

VMware ESX

vCenter Server (\$) (license manager)	Server	ESX (\$) (vMotion, DRS, HA, Storage vMotion)		
	hardware	ESXi (freeware) (ESXi freeware is managed by the Virtual Infrastructure (or vSphere) Client) ESXi (\$) (vMotion, DRS, HA, Storage vMotion)		Guest OS Guest OS Guest OS...
Workstation hardware	Windows or Linux OS	User session	VMware Server (freeware)	Guest OS
			VMware Workstation (\$)	Guest OS
			VMware Player (freeware)	Guest OS...
			vSphere Client for managing ESX(i) hosts (freeware)	

VMware-Server software and datacenter products

- VMware vSphere 5
- VMware vSphere 4 (rebranded version VMware Infrastructure)
- VMware Infrastructure 3
- VMware ESXi (formerly VMware ESX Server ESXi edition)
- VMware ESX (formerly VMware ESX Server)
- VMware Server (formerly VMware GSX Server)
- VMware vCenter Application Discovery Manager
- VMware vCenter AppSpeed
- VMware vCenter Converter (formerly VMware P2V)
- VMware vCenter Lab Manager (formerly VMware Lab Manager)
- VMware vCenter Lifecycle Manager
- VMware vCenter Operations Standard / Advanced / Enterprise
- VMware vCenter Orchestrator
- VMware vCenter Server (formerly VMware VirtualCenter)
- VMware vCenter Server Heartbeat
- VMware vCenter Site Recovery Manager
- VMware vCenter Stage Manager (formerly VMware Stage Manager)
- VMware vCenter Update Manager
- VMware Capacity Planner
- VMware Data Recovery
-

VMware ESX

■ Neki od VMware proizvoda su:

- ❖ *VMware Workstation*
- ❖ *VMware Fusion*
- ❖ *VMware Player*
- ❖ ***VMware ESX***
- ❖ *VMware Server*
- ❖ *Vmotion* u radnom stanju i bez prekida u radu sa jednog na drugi fizički host

■ Drugi VMware alati omogućuju:

- ❖ virtuelizaciju programa/aplikacija (*VMware ThinApp*)
- ❖ upravljanje ESX/ESXi okolinom (*VMware Infrastructure*)
- ❖ druge primene

VMware ESXi

■ **VMware ESX**

- Već spomenuti komercijalni sistem koji se izvodi direktno na hardveru čime se bitno poboljšavaju performanse sistema.

■ **Podrška širok spektar standardnog hardvera**

- ❖ Intel i AMD procesori
- ❖ SAN (engl. *Storage Area Network*)
- ❖ iSCSI (engl. *Internet Small Computer System Interface*)
- ❖ NAS (engl. *Network-attached Storage*)
- ❖ 10 Gb/s Ethernet-a sa balansom opterećenja (engl. *load balancing*)

■ **Vmotion**

- Tehnologija koja omogućava migraciju servisa (virtuelnih mašina) u radnom stanju i bez prekida u radu sa jednog na drugi fizički host.

VMware- Server software

- VMware markets two virtualization products for **servers**:
- **VMware ESX**
- **VMware ESXi**
- **VMware Server**

VMware- Server software

■ VMware ESX

- ❖ (formerly called "ESX Server"),
- ❖ an enterprise-level product,
- ❖ can deliver greater performance than the freeware VMware Server,
- ❖ **due to lower system overhead**

■ VMware ESX is a "bare-metal" product

- ❖ running directly on the server hardware
- ❖ allowing virtual servers to also use **hardware more or less directly**

VMware ESX

VMware ESX

<u>Developer(s)</u>	VMware, Inc.
<u>Stable release</u>	5.0 Update 1 (build 623860) / March 15, 2012; 3 months ago ^[1]
<u>Platform</u>	i386 (discontinued in 4.0 onwards) ^[2] , x86-64
<u>Type</u>	Virtual machine monitor
<u>License</u>	Proprietary
Website	VMware ESX

VMware ESX

- VMware ESX is an enterprise-level computer virtualization product offered by VMware, Inc. ESX is a component of VMware's larger offering, VMware Infrastructure, and adds management and reliability services to the core server product.
- VMware is replacing the original ESX with ESXi
- VMware ESX and VMware ESXi are bare-metal embedded hypervisors that are VMware's enterprise software hypervisors for servers that run directly on server hardware without requiring an additional underlying operating system
- The basic server requires some form of persistent storage (typically an array of hard disk drives) that store the hypervisor and support files.
- A smaller footprint variant, ESXi, does away with the first requirement by permitting placement of the hypervisor on a dedicated compact storage device. Both variants support the services offered by VMware Infrastructure

VMware ESX

- **Naming**
- *ESX* allegedly stands for "Elastic Sky X"
- **Technical description**
- VMware, Inc. refers to the hypervisor used by VMware ESX as "vmkernel"

VMware ESX - Architecture

- VMware states that the ESX product runs on *bare metal*. In contrast to other VMware products, it does not run a top a third-party operating system, but instead **includes its own kernel**. Up through the current ESX version 5.0, a **Linux kernel is started first**, and is used to load a variety of specialized virtualization components, including **VMware's vmkernel component**. This previously-booted Linux kernel then becomes the first running virtual machine and is **called the service console**
- Thus, at normal run-time, the **vmkernel is running on the bare computer** and the **Linux-based service console runs as the first virtual machine**
- The **vmkernel itself**, which VMware says is a microkernel, **has three interfaces to the outside world**:
 - ◆ hardware
 - ◆ guest systems
 - ◆ service console (Console OS)

VMware – ESX - Interface to hardware

- The **vmkernel** handles CPU and memory directly, using
 - ❖ **SBE** (scan-before-execution) to handle special or privileged CPU instructions and the
 - ❖ **SRAT** (system resource allocation table) to **track allocated memory**
- **Access to other hardware** (such as network or storage devices) takes place **using modules**.
 - ❖ At least some of the modules derive from modules **used in the Linux kernel**
 - ❖ To access these modules, an additional module called **vmklinux** implements the Linux module interface.
 - ❖ According to the README file, "This module contains the Linux emulation layer used by the vmkernel."

VMware – ESX - Interface to hardware

■ The vmkernel uses the device drivers:

- ◆ net/e100
- ◆ net/e1000
- ◆ net/e1000e
- ◆ net/bnx2
- ◆ net/tg3
- ◆ net/forcedeth
- ◆ net/pcnet32
- ◆ block/cciss
- ◆ scsi/adp94xx
- ◆ scsi/aic7xxx
- ◆ scsi/aic79xx
- ◆ scsi/ips
- ◆ scsi/lpfcdd-v732
- ◆ scsi/megaraid2
- ◆ scsi/mptscsi_2xx
- ◆ scsi/qla2200-v7.07
- ◆ scsi/megaraid_sas
- ◆ scsi/qla4010
- ◆ scsi/qla4022
- ◆ scsi/vmkiscsi
- ◆ scsi/aacraid_esx30
- ◆ scsi/lpfcdd-v7xx
- ◆ scsi/qla2200-v7xx

VMware-Versions

- VMWare ESX is available in two main types: ESX and ESXi, although since version 5 only ESXi is continued.
- **VMware ESX**
- Version release history:
- VMware ESX Server 1.0 First release was in 2001
- VMware ESX Server 1.1 (January 7, 2002)
- VMware ESX 1.5
- VMware ESX Server 1.5 (May 13, 2002)
- VMware ESX 2.0 (July 21, 2003)
- VMware ESX Server 2.1 Build 22983 (4/13/06)
- VMware ESX Server 2.0.2 Build 23922 (5/4/06)
- VMware ESX 2.5 (December 14, 2004)
- VMware ESX Server 2.5.0 Build 11343 (11/29/2004)
- VMware ESX Server 2.5.1 Build 13057 (05/20/2005)
- VMware ESX Server 2.5.1 Build 14182 (06/20/2005)
- VMware ESX Server 2.5.2 Build 16390 (09/15/2005)
- VMware ESX Server 2.5.3 Build 22981 (04/13/2006)
- VMware ESX Server 2.5.4 Build 32233 (10/05/2006)
- VMware ESX Server 2.5.5 Build 57619 (10/08/2007)
- VMware Infrastructure 3.0 (VI3) (June 5, 2006)
- VMware ESX Server 3.0 Build 27701 (06/13/06)
- VMware ESX Server 3.0.1 Build 32039 (09/25/06)
- VMware ESX Server 3.0.2 Build 52542 (07/31/07)
- VMware ESX Server 3.0.3 Build 104629 (August 8, 2008)
- VMware ESX Server 3.0.3 Update 1 Build 231127 (08 Mar 2010)
- VMware ESX Server 3.5 (December 10, 2007)
- VMware ESX Server 3.5 Build 64607 (20 Feb 2008)
- VMware ESX Server 3.5 Update 1 Build 82663 (10 Apr 2008)
- VMware ESX Server 3.5 Update 2 Build 110268 (13 Aug 2008)
- VMware ESX Server 3.5 Update 3 Build 123630 (6 Nov 2008)
- VMware ESX Server 3.5 Update 4 Build 153875 (30 Mar 2009)
- VMware ESX Server 3.5 Update 5 Build 207095 (03 Dec 2009) This was the last version to support 32-bit systems [22]

VMware

■ Versions

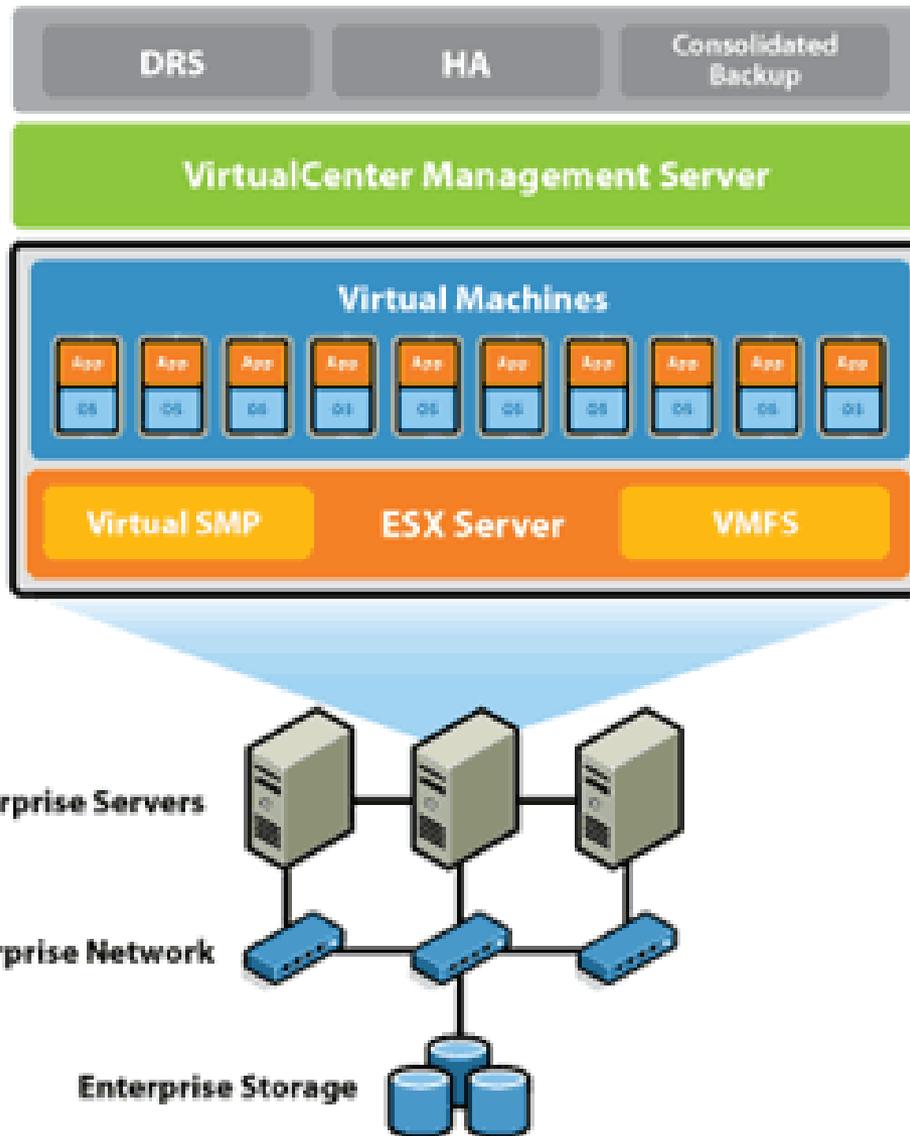
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■ VMware ESX

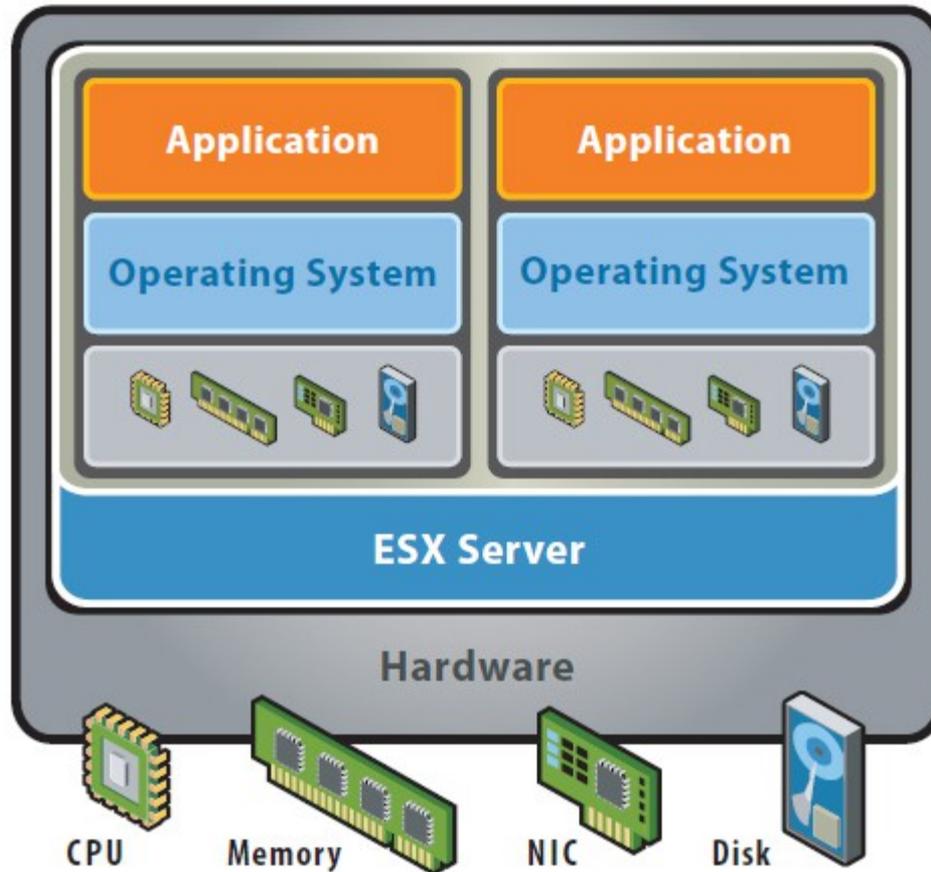
- VMware vSphere 4.0 (May 20, 2009)
- VMware ESX 4.0 Build 164009 (21 May 2009)
- VMware ESX 4.0 Update 1 Build 208167 (19 Nov 2009)
- VMware ESX 4.0 Update 2 Build 261974 (10 Jun 2010)
- VMware ESX 4.0 Update 3 Build 398348 (5 May 2011)
- VMware ESX 4.0 Update 4 Build 504850 (November 17, 2011; 7 months ago)
- VMware ESX 4.1 Build 260247 (July 13, 2010)
- VMware ESX 4.1 Update 1 Build 348481 (Feb 10, 2011)
- VMware ESX 4.1 Update 2 Build 502767 (Oct 27, 2011)

- July 18, 2010 vSphere 4.1 and its subsequent update and patch releases are the last releases to include both ESX and ESXi hypervisor architectures.
- **Future major releases of VMware vSphere will include only the VMware ESXi architecture.** For this reason, VMware recommends that deployments of vSphere 4.x utilize the ESXi hypervisor architecture.

VMware

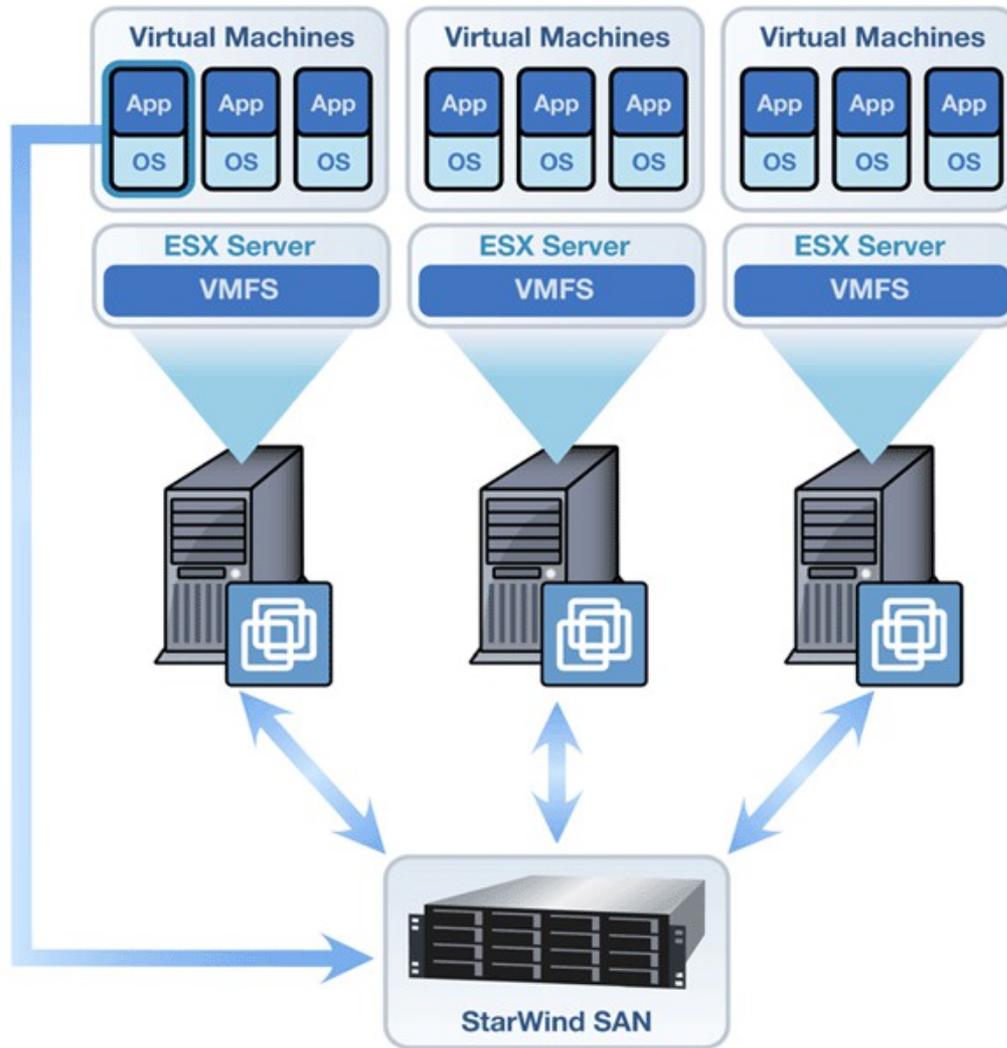


VMware

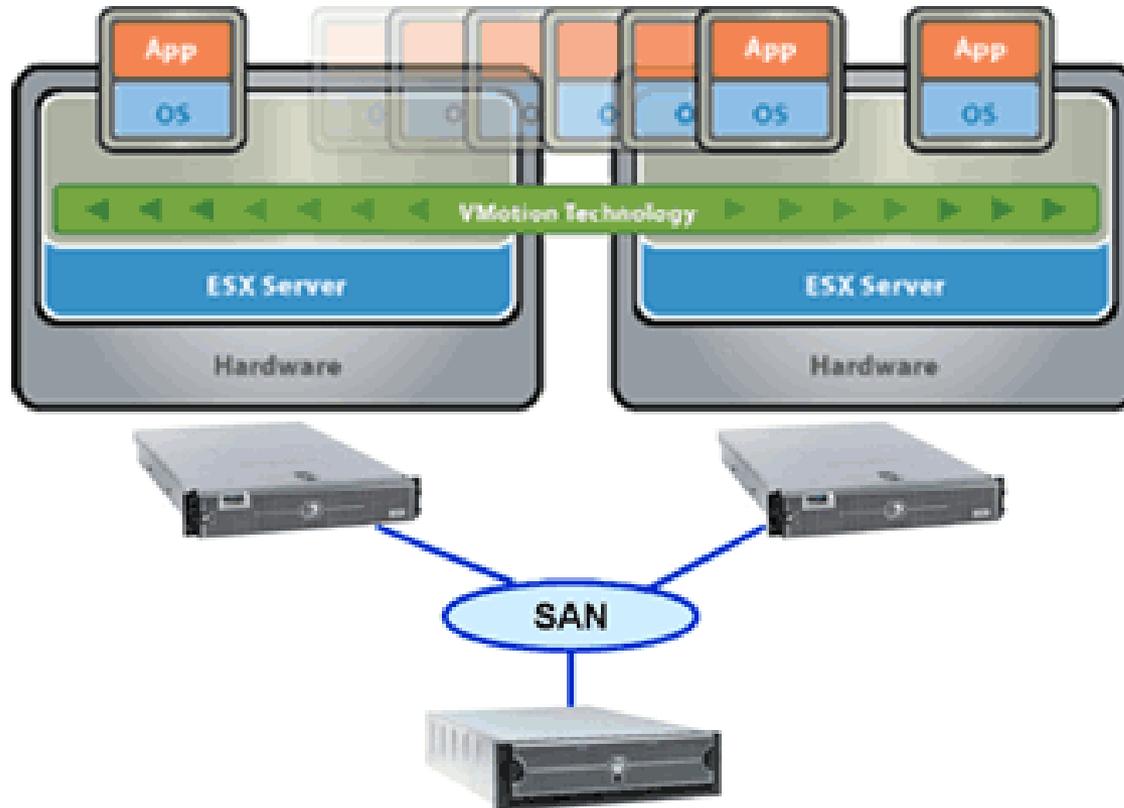


VMware ESX Server virtualizes server storage and networking, allowing multiple applications to run in virtual machines on the same physical server.

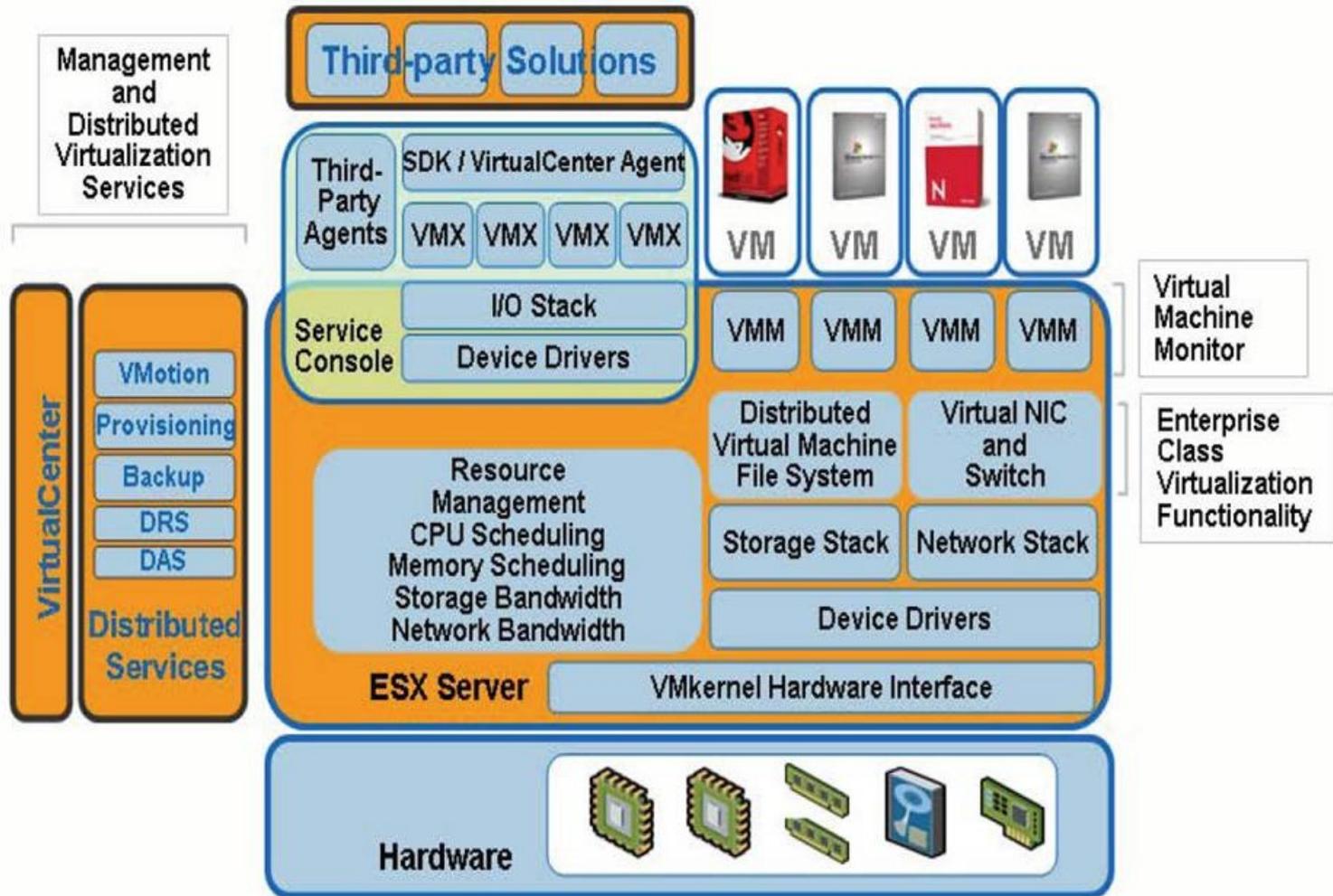
VMware



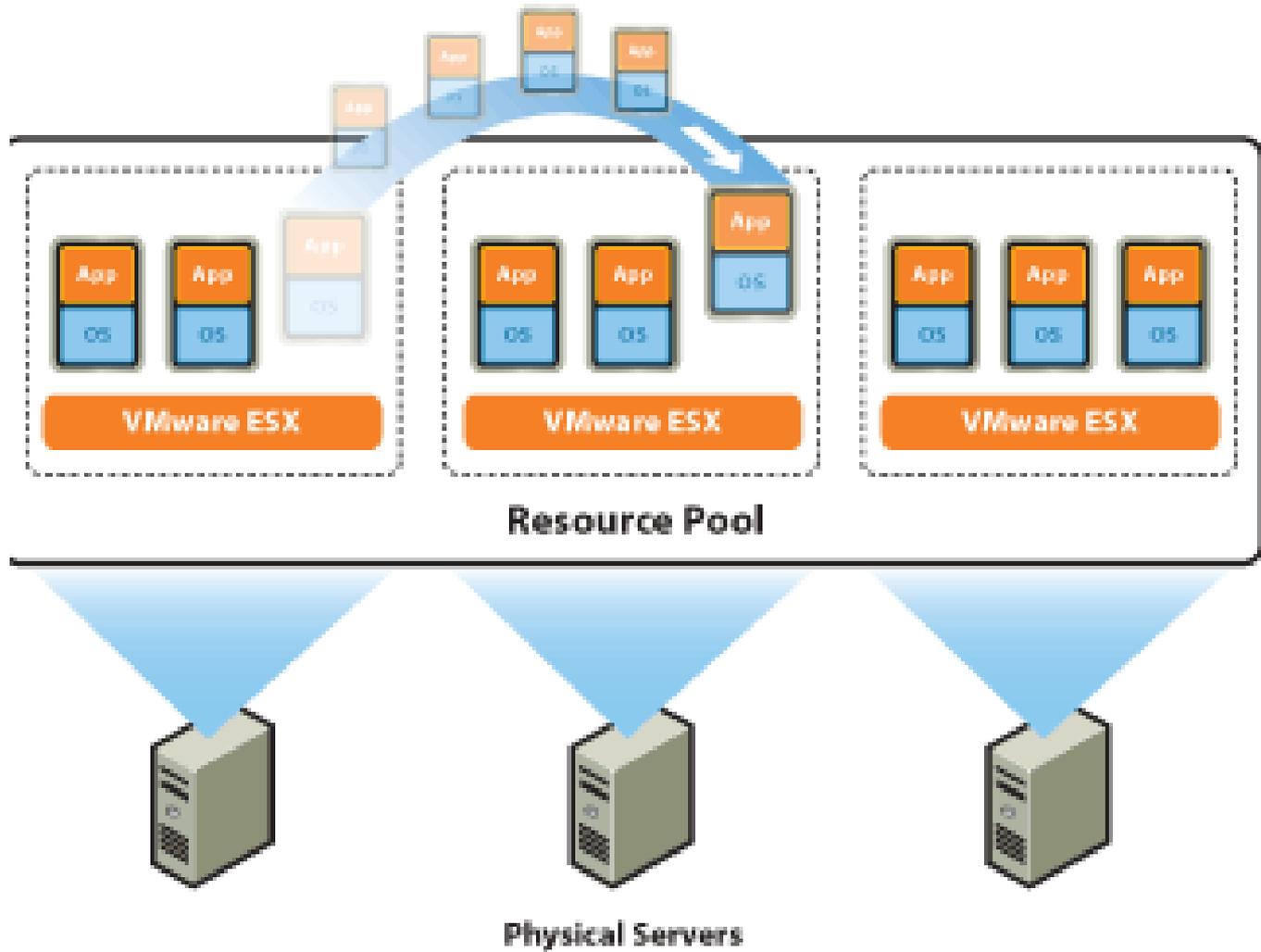
VMware



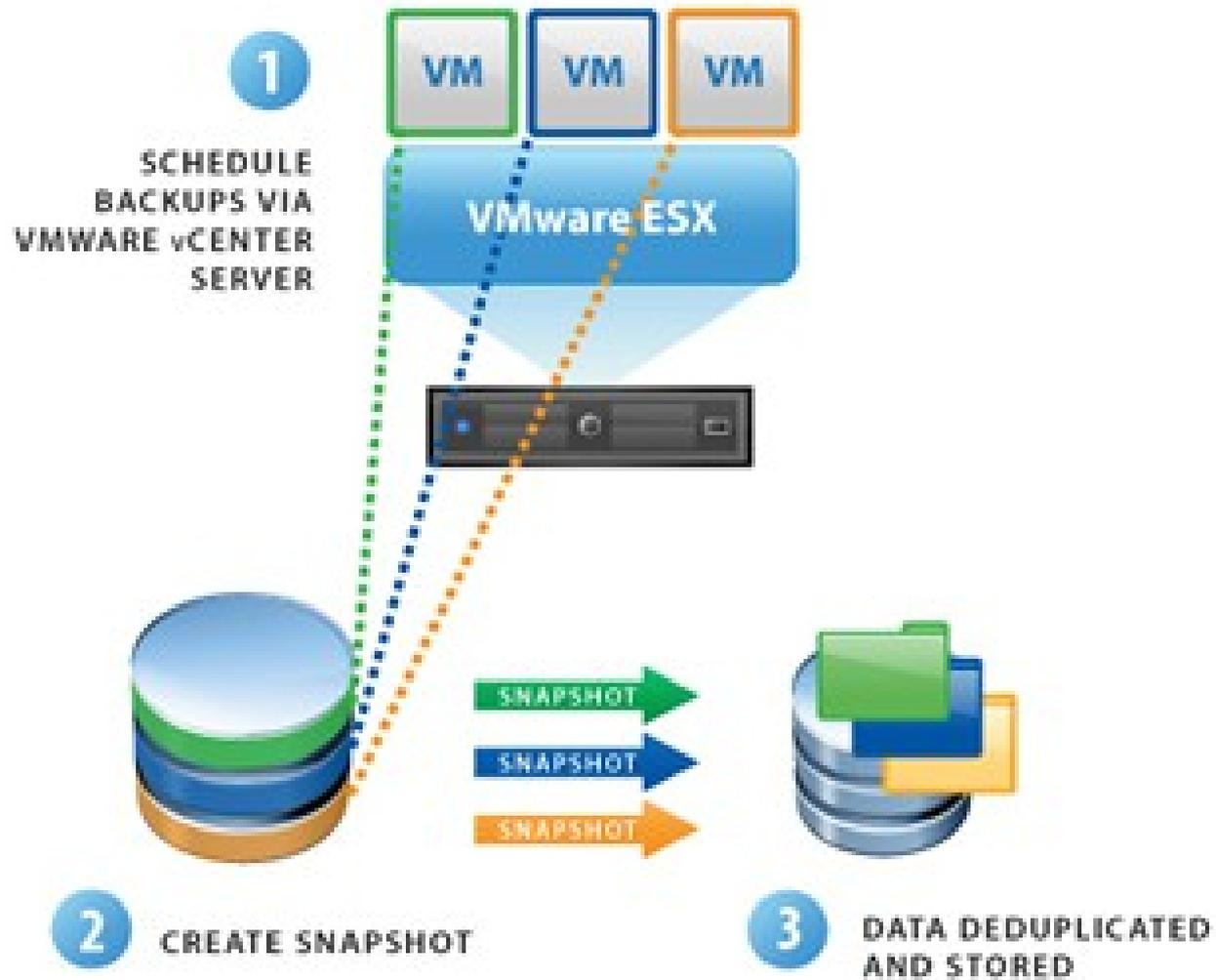
VMware



VMware



VMware



VMware- Server software

- In addition, VMware ESX integrates into **VMware vCenter**,
- which offers **extra services**
- to enhance the reliability and manageability of a server deployment, such as:
 - ✓ **VMotion** — the capability to move a running virtual machine from one ESX host to another and faster than some other editions
 - ✓ **Storage VMotion** — the capability to move a running virtual machine from one storage device to another
 - ✓ **DRS** — Distributed Resource Scheduler — automatic load balancing of a ESX cluster using VMotion
 - ✓ **HA — High Availability** — In case of hardware failure in a cluster, the virtual servers will automatically restart on another host in the cluster

VMware- ESXi

- VMware ESXi (formerly called "VMware ESX 3i"),
 - ❖ is quite similar to ESX,
 - ❖ but differentiates in that the **Service Console** is removed,
 - ❖ and replaced with a **minimal BusyBox** installation.

- **Disk space requirements are much lower** than for ESX
- and the **memory footprint is reduced**

- ESXi is intended to be run from flash disks in servers but can be run from normal disks
- VMware ESXi hosts
 - ❖ can't be managed directly from the console,
 - ❖ all management is performed through a VirtualCenter Server

- In July 2008, VMware decided to give away ESXi for free

VMware ESXi

- **VMware ESXi is a smaller footprint version** of **ESX** that does not include **ESX's Service Console**. It is available as a free download from VMware though certain features are disabled without the purchase of a vCenter license.
- VMware ESXi was originally a compact version of VMware ESX that allowed for a **smaller 32 MB disk footprint** on the Host. With a simple configuration console for mostly network configuration and remote based VMware Infrastructure Client Interface, this allows for more resources to be dedicated to the Guest environments.
- **There are two variations** of ESXi, **VMware ESXi Installable** and **VMware ESXi Embedded Edition**. It has the ability to upgrade to VMware Infrastructure 3 or VMware vSphere 4.0 ESXi
- Originally named VMware ESX Server ESXi edition, through several revisions, finally becoming VMware **ESXi 3**. New editions then followed **ESXi 3.5, ESXi 4 and now ESXi 5**

VMware ESXi

VMware ESXi

<u>Developer(s)</u>	VMware, Inc.
<u>Stable release</u>	5.0 (build 456551) / August 24, 2011; 9 months ago ^[23]
<u>Platform</u>	x86-64
<u>Type</u>	Virtual machine monitor
<u>License</u>	Proprietary
Website	VMware ESXi

VMware ESXi

- Version release history:
- VMware ESX 3 Server ESXi edition
- -- unknown --
- VMware ESXi 3.5 First Public Release (Build 67921) (December 31, 2007; 4 years ago)
- VMware ESXi 3.5 Initial Release (Build 70348)
- VMware ESXi 3.5 Update 1 (Build 82664)
- VMware ESXi 3.5 Update 2 (Build 110271)
- VMware ESXi 3.5 Update 3 (Build 123629)
- VMware ESXi 3.5 Update 4 (Build 153875)
- VMware ESXi 3.5 Update 5 (Build 207095)
- VMware ESXi 4.0 (Build 164009) (May 21, 2009; 3 years ago)
- VMware ESXi 4.0 Update 1 (Build 208167) (December 9, 2009; 2 years ago)
- VMware ESXi 4.0 Update 2 (Build 261974) (June 10, 2010; 2 years ago)
- VMware ESXi 4.0 Update 3 Build 398348 (May 5, 2011; 13 months ago)
- VMware ESXi 4.0 Update 4 Build 504850 (November 17, 2011; 7 months ago)
- VMware ESXi 4.1 (Build 260247) (July 13, 2010; 22 months ago)
- VMware ESXi 4.1 Update 1 (Build 348481) (February 10, 2011; 16 months ago)
- VMware ESXi 4.1 Update 2 (Build 502767) (October 27, 2011; 7 months ago)
- VMware ESXi 4.1 Patch 5 (Build 582267) (January 30, 2012; 4 months ago)
- VMware ESXi 4.1 Patch 6 (Build 659051) (April 26, 2012; 57 days ago)
- VMware ESXi 4.1 Patch 7 (Build 702113) (May 3, 2012; 50 days ago)
- VMware ESXi 4.1 Patch 8 (Build 721871) (June 14, 2012; 8 days ago)
- VMware ESXi 5.0 (Build 469512) (August 24, 2011; 9 months ago)
- VMware ESXi 5.0 Update 1 (Build 623860) (March 15, 2012; 3 months ago)

VMware ESXi - Related or additional products

- The following products operate in conjunction with ESX:
- **vCenter Server**, enables monitoring and management of multiple ESX, ESXi and GSX servers. In addition, users must install it to run infrastructure services such as:
 - ◆ **VMotion** (transferring virtual machines between servers on the fly, with zero downtime)
 - ◆ **SVMotion** (transferring virtual machines between Shared Storage LUNs on the fly, with zero downtime)
 - ◆ **DRS** (automated VMotion based on host/VM load requirements/demands)
 - ◆ **HA** (restarting of Virtual Machine Guests in the event of a physical ESX Host failure)
 - ◆ **Fault Tolerance** (Almost instant stateful fail over of a VM in the event of a physical host failure)
- **Converter**, enables users to create VMware ESX Server- or Workstation-compatible virtual machines from either physical machines or from virtual machines made by other virtualization products. Converter replaces the VMware "P2V Assistant" and "Importer" products — P2V Assistant allowed users to convert physical machines into virtual machines; and Importer allowed the import of virtual machines from other products into VMware Workstation.
- **vSphere Client** (formerly VMware Infrastructure Client), enables monitoring and management of a single instance of ESX or ESXi server. After ESX 4.1, vSphere Client was no longer available from the ESX/ESXi server, but must be downloaded from the VMware web site.

VMware ESXi

■ Known limitations

- **Known limitations of VMware ESX**, as of May 2009, include the following:

■ Infrastructure limitations

- ◆ Some limitations in ESX Server 4 may constrain the design of data centers:
- ◆ Guest system maximum RAM: 255 GB
- ◆ Host system maximum RAM: 1 TB
- ◆ Number of hosts in a high availability cluster: 32
- ◆ Number of Primary Nodes in ESX Cluster high availability: 5
- ◆ Number of hosts in a Distributed Resource Scheduler cluster: 32
- ◆ Maximum number of processors per virtual machine: 8
- ◆ Maximum number of processors per host: 160
- ◆ Maximum number of cores per processor: 12
- ◆ Maximum number of virtual machines per host: 320
- ◆ VMFS-3 limits files to 262,144 (218) blocks, which translates to 256 GB for 1 MB block sizes (the default) or up to 2 TB for 8 MB block sizes. However, on a VMFS Boot drive, it is usually very difficult to use anything other than 1 MB Block size

VMware ESXi

- With **ESXI 5 there has been some changes to these limits**
 - ❖ Guest system maximum RAM: 1 TB
 - ❖ Host system maximum RAM: 2 TB
 - ❖ Number of hosts in a high availability cluster: 32
 - ❖ Maximum number of processors per virtual machine: 32
 - ❖ Maximum number of processors per host: 160
 - ❖ Maximum number of cores per processor: 25
 - ❖ Maximum number of virtual machines per host: 512
 - ❖ VMFS-3 is supported and has the same limits as before
 - ❖ VMFS-5 however has a max volume size of 64 TB and a max file size of 2 TB - 512 B

VMware ESXi -The architecture of VMware eSXi

■ Introduction

- ❖ **VMware® ESXi is the next-generation hypervisor**, providing a new foundation for virtual infrastructure.
- ❖ This **innovative architecture operates independently from any general-purpose operating system**, offering improved security, increased reliability, and simplified management.
- ❖ The **compact architecture** is designed for integration directly into virtualization-optimized server hardware, enabling rapid installation, configuration, and deployment..

VMware ESXi -The architecture of VMware eSXi

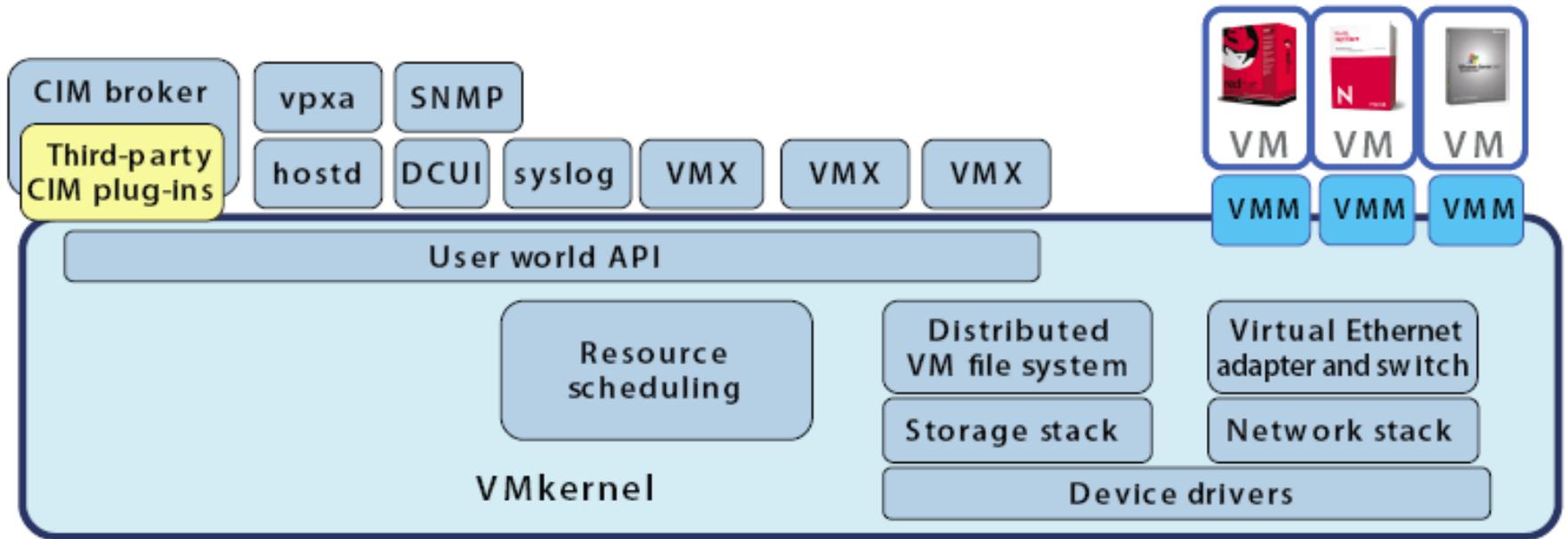
■ Introduction

- ❖ Functionally, ESXi is equivalent to ESX 3, offering the same levels of performance and scalability.
- ❖ However, the **Linux-based service console has been removed**, reducing the footprint to less than 32MB of memory.
- ❖ The functionality of the service console is replaced by new remote command line interfaces in conjunction with adherence to system management standards.
- ❖ Because ESXi is functionally equivalent to ESX, it supports the entire VMware Infrastructure 3 suite of products, including
 - ✓ VMware Virtual Machine File System,
 - ✓ Virtual SMP,
 - ✓ VirtualCenter,
 - ✓ VMotion,
 - ✓ VMware Distributed Resource Scheduler,
 - ✓ VMware High Availability,
 - ✓ VMware Update Manager
 - ✓ VMware Consolidated Backup

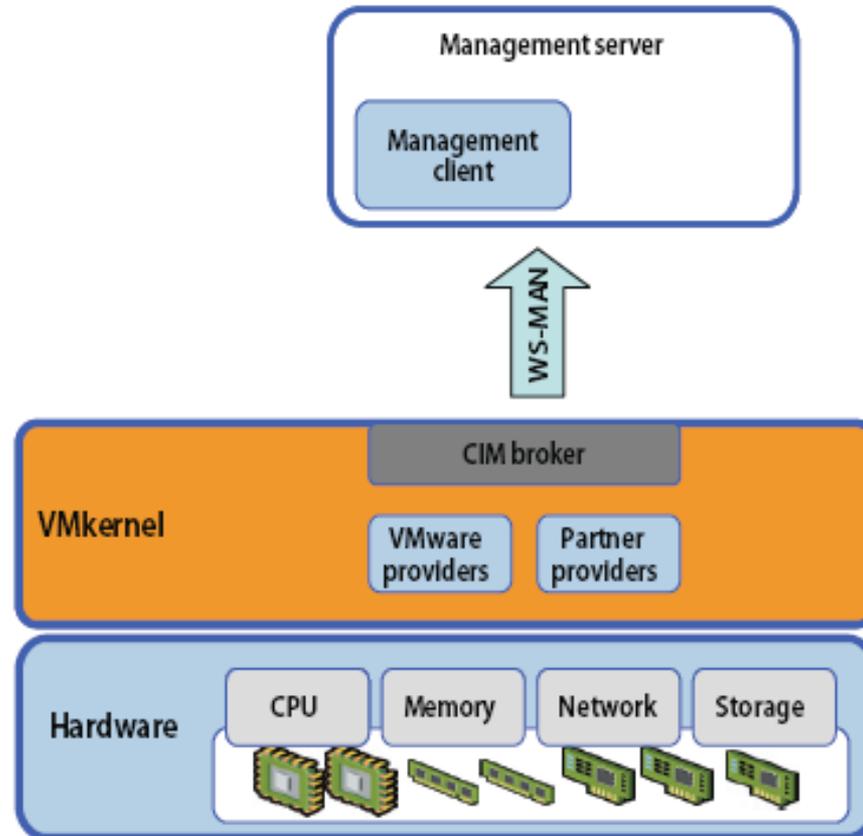
VMware ESXi-Components of ESXi

- The **VMware ESXi architecture** comprises the **underlying operating system, called VMkernel**, and processes that run on top of it. VMkernel provides means for running all processes on the system, including management applications and agents as well as virtual machines. It has control of all hardware devices on the server, and manages resources for the applications.
- The **main processes that run on top of VMkernel** are:
 - ❖ **Direct Console User Interface (DCUI)** — the low-level configuration and management interface, accessible through the console of the server, used primarily for initial basic configuration.
 - ❖ The **virtual machine monitor**, which is the process that provides the execution environment for a virtual machine, as well as a **helper process** known as VMX. Each running virtual machine has its own VMM and VMX process.
 - ❖ **Various agents** used to enable high-level VMware Infrastructure management from remote applications.
 - ❖ The **Common Information Model (CIM) system**: CIM is the interface that enables hardware-level management from remote applications via a set of standard APIs.

VMware ESXi



VMware ESXi Management



VMware ESXi - VI API

- The **VMware Virtual Infrastructure API** provides a powerful interface for developing applications to integrate with the VMware Infrastructure.
- The **VI API enables** your program or framework
- to invoke VirtualCenter Web Service interface functions on **VirtualCenter** to manage and control ESX/ESXi.
- The **VI SDK** provides developers with a full environment for creating applications that interact with ESXi in a variety of programming languages.

VMware ESXi - VI API

- The VI API is actually what is used by the **management clients provided by VMware**, such as
 - ❖ the VI Client
 - ❖ and
 - ❖ remote command line interfaces.
- Furthermore, this API works for VirtualCenter as well as ESX/ESXi.
- The only difference is that certain functions that affect multiple hosts, such as VMotion, are implemented only in VirtualCenter.
- Figure 3 depicts how the VI API is used with VMware Infrastructure.

VMware ESXi

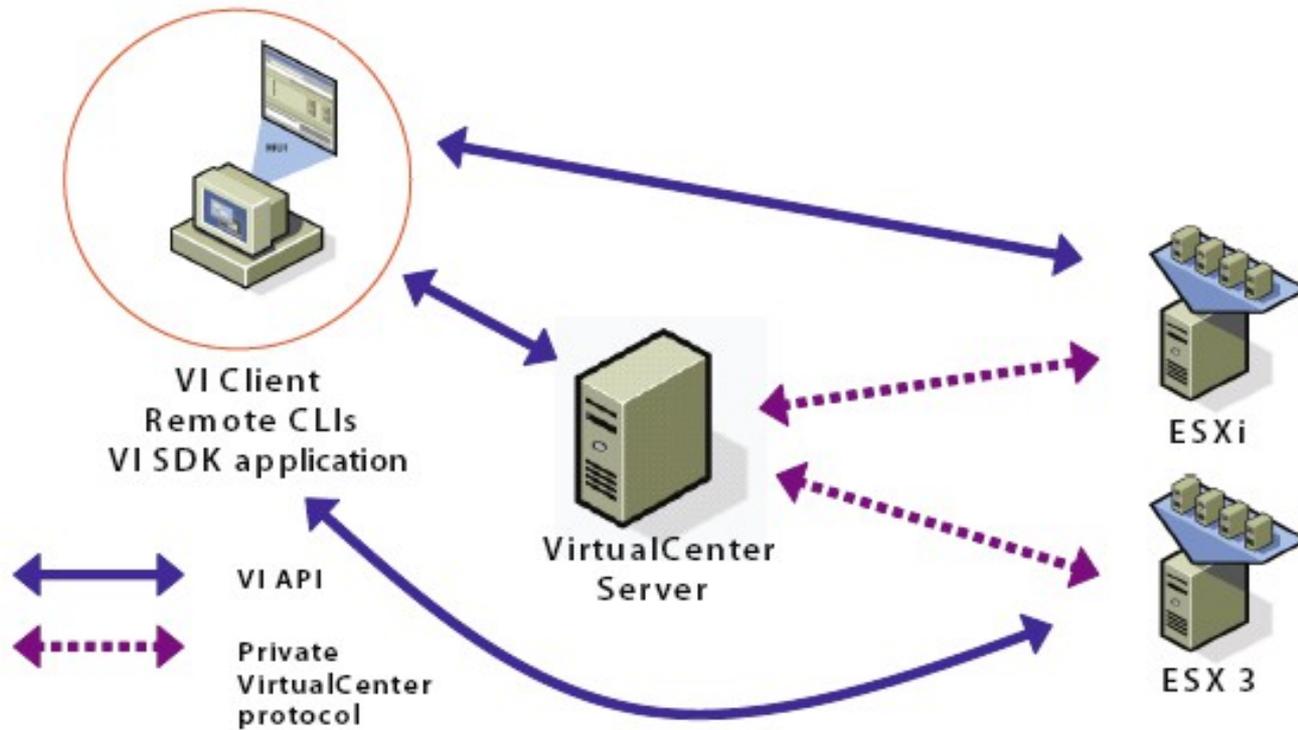


Figure 3: Using the VMware Virtual Infrastructure API in a VMware Infrastructure environment

VMware ESXi - VI API

- Together, the **VI API and the CIM standard provide a comprehensive way to manage an ESXi system** from a **remote or central location**.
- The advantage of this model is that, instead of relying upon locally installed agents, which must be adjusted whenever the underlying platform changes and reinstalled and managed as they are updated, all software related to monitoring and management of a system can exist on an external and centralized system. It becomes much easier to maintain this software, as opposed to managing multiple distributed agents.
- This approach to management also further enables the ESXi host to become a **stateless entity**, because there is nothing to install locally on the host. Eliminating agents from running locally also means that all the compute resources are available for running virtual machines.

VMware ESXi

■ Summary

- ◆ The ESXi architecture offers a **variety of advantages over other virtualization platforms**, including:
 - ✓ **Little state information** — An ESXi system can be treated for practical purposes as a stateless compute node, with all the state information easily uploaded from a saved configuration file.
 - ✓ **Better security** — With a small footprint and minimal interfaces, an ESXi system has a lower overall attack surface.
 - ✓ **Hardware-like reliability** — When it is integrated into firmware, software is much less likely to become corrupted than when it is stored on disk. The option of eliminating the local disk drive can provide even greater system reliability.

VMware ESXi

	VMware ESXi	VMware ESX 3
On-disk footprint	32MB	2GB
Bootstrap	Direct from boot loader	Service console driven
Direct management interaction	DCUI	Service console shell session
Hardware monitoring agents	CIM plug-in modules	Full applications in service console
Other agents	Implemented via VI SDK only	Full applications in service console
Scripts, automation and troubleshooting	DCUI, remote command line interfaces, and VI SDK	Service console shell and VI SDK
Other software	Moved to outside environment	Resident in service console

Table 1: Differences between ESXi and ESX 3

VMware VMFS

- **VMware VMFS** (Virtual Machine File System) is VMware, Inc.'s cluster file system. It is used by VMware ESX Server and the company's flagship server virtualization suite, **vSphere** (and predecessor VMware Infrastructure).
- It **was developed and is used to store virtual machine disk images, including snapshots**. Multiple servers can read/write the same filesystem simultaneously, while individual virtual machine files are locked.
- **VMFS volumes can be logically "grown"** (non-destructively increased in size) by spanning multiple VMFS volumes together.
- It is not mandatory to use VMFS with VMware; an alternative is NFS.

VMware VMFS

VMFS

<u>Developer</u>	VMware, Inc.
Full name	Virtual Machine File System
Introduced	(ESX Server v1.x)
<u>Partition identifier</u>	0xfb (MBR)

Limits

Max file size	2TB - 512 bytes
Max number of files	~100,000 (VMFS-5) [1]
Max volume size	64 TB (VMFS-5) [1]

Features

Transparent compression	No
<u>Transparent encryption</u>	No
<u>Data deduplication</u>	No
Supported <u>operating systems</u>	VMware ESX

VMware –VMFS -Version history

- There are four versions of VMFS, corresponding with ESX Server product releases.
- **VMFS version 1** was used by ESX Server v1.x, which is no longer sold. It **didn't feature the cluster filesystem properties and was used only by a single server at a time**. VMFS1 is a **flat filesystem** with no directory structure. -- Officially named "VMware File System"
- **VMFS version 2** is used by ESX Server v2.x and (in a limited capacity) v3.x. VMFS2 is a **flat** filesystem with no directory structure. -- Officially named "VMware File System"
- **VMFS version 3** is used by ESX Server v3.x and vSphere (4.x). As a most noticeable feature, it **introduced directory structure in the filesystem**. Older versions of ESX Server cannot read or write VMFS3 volumes. Beginning from ESX 3 and VMFS3, virtual machine configuration files are stored in the VMFS partition by default. -- Officially named "VMware Virtual Machine File System"
- **VMFS version 5** is used by ESXi Server v5.x and vSphere (5.x). As a most noticeable feature, it **introduced unified 1MB block-size** (upgraded VMFS5 volumes will however inherit the VMFS3 block size value), and **larger LUN-sizes than 2TB**, but the maximum VMDK-file size remain at 2TB (minus 512 bytes, irrespective of the file-system block size), same as VMFS3. Older versions of ESX/ESXi cannot read or write VMFS5 volumes. Beginning from ESXi 5.0 and VMFS5, virtual machine configuration files are stored in the VMFS5 partition by default.

VMware – VMFS - Features

- **Allows access by multiple ESX servers at the same time** by implementing **per-file locking**. SCSI reservations are only implemented when **logical unit number (LUN)** metadata is updated (e.g. file name change, file size change, etc.)
- **Add or delete an ESX server** from a VMware VMFS volume without disrupting other ESX server hosts.
- **LVM allows for adaptive block sizing and addressing for growing files allows you to increase a VMFS volume on the fly** (by spanning multiple VMFS volumes)
- With ESX/ESXi4, **VMFS volumes also can be expanded using LUN expansion**
- Optimize your virtual machine I/O with adjustable volume, disk, file and block sizes.
- Recover virtual machines faster and more reliably in the event of server failure with Distributed Journaling.

VMware - VMFS

■ Limitations

- Can be shared with up to 64 ESX Servers
- Can support LUNs with max size of 2TB and a max VMFS size of 64 TB as of version 4 (vSphere), and 64 TB as of version 5
- "There is a VMFS-3 limitation where each tree of linked clones can only be run on 8 ESX servers. For instance, if there is a tree of disks off the same base disk with 40 leaf nodes in the tree, all 40 leaf nodes can be simultaneously run but they can only run on up to 8 ESX hosts."
- VMFS-3 limits files to 262,144 (218) blocks, which translates to 256 GB for 1 MB block sizes (the default) up to 2 TB for 8 MB block sizes
- This restriction is lifted in VMFS-5 where a 1MB unified block size is now used for all files, with subblock support for very small files However the maximum file size is now 2 TB - 512 B
- There is also a limit of approx 30720 files on a single VMFS-3 datastore. This has been raised to 130690 files on VMFS-5

■ Open source implementation

- An open source VMFS driver which enables read-only access to files and folders on partitions formatted with the Virtual Machine File System (VMFS) is developed and maintained by fluid Operations AG. It allows features like offloaded backups of virtual machines hosted on VMware ESX hosts up to VMFSv3.

VMware - VMmark

- **VMmark is a freeware virtual machine benchmark** software suite from VMware, Inc., a division of EMC Corporation. The suite measures the performance of virtualized servers while running under load on a set of physical hardware. VMmark was independently developed by VMware
- **Technical overview**
- **In order to measure the efficiency of the virtualization layer - the hypervisor - the suite must run several virtual machines (VMs)** simultaneously. Each VM is configured according to a template, three of which are provided with the VMmark software. The templates mimic typical software applications found in corporate data centers, such as email servers, database servers, and Web servers. The VMmark software collects performance statistics that are relevant to each type of application, such as commits per second for database servers, or page accesses per second for web servers
- **VMs are grouped into logical units called "tiles"**. When evaluating a system's performance, the VMmark software first calculates a score for each tile, culled from the performance statistics produced by each VM, and aggregates the per-tile scores into a final number

VMware - VMmark

VMmark

<u>Developer(s)</u>	VMware, Inc.
<u>Stable release</u>	2.1 / February 9, 2011; 16 months ago [1]
<u>Operating system</u>	Microsoft Windows SUSE Linux
<u>Platform</u>	x86-compatible
<u>Type</u>	Benchmark software
<u>License</u>	Proprietary/Open source
<u>Website</u>	VMmark at VMware.com

VMware - VMmark

■ Software components

- VMmark uses a mixture of free/open source and proprietary software in its virtual machine templates, such as Apache HTTP Server for Web servers and Microsoft Exchange Server for email servers

■ Industry reception

- As of May 2008, four computer system vendors (Dell Computer, Hewlett-Packard, IBM, and Sun Microsystems) have submitted VMmark benchmark results to VMware. Additionally, Dell and Sun have separately published whitepapers with VMmark results obtained on their respective computer systems. SWsoft, one of VMware's competitors in the x86 virtualization market, has levied criticisms against VMmark regarding the realism of the simulated workloads and the choice of software platforms
- By October 2009 that had increased to 10 vendors (HP, NEC, IBM, Unisys, Sun, Dell, Inspur, Lenovo, Fujitsu and Cisco)