

# VMware ESXi

By James Reynolds

# Disclaimer

- I'm new to this stuff
  - I'm still new to the jargon
  - I'm pretty inexperienced
- This presentation barely scratches the surface
- I'm assuming you've never done this before
- I'm focusing on Mac OS and VMware
- This is non-critical servers

# Agenda

- Why
- vSphere, ESXi, and VMware History
- Hardware support and licensing
- Installing and configuring ESXi
- Datastores and creating VM's
- Backup

# Why?

Prepare for changes to macOS Server - January 2018

<https://support.apple.com/en-us/HT208312>

"In fall 2018, Apple will stop bundling open source services such as Calendar Server, Contacts Server, the Mail Server, DNS, DHCP, VPN Server, and Websites with macOS Server. Customers can get these same services directly from open-source providers."

In other words, the open source server software that Apple distributes is really old, and it's really easy to get it on your own, so Apple isn't going to distribute it anymore.

# The writing has been on the wall since 2011

- Xserve, 2002-2011
- Mac OS X Server OS, 1999-2011
- OS X Server App, 2011-2018?



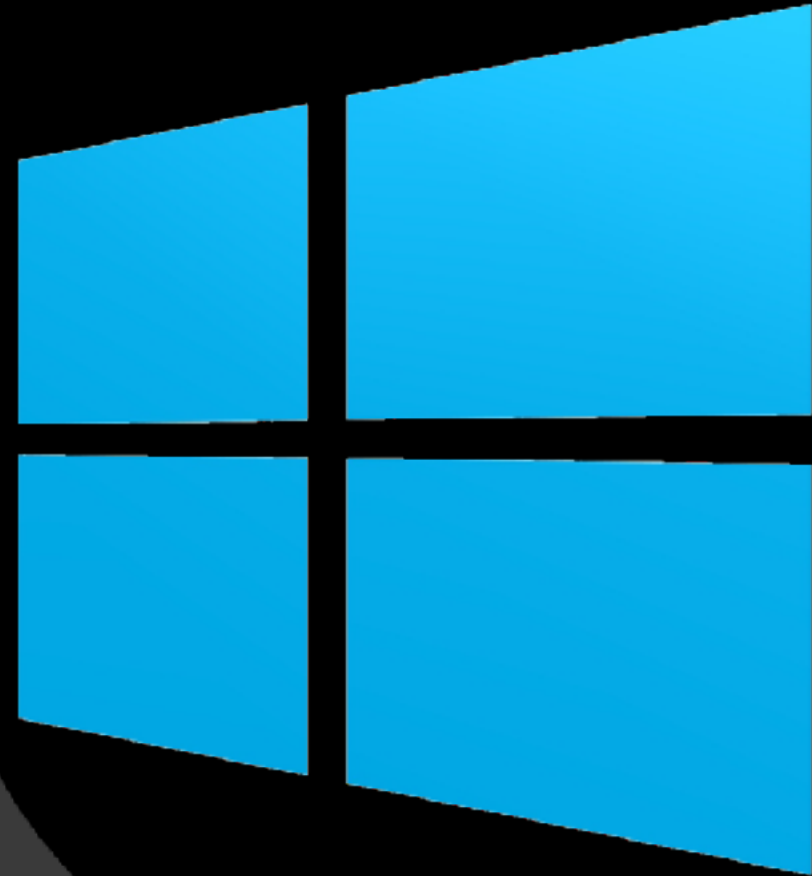
# Advantages

- Run 10.5 - 10.14
  - Run old apps
- Run any virtually any OS, Haiku OS (OpenBeOS), React OS (Win XP clone)
- Apple says to use open source software to replace OS X Server
  - This software is easy on Linux
- All of the advantages of VMs
  - Snapshots, consolidated hardware, easier backups, easier to move to new computers, etc

# Remote Only

- This isn't a replacement for dual booting
- This is not Fusion, VirtualBox, Parallels, Wine, etc
- Remote only
  - This is a replacement for servers in closets that are accessed remotely
  - None of these VM's can be interacted with by plugging in a keyboard, mouse, and display into the computer

# Mac, Linux, Windows





# ESXi - The 4th OS?



# That rules them all?



# Jargon

- There are lots of VMware flash cards with 100's of terms
- I've been doing IT for almost 20 years and I haven't heard of half of these terms
- I'll avoid most of them in this presentation

# What is vSphere?

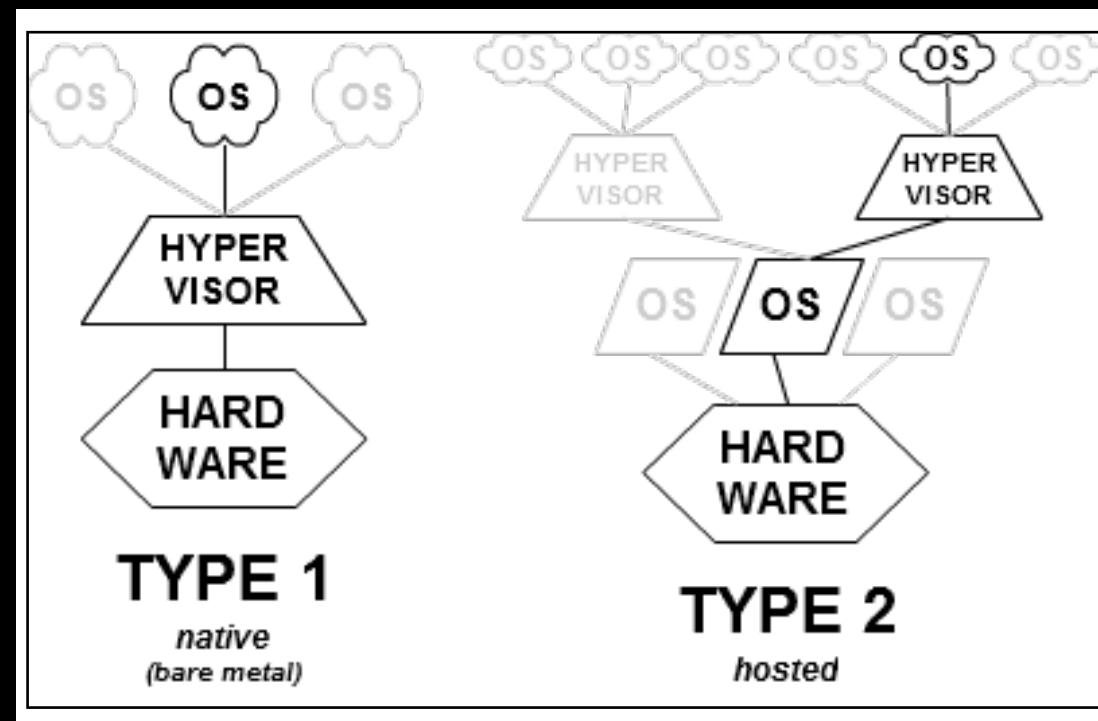
- Umbrella term for the package that includes
  - ESXi
  - vCenter Server
  - vCenter Client (moving to a web client)
  - VMFS

# vCenter Server and Client

- vCenter Server
  - Windows installer
  - Linux appliance (VCSA)
- vCenter Client
  - "vSphere Web Client (FLEX)" moving to "vSphere Client (HTML)"
- Centralized Management of a fleet of hosts

# What is ESXi?

- ESXi = Elastic Sky X (integrated)
- Type 1 hypervisor, "bare metal"
- VMware Fusion and Workstation are type 2 hypervisors



# What is ESXi?

- ESX (not available anymore)
  - Red Hat
  - After booting control passed to VMware

# What is ESXi?

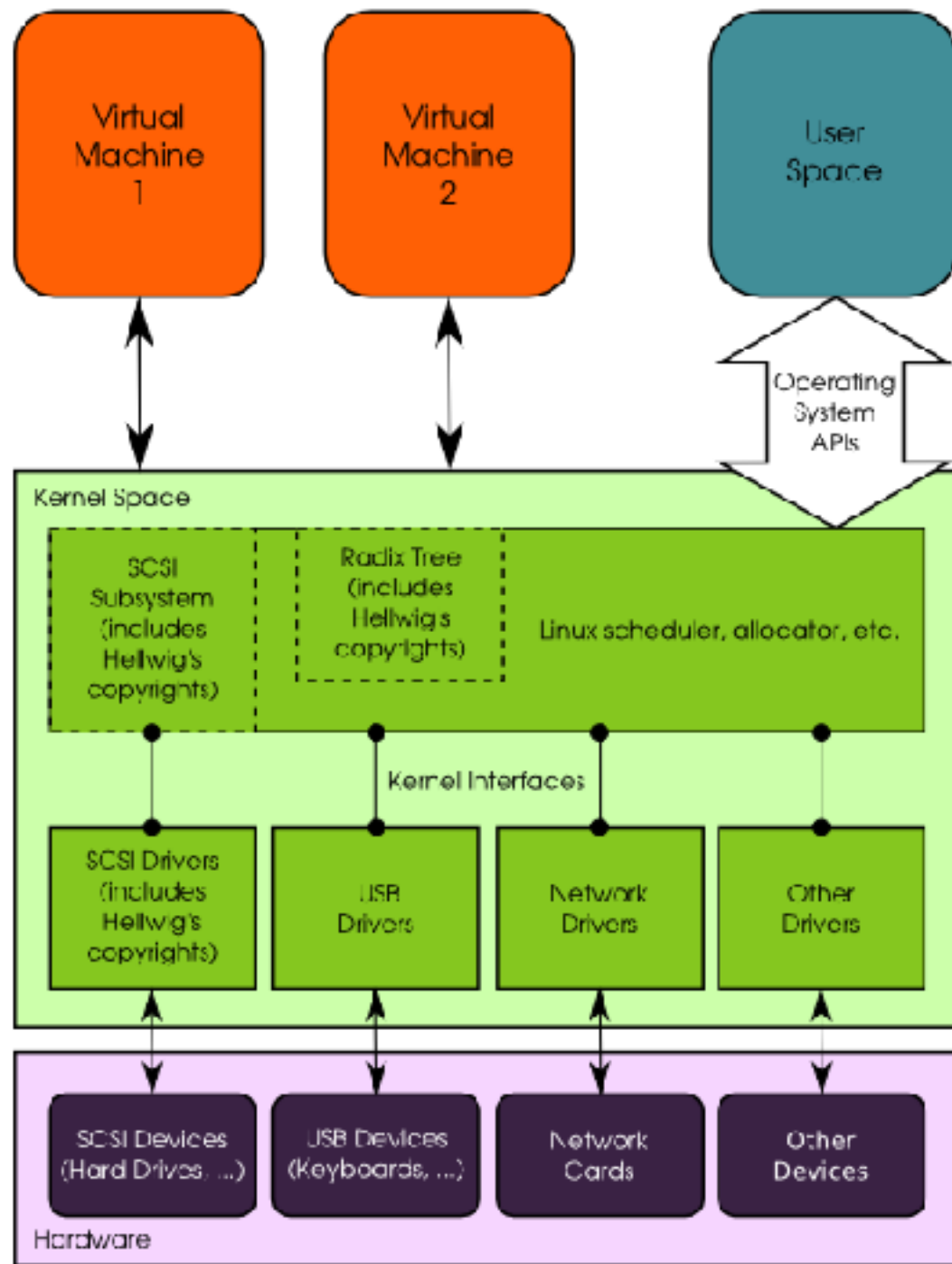
- ESXi
  - Tiny footprint compared to ESX
    - Can be placed on 16 GB flash media (takes 4 GB)
      - 10.3 was 1.5 GB, 10.4 was 3 GB, 10.6 was 5 GB
  - ESXi doesn't need to be rebooted or patched that often
  - ESXi boots much faster than ESX did



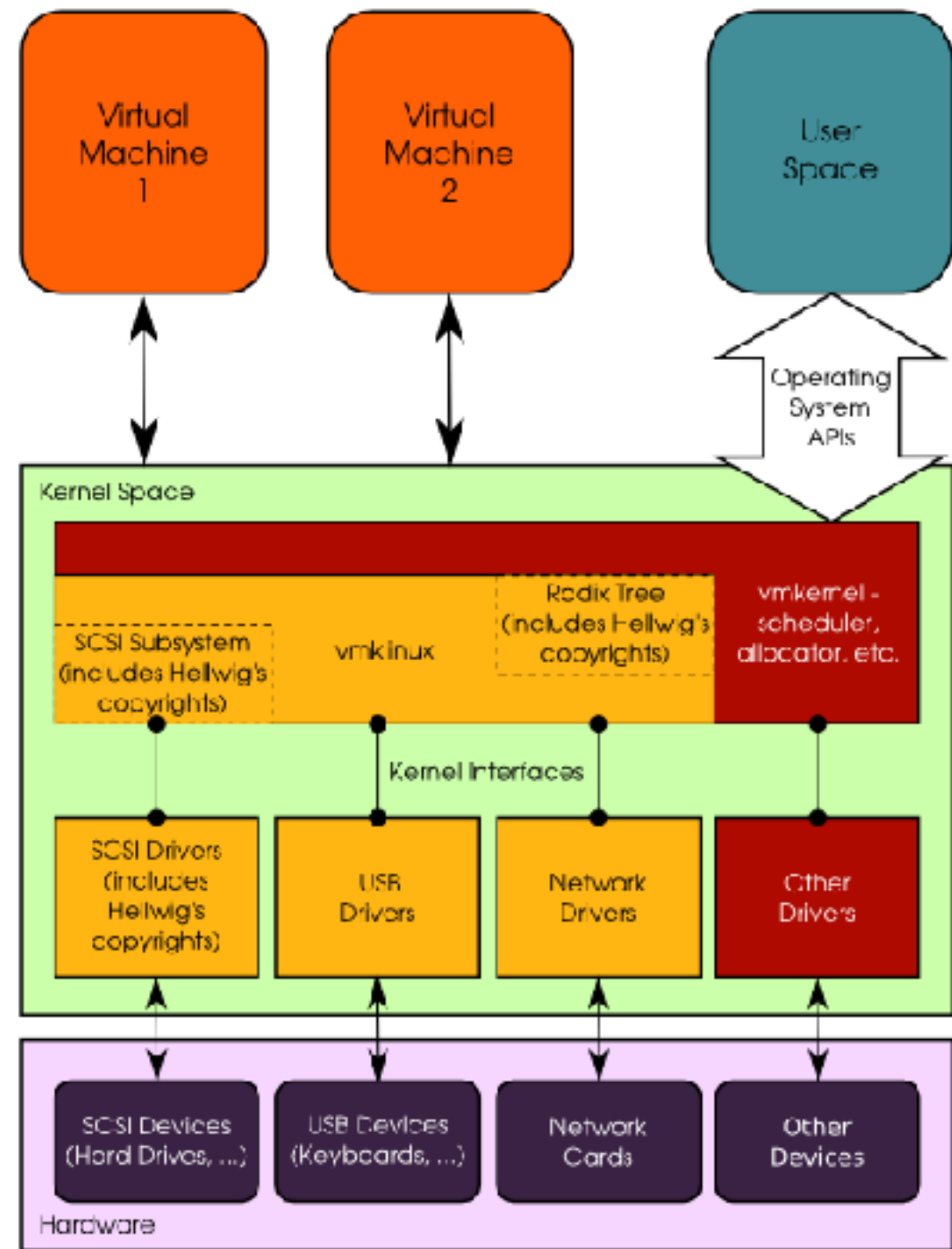
# What is ESXi?

- "ESXi is not Unix"
  - Similar but different enough to not qualify as "Unix"
  - Replaced Linux kernel with "POSIX-like" VMkernel
  - Has Linux-compatible storage and networking drivers
  - BusyBox, other opensource software (firewall, ssh)
- Software Freedom Conservancy is suing VMware for GPL violations

### System Using Complete Linux Kernel



### System with VMware ESXi



Code from Linux kernel (GPLv2)

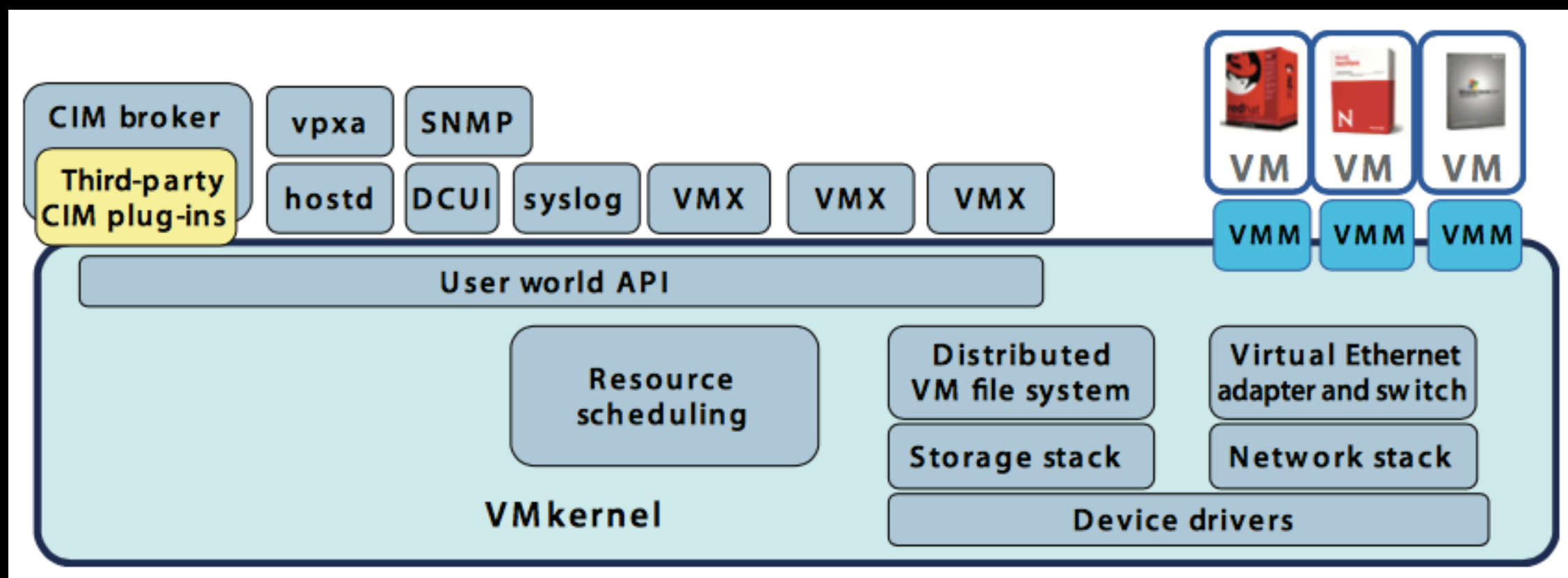


Modified Linux code to assist in vmkernel/Linux (GPLv2)



Code from VMware (proprietary)

# VMware's Architecture



# VMware History

- 1999 - VMware Workstation released
- 2001 - VMware ESX Server
- 2004 - EMC acquires VMware
- 2007 - Mac OS X 10.5 Server allows virtualization
- 2007 - VMware Fusion for Mac OS
- 2008 - ESX free version

# VMware History

- 2010 - VMware vSphere 4.1 (ESXi released)
- 2011 - vSphere 5.0
- 2012 - vSphere 5.1
- 2013 - vSphere 5.5
- 2014 - vSAN
- 2015 - vSphere 6.0

# VMware History

- 2016 - Dell acquires EMC
  - 800 US Workstation & Fusion developers fired
- 2016 - vSphere 6.5
- August 2018 - 15th VMworld conference held in Las Vegas, 23,000+ attendees
- 2018 - vSphere 6.7

# Dell

- In 2016 Dell bought EMC for \$67b to become Dell EMC
  - Largest tech merger & largest private tech company
  - VMware is the crown jewel, but is public & independent
- Dell EMC owns 80% (or something) of VMware
  - In January 2018 rumor was VMware would buy Dell
  - But in July 2018 Dell bought DVMT, went "sort of" public, and gained more control of VMware

# Dell PowerEdge

- Dell's server line
  - #1 server at 19% - 20% marketshare
    - HPE closely behind (by decimals)
  - Starting from the \$1,200's (upper limit? \$100,000's?...)





# Mac OS VM's on Dell?

# NO

- Apple's license does not allow it
- VMware will only run Mac OS VM's on Apple hardware

# Mac OS VM's on Dell on Macs?

- What if Mac OS VM's are \*literally\* (instead of virtually) on Apple hardware?



# Officially Supported Mac Hardware

- Xserve3,1 (Early 2009) - ESXi 5.0
- MacPro5,1 (2010-2012) - ESXi 6.0
- MacPro6,1 (Late 2013, the trash can) - ESXi 6.7
  - 1 Ivy Bridge CPU; 4, 6, 8 or 12 Cores
  - 64 GB (128 GB via 3rd party) Max RAM
  - \$3000 - \$7000 retail



MacPro5,1 6.0

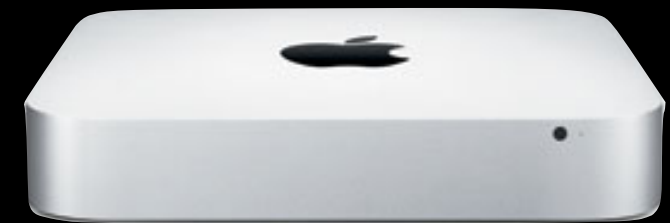


MacPro6,1 6.7

# Unsupported Hardware

- ESXi will not run at all on iMacs or laptops
- Mac Mini unofficial support
  - They are not in the Hardware Compatibility Guide (HCL)
  - Not all versions of ESXi work
  - New Mac Mini's will lack support
    - It will take a year or so to add support in ESXi

# Mac Mini's & ESXi 6.7



- Macmini6,2 (Late 2012)
  - Dual Core i5 2.5 GHz or Quad Core i7 2.3 or 2.6 GHz
  - Max 16 GB RAM (upgradable)
- Macmini7,1 (Late 2014, the 4 year old current model)
  - Dual Core i5 2.6 or 2.8 GHz or Core i7 3 GHz
  - 8 GB or 16 GB RAM (not-upgradable)



Macmini7,1

# Mac Mini Pros & Cons

- Pros

- CHEAP

- Cons

- Limited to internal drives (more on this later)
- Internal hard drives are a pain to swap (mod the case?)
- ESXi support is not guaranteed (not all versions work)
- New Mac Mini soon? How long before it is supported?



# What I'm using

- Macmini6,2 (Late 2012)
  - Quad Core i7 2.6 GHz
  - Max 16 GB RAM
  - 1 TB SSD
- I don't run more than 4 Mac OS VM's at the same time
  - Most VM's are test images

# VMware Licensing

- Confusing
- USHE has an agreement until 12/28/2021
- Email OSL to get a license
- vSphere licensing is per CPU (not core)
- vCenter licensing is per vCenter server instance
  - I'm pretty sure nobody here needs more than 1
- vSAN not covered by campus agreement



# vSphere Licensing

- ESXi Free ("you should never use for free")
  - No vCenter, max 2 CPUs, max 8 vCPUs, no support
- Essentials or Essentials Plus, 3 hosts max
- Standard (part of campus agreement)
- Enterprise Plus (part of campus agreement)
- Operations Management Enterprise Plus (vRealize Operations)
  - Not part of the campus agreement

# vSphere Standard

- Data Protection
- High Availability
- vMotion
- Storage API's for backup

# vSphere Enterprise Plus

- DRS (Distributed Resource Scheduler)
- vSphere Distributed Switch
- Host Profiles and Auto Deploy
- Storage and Network I/O Control
- VM encryption
- vGPU

# Installing ESXi

- Create an account on [my.vmware.com](https://my.vmware.com) and download "VMware vSphere Hypervisor (ESXi ISO) image (Includes VMware Tools)"
- Use UNetbootin and burn that image to a USB flash disk
  - <https://unetbootin.github.io>
  - (Format flash as Fat32/MBR)
- Boot the computer from USB disk and finish installation

# Embedded vs Installable

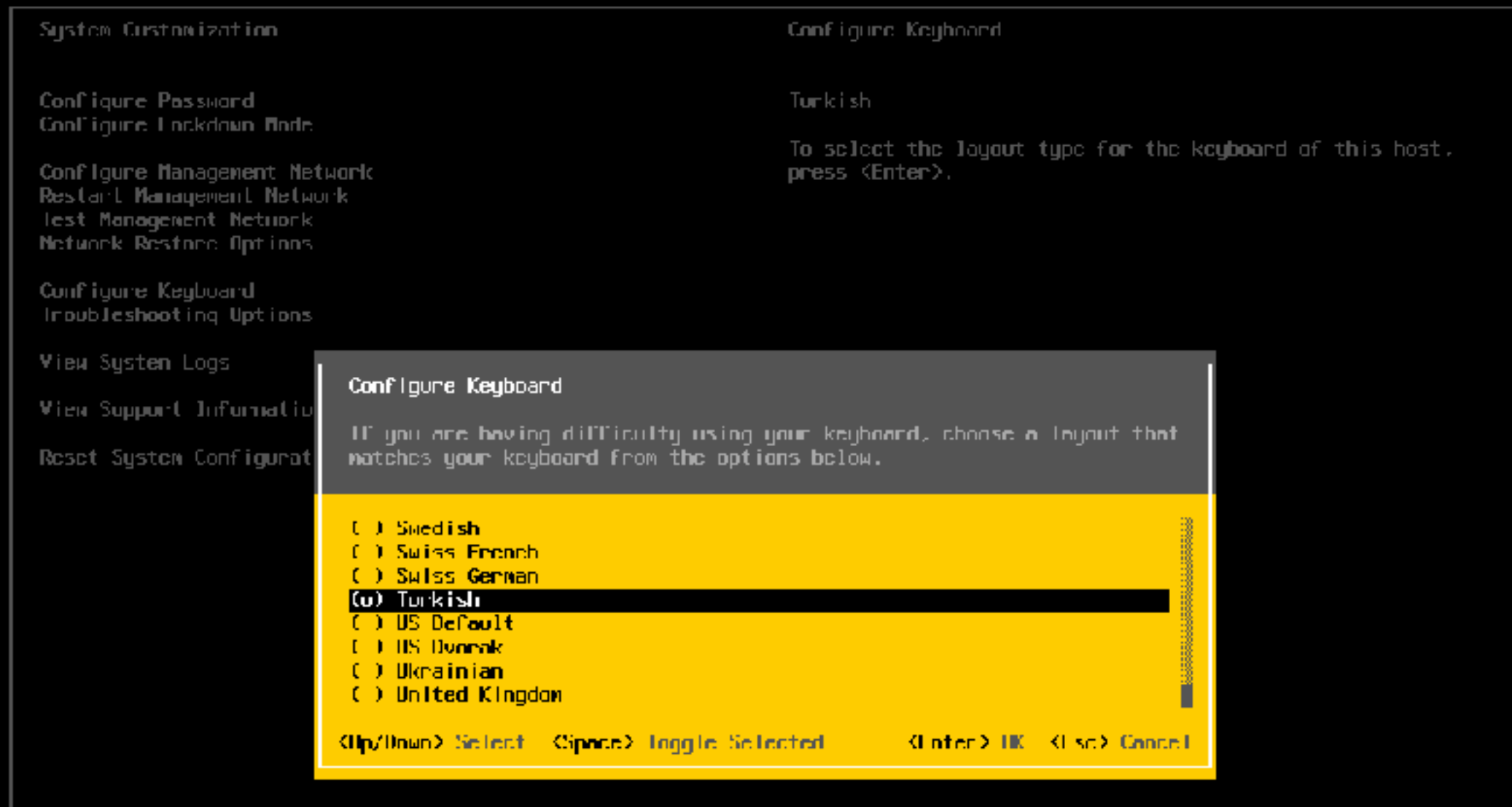
- ESXi has 7 partitions
- ESXi Installable
  - All 7 partitions on the boot drive (only 2 are writable)
- ESXi Embedded
  - USB flash, SD card, PXE boot
  - 5 read-only partitions (unless there's a core dump)
  - Uses a RAM disk or your 1st datastore for logs

# Darwin Tools Image

- Go to [my.vmware.com](https://my.vmware.com), "View & Download Products"
- Find and download darwin.iso\* (3 files)
- Copy them to /usr/lib/vmware/isoimages
  - symlink to one of the partitions packages/  
vmtoolsRepo/vmtools

# Direct Console UI

- Use to configure networking, passwords, low-level debug
- Can't manage VM's



# ESXi Host Client

- Point a web browser at your host's IP
- This is not the vSphere web client





Navigator

- Host
  - Manage
  - Monitor
- Virtual Machines 6
- Storage 2
- Networking 1

s-it-esxi1

Get vCenter Server | 
 Create/Register VM | 
 Shut down | 
 Reboot | 
 Refresh | 
 Actions



**s-it-esxi1**  
 Version: 6.7.0 (Build 8169922)  
 State: Normal (not connected to any vCenter Se...  
 Uptime: 12.83 days

**CPU** FREE: 10.2 GHz  
 USED: 219 MHz CAPACITY: 10.4 GHz  
 2%

**MEMORY** FREE: 6.45 GB  
 USED: 9.46 GB CAPACITY: 15.91 GB  
 59%

**STORAGE** FREE: 157.52 GB  
 USED: 796.23 GB CAPACITY: 953.75 GB  
 83%

Hardware	
Manufacturer	Apple Inc.
Model	Macmini6,2
CPU	4 CPUs x Intel(F) Core(TM) i7-3720QM CPU @ 2.60GHz
Memory	15.91 GB
Persistent Memory	0 B
Virtual flash	0 B used, 0 B capacity
Networking	

Recent tasks

Task	Target	Initiator	Queued	Started	Result	Completed

# Configuring ESXi

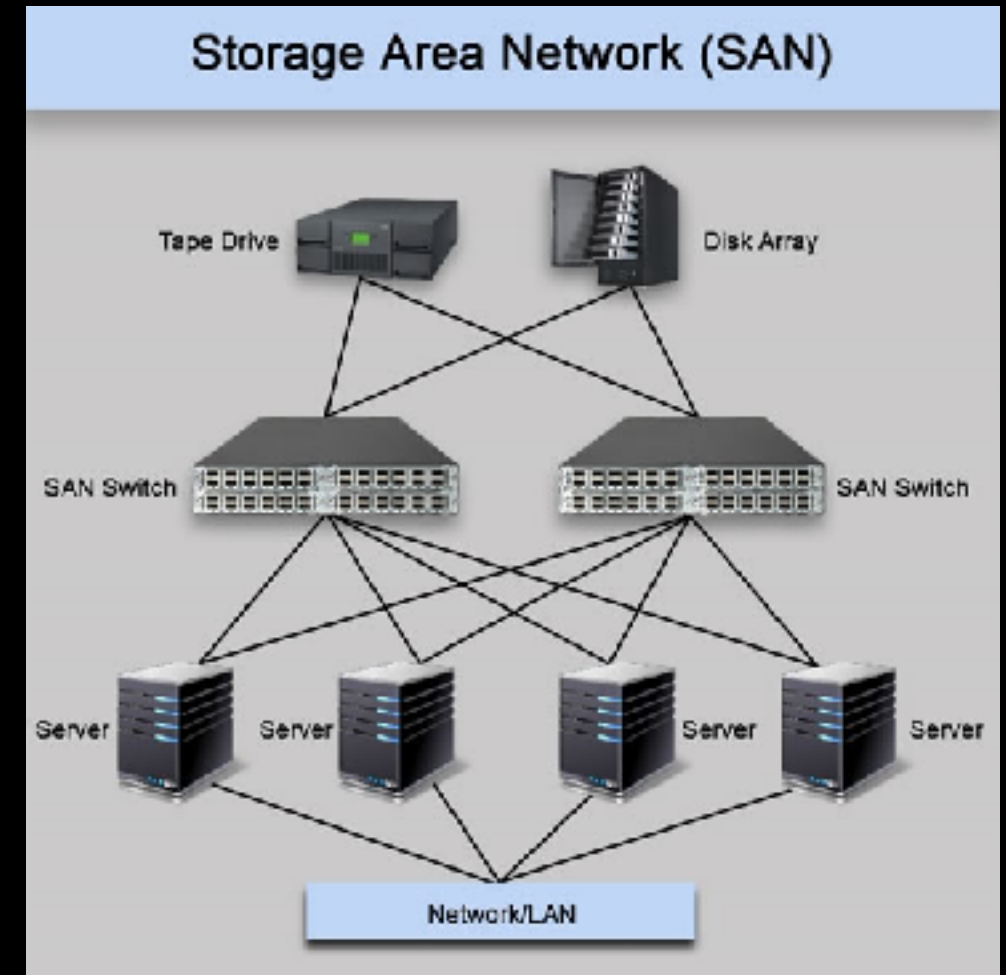
- Autostart
- License
- Services (ntpd, snmpd, ssh, syslog, X.Org server, etc)
- Users & Groups
- Datastores

# Datastores

- Where the VM images are stored
- Datastores can be networked or local

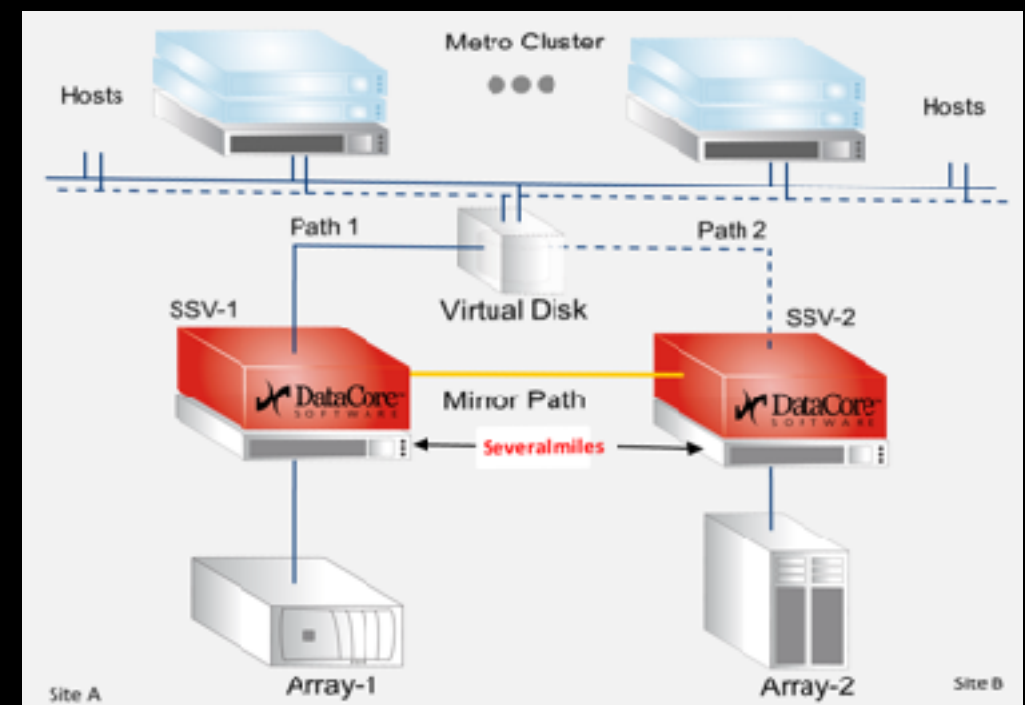
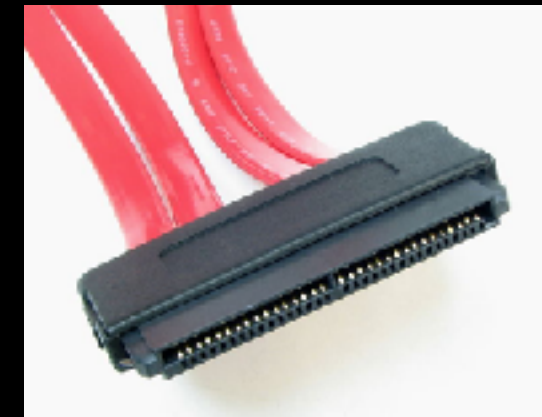
# Networked Datastores

- Storage Area Network (SAN)
  - Network block level access
  - Fibre Channel or iSCSI
- Network Attached Storage (NAS)
  - Network file level access
  - NFS
  - Not CIFS (SMB)



# Local Storage (LS)

- Internal drives
- Directly Attached Storage (DAS)
  - SATA or SAS (Serial Attached SCSI)
- Shared SAS, (Dell VRTX)
- "Hyperconverged"
  - E.g. [datacore.com](http://datacore.com) starts at ~\$750/TB



# Mac Hardware & Datastores

- Internal drives: Yes
  - Mac Mini and the data doubler
  - MacPro5,1 has 4 bays! Except ESXi 6.0 only :(
- NAS: Yes (more about this later)
- iSCSI & Fibre Channel requires PCIe slots for HBA's: No
- USB: No (USB is passed through to VM's)
- That leaves Thunderbolt to the rescue!



# Thunderbolt...

- Requires drivers...
- ATTO's ThunderLink® - Thunderbolt Fibre Channel adapters are the only supported Thunderbolt product
  - \$1095-\$3495 for Fibre Channel adapters



# Stuff others got to work with ESXi 6.0

- Old Promise STEX driver
  - `scsi-stex-4.07.0000.75-1OEM.500.0.0.472560.x86_64`
- Sonnet Thunderbolt PCIe Expansion Systems
- Sata-xahci driver (adds PCI ID's to the generic ahci driver)
- Areca SAS RAID driver
- Laci Rugged Thunderbolt drives



# PSOD

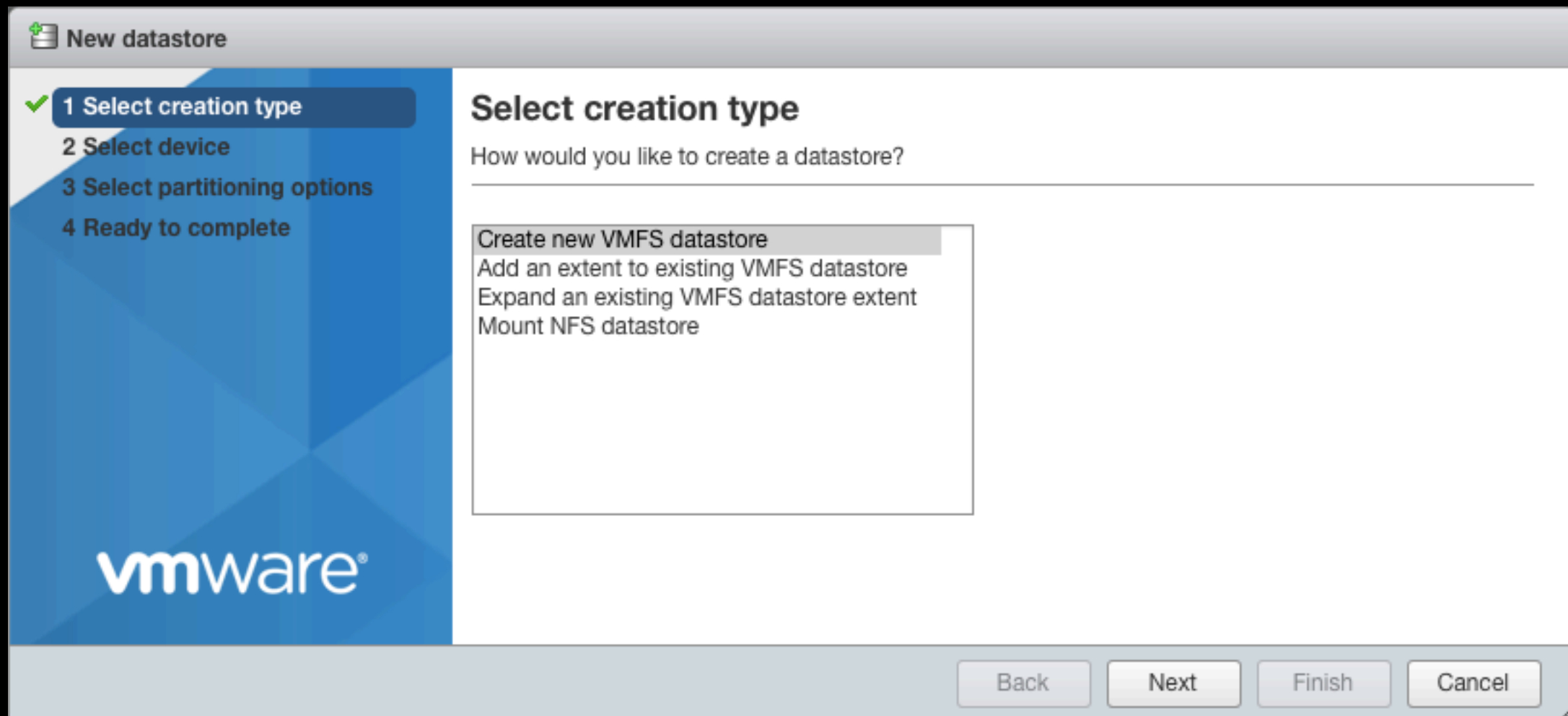
```
VMware ESXi 5.5.0 [Releasebuild-1331820 x86_64]
#PF Exception 14 in world 35830:vmn0:      IP 0x418022810c57 addr 0x0
PTEs:0x0;
cr0=0x80050031 cr2=0x0 cr3=0x1d0c3c000 cr4=0x2668
Last branch from 0x418022976f51 to 0x4180226a164c
frame=0x4123afd9d340 ip=0x418022810c57 err=0 rflags=0x10216
rax=0x0 rbx=0xf rcx=0x0
rdx=0x2 rbp=0x4123afd9d7e8 rsi=0x0
rdi=0x4108671476c0 r8=0x0 r9=0x0
r10=0x41111740e080 r11=0x4 r12=0x41000859cef4
r13=0x1 r14=0x4123afd9d6f8 r15=0x4123afd9d74c
*PCPU0:35830/vmn0:
PCPU  0: VVVV
Code start: 0x418022600000 VMK uptime: 0:00:06:24.721
0x4123afd9d7e8: [0x418022810c57]E1000PollRxRing@vmkernel#nover+0xb73 stack: 0x4123afd9d818
0x4123afd9d858: [0x418022813bb5]E1000DevRx@vmkernel#nover+0x3a9 stack: 0x1
0x4123afd9d8f8: [0x418022792164]IOChain_Resume@vmkernel#nover+0x174 stack: 0x0
0x4123afd9d948: [0x418022779e22]PortOutput@vmkernel#nover+0x136 stack: 0x4108787d8b38
0x4123afd9d9a8: [0x418022d26f58]EtherswitchForwardLeafPortsQuick@<None>#<None>+0x4c stack: 0x1dd39
0x4123afd9dbc8: [0x418022d27f51]EtherswitchPortDispatch@<None>#<None>+0xe25 stack: 0x300000014
0x4123afd9dc38: [0x41802277a7d2]Port_InputResume@vmkernel#nover+0x192 stack: 0x412e8461b440
0x4123afd9dc88: [0x41802277ba39]Port_Input_Committed@vmkernel#nover+0x25 stack: 0xf
0x4123afd9dcf8: [0x41802281763a]E1000DevAsyncTx@vmkernel#nover+0x112 stack: 0x4123afd9de78
0x4123afd9dd68: [0x4180227add70]NetWorldletPerVMCB@vmkernel#nover+0x218 stack: 0x410857626d10
0x4123afd9dec8: [0x4180226eae77]WorldletProcessQueue@vmkernel#nover+0xcf stack: 0x4123afd9def8
0x4123afd9df08: [0x4180226eb93c]WorldletBHHandler@vmkernel#nover+0x54 stack: 0xfffffffffc008d10
0x4123afd9df98: [0x41802262e94f]BH_DrainAndDisableInterrupts@vmkernel#nover+0xf3 stack: 0x4180000000
0x4123afd9dfe8: [0x4180226cdc6a]VMMVMKCall_Call@vmkernel#nover+0x2c6 stack: 0x0
0x4180226cd484: [0xfffffffffc225baa]__param_heap_initial@<None>#<None>+0xd8d76002 stack: 0x0
base fs=0x0 gs=0x418040000000 Kgs=0x0
Coredump to disk. Slot 1 of 1.
Finalized dump header (12/12) DiskDump: Successful.
Debugger waiting(world 35830) -- no port for remote debugger. "Escape" for local debugger.
```

# Local Datastore: VMFS

- Versions match the version of ESXi
- Multiple servers can read/write to this disk
- Can span multiple volumes
- ESXi is the only OS that can read & write this format
  - 3rd party (read) FUSE drivers: fluidOps, & glandium

# New Datastore

- Click "Storage" and "New datastore"
- Create new VMFS datastore



# My Internal SSD

The screenshot shows the vSphere Storage browser interface for a data store named 'data-esxi1'. At the top, there are navigation options: 'Register a VM', 'Datastore browser', 'Increase capacity', 'Refresh', and 'Actions'. On the right, a storage usage bar indicates 83% usage, with 157.52 GB free and a total capacity of 953.75 GB. The main area displays the datastore's metadata:

- data-esxi1**
- Type: VMFS6
- Location: /vmfs/volumes/5b60aa03-8e683cb8-ecd1-10...
- UUID: 5b60aa03-8e683cb8-ecd1-10ddb1d94496
- Hosts: 1
- Virtual Machines: 6

Below this, a 'VMFS details' table provides further information:

VMFS details	
Version	6.82
Local	Yes
Block size	1 MB
UUID	5b60aa03-8e683cb8-ecd1-10ddb1d94496
Extent 0	t10.ATA____Samsung_SSD_860_PRO_1TB____S41ANF0K500262T____, partition 1

# Creating VM's

- Just like VMware Fusion or VirtualBox

New virtual machine - 10.14 beta test (ESXi 6.7 virtual machine)

✓ 1 Select creation type  
2 Select a name and guest OS  
3 Select storage  
4 Customize settings  
5 Ready to complete

## Select a name and guest OS

Specify a unique name and OS

Name

Virtual machine names can contain up to 80 characters and they must be unique within each ESXi instance.

Identifying the guest operating system here allows the wizard to provide the appropriate defaults for the operating system installation.

Compatibility

Guest OS family

Guest OS version

# How to Install VM OS

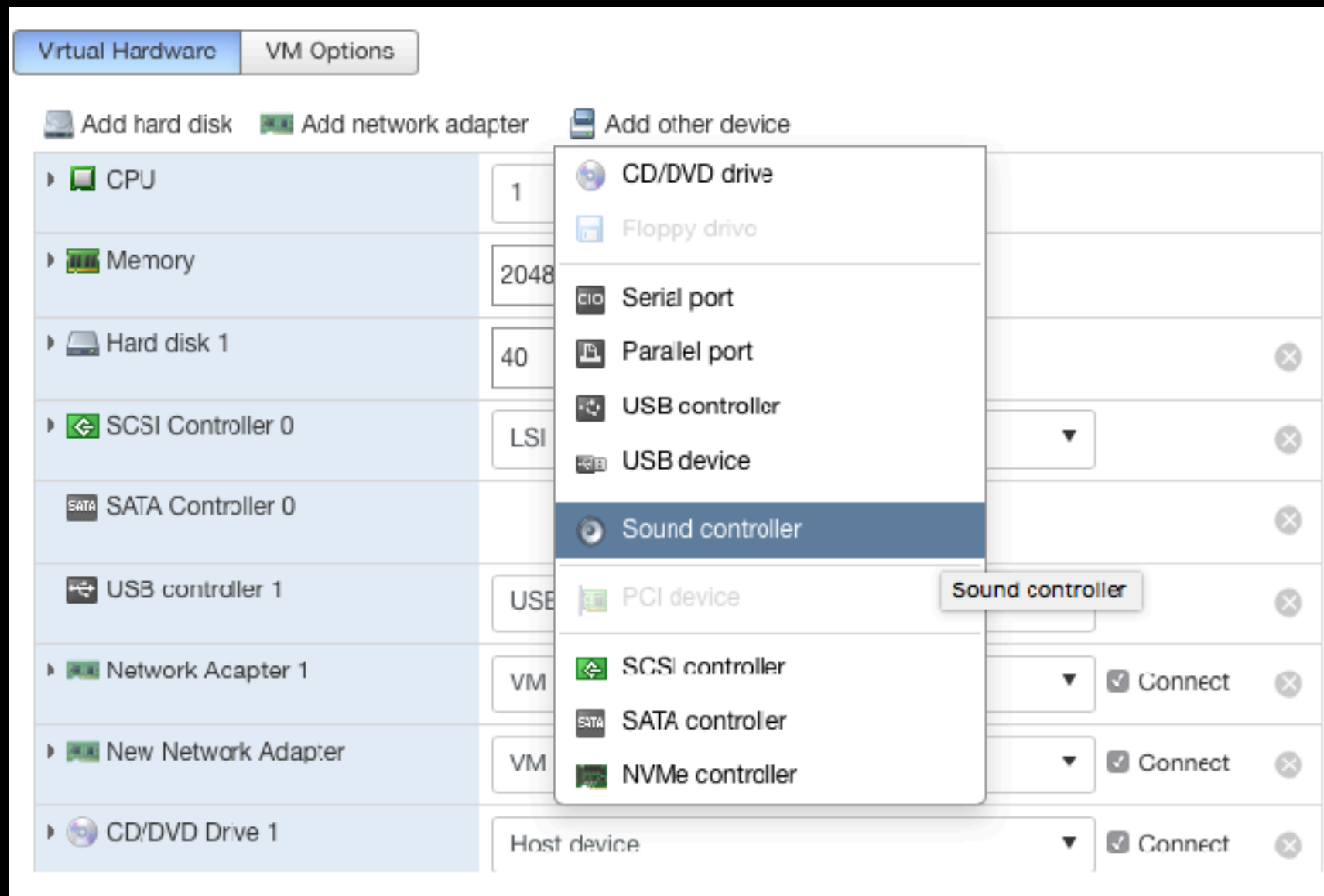
- Non-Mac OS'es
  - Upload ISO's to datastore and set it to the DVD drive
- Mac OS installer app...
  - Convert to bootable installers
  - Use VMware Fusion and upload the VM
  - Create an image with AutoDMG and Netboot the VM

# Other Mac OS Things

- Copying VM's
  - Change uuid.bios
- Display size
  - ESXi Web Console
  - `/L/AS/VMware Tools/vmware-resolutionSet 1920 1080`
  - [github.com/MarLoe/VMware.PreferencePane](https://github.com/MarLoe/VMware.PreferencePane)

# Sound Driver

- Mac OS VM's need sound driver added if you use `say`





# Linux Appliances

- Import free virtual appliances (OVF/OVA format)
  - Bitnami
    - Wordpress, Joomla, Redmine, Drupal, WAMP, ExternalDNS, Moodle, Magento, etcd, ownCloud, Kubewatch, LAMP, NATS, PrestaShop, GitLab CE, MediaWiki, Redis Sentinel, Ruby, phpBB, ELK, Django, Tomcat, Jenkins, phpMyAdmin, MODx, Roundcube, Node.js, Diaspora, Mantis, Hadoop, etc
  - Turnkey Linux

- ✓ 1 Select creation type
- 2 Select OVF and VMDK files
- 3 Select storage
- 4 License agreements
- 5 Deployment options
- 6 Additional settings
- 7 Ready to complete

### Select creation type

How would you like to create a Virtual Machine?

- Create a new virtual machine
- Deploy a virtual machine from an OVF or OVA file
- Register an existing virtual machine

This option guides you through the process of creating a virtual machine from an OVF and VMDK files.

- ✓ 1 Select creation
- 2 Select OVF and VMDK files
- 3 Select storage
- 4 License agreements
- 5 Deployment options
- 6 Additional settings
- 7 Ready to complete

### Select OVF and VMDK files

Select the OVF and VMDK files or OVA for the VM you would like to deploy

Enter a name for the virtual machine.

bitnami-ELK

Virtual machine names can contain up to 80 characters and they must be unique within each ESXi instance.

X  bitnami-elk-6.4.0-0-linux-debian-9-x86\_64.ova



# Controlling VMs

- vCenter web console
- ESXi Host web console
- VMware control
- VNC (ARD)
- SSH
- etc

# Transferring Files (VM's)

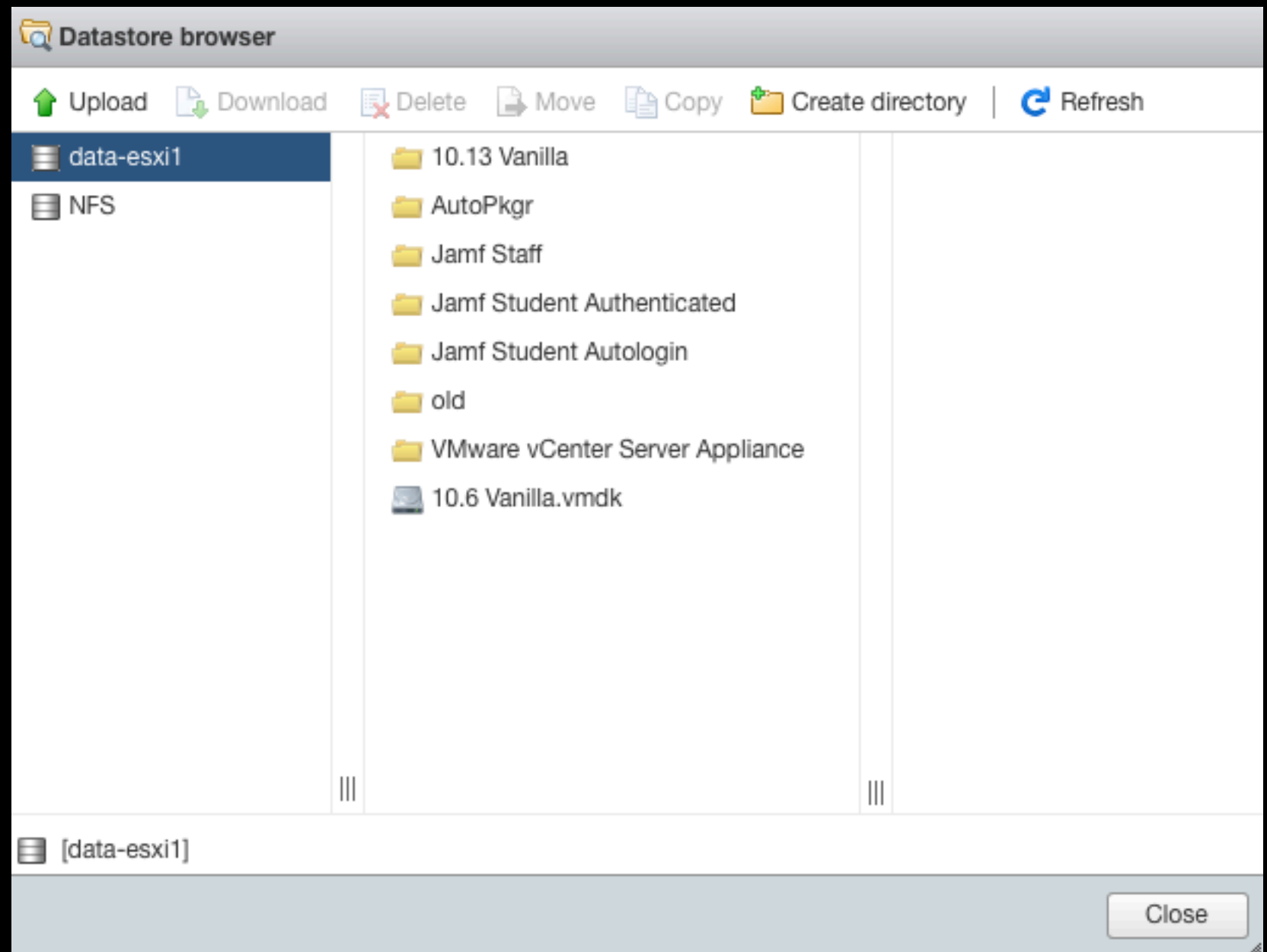
- Enable ssh on host and use scp
- Just to the datastore
  - ESXi web client datastore browser
    - NFS datastore
  - VMware Fusion
  - VMware Fusion's ovftool
  - vSphere web client

# NFS 3 (Mac OS X)

- NFS 3, authenticates using IP, no encryption, requires root
- Be sure to read "NFS Protocols and ESXI" at [docs.vmware.com](https://docs.vmware.com)
- Edit /etc/exports (BSD and Linux syntaxes differ)
  - Each line is an export point followed by allowed clients
  - /path [options] client1 [client2...]  
  
/path -maproot=root:wheel 10.0.1.2 10.0.1.3  
/path -maproot=root:wheel -network 10.0.0.1 -mask 255.255.255.0
- sudo nfsd enable

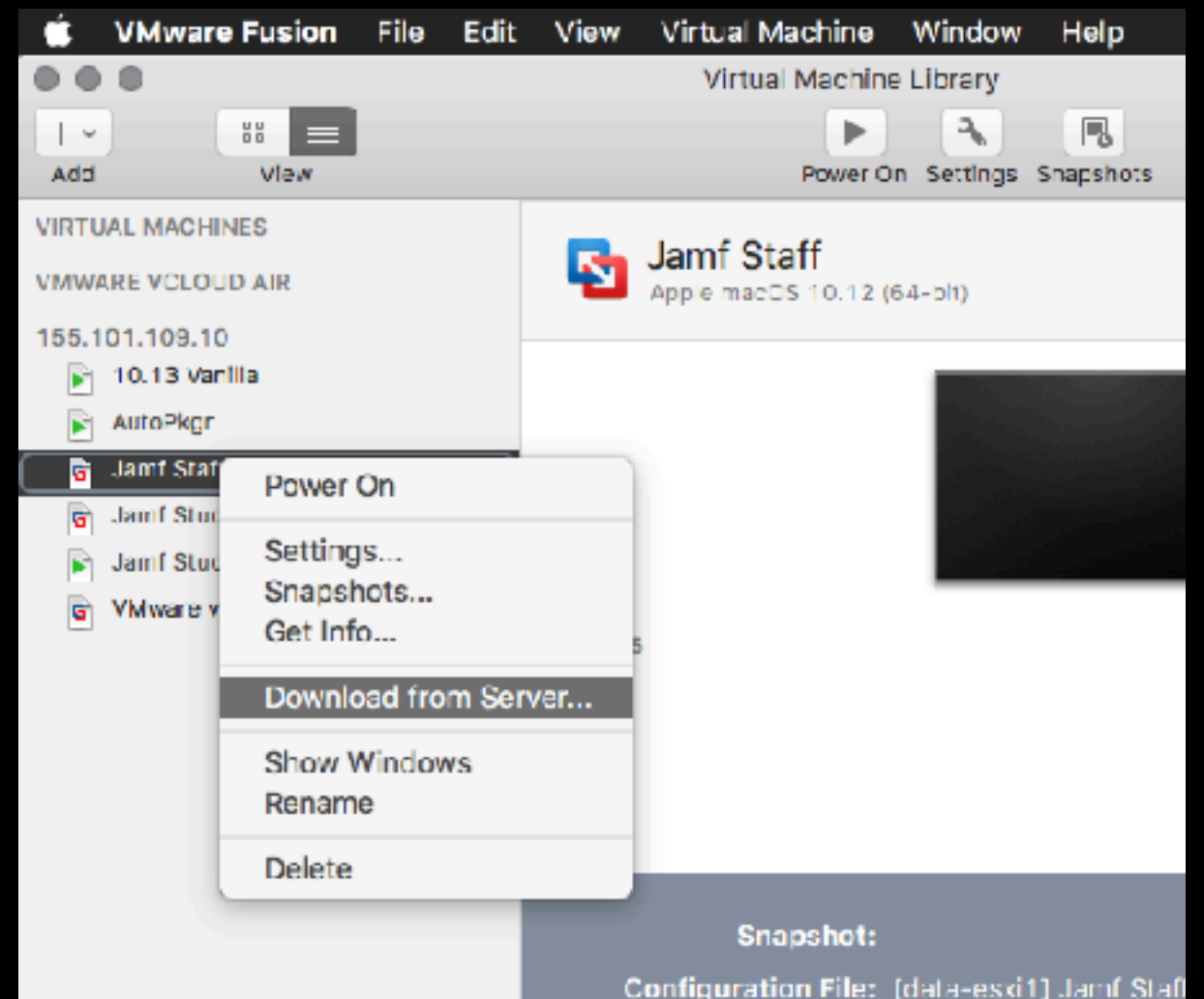
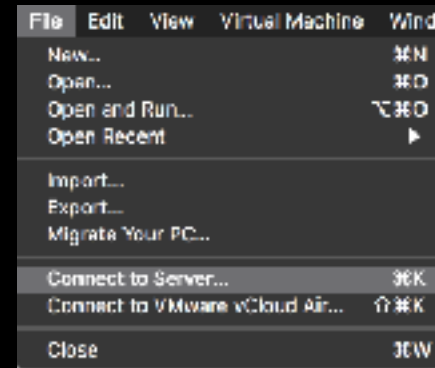
# ESXi Datastore Browser

- Upload
- Download
- Delete
- Move
- Copy



# VMware Fusion

- Connect to Server...
- Download to Server...
- Snapshots...
- Upload to Server...
- Show Windows
- Settings



# vSphere Client

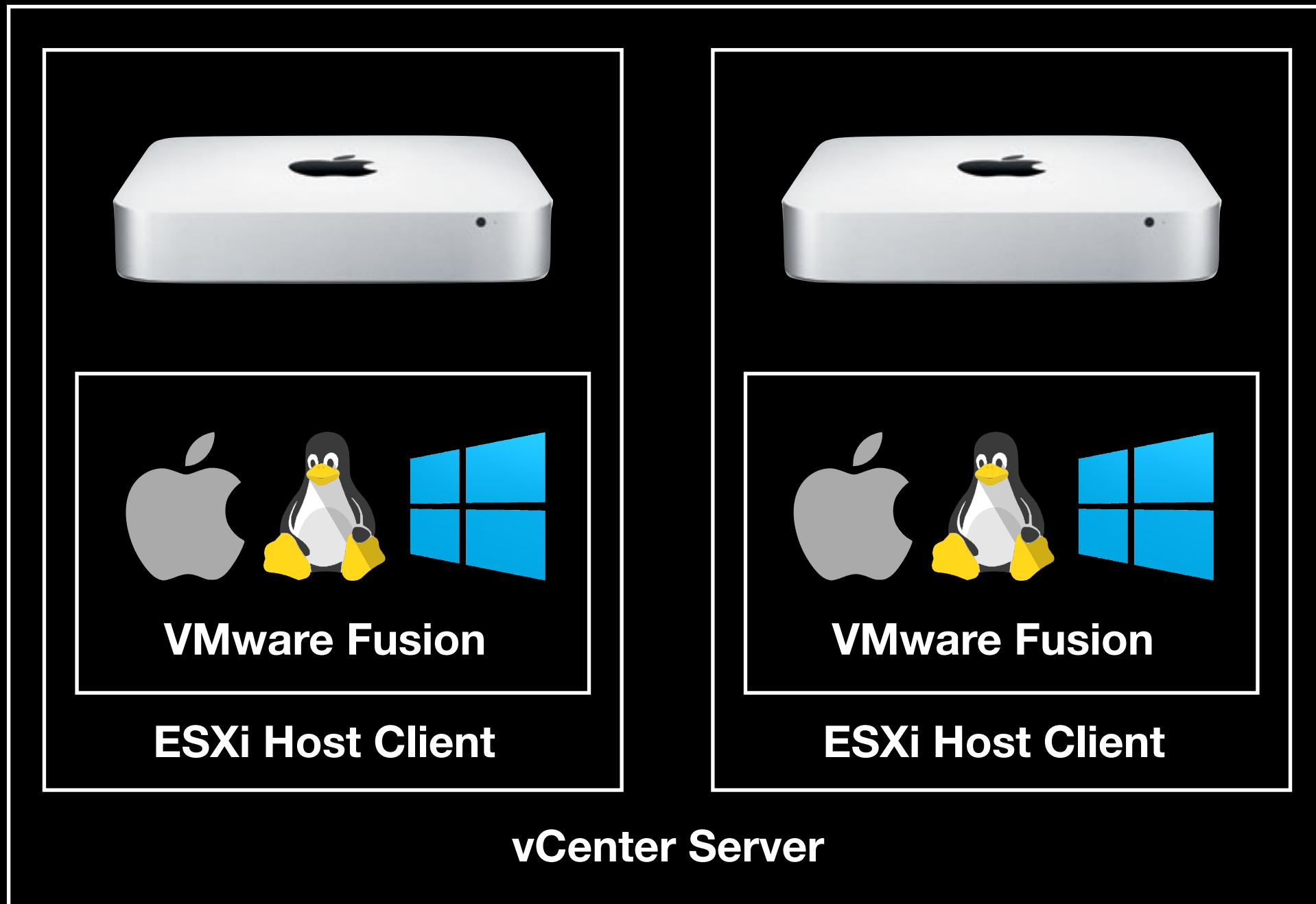
The screenshot displays the vSphere Client interface. On the left, a navigation pane shows the hierarchy: 155.101.109.19 > Biol 145 > data-esx1 > nfs-backup2. The main area is titled 'nfs-backup2' and has tabs for Summary, Monitor, Configure, Permissions, Files (selected), Hosts, and VMs. A search bar is present above the file list. The file list table contains the following items:

Name	Size	Modified	Type
yes	0 KB	07/18/2018, 3...	File
VMware vCenter S...		07/20/2018, 1...	Folder
test		09/07/2018, ...	Folder
no	0 KB	07/18/2018, 3...	File
Jamf Student Auto...		07/20/2018, 1...	Folder
Jamf Student Auth...		07/31/2018, 1...	Folder
backups		09/11/2018, 1...	Folder
AutoPkgr-flat2.vmdk	41,943,040 KB	07/19/2018, 9...	File
AutoPkgr-flat.vmdk	41,943,040 KB	07/19/2018, 1...	File
AutoPkgr		07/31/2018, 1...	Folder
8_3gb.dimg	8,337,892 KB	09/07/2018, ...	File
10.13 Vanilla		09/11/2018, 3:...	Folder

At the bottom right of the interface, it indicates '12 items'.



# Capabilities of Each Tool



# Backup

- VMware vSphere Storage APIs (VADP)
  - Not part of ESXi free
  - Creates and backs up snapshots
  - Full backups
- Change Block Tracking (CBT)
  - Keeps track of which blocks have changed
  - Incremental backups

# Backup

- Backing up the VM's from inside the guest OS
  - Amanda
  - Bacula
  - etc

# Backup

- Backing up the VM's from the host
  - Unitrends
  - Acronis
  - CloudBacko
  - Thinware vBackup
  - VSquare

# Backup

- Backing up the VM's from the host
  - Veeam
  - Free scripts that work with the free ESXi
    - XSIBackup
    - GhettoVCB

# Veeam Backup & Replication

- Free and paid version
- Installs on Microsoft Server, requires SQL Server
- File level backup and restore
- Full VM backup and restore
- Installs on vCenter

# XSIBackup

- Free and paid version
- Large feature set
- Very quick to set up
- Installs on host
- Requires a free license key
- Requires basic shell skills

# ghettoVCB

- Free
- Large feature set and mature
- Easy to install (it's a VIB)
- Installs on host
- Good documentation
- Deployment is not self-explaining
- Requires basic shell skills



# Troubleshooting

- VMFS
  - Mac Mini internal hard drives
  - Can't erase disk, because I formatted it as GPT?
- vim-cmd hostsvc/maintenance\_mode\_enter
- esxcli
- esxtop (TERM=xterm before ssh'ing)

# What about Hyper-V?

- Microsoft Hyper-V does not run Mac OS
- If you don't need Mac OS
  - The free version is highly recommended

# Things I didn't talk about

- Auto deploying and configuring hosts
- Auto deploying and configuring VMs
  - Docker, Vagrant, Salt stack, etc
- Redundancy and zero-downtime
- Data de-duplication
- Virtual Networking

# Review

- Apple is exiting the server market completely
- vSphere is the umbrella term, ESXi is the host OS, vCenter Server manages multiple hosts
- Datastores: SAN, NAS, SAS, LS, DAS, Converged, Hyperconverged; Mac datastores are limited
- Creating VM's is just like in Fusion
- Backing up can cost or is free
- I've barely scratched the surface

# Links

- [communities.vmware.com](https://communities.vmware.com)
- [virtuallyghetto.com](https://www.virtuallyghetto.com)
- [labs.hol.vmware.com](https://labs.hol.vmware.com)
- [www.v-front.de](http://www.v-front.de)
- [community.spiceworks.com/virtualization/vmware](https://community.spiceworks.com/virtualization/vmware)
- [reddit.com/r/vmware](https://reddit.com/r/vmware)
- esxi at [macadmins.slack.com](https://macadmins.slack.com)

# Questions