS VMs should refer to Fusion on Apple Silicon does not run macOS VMson page 32 for guidance.

2.10   Features not available in Fusion 13.5 on Apple Silicon

Features not available in Fusion 13.5 on Apple Silicon (all guest operating systems)	
• Running of virtual machines requiring Intel x86 or x64 CPUs • Virtualization of any version of macOS • Virtual machine import/export using .ova or .ovf formatted files	• Virtual Printer (ThinPrint) sharing with the host Mac (workaround available) • Conversion of virtual machines from Parallels (workaround available) • Nested virtualization

In addition, please refer to the VMware KB article "Features of Windows 11 VM on Mac with Intel vs. Apple silicon (95031)" https://kb.vmware.com/s/article/95031 . This article compares the features available for Windows guest operating system in Fusion 13.x for Intel Macs, Fusion 13 for Apple Silicon, and Fusion 13.5 for Apple Silicon.

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[3] While Rosetta 2 allows applications compiled for Intel Macs to run on Apple Silicon CPUs, it does not enable hypervisors to run Intel operating systems. This is a documented Apple restriction.
[4] VMware does not support or allow macOS VMs to run on VMware Workstation. Apple's macOS licensing prohibits the use of macOS on non-Apple hardware.

2.11   Arm64 operating systems known to work on Fusion

This is not a comprehensive list.

Arm64 guest operating systems known to work with Fusion 13	
• AlmaLinux 9.1 and later • CentOS 9 Stream • Fedora 38, 39, and Rawhide • Debian 11.7, 12 • Kali Linux 2022.3 and later • OpenSUSE Leap 15.5	• OpenSUSE Tumbleweed • Oracle Linux 8.7, 9.1 and later • Red Hat Enterprise Linux 9.1 and later • Ubuntu 20.04.5, 22.04.3, 23.04, 23.10 • Windows 11 ARM 22H2 and later

It's recommended to use the latest publicly released version of any Arm64 architecture operating system. As the operating system kernel developers gain experience, they have improved both the stability and performance of ARM architecture operating system.

Some end-of-life/unsupported versions of the operating systems in the list may also work. Refer to the distribution-specific sections of the Guide to see if those EOL versions are usable – but note that EOL versions may contain unpatched security issues.

Arm64 Linux distributions that have ISO installation media with reasonably current kernels (5.19 and later) and support the hardware described in the KB article https://kb.vmware.com/s/article/90364 will likely work with Fusion. You are encouraged to try them and report your experiences back to the broader Fusion community.

2.12   Arm64 operating systems that won't work on Fusion

Operating system versions older than those found in Arm64 operating systems known to work on Fusion *may not work*. Older distributions tend to contain bugs and other incompatibilities on arm64 that render them unusable on Fusion.

Linux installers and images targeted for Raspberry Pi (and similar) arm64 single-board computers *will not work* on Fusion. Fusion does not provide virtual hardware for the storage, GPU, and boot firmware present on these devices.

2.13   Linux 3D graphics acceleration

Fusion supports OpenGL 4.3 for 3D accelerated graphics on arm64 Linux virtual machines through the Mesa 3D libraries.

Fusion does not currently support Vulkan.

3D acceleration for an arm64 Linux VM on Fusion requires:

- Virtual hardware version 20 or later.

- A VM with a 5.19 or later Linux kernel. These versions contain the VMware graphics driver enhancements needed to support 3D acceleration on arm64 virtual machines.
- Mesa 3D 22.1.1 or later installed in the VM.

3D acceleration is known to work on the following arm64 Linux distributions:

- Ubuntu 22.04.2 LTS and 22.04.3 LTS (when running the HWE kernel)
- Ubuntu 22.10 and later
- Fedora 37 and later
- Fedora Rawhide
- Debian 12 "bookworm"
- OpenSUSE Tumbleweed snapshot 20230403 and later
- Kali Linux 2023.1 and later

3D acceleration *will not work* on the following arm64 Linux distributions:

- Ubuntu 22.04.x LTS with 5.15 standard kernel
- Ubuntu 20.04.x
- Red Hat Enterprise Linux - all versions and all downstream derivatives such as Rocky Linux and AlmaLinux.
- Oracle Linux – all versions
- CentOS 9 Stream
- Debian 11 "bullseye"
- OpenSUSE Leap 15.x

Do not enable 3D acceleration on guests that do not meet the prerequisites. There have been reports of Fusion crashing early in the boot process when 3D acceleration is enabled for distributions that do not support it.

2.14   Importing Parallels virtual machines

Fusion on Apple Silicon Macs does not directly support the importing of virtual machines from Parallels. @neanti and others have provided the following workaround:

1. Locate the Parallels .pvm file for the Parallels VM in the Finder, and double click on it. Fusion will open, create a new virtual machine, and convert the Parallels disk to VMware vmdk format.

    Note that this VM will not be bootable under Fusion. Do not attempt to power it on because it will be flagged as requiring an X86 machine architecture.

2. Create a new VM in Fusion. In the "**Select an Installation Method**" dialog select "**Create a custom virtual machine**".

3. In the "**Choose Operating System**" dialog, select the operating system type that you installed in the Parallels VM. For example, if you have a Windows VM in Parallels, select "Windows 11 64-bit Arm".

4. In the "**Choose Firmware Type**" dialog, you can leave the "UEFI Secure Boot" box unchecked.

5. If you are presented with the "**Choose Encryption**" dialog and are using a Windows VM, choose the default "**Only the files needed to support a TPM are encrypted**" option. Provide the password for your new VM as requested. Even if you check "**Remember password and store it in the Mac's keychain**", it's recommended to remember the password yourself. If something goes horribly wrong with the macOS keychain or you anticipate needing to move the VM to another system, you'll need to know the password to unlock the VM.

    Encrypting Linux virtual machines is optional.

6. In the "**Choose a virtual disk**" dialog, choose "**Use an existing virtual disk**". and click on the "**Choose virtual disk...**" button. A file browser window will open. Use this window to navigate into the converted VM bundle created in step 1. (yes, it will let you drill into the bundle like it's a normal folder, and not have to go through "Show Package Contents"). Select the .vmdk file that doesn't have -s0xx.vmdk in the name. It should be the only one not grayed out.

7. Before hitting "**Choose**", make sure the option is selected to "**Make a separate copy of the virtual disk**". That will copy the virtual disk into your new virtual machine, leaving the original untouched. Now click "**Choose**".

8. In the Finish dialog, you can click the "**Customize Settings**" or "**Finish**" buttons. **Finish** will power on the vm, **Customize Settings** gives you a chance to change things like memory and CPUs before powering on the VM.

    Either way, you'll be presented with a dialog to save the new VM. Once. you provide the name and location for the new VM and click "**Done**" the data will be copied from the old VM.

The converted Windows VMs have been reported to run without further.

Converted Linux VMs may not boot due to virtual hardware differences between a Parallels virtual machine and a Fusion virtual machine. The VM's disks will contain all settings and all apps from the previous installation. If the VM fails to boot, use the Linux installer ISO for the distribution you initially used to install Linux on Parallels and boot it to rescue mode. You will then be able to fix any issues preventing the OS from booting. Sample instructions on how to perform this kind of repair for OpenSUSE can be found here: https://forums.opensuse.org/t/repair-a-broken-uefi-grub2-opensuse-boot-scenario/129018. Similar instructions may be able to be found for other distributions.

Once you've verified that the new VM is running, you can delete the Parallels VM and the VM created in step 1 to save disk space.

2.15 Virtual USB controller vulnerabilities (VMSA-2024-0006-1)

On 2024-03-04, VMware provided security advisory VMSA-2024-0006-1 https://www.vmware.com/security/advisories/VMSA-2024-0006.html that describes multiple vulnerabilities in the virtual UHCI USB controller. The most severe of these vulnerabilities is rated as "Critical". The issues are reported by VMware to exist in Fusion 13.x but should be assumed to be present in older releases.

VMware fixed these issues in Fusion 13.5.1. There is no plan by VMware to back-port these fixes to earlier Fusion releases.

2.16 Known Issues

2.16.1 Some arm64 Linux installers do not boot on Fusion

Some older arm64/aarch64 installation ISOs may not boot on Fusion. They will display a blank screen with either no cursor or a static non-blinking cursor.

A common cause of this problem is a Linux kernel that contains an older version of the VMware SVGA virtual graphics driver (vmwgfx). This driver appears to have issues when running under Fusion.

See if the installer has an option to boot with a generic graphics adapter. If it doesn't, try disabling the vmwgfx driver at boot time using the following procedure so that the kernel will not load it. In some cases, this will allow the installer or virtual machine to boot using the default Linux frame buffer graphics driver.

1. Boot the virtual machine to the GRUB boot loader menu and use the keyboard up/down arrow keys to highlight the desired kernel.

   Do not press '**Enter**'. Instead, press '**e**'. This will display the details of the GRUB booting commands for that kernel.

2. See the documentation for GRUB and your distribution for complete instructions on how to block kernel drivers from loading.

   For many non-Debian Linux distributions, adding the following to the kernel arguments will prevent the vmwgfx driver from loading:

   ```
   modprobe.blacklist=vmwfgx
   ```

   For Debian-derived releases (including Kali Linux), add the following instead:

   ```
   module_blacklist=vmwfgx
   ```

3. Press `Control-x` to boot the kernel with the updated arguments.

The kernel should now boot to the graphical login screen or installer. If it doesn't, the VMware graphics driver may not be the problem and additional troubleshooting needs to be performed.

2.16.2 "Install VMware Tools" is greyed out in Fusion menu bar

The Fusion GUI menu item to "Install VMware Tools" is greyed out for arm64 Linux VMs. That's because VMware doesn't provide VMware Tools installable packages as part of Fusion for arm64 Linux.

The solution is to install open-vm-tools and open-vm-tools-desktop from the Linux distributions' repositories. open-vm-tools are the VMware-recommended in-guest tools for all current Linux operating systems and are the only in-guest tools available for arm64 Linux VMs.

2.16.3 "Start pxe over ipv4" message displayed during guest power up

"Start pxe over ipv4" is displayed when the guest is attempting to boot from a network interface. In almost all cases, this means that the guest cannot find a bootable operating system from either the hard disk or the CD/DVD drive.

If this message appears, check to see if one of the following has occurred:

Cause	What to do
The virtual CD/DVD drive is not configured to use the installation ISO.	Configure the installation ISO to the virtual CD/DVD drive and connect the drive to the guest.
The virtual CD/DVD drive is not connected to the guest.	Connect the virtual CD/DVD to the guest and restart the guest.
Corrupt or invalid ISO file.	Verify that you have installation media that contains a bootable ARM architecture operating system.
Trying to install from ISO installation media that is built for use on 32 or 64-bit Intel PCs.	Ensure you have arm64/aarch64 architecture ISO installation media for your operating system.
When installing Windows 11 ARM, the "Press any key to start from CD or DVD" prompt timed out.	See **Windows installation ISO won't boot** on page **65**

2.16.4   Unable to change the display resolution of a Linux virtual machine

Changing the resolution of a Linux virtual machine display requires a Linux kernel that contains the VMware SVGA (vmwgfx) driver. VMware provided the vmwgfx driver to the Linux kernel source tree, and it should be included out-of-the-box in most vendor distributions with a 5.14 kernel or later.

Most of the time this issue is seen with Debian 11. The kernel that is released with Debian 11 is a 5.10 version which does not contain the VMware video driver.

2.16.5   Shared folders do not automatically mount in a Linux virtual machine

This a known issue for Linux VMs using open-vm-tools on both x64 and arm64 operating systems. See the following VMware KB article for more information on why this occurs https://kb.vmware.com/s/article/60262.

The documented workaround for this issue is to disable and enable the Shared Folders feature of the virtual machine from the Fusion GUI while the VM is running. However, this workaround is not persistent, and must be repeated after each reboot of the virtual machine.

A solution that will mount shared folders automatically at VM boot is to add an entry to **/etc/fstab** in the virtual machine that mounts the shared folders automatically on boot.

1.   Log into the VM and sudo to root.

2.   Verify the mount point directory **/mnt/hgfs** exists in the VM. If it doesn't, create the empty directory.

3.   Edit **/etc/fstab**. Add the following line to the file:

```
vmhgfs-fuse /mnt/hgfs fuse defaults,allow_other,_netdev 0  0
```

4.   Reboot the virtual machine

Shared folders configured in the Fusion GUI for the virtual machine should now mount at boot time.

Another persistent solution for distributions using systemd can be found in the following VMware Knowledge Base article: https://kb.vmware.com/s/article/74650.

2.16.6   Erratic behavior when multiple virtualization products are in use

(Thanks to @ColoradoMarmot for finding this)

Erratic behavior has been observed when running Fusion at the same time as running another virtualization product (in the reported case, Parallels). The issue reported is that host crashes have occurred when under heavy load.

A prudent practice would be to avoid running multiple virtualization products at the same time.

See this post for more details: https://communities.vmware.com/t5/Fusion-22H2-Tech-Preview/Warning-about-running-multiple-hypervisors-at-once/td-p/2921430.

2.16.7   Host printers are not shared with the VM

Fusion on Apple Silicon Macs does not contain virtual printing (ThinPrint) features that allow printers defined on the host Mac to be shared with the VM. VMware has not commented whether they will re-introduce the feature in a future release.

In the meantime, try one of the following workarounds to print from a guest:

- If using Bridged networking, use the network printer configuration capabilities that are present in the guest. Versions of Linux and Windows that run on Apple Silicon can discover most reasonably modern networked printers available on your network.

- If using NAT networking, enable printer sharing on macOS for the printers you wish to use in the VM. The VM will be able to discover those printers with the guest operating systems' networked printing capabilities. This works for any printer configured to the Mac host.

2.16.8   Sound issues in Linux virtual machines

Some Linux distributions are reported to have issues playing sounds when run in a Fusion virtual machine. The reported issues usually include stuttering and lags of the sound output. In most cases, the Linux distributions that exhibit the issue are running "pipewire" versions prior to 1.0.0 instead of PulseAudio for sound support.

Fedora 39 and Debian Testing (a.k.a. trixie/sid) distros ship with pipewire 1.0.0 which appears to fix the issue. For distributions shipping with earlier versions of pipewire, users are recommending one of the two following work-arounds

- @gnttz79xro reports that the issues can be fixed in Fedora 38 using the instructions in the article
  https://gitlab.freedesktop.org/pipewire/pipewire/-/wikis/Troubleshooting#stuttering-audio-in-virtual-machine. These instructions may be useful for other Linux distributions as well.

- @maxmori reports that disabling pipewire and switching back to PulseAudio also addresses the problem. See https://communities.vmware.com/t5/VMware-Fusion-Discussions/No-sound-in-Linux-on-Apple-Silicon/m-p/2969293 .

2.16.9   Copy/Paste/Drag/Drop on Linux VMs isn't working

If you find that copy, paste, drag, or drop is not working between your Linux VM and your Mac, check that the "open-vm-tools-desktop" package provided by your Linux distribution is installed in the VM. Many distributions will install automatically install the base open-vm-tools package but may not install open-vm-tools-desktop for you.

If you find that drag/drop of files between host and guest are not working, make sure you are running a Xorg (X11) session and not Wayland. Drag/Drop currently requires X11 as the windowing environment.

2.16.10   VMs on Sonoma crash at power-up

When running Fusion on macOS 14 Sonoma versions prior to 14.4, virtual machines crash immediately after power-up. This happens when the macOS Accessibility features VoiceOver or Full Keyboard Access are enabled.

This issue does not appear on Ventura or earlier macOS releases.

Updating to macOS Sonoma 14.4 or later fixes this issue.

2.16.11   GNOME 46 applications don't display with 3D enabled

Users of arm64 distributions that contain the GNOME 46 desktop environment may find that GNOME applications (such as Settings or Software) don't display as expected when 3D acceleration is enabled for the VM. The application windows may appear blank, and items within the window may appear briefly and incorrectly when the mouse pointer is moved over them. **Figure 1** contains an example from the Settings application on OpenSUSE Tumbleweed using the GNOME environment:
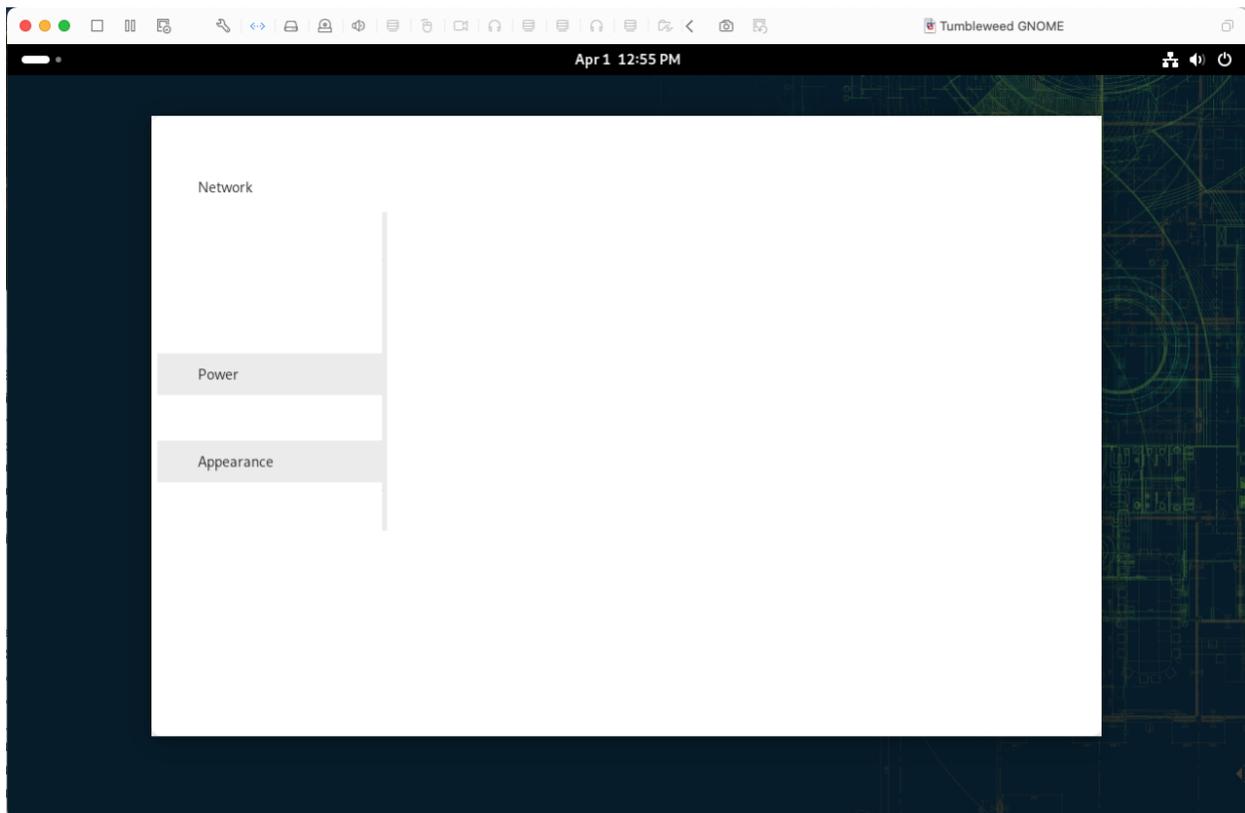
Figure 1: *GNOME 46 3D rendering bug*

This issue is seen in the latest arm64 versions of OpenSUSE Tumbleweed, Fedora 40, and Fedora rawhide. It may appear on other Linux distributions that include GNOME 46. The issue is not seen on x86_64 Linux, or on arm64 Linux distributions that are using GNOME 45 and older GTK4 toolkits. It is also not seen when using the KDE Plasma desktop environment.

Use one of the following workarounds until the developers fix the underlying issue:

- Disable 3D acceleration in the VM's settings
- Leave 3D enabled and force the GTK4 toolkit to use the older OpenGL renders. This can be done system-wide in most Linux distributions by opening a terminal session as root and executing the following:

```
echo "export GSK_RENDERER=gl" > /etc/profile.d/gtk_renderer.sh¬
```

  Reboot the VM for this to take effect.
  Thanks to @parhom and @brad-x for this workaround.

- Use another desktop environment such as KDE

3   Arch Linux

Abandon all hope, ye who enter here.

– Dante, "Inferno"

3.1   General notes

The Fusion Community is reporting that the Arch Linux ARM port has not been successfully installed on Fusion. Unlike the Intel versions of Arch, the ARMv8 supported platforms and images for the Arch ARM port are either single-board computers (Raspberry Pi/ARM development boards) or Chromebooks. The installation images assume the hardware contains devices that are not provided by Fusion's virtual hardware. For example, most of the supported boards have MicroSD cards, which Fusion does not provide.

Arch Linux ARM does not provide a port of open-vm-tools. That will limit the availability of Fusion features such as shared folders and copy/paste/drag/drop even if you can get it to run.

Unless you are an experienced developer and have plenty of time on your hands, avoid Arch Linux on Apple Silicon. And petition the Arch developers to port to a real ARM computer with NVMe disks and EFI firmware.

4   CentOS 9 Stream

4.1   General notes

CentOS 9 Stream arm64 will install and run on Fusion.

- 3D acceleration is not available.
- open-vm-tools and open-vm-tools-desktop are both available from the CentOS repos.
- The console resolution can be changed (from within the VM and auto-fit when resizing the console window).

CentOS 8 Stream arm64 does not work on Fusion. The kernels included in those releases are incompatible with the Apple Silicon hardware. They exhibit the same issue noted in RHEL 8 and earlier do not work on page 39.

There is no workaround. Use CentOS 9 Stream instead.

4.2   Creating a Centos 9 Stream VM

Use "Red Hat Enterprise Linux 9 64-bit Arm" as the operating system type when creating a CentOS Stream virtual machine. This recommended operating system type creates a VM with 4 GB of memory, 2 CPUs and a 20 GB disk. Other operating system types such as "Other Linux 5.x Kernel 64-bit Arm" may not configure the VM with the minimum amount of memory or disk required for CentOS, resulting in the failure of the installation.

4.3 Do not select a 64KB kernel when installing CentOS 9 Stream

Recent CentOS 9 Stream installers will offer the option for 4K or 64KB page size in the Software Selection dialog: (see **Figure 2**).
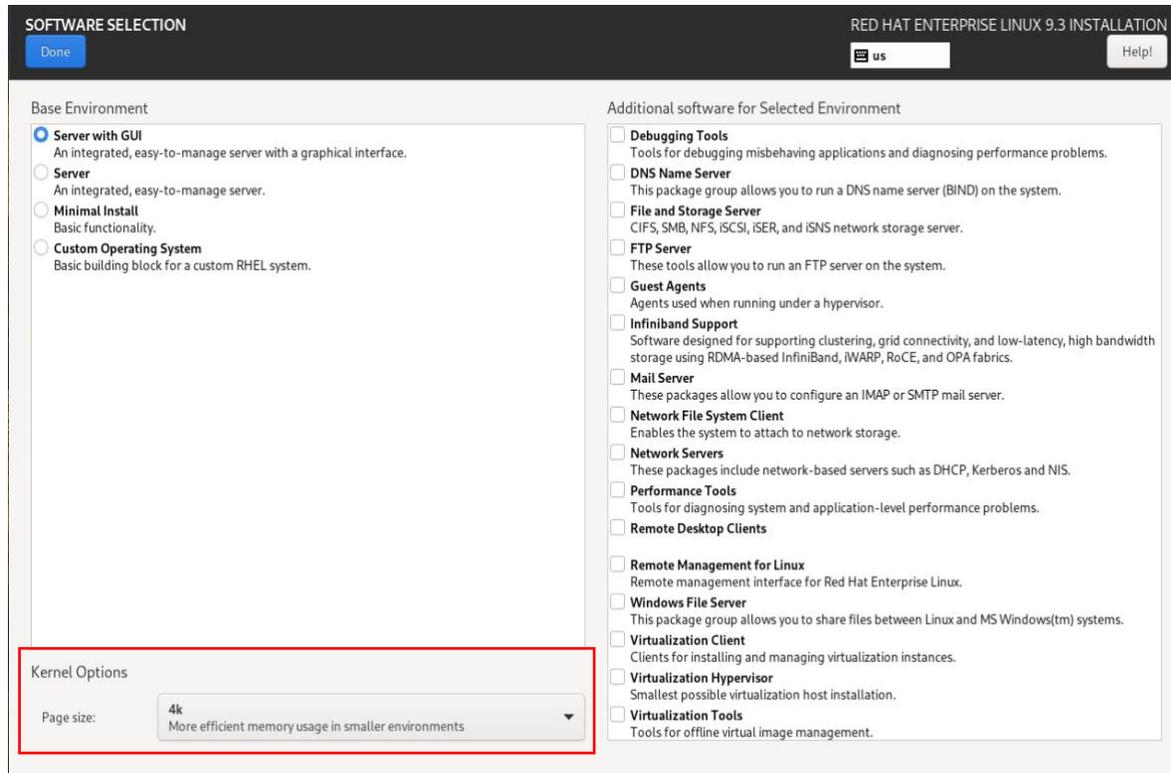
Figure 2: *CentOS 9 Stream installer software selection dialog*

Leave the **Page size** setting in the **Kernel Options** at the default of "**4k**". *Do not choose "64k" – you will end up with a VM that won't boot*.

See RHEL 8 and earlier do not work on page 39 for more details.

5   Debian

5.1   General notes

Debian 11 "bullseye" 11.4 and later work on Fusion.

- 3D acceleration is not available.
- Resizing of the screen resolution is not available out-of-the-box. See Obtaining newer kernel versions for Debian 11 on page 23 for a work-around.
- open-vm-tools and open-vm-tools-desktop are not in the standard repos. See open-vm-tools are now available for Debian 11 on page 24.

Debian 12 "bookworm" and Debian Testing (trixie/sid) work on Fusion.

- Console resolution change is supported (both from within the VM and auto-fit on console window resizing).
- 3D acceleration works.
- Open-vm-tools and open-vm-tools-desktop are available in the "bookworm" repos and are installed by default.

5.2   Creating a Debian VM

Either drag/drop of the ISO or custom virtual machine methods can be used.

For a Debian 11 VM, set the operating system type to "Debian 11.x 64-bit Arm". For a Debian 12 or Testing VM, set the operating system type to "Debian 12.x 64-bit Arm".

5.3   Obtaining newer kernel versions for Debian 11

Debian 11 on arm64 platforms ships with a 5.10 version of the Linux kernel. While this kernel works with Fusion, it does not contain a VMware virtual graphics driver that will allow resizing of the console resolution.

The general solution to this issue is to upgrade to Debian 12, which does support resizing of the console resolution.

If you must stay with Debian 11, installing a 5.18 or later kernel from the "bullseye-backports" repository will allow the screen resolution to be changed. To access this repository, it must be added to the list of available repositories for installation. Full instructions on how to do this can be found at https://backports.debian.org/Instructions. A short version follows:

1.   Open your terminal application and sudo to root.

2.   Add the following line to /etc/apt/sources.list:

```
deb http://deb.debian.org/debian bullseye-backports main contrib non-free
```

3.   Run the following command to update the available package information:

```
apt update¬
```

4. Run the following command to list kernels available for installation.
```
apt list 'linux-image*'¬
```

Anything with "bullseye-backports" attached to the name is available from the backports repo.

5. Install a 5.18 or later kernel from the bullseye-backports repo. Example:
```
apt install linux-image-5.19.0-0.deb11.2-arm64/bullseye-backports¬
```

Note: be sure to specify the exact name of the package. A command such as
```
apt install linux-image-5.19.0-0.deb11.2/bullseye-backports¬
```

will attempt to install all variants of the given kernel and will result in an installation failure.

None of the bullseye-backport kernels receive security updates.

> **Tip:** Kernels available in the bullseye-backport repository that are known to work include:
> - linux-image-6.0.0-0.deb11.2-arm64/bullseye-backports
> - linux-image-5.19.0-0.deb11.2-arm64/bullseye-backports
> - linux-image-5.18.0-0.deb11.4-4-arm64/bullseye-backports
> - linux-image-5.18.0-0.bpo.1-arm64/bullseye-backports

5.4 open-vm-tools are now available for Debian 11

Debian has made open-vm-tools and open-vm-tools desktop packages available for Debian 11 in the "bullseye-backports" repository.

To install open-vm-tools

- Add the "bullseye-backports" repository to **/etc/apt/sources.list** as noted in Obtaining newer kernel versions for Debian 11 on page 23.

- Install the open-vm-tools packages from the backports repository. Here's an example:
```
apt install –t bullseye-backports open-vm-tools open-vm-tools-desktop
```

Best results have been reported when using open-vm-tools with a "bullseye-backports" 5.18 or later kernel.

5.5   Upgrading Debian 11 to Debian 12

Debian supports the in-place upgrading of an existing Debian 11 "bullseye" system to Debian 12 "bookworm". See the Debian 12 release notes for guidance on how to perform this upgrade.

Debian recommends that systems to be upgraded should remove packages installed from the bullseye-backports repo before attempting the upgrade. If you have installed a kernel or open-vm-tools packages into a Debian 11 VM from using the information in this section, please remove them and revert the sources.list file to its standard contents before upgrading.

6   EVE-NG and GNS3

I'm sorry, Dave. I'm afraid I can't do that.

– HAL 9000, "2001: A Space Odyssey"

6.1   GNS3 or EVE-NG VMs don't work

This is seen frequently enough in the Fusion forums that it merits its own discussion.

Many networking professionals and students preparing for network certification use these two tools to emulate physical networking configurations. After purchasing a new M1/M2/M3 Mac, these users find that they are unable to install and run these pre-packaged virtual machines like they could on Intel Macs.

This isn't a problem with Fusion or your Mac. The GNS3 or EVE-NG virtual machines will not run as Fusion VMs on ARM architecture CPUs.

The virtual machines provided by these two are built for Intel CPUs. They also require nested virtualization for the virtual machines to run properly. These system requirements unfortunately mean that these tools cannot run under Fusion on Apple Silicon Macs. There is nothing you can do to get them to run except run them on an Intel Mac or Intel PC.

The developers of both EVE-NG and GNS3 have no published plans to date to port these pre-packaged VMs to run on ARM architectures.

7 Fedora

7.1 General notes

Fedora 38, 39, and Rawhide and will install and run with Fusion.

The following End-of-Life releases are also known to work with Fusion on Apple Silicon.

- Fedora 35 (EOL 2022-12-13)
- Fedora 36 (EOL 2023-05-16)
- Fedora 37 (EOL 2023-12-05)

Since EOL releases are no longer receiving updates for bug fixes or security issues, Fedora does not recommend their continued use.

For all these releases:

- The console resolution can be changed (from within the VM and auto-fit when resizing the console window).
- 3D acceleration is supported with Fedora 36 and later.
- open-vm-tools and open-vm-tools-desktop are available from Fedora repos. In most cases they'll be installed for you automatically.

7.2 Creating a Fedora VM

Either drag/drop of the ISO or custom virtual machine methods can be used. The guest operating system type will be automatically set to "Fedora 64-bit Arm" when using the drag/drop method.

7.3 Known issues

7.3.1 Fedora 40 beta/Rawhide installers don't work with 3D enabled

The installers for Fedora 40 beta and Rawhide releases fail to display properly when 3D acceleration is enabled for the VM. These releases use GNOME 46 and have the issue described in GNOME 46 applications don't display with 3D enabled on page 18.

To install Fedora 40 beta or Rawhide, disable 3D acceleration in the VM's Display settings. Once the VM is installed, you can re-enable 3D acceleration with the following procedure:

1. Boot the VM after installation.

2. Open the Terminal app, sudo to root. and execute the following command:

   ```
   echo "export GSK_RENDERER=gl" > /etc/profile.d/gtk_renderer.sh¬
   ```

3. Shut down the VM.

4. Enable 3D acceleration in the VM's Display settings.

5. Restart the VM.

8 Gentoo

Hic sunt dracones (Latin to English translation: "Here be dragons")

– inscribed on the Hunt-Lenox Globe (c. 1504)

8.1 General notes

Gentoo for arm64 has been reported to install on a Fusion virtual machine. But note that it is somewhat experimental and not as polished as the other Gentoo supported architectures.

Use the arm64 Minimal Installation CD boot media to install Gentoo.

The Stage 3 archives containing systemd are known to work. OpenRC has not been tested at this time, but there should be no reason why it won't work.

There is no Gentoo Handbook for arm64. Use the Handbook for amd64 architectures as your guide.

When building a VM for Gentoo:

- Create a custom virtual machine. Do not drag/drop the ISO to create the VM.
- Set the virtual machine operating system to "Other 5.x Linux kernel 64-bit Arm".
- Assign 2 cores and 4096 MB of memory to the VM.
- Create a virtual disk of 20 GB or more (40 GB if you are attempting to install a desktop profile with a GNOME or KDE desktop as 20 GB is insufficient for compilation of the packages).
- Assign the boot media ISO to the virtual CD/DVD drive and connect it to the virtual machine.

9   Kali Linux

Il faut qu'il n'exige pas le secret, et qu'il puisse sans inconvénient
tomber entre les mains de l'ennemi.[5]

– Auguste Kerckhoffs (1883). "La cryptographie militaire"

9.1   General notes

Kali Linux (a Linux distribution containing tools for penetration testing and ethical hacking) arm64 versions run on Fusion.

- Console resolution can be changed from within the VM.
- Auto-fit of the resolution when resizing the console window does not work when using the default XFCE window manager. See Screen resolution fails to change when resizing the VM's window on page 31.
- 3D acceleration is supported.
- open-vm-tools and open-vm-tools-desktop are available from Kali repos.

Use Kali Linux 2022.3 or later releases. Earlier releases have issues with the bootable installer.

9.2   Creating a Kali Linux VM

Either the drag and drop of the ISO onto the "Select the Installation Method" dialog or "Create a custom virtual machine" method can be used to create a Kali virtual machine from the installation ISO.

The recommended virtual machine configuration for Kali Linux is:

- Guest operating system type of "Debian 12.x 64-bit Arm" or "Other 6.x Linux kernel 64-bit Arm"
- 2 Virtual CPUs
- 4096 MB memory
- 20 GB virtual hard drive

---

[5] English translation: "He must not demand secrecy and must be able to fall into the hands of the enemy without inconvenience."

9.3 Choosing the Kali installer

In the Kali download web site, use either **Installer Images** or **Live Boot** media. When downloading the media, be sure select media labelled for "Apple Silicon (ARM)". Media labelled as "32-bit" or "64-bit" are for Intel CPUs (see **Figure 3**).
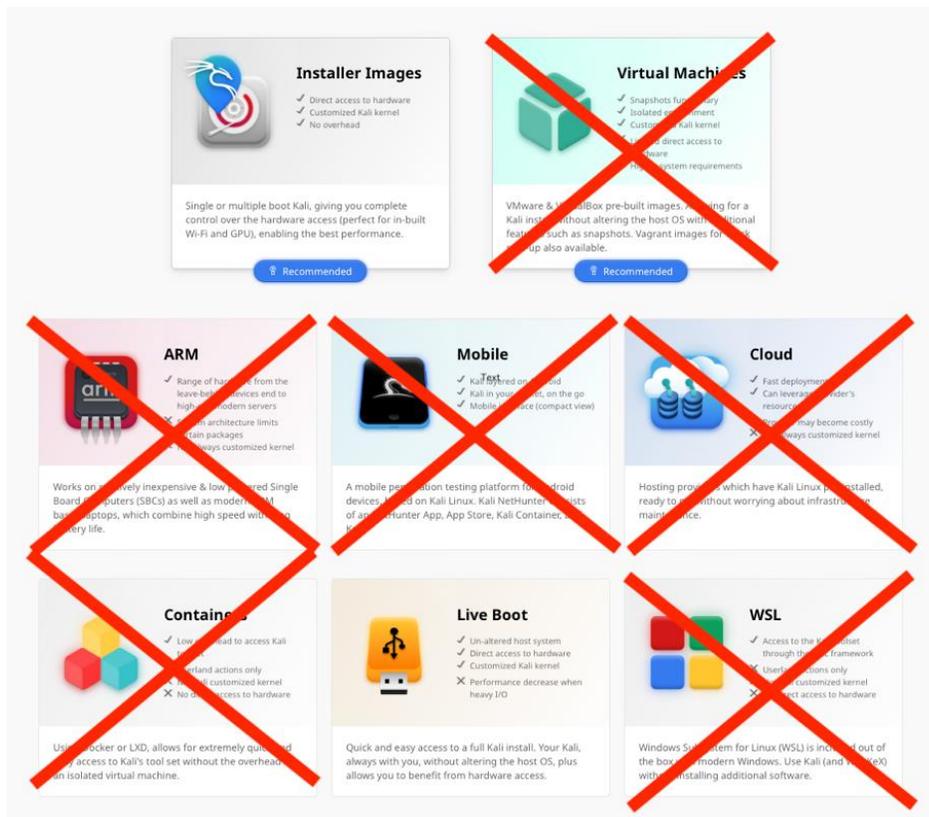
Figure 3: Kali Linux media types

Do not use any of the other platform types on this page with Apple Silicon Macs. They will not work.

9.4 Known Issues

9.4.1 Installation fails at "Select and install software"

The installation of Kali Linux may fail during the "Select and install software" phase with the message shown in **Figure 4**.

Figure 4: Kali Linux installation failure due to insufficient disk space

If this occurs, check the size of your virtual hard drive. The installation will fail with this error message if there is insufficient space to install all the Kali software components. Typically, a 20GB virtual hard drive will allow the installation to complete successfully.

9.4.2   Screen resolution fails to change when resizing the VM's window

(Thanks to @JamesRule and @Mikero for reporting and explaining this)

Resizing the window of a Kali Linux VM will not change the console resolution. The console resolution can be changed within the VM, which will then change the window size.

According to @Mikero, this is an issue with the XFCE window manager that Kali uses by default. The console resolution will change when resizing the VM's window in KDE, GNOME, and Cinnamon, but not XFCE.

10   macOS

You can't get there from here.

– US New England regional idiom

10.1   Fusion on Apple Silicon does not run macOS VMs

Per VMware KB article https://kb.vmware.com/s/article/90364, Fusion on Apple Silicon does not support virtualization of any macOS version.

If you want to run a VM with any macOS version that runs on an Intel Mac, you must use Fusion on an Intel Mac[6].

There are no options to virtualize macOS 11 Big Sur on an Apple Silicon Mac.

To virtualize macOS 12 Monterey and later releases on an Apple Silicon Mac, your options include:

- UTM (https://mac.getutm.app), free from the website or $9.99 from the Mac App Store. Both versions are functionally identical, but the App Store version provides automatic updates and a donation to the author to fund future development.
- Parallels Desktop, commercial product, paid.

Both use Apple's high level Virtualization Framework and have identical capabilities for macOS virtualization. They also all share the following restrictions imposed by Apple's framework:

• No virtualization of macOS 11 Big Sur • No resizing of virtual disks • No virtual disk snapshots • No drag/drop of files between host Mac and VM	• No ability to pass USB devices to the VM • No ability to sign in with an Apple ID in the VM • No more than 2 macOS VMs can run at once

VMware has stated that they are working on a full-featured virtualization solution for macOS on Apple Silicon but has not committed to when it will be released.

---

[6] Apple's EULA for macOS prohibits the use of macOS on non-Apple hardware. VMware does not support macOS VMs on non-Apple hardware. They also do not allow discussions of running macOS on non-Apple hardware on their VMware Community forums.

11   OpenSUSE Leap

11.1   General notes

OpenSUSE Leap ("Leap") version 15.5 is recommended for use in Fusion VMs.

> **Leap 15.4 and earlier are not recommended**
>
> Leap 15.4 and earlier have reached their End-Of-Life dates and no longer receive updates of any kind (including security updates). OpenSUSE recommends that they no longer be used.

For Leap 15.5:

- Console resolution can be changed from within the VM and via auto-fit when resizing the VM's window.
- No 3D acceleration support.
- open-vm-tools and open-vm-tools-desktop are available from Leap repos.

11.2   Creating a Leap VM

When creating a new Leap VM, do not drag and drop the arm64 Leap installation ISO onto the Fusion "**Select the Installation Method**" dialog. If you do, an error message stating that the virtual machine requires an x86 machine architecture is displayed. The resulting VM will not be created correctly, and the VM won't run.

Use the following procedure to create and install a Leap VM:

1. From the Fusion GUI menu bar, select **File > New**.

2. In the "Select the Installation Method" dialog:

    - Click on "Create a custom virtual machine".
    - Click "**Continue**".

3. In the "Choose Operating System" dialog:

    - Select a Linux operating system of **"Other Linux 5.x kernel 64-bit Arm"**.

4. In the "Choose a Virtual Disk" dialog:

    - Accept the default answer to create a new virtual disk.
    - Click "**Continue**".

5. Select a name for the new virtual machine and save it.

6. The **"Settings"** dialog for the new virtual machine will appear. Make the following changes:

    - **Processors and Memory**: 2 virtual processors and at least 2048 MB of memory.

- **Hard Disk (NVMe)**: Increase the disk size to at least 20 GB.
- **CD/DVD (SATA)**: Configure the virtual CD/DVD device to use the OpenSUSE Leap installation ISO and check the **"Connect CD/DVD Drive"** checkbox.

7.   Power on the virtual machine to start the installer

12   OpenSUSE Tumbleweed

12.1   General notes

OpenSUSE Tumbleweed ("Tumbleweed") is OpenSUSE's continually updated or rolling distribution.

Tumbleweed arm64 will install and run on Fusion.

- Console resolution can be changed (from within the VM and via auto-fit when resizing the VM's window).
- 3D acceleration is supported.
- open-vm-tools and open-vm-tools-desktop are available from Tumbleweed repos.

12.2   Creating an OpenSUSE Tumbleweed VM

A Tumbleweed VM can be created by dragging/dropping the installation ISO on the Fusion "**Select the Installation Method**" dialog.

Configure the VM as follows:

- Set the operating system type for the VM to "Other Linux 6.x kernel 64-bit Arm".
- In the "Finish" dialog, click "Customize Settings" rather than "Finish".
- Set the VM's memory to a minimum of 4096 MB.
- Change the hard disk size to 20 GB or more. This will give sufficient space for future upgrades.

You must change the memory and hard disk size before powering up the VM. Tumbleweed will not install with the default VM settings.

12.3   Known issues

12.3.1   GNOME applications fail to display correctly when 3D is enabled

When using the GNOME desktop environment in recent snapshots/updates of Tumbleweed, GNOME applications fail to display correctly when 3D acceleration is enabled for the VM. This is due to Tumbleweed's inclusion of GNOME 46. See GNOME 46 applications don't display with 3D enabled on page 18 for more details and workarounds to the issue.

13   Oracle Linux

13.1   General notes

The only kernel Oracle provides for Oracle Linux on aarch64 (ARM) architectures is the Unbreakable Enterprise Kernel (UEK). The Red Hat Compatible Kernel (RHCK) is only available for x86_64 (Intel) architectures.

UEK R6 and earlier arm64 kernels will not run on Apple Silicon CPUs as they are compiled for 64KB page sizes. Oracle Linux versions 8.6 and earlier ship with these incompatible kernels and therefore will not work with Fusion. See RHEL 8 and earlier do not work on page 39 for more information.

UEK R7 arm64 kernels will run on Fusion. Oracle Linux arm64 versions starting with 8.7 (including all Oracle Linux 9.x versions) ship with UEK R7 kernels. These Oracle Linux versions will all run on Fusion.

13.2   Creating a Oracle Linux VM

When creating a VM for Oracle Linux, create a custom virtual machine. Configure the virtual machine with:

- Operating system type set to "Other 64-bit Linux 5.x kernel 64-bit Arm"
- Minimum 2 virtual CPUs and 4096 MB memory
- Minimum virtual disk size of 20 GB

13.3   Known issues

13.3.1   No open-vm-tools for Oracle Linux 8.7

Oracle does not provide open-vm-tools and open-vm-tools-desktop for Oracle Linux 8.7 in their repositories. No copy/paste/drag/drop is available between the host and guest, nor is there support for Fusion folder sharing between host and guest.

Both open-vm-tools and open-vm-tools-desktop packages are available in the Oracle Linux 9.x repositories.

14　Red Hat Enterprise Linux and downstream distros

> **Note:**
>
> References to Red Hat Enterprise Linux (RHEL) in this section also apply to "downstream" distributions that are re-builds of Red Hat Enterprise Linux such as:
>
> - Rocky Linux
> - CentOS Linux 8 and earlier (before the switch to CentOS Stream)
> - AlmaLinux
>
> Oracle Linux differs from RHEL enough to warrant its own discussion. See **Oracle Linux** on page 36

14.1　General notes

RHEL 9.1 and later arm64 releases provide the best experience when running under Fusion.

- Console resolution can be changed (from within the VM and auto-fit when resizing the VM's window).
- 3D acceleration is not supported.

open-vm-tools and open-vm-tools-desktop are available from RHEL 9 repos.

14.2　Creating a RHEL 9 VM

Either drag/drop or custom virtual machine methods can be used to create a RHEL 9 VM.

When creating a RHEL 9 virtual machine, set the operating system type to "Red Hat Enterprise Linux 9 64-bit Arm".

14.3   Do not select a 64KB kernel during installation

Recent RHEL 9 installers will offer the option for 4K or 64KB page size in the Software
Selection dialog (see **Figure 5**):
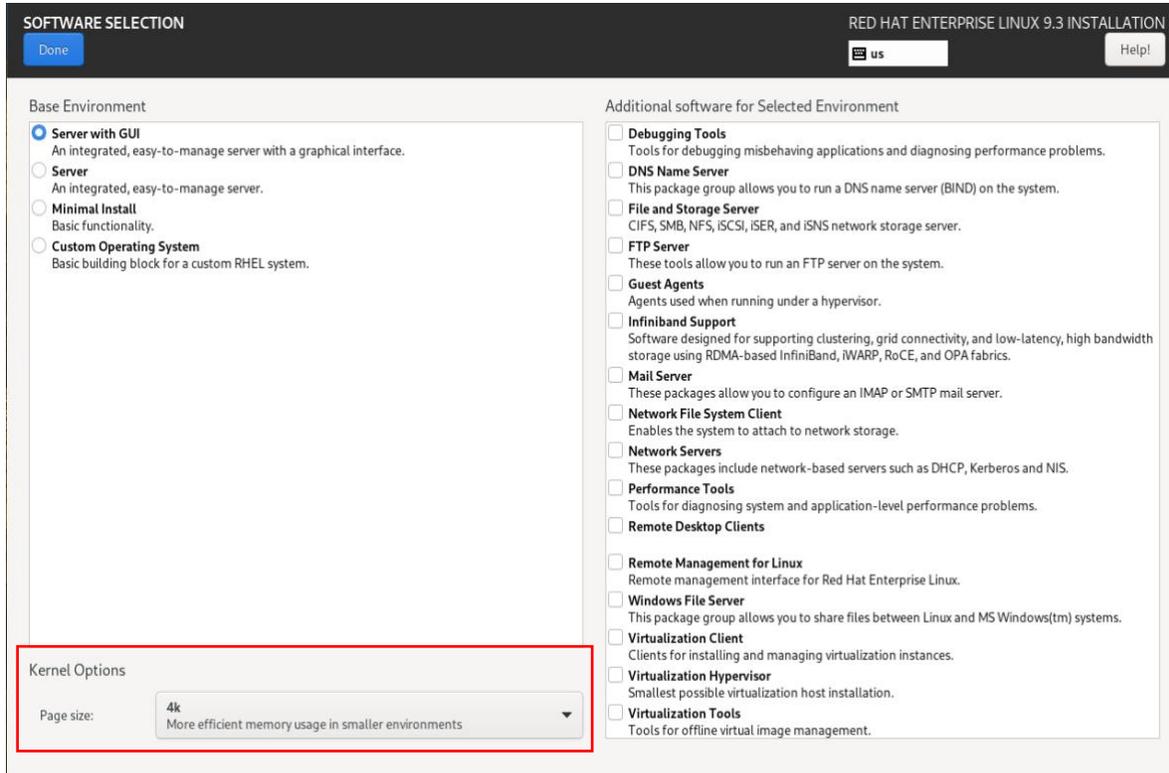
Figure 5: *RHEL 9 installer software selections dialog*

Leave the **Page size** setting in the **Kernel Options** at the default of "**4k**". *Do not choose "64k" –
you will end up with a VM that won't boot*.

See RHEL 8 and earlier do not work on page 39 for more details.

14.4   Known Issues

14.4.1   RHEL 9.0 installation issues

The installer for RHEL 9.0 has issues which require manual workarounds to install the operating
system. This makes it difficult to install out of the box.

Use RHEL 9.1 or later installation media instead. Not only have the installation issues been
fixed, but the newer releases include both bug and security fixes.

14.4.2   RHEL 8 and earlier do not work

RHEL 8 releases will not work in a Fusion VM. The kernels in RHEL 8 only support 64KB page sizes which is not supported by Apple Silicon hardware. There is no option for a 4KB page size kernel in RHEL 8 like there is for RHEL 9.

There is nothing you can do to make RHEL 8 run. Your options are:

- If you want an RHEL 8 compatible environment, consider Oracle Linux 8.7 or later.
- If you want a Red Hat distribution, use RHEL 9.1 or later.

15 Ubuntu

I've got to admit it's getting better. A little better all the time (It can't get no worse).

– The Beatles, "Getting Better"

15.1 General notes

Ubuntu arm64 releases known to work on Fusion are:

- 20.04.5 LTS (Focal Fossa).
- 22.04.3 LTS (Jammy Jellyfish)
- 22.10 (Kinetic Kudu) – EOL, but works
- 23.04 (Lunar Lobster)
- 23.10 (Mantic Minotaur)

According to VMware KB article https://kb.vmware.com/s/article/90364 earlier releases of Ubuntu arm64 are not supported and are generally known not to work. Their kernels have bugs and other deficiencies that prevent them from working properly on Fusion.

For Ubuntu 22.04.3 and later:

- Console resolution can be changed (from within the VM and auto-fit when resizing the VM's window).
- 3D acceleration is supported (22.04.3 needs to run HWE kernel).
- open-vm-tools and open-vm-tools-desktop are available from Ubuntu repos.

15.2 Creating an Ubuntu VM

Either drag/drop of the ISO or custom virtual machine methods can be used.

The operating system type will be automatically set to "Ubuntu 64-bit Arm".

15.3 Where is Ubuntu Desktop for arm64?

Canonical did not provide GA versions of Ubuntu Desktop arm64 prior to 23.10. Starting with 23.10, Canonical released Ubuntu Desktop for Lenovo X13s Gen 1 ARM PCs. This ISO is an arm64 version of Ubuntu and will boot and install in a Fusion VM (with a slight tweak to the ISO boot process). See <u>Links to Ubuntu arm64 downloads</u> on page <u>43</u> for the download location, and <u>Installing Ubuntu Desktop for Lenovo X13s Gen 1</u> on page <u>44</u> for instructions on how to use this installer to install a Fusion VM.

For versions of Ubuntu earlier than 23.10, you may find that the arm64 daily desktop development builds found in <u>Links to Ubuntu arm64 downloads</u> on page <u>43</u> will work for you. You can also install Ubuntu Server arm64 for any Ubuntu version and then "convert" it to an Ubuntu Desktop equivalent using the procedure in <u>How to convert Ubuntu Server to Ubuntu Desktop</u> on page <u>41</u>.

15.4   Use the Ubuntu 22.04.3 LTS installer for a 22.04 VM

If you want to install Ubuntu 22.04 LTS in a Fusion virtual machine, use the arm64 installation ISO for 22.04.3 LTS or later. The installation ISOs for Ubuntu Server 22.04 LTS and 22.04.1 LTS will not boot on Fusion. The 22.04.2 ISO will boot with its standard 5.15 kernel, but the optional HWE kernel on the 22.04.2 ISO will not work properly on Fusion. Both these issues are fixed in the 22.04.3 and later installation ISOs.

15.5   How to convert Ubuntu Server to Ubuntu Desktop

By adding a few packages and making a configuration change, Ubuntu Server can be "converted" into the equivalent of Ubuntu Desktop. Use the following procedure to perform the conversion.

Credit: The process to convert the networking configuration from using systemd.networkd to NetworkManager was sourced from https://www.configserverfirewall.com/ubuntu-linux/ubuntu-network-manager/ .

1.   Boot the Ubuntu Server VM and log in.

2.   Install the Ubuntu Desktop packages.

     If you are running any version of Ubuntu, you can install the full set of Ubuntu Desktop packages using the following command:

     ```
     sudo apt install ubuntu-desktop¬
     ```

     If you are running Ubuntu 23.10 or later, you can install a minimal set of Ubuntu Desktop packages using the following command

     ```
     sudo apt install ubuntu-desktop-minimal¬
     ```

3.   Install open-vm-tools-desktop.

     ```
     sudo apt install open-vm-tools-desktop¬
     ```

4.   If you are running Ubuntu 23.04 or earlier, install Ubuntu Software from the Snap store using the following command:

     ```
     sudo snap install snap-store¬
     ```

     If you are running Ubuntu 23.10, install the new App Center with the following command:

     ```
     sudo snap install snap-store --channel=latest/stable/ubuntu-23.10¬
     ```

5.   Disable the use of systemd-networkd for networking management.

     ```
     sudo systemctl disable systemd-networkd.service¬
     sudo systemctl mask systemd-networkd.service¬
     sudo systemctl stop systemd-networkd.service¬
     ```

6.   Save a copy of the `.yaml` file found inside the `/etc/netplan` directory.

     ```
     cp /etc/netplan/*.yaml ./¬
     ```

7. Edit the `.yaml` file found inside the `/etc/netplan` directory (there should be only one, and its name may vary between Ubuntu releases). Use the editor of your choice; you will need to execute the editor with sudo as the .yaml file is owned by root.

   Example using the vi text editor:

   ```
   cd /etc/netplan¬
   sudo vi 00-installer-config.yaml¬
   ```

8. Replace the entire contents of the `.yaml` file with the following:

   ```
   network:

       version: 2

       renderer: NetworkManager
   ```

9. Set the system to use NetworkManager for networking management.

   ```
   sudo netplan generate¬
   sudo systemctl unmask NetworkManager¬
   sudo systemctl enable NetworkManager¬
   sudo systemctl start NetworkManager¬
   ```

10. Update boot files

    ```
    sudo update-initramfs -u -k all¬
    ```

11. Reboot the VM

    ```
    sudo systemctl reboot¬
    ```

Upon reboot, the VM should display a graphical login. Logging in will now start a graphical session.

15.6   Links to Ubuntu arm64 downloads

These links were verified as of 2023-11-05. They may change without notice.

Ubuntu Version	Download Link
20.04.5 LTS (Focal Fossa) Server	https://cdimage.ubuntu.com/ubuntu/releases/20.04.5/release/ubuntu-20.04.5-live-server-arm64.iso
22.04.3 LTS (Jammy Jellyfish) Server	https://cdimage.ubuntu.com/ubuntu/releases/22.04.3/release/ubuntu-22.04.3-live-server-arm64.iso
22.04 LTS (Jammy Jellyfish) Desktop daily development build	https://cdimage.ubuntu.com/jammy/daily-live/current/jammy-desktop-arm64.iso
22.10 (Kinetic Kudu) Server (EOL)	http://old-releases.ubuntu.com/releases/22.10/ubuntu-22.10-live-server-arm64.iso
23.04 (Lunar Lobster) Server	https://cdimage.ubuntu.com/releases/23.04/release/ubuntu-23.04-live-server-arm64.iso
23.10.1 (Mantic Minotaur) Server	http://cdimages.ubuntu.com/releases/23.10.1/release/ubuntu-23.10-live-server-arm64.iso
23.10.1 (Mantic Minotaur) Desktop for Lenovo X13s Gen 1	http://cdimages.ubuntu.com/releases/23.10.1/release/ubuntu-23.10.1-desktop-arm64+x13s.iso See the topic Installing the Ubuntu Desktop image for Lenovo X13x Gen 1 for installation instructions.
24.04 (Noble Numbat) Desktop daily development build	http://cdimages.ubuntu.com/daily-live/current/noble-desktop-arm64.iso

15.7   Installing Ubuntu Desktop for Lenovo X13s Gen 1

Canonical has released an Ubuntu Desktop 23.10 installation ISO for Lenovo X13s Gen 1 PCs. The Lenovo X13s Gen 1 is an ARM PC containing a Qualcomm Snapdragon ARM CPU.

This installer can be modified to boot on Fusion and will install Ubuntu Desktop 23.10 without the need to install Ubuntu Server and "convert" it.

To boot this installer on Fusion:

1.   Create a new virtual machine by dragging and dropping the Ubuntu installation ISO on the "Select the Installation Method" dialog. Make any changes necessary and ensure that the virtual machine guest type is "Ubuntu 64-bit Arm".

2.   Power on the VM. The GRUB boot loader screen shown in **Figure 6** will appear:


```
              GNU GRUB   version 2.12~rc1

 *Try or Install Ubuntu
  Boot from next volume
  UEFI Firmware Settings




     Use the ▲ and ▼ keys to select which entry is highlighted.
     Press enter to boot the selected OS, `e' to edit the commands
     before booting or `c' for a command-line.
```
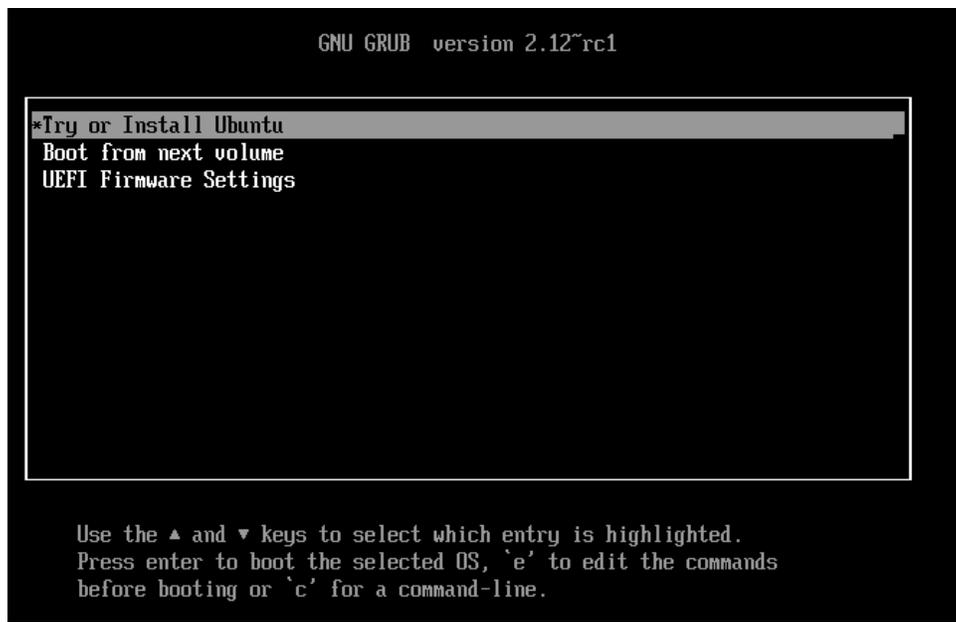
Figure 6: *Ubuntu 23.10 GRUB boot loader display for Lenovo X13 installer ISO*

3.   Use the keyboard up/down arrows to select "**Try or Install Ubuntu**". Then press "**e**" on the keyboard to edit the commands.

4. The screen shown in **Figure 7** will appear with the GRUB commands for the default boot selection.

Figure 7: Boot arguments for Ubuntu installer

Use the keyboard arrow keys and the **Delete** key to move the cursor and remove the following kernel arguments (from the line beginning with "linux"):

clk_ignore_unused

pd_ignore_unused

layerfs-path=minimal.standard.live.squashfs

Additionally, remove the entire line that contains:

devicetree /casper/sc8200xp-lenovo-thinkpad-

x13s-dtb

The boot commands should now look like **Figure 8**:

Figure 8: Boot commands after recommended updates

6. Press **`Control-x`** to boot the VM and the installer.

7. Install Ubuntu as you normally would.

15.8   Change delay for display of GRUB boot loader menu

The GRUB boot loader's boot menu is useful in situations where a kernel update (or other circumstance) requires manual intervention to the Linux boot process. Ubuntu documentation describes how to display the GRUB boot loader menu during boot by pressing the "Esc" key immediately after boot and before the Ubuntu splash screen is displayed. However, the window is very short for the key to be recognized. Most people can't get the process to work for them reliably.

The timing can be altered so that it delays the boot of the default kernel, giving you more of a chance for the "Esc" key to be recognized.

1. Log into the VM.

2. Sudo to a root shell, and edit **`/etc/default/grub`**:

3. Find the line containing

    ```
    GRUB_TIMEOUT=0
    ```

    and change it to

    ```
    GRUB_TIMEOUT=5
    ```

    GRUB_TIMEOUT is the delay (in seconds) until the default kernel is booted. During the delay, the boot menu can be entered by pressing the "Esc" key on the keyboard.

    > **Tip:** A delay of 5 seconds is typically sufficient. Longer delays can be specified if desired.

4. Save the changes and exit the editor.

5. Update the grub configuration:

    ```
    update-grub¬
    ```

The GRUB boot menu will now give you 5 seconds to press the "**`Esc`**" key to display the boot menu. If no "**`Esc`**" key is pressed, the default kernel will boot.

16 Windows 11 ARM

16.1 General notes

According to VMware KB article https://kb.vmware.com/s/article/90364, Windows 11 ARM is the only version of Windows supported with Fusion on Apple Silicon Macs[7].

Fusion provides the virtual hardware features required by Windows 11 (both UEFI Secure Boot and Trusted Platform Module) as well as Windows 11 ARM device drivers for the VMware virtual graphics and virtual network adapters.

Fusion 13.5 contains a built-in tool to obtain ISO installation media for your Windows 11 ARM virtual machine. See Obtaining Windows 11 ARM ISO installation media on page 48.

> **Microsoft does not provide an ISO for Windows 11 ARM**
>
> Microsoft does not currently provide Windows 11 ARM ISOs for consumer download. ISO media you download from Microsoft's web site is for 64-bit Intel/AMD processors only. They don't work on VMs created on Apple Silicon Macs.
>
> Use the built-in tool found in Fusion 13.5 and later to obtain Windows 11 ARM installation media.

Users of Windows 11 ARM virtual machines should use Fusion 13.5 or later. Fusion 13.5 dramatically improves the user experience for Windows 11 ARM.

16.2 Features supported by Fusion for Windows 11 ARM guests

The VMware KB article **"Features of Windows 11 VM on Mac with Intel vs. Apple silicon (95031)"** https://kb.vmware.com/s/article/95031 documents the features that are supported for Windows 11 ARM guest operating systems. The following common features remain unsupported for Windows 11 ARM guests:

- Unity mode
- Shared folders (see Fusion folder sharing with the Mac host is not supported on page 67 for a workaround)

16.3 3D support on Windows ARM VMs

- DirectX 11 with feature levels 11_0, 10_1, 10_0, 9_3, 9_2, and 9_1 is supported when using the VMware Tools bundled with Fusion 13.5 and 13.5.1. OpenGL is not supported with the default VMware Tools.

---

[7] Windows 10 ARM isn't supported, and users have failed to get it to work. It goes without saying that Windows 8, 8.1, 7, Vista, XP, NT, 98, 95, NT, and any Windows Server release won't run as these all require an Intel compatible CPU.

- OpenGL 4.2 support is available starting with VMware Tools 12.4. These updated tools are not bundled with Fusion 13 or 13.5 but can be downloaded from VMware and installed manually. See Updated VMware Tools are available for Windows 11 ARM on page 64 for instructions on how to obtain these updated Tools.

16.4   Windows 11 ARM licensing

Windows isn't free

Even though Microsoft will not stop you from running an unlicensed copy of Windows, please respect Microsoft licensing policies and (legally) obtain Windows 11 licenses for those Windows 11 ARM VMs that you run regularly in a Fusion VM.

Microsoft allows retail licenses for Windows 11 Home or Professional to activate Windows 11 ARM. Yes, this means you can use a license purchased for an Intel PC on Windows 11 ARM that is installed in a Fusion VM. If you don't have a license, purchase it from any Microsoft authorized seller (for your protection). You also can purchase a license directly from the Microsoft Store once the VM is running.

Windows 10 retail licenses can also be used to activate Windows 11 ARM.

Windows 11 ARM can be used without activation, but some features such as personalization are not available. You will also be nagged about having an inactivated copy of Windows. This is no different than running an inactivated copy of Windows 11 on an Intel PC.

16.5   Obtaining Windows 11 ARM ISO installation media

The Internet can be wrong about where to find Windows 11 ARM ISOs

The Internet contains much obsolete or incorrect information, and it never gets updated or deleted. Chances are that it will turn up in a search that you do today.

There are Internet videos and guides that advise you to build ISO media from uupdump.net, use Windows 11 Insider Preview VHDX files, or *(gasp!)* download Parallels Desktop to run Windows 11 ARM on Fusion. This advice is woefully obsolete and will waste your time.

Download Windows 11 ARM using the tool that VMware provides in Fusion 13.5 and later. If you require the use of Windows Insider builds to perform development testing with the next version of Windows, see **Installing from Windows Insider Preview VHDX files** on page 54.

Fusion 13.5 includes a tool in the **"Select the Installation Method"** dialog (see **Figure 9**) to download the officially released production version) of Windows 11 ARM installation media directly from Microsoft. The tool that VMware provides is easy to use and gives you the current General Availability Channel build of the Windows 11 ARM installer (currently 23H2).
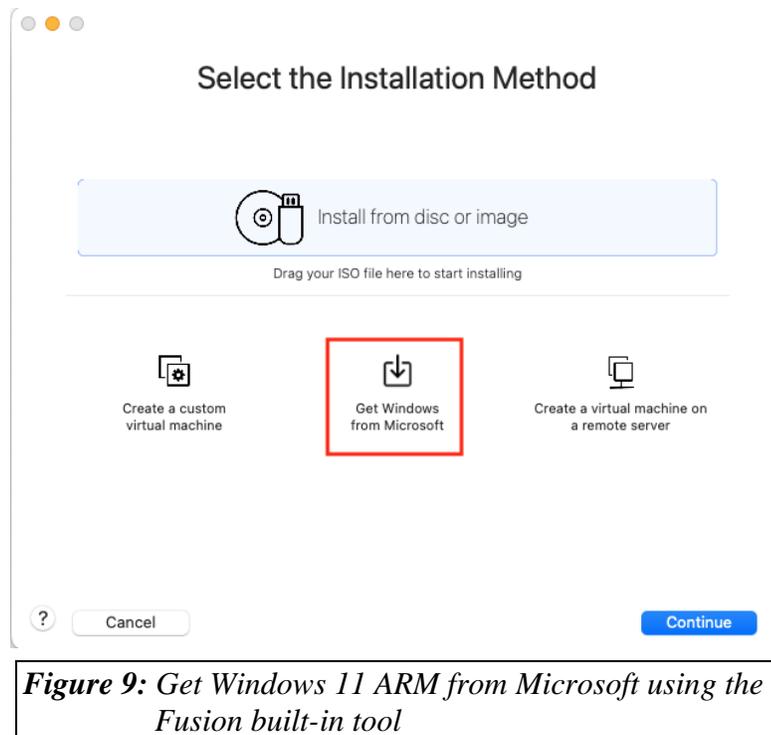
Figure 9: *Get Windows 11 ARM from Microsoft using the Fusion built-in tool*

It is no longer necessary to use w11arm_esd2iso, uupdump,net, or CrystalFetch to create Windows 11 ARM ISO media.

Refer to the Fusion documentation for instructions on how to use the "Get Windows from Microsoft" option. Look for the topic **"Download and Install Windows 11 as Guest Operating System on Apple Silicon Macs".**

The ISO that is generated by this tool is saved on your hard drive. It can be reused for future Windows 11 ARM installations.

> **Tip:** Ensure you have a minimum of 12 GB of free disk space on your Mac before creating the ISO media using the VMware tool.
>
> **Tip**: If you are looking to install Windows 11 Home, choose the "Professional" edition in the Fusion tool. The generated ISO will contain both Windows 11 Home and Windows 11 Professional.

Unlike other methods of generating Windows 11 ARM installation media, the Fusion-generated ISO contains the VMware graphics and network drivers for Windows 11 ARM. These drivers will be automatically installed into a new VM. This simplifies the installation of Windows 11 ARM as networking will be available for discovery by Windows Setup.

> **What if I have media created some other way?**
>
> If you have existing Windows 11 ARM ISO media created by using w11arm_esd2iso, CrystalFetch, or Parallels, you can use that media to install a Windows 11 ARM VM on Fusion
>
> The ISO media created by these utilities does not contain drivers for the VMware graphics or network devices. To successfully install Windows 11 ARM from these ISOs, you will need open a command prompt with `Fn-Shift-F10` the first time the Windows Setup "**Choose your country or region**" prompt is displayed and perform one of the following two steps
>
> - Mount the VMware Tools installer, and execute the VMware Tools setup.exe utility manually to install the VMware network driver, or
>
> - Disconnect the virtual NIC from the VM, then disable the Windows check for networking by entering `OOBE\bypassnro` in the command prompt.
>
> You can avoid this extra work by rebuilding your Windows 11 ARM ISO installation media with Fusion 13.5. The Fusion-generated media will automatically install the VMware network and video drivers.

16.6   Creating the Windows 11 ARM ISO from the command line

VMware provides a command line equivalent of the "Get Windows from Microsoft" tool found in the GUI. Use the following procedure to download the ISO using the command line.

1. Open the Terminal app.

2. Change the working directory to the Desktop

```
cd ~/Desktop¬
```

3. Mount the ISO file containing the VMware Tools for Windows 11 ARM

```
hdiutil attach /Applications/VMware\ Fusion.app/Contents/Library\¬
/isoimages/arm64/windows.iso¬
```

The ISO will appear on the Desktop as "VMware Tools" and will be found at /Volumes/VMware Tools.

4. Download the ESD from Microsoft for the desired edition and language:

```
/Applications/VMware\ Fusion.app/Contents/Library/vmw_esd2iso \¬
getesd --edition "edition" --lang "tag"¬
```

where

edition is **Professional** for an ISO containing Home and Professional editions, or **Enterprise** for an ISO containing Professional and Enterprise editions.

tag is one of the Windows 11 ARM language tags used to select the desired language of the Windows installer (see **Table 1**):

Tag	Language Description	Tag	Language Description
bg-bg	Bulgarian (Bulgaria)	lt-lt	Lithuanian (Lithuania)
cs-cz	Czech (Czechia)	lv-lv	Latvian (Latvia)
da-dk	Danish (Denmark	nb-no	Norwegian Bokmål (Norway)
de-de	German (Germany)	nl-nl	Dutch (Netherlands)
el-gr	Greek (Greece)	pl-pl	Polish (Poland)
en-gb	English (United Kingdom)	pt-br	Portuguese (Brazil)
en-us	English (United States)	pt-pt	Portuguese (Portugal)
es-es	Spanish (International Sort)	ro-ro	Romanian (Romania)
es-mx	Spanish (Mexico)	ru-ru	Russian (Russia)
et-ee	Estonian (Estonia)	sk-sk	Slovak (Slovakia)
fi-fi	Finnish (Finland)	sl-si	Slovenian (Slovenia)
fr-ca	French (Canada)	sr-latn-rs	Serbian (Latin, Serbia)
fr-fr	French (France)	sv-se	Swedish (Sweden)
he-il	Hebrew (Israel)	th-th	Thai (Thailand)
hr-hr	Croatian (Croatia)	tr-tr	Turkish (Turkey)
hu-hu	Hungarian (Hungary)	uk-ua	Ukrainian (Ukraine)
it-it	Italian (Italy)	zh-cn	Chinese (Simplified, China)
ja-jp	Japanese (Japan)	zh-tw	Chinese (Traditional, Taiwan)
ko-kr	Korean (Korea)		

Table 1: Windows languages

The ESD file will be downloaded to your Desktop. Note its name as you will need it for the next step.

5. Create the ISO file from the ESD and include VMware video and network drivers (the drivers will be installed by Windows setup).

```
/Applications/VMware\ Fusion.app/Contents/Library/vmw_esd2iso \¬
    generateiso --esd "esd-file" --drivers \¬
    "/Volumes/VMware Tools/svga,/Volumes/VMware Tools/vmxnet3"¬
```

where *esd-file* is the name of the ESD file downloaded in step 4. Enclose the file name in double quotes if the name contains spaces.

The arguments to the **--drivers** option must be enclosed in quotes as noted above because they contain spaces in the file names.

The ISO file will be generated in the Desktop folder.

6. Clean up after the ISO is generated.

Unmount the VMware Tools ISO with the following command:

```
hdiutil detach "/Volumes/VMware Tools"¬
```

Use the Finder to delete the downloaded ESD file from the Desktop folder (don't forget to empty the Trash!). The ESD file is no longer needed. .

16.7   Creating the VM and installing Windows 11 from ISO

To create and install a Windows 11 ARM virtual machine, see the Fusion documentation for the topic "**Download and Install Windows 11 as Guest Operating System on Apple Silicon Macs**".

The Fusion documentation contains a workflow for the creation of the Windows 11 ARM guest. It assumes that you are familiar with installing Windows from a Microsoft ISO file. If you are not familiar with installing Windows from an ISO file, see Appendix C Windows 11 Installation Resources.

> **Tip:** In the "**Choose Encryption**" dialog box, it's recommended to choose "**Only the files needed to support a TPM**".
>
> **Tip:** Remember the password of an encrypted VM (even if saving it in the macOS Keychain). You will need the password to open the VM should you want to move the VM to another system or have a problem with the macOS Keychain. VMware can't retrieve a lost encryption password.

After installation, open the Microsoft Store and apply all available bundled application updates. The Microsoft Store may take a few moments to open the first time as it is being downloaded from Microsoft and installed.

> **The Microsoft Store might not work on a new installation**
>
> In some cases, and for some Windows languages you may find that
>
> - the Microsoft Store doesn't seem to work properly after Windows is installed (e.g., it crashes on open)**, or**
> - "Standard" Windows applications like Notepad have a small gray icon in the Start menu and won't launch**, or**.
> - The Microsoft Store can't be found in the VM and isn't automatically downloading.
>
> If any of these occur, see **Microsoft Store app doesn't exist or crashes in a newly installed VM** on page 66.

After installation of Windows 11 ARM, log in and install the complete VMware Tools package. See Installing VMware Tools on Windows 11 ARM on page 53.

Once Windows is installed and you've successfully logged in, run Windows Update to obtain the most recent updates for Windows 11. You may need to do this more than once.

16.8   Installing VMware Tools on Windows 11 ARM

Use the procedure in "Manually Install VMware Tools" found in the Fusion documentation to install or upgrade VMware Tools in a Windows ARM VM. However, **ignore the note that tells you to use Powershell when installing Tools for Windows on ARM**. The installer for the VMware Tools bundled with Fusion 13.5 works the same way on Windows on ARM as it does for Windows on Intel.

Tip: You may get a Windows UAC prompt asking you to grant permission to VMware Tools setup to modify your system. Grant the permission.

Tip: If Autorun is not enabled, you can open a command prompt and start the setup as noted in the documentation. For Windows 11 ARM, the setup program is named `setup.exe`.

Tip: In certain circumstances, you may need to move windows or use **Option-Tab** to see the VMware Tools Setup wizard.

Tip: When installing VMware Tools, select the "**Complete**" setup option.

16.9   Installing from Windows Insider Preview VHDX files

About Windows Insider Preview releases

Insider Preview releases are not required to be used with Fusion. Use Insider Preview releases of Windows only if you need to perform development testing of future versions of Windows 11. You will need to register for the Microsoft Windows Insider program to obtain Windows Insider builds.

Windows Insider builds are pre-release builds. They do not have the same level of stability or support as General Availability Channel Windows builds. In addition, there may be features in Insider Preview builds that may or may not make it into future Windows releases or may appear in different forms.

To download and install Windows 11 ARM Insider Preview releases from VHDX files provided by Microsoft, use the following procedure.

1. Download the desired Windows 11 ARM Insider Preview VHDX file from the Microsoft Windows Insider site using the following link: https://www.microsoft.com/en-us/software-download/windowsinsiderpreviewARM64.

   The Beta Channel release is typically the best choice as it will be updated through Windows Update. Other channels (Dev or Canary) will expire and will not update themselves to newer builds (requiring you to perform a full re-installation of Windows).

2. In the Terminal application, change the working directory to the location where you downloaded the VHDX file.

   Convert the VHDX file to VMDK format using the following command

   ```
   /Applications/VMware\ Fusion.app/Contents/Library/vmware-vdiskmanager \¬
     -r ./vhdx.VHDX -t 1 ./Windows11.vmdk
   ```

   If you have installed QEMU, you may use the following command instead:

   ```
   qemu-img convert -p -O vmdk ./vhdx.VHDX ./Windows11.vmdk
   ```

   In both commands, replace *vhdx.VHDX* with the name of the downloaded file from Microsoft, and **Windows11.vmdk** with the name you want for the converted vmdk file. Ensure that the converted file name contains the .vmdk extension.

3. Create a new virtual machine in Fusion using "**File > New…**" in the Fusion menu bar.

4. In the "Select the Installation Method" dialog, click "Create a custom virtual machine" (see **Figure 10**).
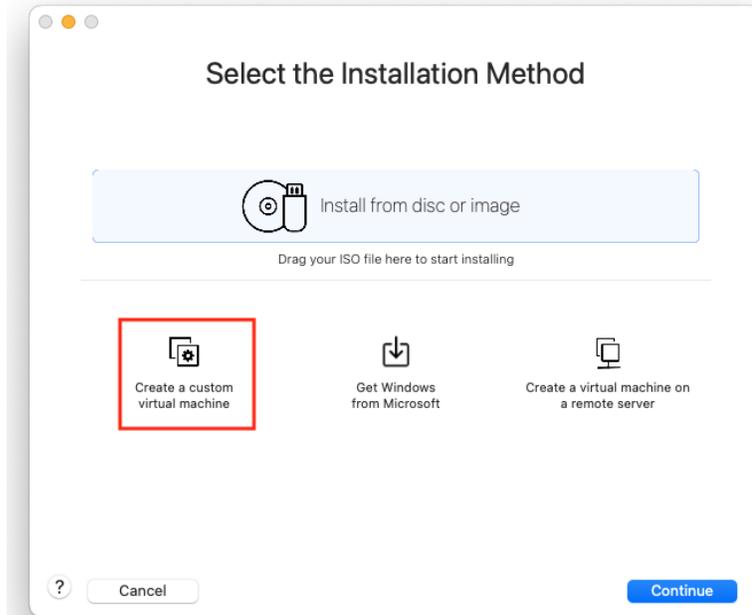
Figure 10: *Creating a custom virtual machine*

Click "**Continue**".

5. In the "**Choose Operating System**" dialog, select "**Microsoft Windows**" in the left hand pane, and "**Windows 11 64-bit Arm**" in the right hand pane (see **Figure 11**).
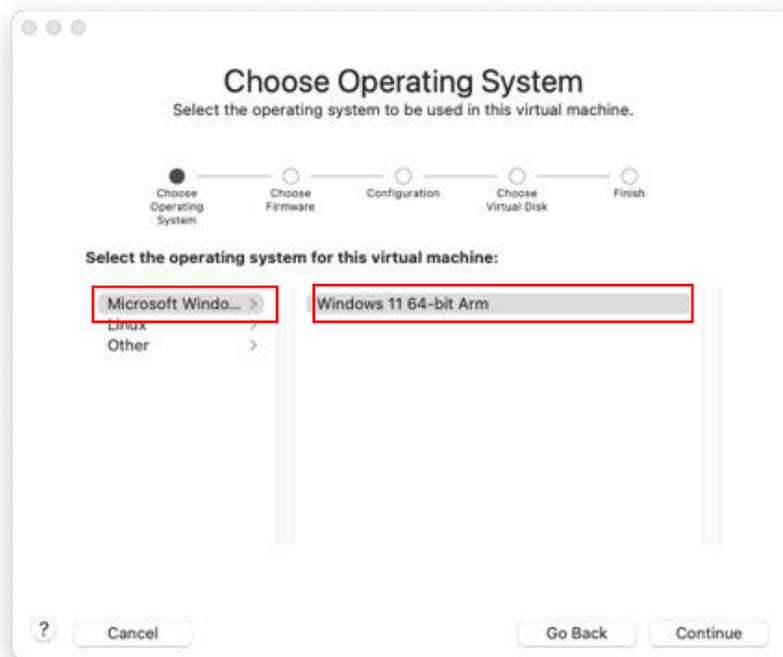
Figure 11: *Choosing Windows 11 ARM as the operating system*

Click "**Continue**".

6. In the "**Choose Firmware Type**" dialog, UEFI firmware is automatically selected and can not be changed. You may check the "**UEFI Secure Boot**" box if desired (see **Figure 12**).
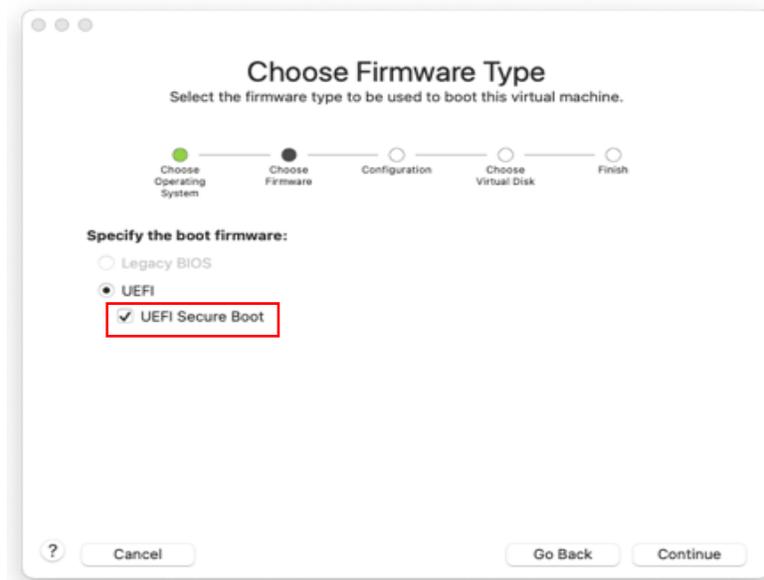
Figure 12: *Choosing UEFI firmware type*

Click "**Continue**".

7.   The "**Choose Encryption**" dialog will now appear (see **Figure 13**).
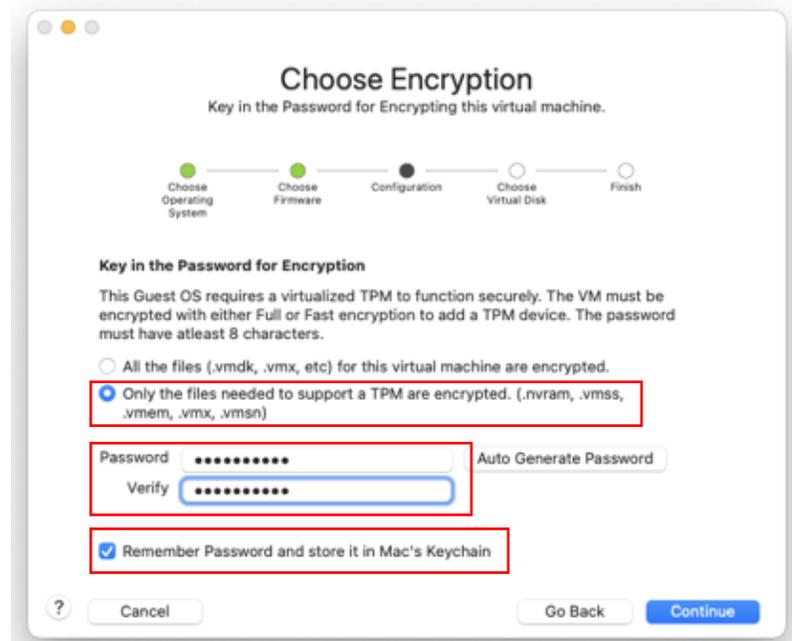
Figure 13: Selecting encryption options for the VM

In this dialog:

- Select "**Only the files needed to support a TPM are encrypted**".

- Enter a password for the VM either by creating one yourself or by clicking the "**Auto Generate Password**" button.

  Tip: Create the password yourself and record it in your favorite password manager even if you opt to have it remembered in the Keychain.

- Optionally, select "**Remember Password and store it in Mac's Keychain**". This option will allow Fusion to automatically unlock a virtual machine for you when necessary (you don't have to type in the password). You can also find the password in the user's login Keychain with the macOS Keychain Access app.

  Tip: **Storing the password in the Keychain is no substitute for you knowing the VM's password.** You will need to know the password to transfer an encrypted virtual machine to another machine/user, or to access your VM should you have an issue with the Keychain.

The Trusted Platform Module (TPM) device required by Windows 11 will be automatically added to the virtual machine configuration at this point.

Click "**Continue**".

8.   In the **"Choose a Virtual Disk"** dialog, select **"Use an existing Virtual Disk"**, then click the **"Choose virtual disk.…"** button.
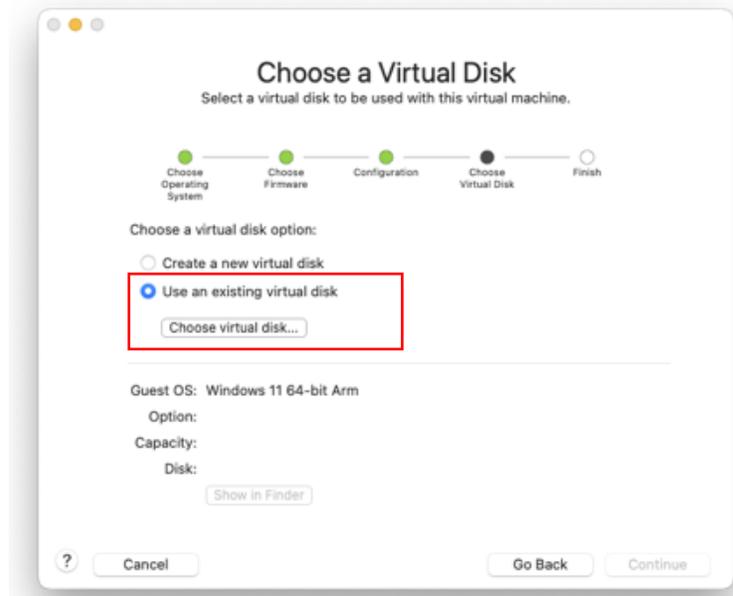
Figure 14: Choosing the virtual disk dialog

9.   The file selection box shown in **Figure 15** will then be displayed.

Use this box to find and select the converted VMDK file.
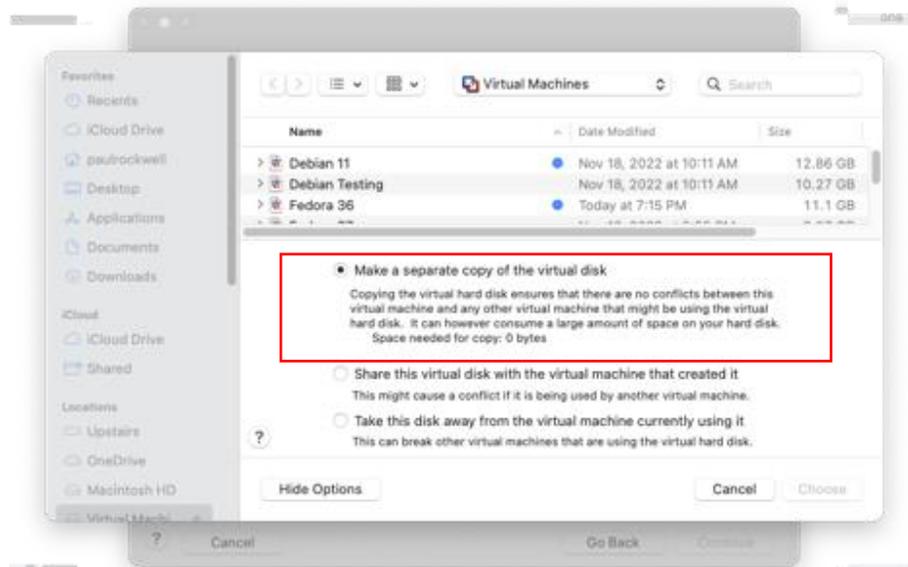
Figure 15: Choosing the converted VHDX virtual disk

After finding the converted .vmdk file, make sure that the "**Make a separate copy of the virtual disk**" button is selected. This will copy the converted virtual disk into the new Windows 11 VM and leaves the original copy of the converted virtual disk intact for future use.

Click "**Choose**" when finished. This dialog will close and return you to the "**Choose a Virtual Disk**" dialog from step 8.

Click "**Continue**" on the "**Choose a Virtual Disk**" dialog.

10. At the "**Finish**" dialog shown in **Figure 16**, click the "**Customize Settings**" button rather than "**Finish''**. This will allow you to alter settings of your virtual machine before starting the installation.
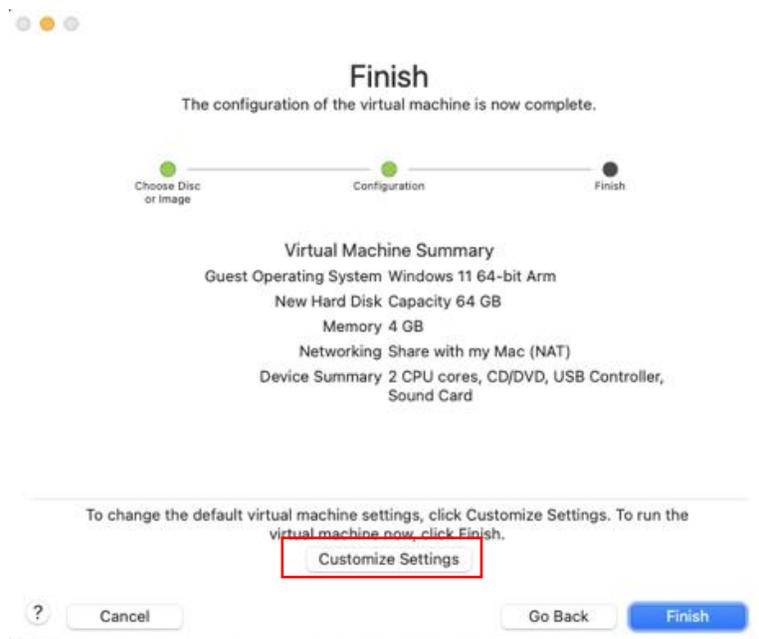
Figure 16: Finish virtual machine configuration

After clicking "**Customize Settings**", name your VM and select the folder where the VM is to be stored.

11. The virtual machine's "**Settings**" panel will appear. Make any changes to the number of processors, memory, and virtual hard disk size that are desired.

Note that the minimum hardware requirements for Windows 11 are 2 CPUs, 4 GB memory and a 64GB hard drive. The Windows installer will fail if these minimums are not met.

12 Power on the virtual machine.

13.   The first screen of the Windows 11 setup process appears (See **Figure 17**):
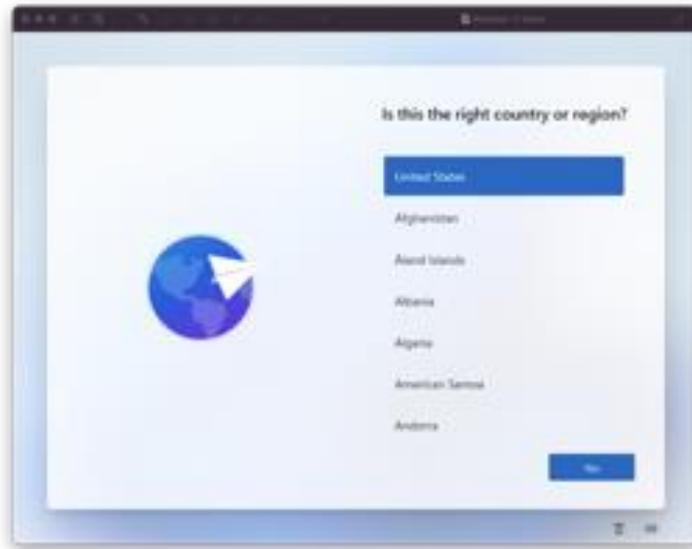
Figure 17: *Windows Setup initial screen*

Do not click on the **"Yes"** button.

13.   VMware Tools need to be installed at this point so that Windows Setup can discover the network and complete its tasks.

Follow the procedure in the topic Installing VMware Tools on Windows 11 ARM on page 53 to install VMware Tools.

Autoplay is not enabled at this point in the Windows setup process. You will need to open a command prompt with `Shift-Fn-F10` and manually execute the VMware Tools setup.exe program found on the D: drive (the virtual CD/DVD) to install VMware Tools.

Once you start the VMware Tools Setup, you may need to move windows or use `Option-Tab` to find the Tools Setup wizard.

When prompted, restart the VM at the completion of the Tools setup process.

14.   You will be returned to the first screen of the Windows 11 setup process after the VM restarts (see **Figure 18**):
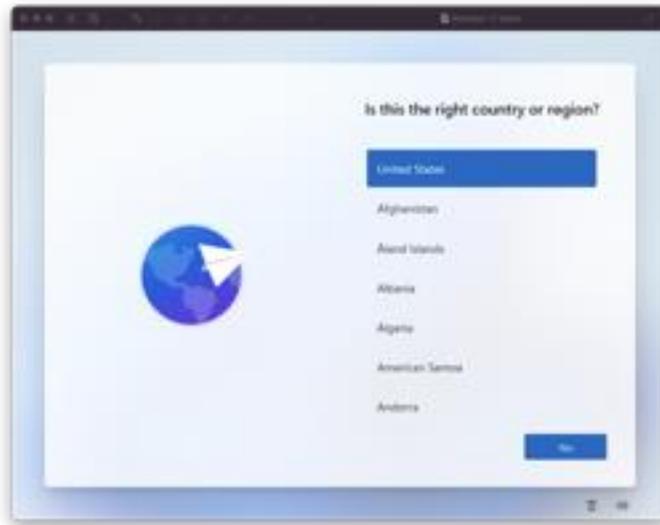
Figure 18: Return to initial Windows Setup screen

Continue with Windows Setup. Setup will discover the network, and VMware Tools are already installed.

16.10   Enabling/disabling Secure Boot on Fusion Player

Both Fusion Pro and Fusion Player will allow you to configure a Windows 11 ARM VM for UEFI Secure Boot at the time the VM is created. After the VM is created, Fusion Pro will allow you to enable or disable Secure Boot through the Advanced panel of a VM's Settings. Unfortunately, Fusion Player doesn't.

> **How to verify Secure Boot settings in from within the Windows VM**
>
> See the following Microsoft article for instructions on how to check the status of Secure Boot in your virtual machine: https://learn.microsoft.com/en-us/mem/intune/user-help/you-need-to-enable-secure-boot-windows

If you are running Fusion Player and need to change the Secure Boot state, follow one of the following two procedures depending on the choice of encryption for the VM.

16.10.1 VM is encrypted with "Only the files needed to support a TPM

1. Shut down the VM and close any open Settings windows for the VM. Do not shut down the Fusion GUI.

2. Right-click the VM's name in the Virtual Machine Library, and then press the `Option` key. Then select "`Open Config File in Editor`"

   The contents of the config file (.vmx file) will be opened in the Mac's TextEdit app.

3. Search for a line in the file starting with:

   ```
   uefi.secureBoot.enabled =
   ```

   If it doesn't exist, add the following line to the file (type it in exactly as shown, and the spaces around the "=" sign are required)

   ```
   uefi.secureBoot.enabled = "FALSE"
   ```

4. To enable Secure Boot, change the line to read:

   ```
   uefi.secureBoot.enabled = "TRUE"
   ```

   To disable Secure Boot, change the line to read:

   ```
   uefi.secureBoot.enabled = "FALSE"
   ```

5. Save the file and exit the TextEdit app.

6. Restart the VM.

16.10.2   VM is encrypted with "All the files"

Read this before using this procedure:

Before doing anything:

- Shut down (do not suspend) the virtual machine.
- Shut down Fusion.
- Use the Finder to make a backup copy of the entire VM bundle to another disk.

This procedure will decrypt then re-encrypt your VM. Make sure you have sufficient disk space to hold a complete copy of the VM's virtual disk during the decryption and re-encryption processes

This procedure deletes the TPM for the VM. If you enabled Bitlocker in the Windows 11 VM, you must have the Bitlocker recovery key to regain access to your VM. See the following Microsoft articles for information on backing up and finding your Bitlocker recovery key:

https://support.microsoft.com/en-us/windows/back-up-your-bitlocker-recovery-key-e63607b4-77fb-4ad3-8022-d6dc428fbd0d

https://support.microsoft.com/en-us/windows/where-to-look-for-your-bitlocker-recovery-key-fd2b3501-a4b9-61e9-f5e6-2a545ad77b3e

1. After making sure you have a backup of the VM, start VMware Fusion. Make sure the VM is shut down (not suspended) and remove all snapshots for the VM.

2. Open the VM's Settings.

3. Click on **"Trusted Platform Module"** and then click the **"Remove Trusted Platform Module"** button that appears. Confirm that you want the device removed.

4. Click the **"Show All"** button at the top of the window, then click on **"Encryption".**

    In the panel that appears, the current encryption state of the VM should be displayed. Select **"The virtual machine is not encrypted"** to remove the VM's encryption.

    Enter the password for the virtual machine if requested.

5. Be patient and wait for the virtual machine's encryption to be removed.

6. Close the VM's settings.

7. Perform steps 2 through 5 of the procedure VM is encrypted with "Only the files needed to support a TPM on page 62. Do not restart the VM.

    After step 5 is completed, do not restart the VM. Return here and continue with step 8.

8. Open the VM's Settings.

9. Re-encrypt the VM. Click on **"Encryption"** and select the desired type of encryption to apply to the VM. It is recommended to choose **"Only the files needed to support a TPM".**

Choose a password (and remember it) and optionally select to save it in the Mac's Keychain.

10. Wait for the VM to re-encrypt itself (if you chose **"All the files"** it will take a while, so be patient).

11. Click the **"Show All"** button to return to the main Settings page.

12. Click the **"Add Device"** button in the upper right-hand corner. A list of devices will appear.

13. Click on "**Trusted Platform Module**", then click "**Add**".

14. Close the VM's Settings.

You may now restart your VM.

If you had Bitlocker enabled, you will need to perform Bitlocker recovery per Microsoft's instructions.

You may be required to re-verify your login credentials the first time that you log into the VM. This is likely to happen if you've configured your login to use a Microsoft account and you're using Windows Hello with a PIN instead of specifying a password.

16.11   Updated VMware Tools are available for Windows 11 ARM

On 2024-03-22 VMware announced VMware Tools 12.4.0. This version updates some bundled library components and adds emulated x32/x64 support for OpenGL 4.2 graphics.

VMware Tools 12.4.0 is not yet included with Fusion. If you want to use this version, you must download it to your VM and install it.

- Download link for VMware Tools 12.4.0 (contains downloads for all supported platforms):
  https://customerconnect.vmware.com/en/downloads/details?downloadGroup=VMTOOLS1240&productId=1259&rPId=117823

- Release notes for VMware Tools 12.4.0: https://docs.vmware.com/en/VMware-Tools/12.4.0/rn/vmware-tools-1240-release-notes/index.html

> **Tip:** If you have already installed VMware Tools in your Windows 11 ARM VM, upgrade the tools using the **"VMware Tools for Windows Arm, in-guest installer"** rather than the **"VMware Tools packages for Windows Arm"** zip or gz downloads.
>
> Download the in-guest installer directly into the VM, unzip it, and run the extracted executable to upgrade the tools.

16.12   Known issues

16.12.1   "Get Windows from Microsoft" tool in Fusion GUI fails to create ISO

If you are running Fusion 13.5 and the macOS system language is set to other than English, the "Get Windows from Microsoft" tool in the Fusion 13.5 GUI may fail to create an ISO.

Upgrading to Fusion 13.5.1 fixes this issue.

16.12.2   Windows installation ISO won't boot

A common problem that users encounter when installing Windows 11 ARM from ISO media is that the installer doesn't boot. The virtual machine powers on, but prints "Start PXE over IPv4" on the console - or eventually drops into a "DOS" or "EFI firmware" prompt.

Many users suspect a problem with Fusion. *There's nothing wrong with the VM or Fusion.* Almost all the time this happens because a key step in the boot process was missed.

The Windows installation ISO media displays a "**Press any key to boot from CD or DVD**" prompt when it is first booted. Keyboard focus must first be set to the VM so the VM recognizes the key press and then any key on the keyboard must to be pressed. *This sequence must occur within 5 seconds to boot the installer.* If this doesn't happen, the VM will try to boot from the hard drive - which will fail as there's no installed Windows operating system. A network boot will usually be tried next - which will also fail. If no bootable media is found after trying all the available devices in the VM, the EFI firmware "shell" (or "DOS prompt") appears.

To avoid this, make sure you perform the following steps immediately after VM power up to get the Windows installer to boot:

- Click the mouse in the VM's console window or type **Command-G** to set keyboard focus to the VM.
- Press any key on the keyboard.

You only get about 5 seconds to do these 2 steps. If you don't do them quickly enough, don't worry. Simply power the VM off using the Fusion GUI, then power it on again to start over.

16.12.3   Windows 11 ARM VMs can't be enrolled in Windows Insider

If you try to enroll a Fusion Windows 11 ARM virtual machine in the Microsoft Windows Insider program via **Settings > Windows Update > Windows Insider Program**, the message in **Figure 19** will be displayed:

Figure 19: *Error message when registering for the Windows Insider Program*

Technically this is correct behavior. Microsoft does not recognize Fusion on Apple Silicon CPUs to be a certified solution for Windows 11 ARM. The registration for the Windows Insider Program is checking the CPU identification present in the Fusion VM and does not recognize it as a valid supported CPU chipset.

Do not try to install Windows 10 as the notice recommends. Windows 10 is not supported by Fusion on Apple Silicon.

The Windows 11 ARM Insider Preview Beta Channel release can be installed using the procedures found in Installing VMware Tools on Windows 11 ARM on page 53. Other Windows Insider Preview channels may be able to be installed using either the Windows Insider VHDX files or ISO media built from uupdump.net on a Windows system. Procedures for building ISOs from uupdump.net are outside the scope of the Companion Guide.

We hope that this restriction will be removed in the future.

16.12.4   Microsoft Store app doesn't exist or crashes in a newly installed VM

Normally the Microsoft Store will be automatically installed for you by Windows 11 the first time that you open it. Occasionally though, the Microsoft Store app may not exist in a newly installed VM, or it may crash if you try to start it. If this happens, try this procedure to manually install the Microsoft Store app:

1.   Open a Windows command prompt as administrator.

2.   Execute the following command:

```
wsreset.exe -i¬
```

3.   Wait for the Microsoft Store to install. This may take a while (longer than you might expect), so please be patient.

Up to 2 items may be installed:

- Store Experience Host
- Microsoft Store app

Windows will provide notifications as these components are installed.

When the procedure completes, the Microsoft Store should be installed and able to be opened.

16.12.5   Fusion folder sharing with the Mac host is not supported

The Folder Sharing option is not available for a Windows 11 ARM VM. Consider one of the following workarounds to share files between the Mac host and a Windows 11 ARM VM:

- Configure macOS Windows file sharing

  Consult macOS Help (found in the Finder's Help menu bar) or Internet resources for instructions on how configure macOS Windows file sharing, and then add the folders you wish to share with your VM to the configuration. This will allow the Windows VM to access the host via standard Windows file sharing.

  This workaround should only be used when connected to a trusted network such as a home network. The use of macOS file sharing when connected to an untrusted network such as public or hotel Wi-Fi is a security risk. To mitigate this risk, disable file sharing in macOS when connected to an untrusted network.

- Drag and Drop

  For simple file transfers between host and guest, consider dragging and dropping files between the Mac host and Windows 11 ARM guests. The speed of drag/drop has been noticeably increased over prior versions of Fusion (even on Intel) and may meet your needs if they don't include syncing folders with the host.

- Use a Remote Desktop client

  If using Windows 11 Pro or Enterprise, you can access the VM with a Remote Desktop Protocol (RDP) client such as Microsoft Remote Desktop on the Mac and utilize its folder redirection capabilities. Consult Windows documentation on how to configure Windows for remote console access, and your RDP client documentation on how to enable folder redirection.

- Install Microsoft OneDrive, Dropbox, or a similar cloud file sharing client in both the VM and the Mac

  Using cloud file sharing services in a VM allows content to be shared to Macs and any other platform that supports the service.

- Use a network file transfer utility such as WinSCP to transfer files between the Windows VM and the Mac host.

16.12.6   WSL2/Hyper-V/etc do not work in a Windows 11 ARM VM

WSL2, Hyper-V, and other Microsoft technologies that use virtualization functions cannot work in a Windows 11 ARM VM. This is because the Apple Hypervisor Framework that Fusion uses as its hypervisor engine does not support nested virtualization.

WSL1, which does not require Hyper-V features, will work in a Windows 11 ARM VM.

16.12.7   Screen flickering / screen goes black after upgrading VM

Thanks to @joedec for this tip.

After upgrading a Windows 11 VM to Fusion 13.5 (upgrade of virtual hardware version and installation of the latest VMware Tools), the console window may go blank or go black every few seconds. If this happens to you, shut down the VM and open **Settings > Display** for the VM. Make sure that "**Shared graphics memory**" is set to recommended value of 8192 as in **Figure 20**.
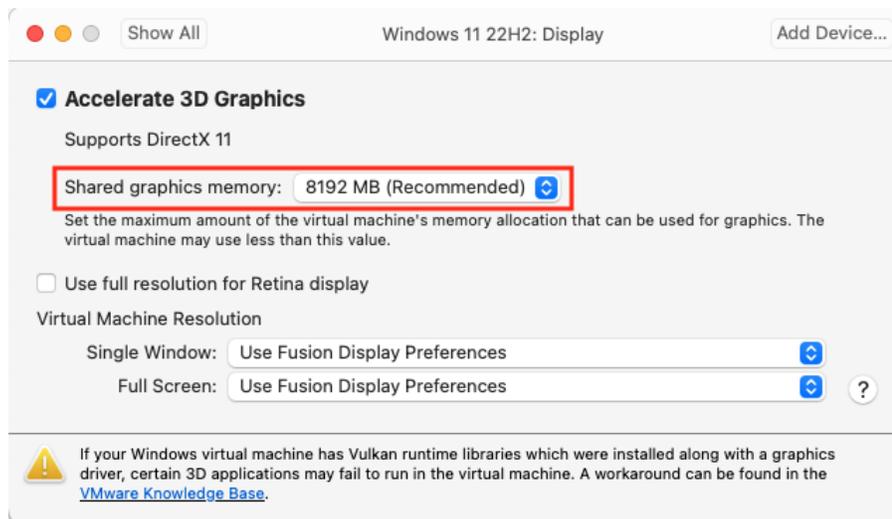
Figure 20: *Setting shared graphics memory*

16.12.8   Windows Device Manager shows no driver for two devices

Thanks to @coolryg for the explanation of why this happens.

Windows 11 ARM users will find that two devices in the Device Manager are present but have no device driver as shown in **Figure 21**:
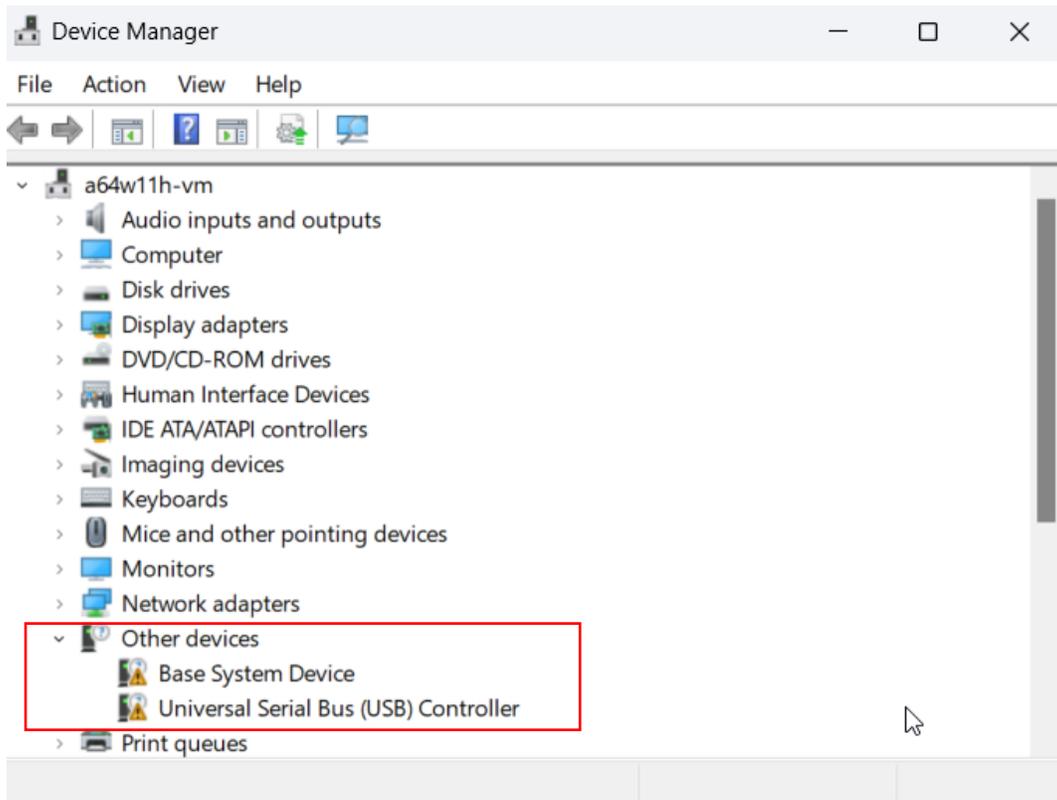
Figure 21: Missing device drivers for Windows 11 ARM

The lack of a driver for these two devices can be ignored. They will not impact operation of the VM.

Why those missing devices don't matter

The Base System Device with a missing driver is the VMware VMCI Bus device. This device is used in VMware products to support host-to-guest application-level communication (Vsockets). If you're interested in more details on what Vsockets are, see https://vdc-download.vmware.com/vmwb-repository/dcr-public/a49be05e-fa6d-4da1-9186-922fbfef149e/a65f3c51-aaeb-476d-80c3-827b805c2f9e/ws9_esx60_vmci_sockets.pdf.

VMware currently does not provide a driver for the VMCI Bus device on Windows 11 ARM. It is reportedly planned for a future release. This isn't a problem other than not supporting Vsocket functionality like it does on Intel Macs.

The Universal Serial Bus (USB) Controller with a missing driver is a UHCI USB virtual device that Fusion presents to the virtual machine. Neither VMware nor Microsoft provide a driver for this device for Windows 11 ARM.

This isn't a problem because Fusion doesn't use the UHCI controller to present USB devices to the VM. It uses a second virtual USB controller, an eXtensible Host Controller (XHCI) USB controller. Windows does provide a driver for this XHCI controller. Fusion connects USB devices to the VM through the XHCI controller, not the UHCI controller.

If you don't like the clutter of having a device without a driver, the UHCI USB virtual controller can be disabled by editing the VM's configuration file and adding the following line:

```
usb.uhci.present = "FALSE"
```

16.12.9   VM hangs or crashes with DPC_WATCHDOG_VIOLATION

Users may encounter either a BSOD with DPC_WATCHDOG_VIOLATION or hang. This occurs when VMware Tools are installed on Windows 11 ARM and 3D acceleration is enabled. The issue is seen with 3D games or when resizing a remote desktop window.

This is a known issue with the VMware graphics driver. Please see the VMware KB article https://kb.vmware.com/s/article/95283 which contains the known workarounds.

VMware states that this will be fixed in a future release.

16.12.10   Poor application graphics performance

Users are reporting that some applications are exhibiting poor graphics performance when 3D acceleration is enabled in the VM. Turning off 3D acceleration in the VM's settings is a workaround that has been found to help some users.

Appendix A.   Glossary

Apple Silicon	Apple's term for its in-house developed SoC (system on a chip) CPUs based on the ARM architecture. Apple Silicon chips are used in Macs, iPhones, iPads, Apple TV, and Apple Watch.
	The M1 and M2 CPU chips are Apple Silicon CPUs.
ARM	The RISC CPU architecture used by Apple as the basis for its Apple Silicon CPUs. It is different from and incompatible with Intel/AMD CPU architectures.
	Also refers to the company (Arm Ltd.) that develops the ARM CPU architectures and licenses them to vendors such as Apple or Qualcomm that produce ARM CPU chips.
arm64/aarch64	Refers to the 64-bit ARM CPU architecture or instruction set. Incompatible with x86 or x64/x86_64 architectures.
Blacklisting a driver	The process of preventing the Linux kernel from using a specific device driver module that has been included with the kernel. It is most often used to disable the use of a graphics adapter driver that is not working correctly, and forces the use of an alternate, generic graphics device driver.
	This document prefers the term "disabling the use of a driver", even though the mechanisms used to accomplish the task still use the term "blacklist".
Bridged networking	A virtual network configuration that connects the virtual machine network directly to a network that the host is using. There is no isolation of the virtual machine from network traffic.
	The IP address for a VM configured for a bridged network will be a unique address on the same network as the host.
	Compare with '**NAT networking**'.
EOL	Shorthand for **E**nd **o**f **L**ife. The phase in a software's lifecycle where the developer is stops development of a version of its software and is no longer providing support for it. This usually means that the developer is no longer providing updates or security patches for the software.

Emulation	The ability to simulate a different architecture and instruction set on the current hardware. An example is QEMU - software that emulates an Intel CPU on Apple Silicon hardware and allows Intel based operating system to run. Typically runs emulated CPU instructions more slowly than native instructions.

Compare with '**Virtualization**'. |
| EULA | Shorthand for **E**nd **U**ser **L**icense **A**greement. EULAs are a legal contract between a software provider and customer. They specify the rights and restrictions that apply to the use of the software by the customer. |
| GA | Shorthand for "**G**enerally **A**vailable". GA software versions are publicly released by the developer to all users and typically receive full support from the developer.

This contrasts with pre-release versions such as beta, preview, or development versions which may not be publicly available to all users and may not receive the same support from the developer (or any support at all) that GA versions do. |
| GRUB | Software that manages the early stages of the boot process for a Linux operating system. It is the de-facto standard system bootstrap utility for almost all Linux operating system distributions.

GRUB is shorthand for '**GR**and **U**nified **B**ootloader' in case you were wondering. |
| Guest | A virtual machine that runs under the control of a hypervisor.

Compare with '**Host**'. |
| Host | An operating system that runs a hypervisor that permits the use of virtual machines. Example: A Mac that is running VMware Fusion is considered the host.

Compare with '**Guest**'. |
| Hypervisor | From Wikipedia: https://en.wikipedia.org/wiki/Hypervisor

A hypervisor is a type of computer software, firmware or hardware that creates and runs virtual machines. The hypervisor presents the guest operating systems with a virtual operating platform and manages the execution of the guest operating systems. Unlike an emulator, the guest executes most instructions on the native hardware. |

ISO	Colloquial term for an industry-standard, cross-platform disk image format that is typically used for the distribution and installation of software such as operating systems.
	The term is derived from the ISO 9660 international standard that describes the format of the disk image.
KB article	Shorthand for "Knowledge Base" article or tech note.
Kernel	From Wikipedia: https://en.wikipedia.org/wiki/Kernel_(operating_system):
	The kernel is a computer program at the core of a computer's operating system and generally has complete control over everything in the system It is the portion of the operating system code that is always resident in memory and facilitates interactions between hardware and software components.
	The term 'kernel' is typically used in Linux environments to refer to the memory resident portion of the Linux operating system that is loaded into the computer's memory by the boot loader.
M1, M2, and M3	Apple Silicon CPU chips used by Apple in Macs beginning in late 2020.
NAT networking	A virtual network adapter configuration that creates a unique localized network that's isolated from the host's network. This is like what you would find on a home wireless router to isolate you from a broadband provider's network.
	The IP address for a VM connected to a bridged network will be on a different network than the host. A NAT firewall implemented by Fusion routes network traffic from virtual machines running within the NAT network to the host's configured network.
	Also known as 'Shared with my Mac' in the Fusion virtual machine network adapter configuration.
	Compare to 'Bridged networking'
Nested virtualization	The ability to run a hypervisor application in a virtual machine, which in turn allows virtual machines to run using that hypervisor inside the virtual machine
	Thinking of the film 'Inception' may help you understand this concept. Or the "gangster movie within a movie" from 'Home Alone'.

open-vm-tools	Open source versions of VMware's in-guest hypervisor tools for Linux and other UNIX-like operating systems. open-vm-tools are created and maintained by VMware and donated to the open source community.
	Open-vm-tools packages are available in most Linux distributions (including arm64 versions) through their repositories. They are the preferred tools for Linux guests running under VMware products.
	See 'VMware Tools'.
.ova/.ovf	A vendor-neutral virtual machine interchange format. Allows a virtual machine to be more easily transported from one virtualization product to another while retaining important settings and configuration.
Repository/Repo	A storage location for software packages maintained by an operating system's vendor. Package managers in Linux distributions typically use on-line repositories to install and/or update software on systems.
	Credit: Wikipedia https://en.wikipedia.org/wiki/Software_repository
Virtualization	The ability to share hardware resources of a computer to run additional operating system environments of the same CPU architecture. Typically runs most CPU instructions at native CPU speed.
	See 'Hypervisor'.
	Compare with '**Emulation**'.
VM	Shorthand for virtual machine or guest.
VHDX file	The file format used by Microsoft Hyper-V for its virtual disk files. Can be converted for use under Fusion.
	Compare with '**VMDK file**'.
VMDK file	The file format used by VMware Fusion for its virtual disk files.
	Compare with '**VHDX file**'.
VMware SVGA 3D	The graphics adapter that is presented to virtual machines by Fusion (and other VMware hypervisors).
	Virtual machines do not have direct access to a host's graphics card. The VMware SVGA 3D adapter provides a graphics display to the virtual machine that can be shared with the host's graphics adapter.

VMware Tools	Proprietary versions of VMware's in-guest hypervisor integration tools provided directly by VMware for Windows and older x86/x64 Linux distributions that do not support open-vm-tools. See 'open-vm-tools'.
vmwgfx	The Linux kernel device driver that provides support for the VMware SVGA 3D virtual graphics adapter. See 'VMWare SVGA 3D'
Windows 11 ARM	The version of Windows 11 produced by Microsoft to run on ARM architecture PCs. It is the Windows version that is used in Microsoft Surface devices with Microsoft SQ CPU chips and OEM devices that use Qualcomm Snapdragon CPUs such as those from Lenovo, HP, Acer, and Samsung
x64/x86_64	Refers to the 64-bit Intel/AMD CPU architecture or instruction set. Incompatible with arm64/aarch64 architectures.
x86	Refers to the 32-bit Intel/AMD CPU architecture or instruction set. Incompatible with arm64/aarch64 architectures.

Appendix B.   Archived Topics

The topics in this section discuss issues that were reported in older versions of Linux operating systems. In almost all cases, these issues have been fixed in current Linux operating system releases.

B.1.   FIXED: RHEL 9.0 installation ISOs will not boot

This issue is fixed in RHEL 9.1 and later.

B.2.   FIXED: Blank screen when text mode installation is selected

This issue was seen with RHEL 9.0 and older CentOS 9 Stream ISO installation media. Use RHEL 9.1 or later or current releases of CentOS 9 Stream where this issue is fixed.

B.3.   FIXED: Unable to change graphics resolution in a RHEL 9.0 VM

This issue is fixed in RHEL 9.1 and later. Use those installers instead of RHEL 9.0.

B.4.   FIXED: Unable to change screen resolution in a KDE Plasma session

The issue is fixed in KDE Plasma releases starting with 5.24.2. Upgrade your distro or KDE Plasma version to later releases.

B.5.   Leap 15.4 installer hangs at "Starting udev"

Leap 15.4 is an EOL release and is no longer recommended for use by OpenSUSE. This issue is fixed in Leap 15.5 and later.

Appendix C.   Windows 11 Installation Resources

Installing Windows 11 from ISO installation media (either Intel or ARM versions) is a system administration task that is outside the scope of the Companion Guide (remember the disclaimer at the beginning of the guide that some system administration skills are required?).

If you are not familiar with installing Windows from Microsoft ISO media, here are some resources that can assist you. Most of these are geared toward Intel versions of Windows, but the information can be used for Windows 11 ARM.

https://www.digitalcitizen.life/install-windows-11/

https://www.digitaltrends.com/computing/how-to-install-windows-11/#dt-heading-how-to-clean-install-with-windows-11-installation-media (Skip to the section on "How to clean install with Windows 11 Installation Media)

https://www.tomshardware.com/how-to/clean-install-windows-11 (Skip to the section "Installing Windows 11 on the Target PC")