

18 *Short Topics in* **System Administration**

Jane-Ellen Long, Series Editor

Deploying the VMware Infrastructure

John Arrasjid, Karthik Balachandran,
Daniel Conde, Gary Lamb, and Steve Kaplan

About SAGE

SAGE is a Special Interest Group of the USENIX Association. Its goal is to serve the system administration community by:

- ❖ Offering conferences and training to enhance the technical and managerial capabilities of members of the profession.
- ❖ Promoting activities that advance the state of the art or the community.
- ❖ Providing tools, information, and services to assist system administrators and their organizations.
- ❖ Establishing standards of professional excellence and recognizing those who attain them.

SAGE offers its members professional and technical information through a variety of programs. Please see <http://www.sage.org> for more information.

Authors' Note: We have changed some names for VMware products from the first printing of this booklet in order to adhere to product name changes that the company has undertaken. These include changes from VirtualCenter to VMware vCenter and from Virtual Desktop Manager to VMware View Manager.

© Copyright 2008 by the USENIX Association. All rights reserved.

ISBN 978-1-931971-62-1

To purchase additional copies, see http://www.sage.org/pubs/short_topics.html.

The USENIX Association
2560 Ninth Street, Suite 215
Berkeley, CA USA 94710

<http://www.usenix.org/>

Second Printing 2008

USENIX is a registered trademark of the USENIX Association.

USENIX acknowledges all trademarks herein.

Contents

Acknowledgments v

Foreword vii

1. **Introduction** 1
 - VMware Technology Overview 1
2. **What Is Virtualization?** 5
 - Virtual Machines 6
 - Characteristics of a Virtual Machine 6
 - Components of the VMware Infrastructure 9
 - Additional VMware and Third-Party Components 12
3. **The Benefits of Infrastructure Virtualization** 15
 - Capital Expense Reduction 15
 - Operational Expense Reduction 15
 - Improved Agility 15
 - Summary of Benefits 16
 - The Business and Operational Case for Virtualization 16
 - Return on Investment (ROI) 18
 - ROI/TCO Calculator 20
4. **Use Cases for Virtualization** 23
 - Production Environments 23
 - Software Test/Development and Testing 23
 - Disaster Recovery 23
 - Remote Offices 24
 - Desktops 24
5. **Virtualizing Your IT Infrastructure** 25
 - VMware Server Consolidation Methodology 25
 - Identifying Virtualization Candidates 26
 - Conducting a Virtualization Assessment 27
 - Inventory 27
 - Application Resource Considerations 27
6. **Building a VMware Infrastructure** 31
 - Server Hardware 31
 - Storage Hardware 33
 - ESX 34
 - VMware vCenter Installation 36
7. **Managing the VMware Infrastructure** 39
 - VMware vCenter Server 39
 - Virtual Machine Provisioning 40
 - Infrastructure Management with VMware vCenter 43
 - Virtual Machine Deployment 48
 - Migration of Virtual Machines to Alternate Platforms 49
 - VMware Update Manager 51

8. Migrating Candidates	53
VMware Physical-to-Virtual Process	53
VMware Converter	53
Third-Party Migration Tools	54
Considerations for Successful Migrations	54
Virtual-to-Physical Process	55
Virtual-to-Virtual Process	55
9. Optimization	57
ESX Optimization	57
Virtual Machine Optimization	61
VMware VMmark	62
10. Disaster Recovery and Security	63
Backup and Recovery Strategies	63
Networking Strategies for Disaster Recovery	66
Security Considerations	67
11. Advanced Capabilities	69
VMware High Availability	69
VMware Consolidated Backup	69
Virtual Machine Snapshots	71
Site Recovery Manager	72
12. Virtual Desktop Infrastructure	73
VDI Overview and Planning	73
Connection Brokering	74
Vendor-Specific Implementations	76
Appendix. Virtualization Technologies	79
Operating System Virtualization	79
Hardware Virtualization	79
Virtual Machine Monitor	80
CPU Virtualization	81
Device Virtualization	82
Other Forms of Virtualization	82
About the Authors	85



Acknowledgments

Thank you to John Gannon and Shridhar Deuskar for content contribution. Thank you to editor extraordinaire and writer guru, Matthew Wood, for his attention to detail, document flow, and support. Thank you to Evelyn Eldridge of VMware and Bryan Dickson of INX for editorial assistance. I would like to thank my co-authors in creating this SAGE Short Topics booklet. This document has also benefited from review by several individuals, and we would like to thank them for their efforts. They are Gretchen Phillips, Todd Massey, Karen Zeller, Jarrod Swetland, Cheryl Eagan, Philip Callahan, Kris Boyd, Mark Broda, and Lance Owen. Thank you to my VMware management team (Lawrence Rupp and Jason Martin) for supporting the creation and release of this material to the SAGE community.

Thank you to Amy, Catherine, Sofi, and Lila, whose love and support have enabled me to complete this project, and to my parents, Dorine and Harun, for years of encouragement and sacrifice to ensure that family always came first. This book is dedicated to my family.

Thank you to the USENIX Association for inviting me to create and deliver tutorials around VMware virtualization technology for the past few years, and for encouraging the publication of this booklet for the SAGE community. USENIX continues to hold a high standard for both the research and administration aspects of system administration.

This booklet is dedicated to Diane Greene and Mendel Rosenblum for their leadership, support, and friendship.

This booklet gives you a starting point for understanding the VMware Infrastructure and deploying it for cost reduction, quicker deployments of systems, and better control of resource utilization, as well as datacenter management and high availability. Welcome to VMware Infrastructure.

John Y. Arrasjid
VCP, VMware, Inc.



Foreword

After years of working in the computer industry, we have come to realize that although almost everything has been done before, approaches to problems have changed.

The evolution in processing power and declining costs has driven many of these changes. In the early days of computing, hardware was expensive. In the 1960s, virtual machines were developed on mainframe computers, notably from IBM, to enable multiple users to share expensive resources. In the 1970s came mini-computers, such as those from Digital Equipment Corporation, which were cheaper and enabled decentralized computing at a departmental level. In both cases, remote terminals accessed these shared systems.

In the 1980s, personal computers (IBM, Apple) and UNIX engineering workstations (Sun, DEC, SGI) further popularized decentralized computing, as microprocessors became faster and cheaper. Instead of having to share a departmental computer, each user had his or her own, and virtual machines became less popular.

In parallel, during the 1980s, graphical user interfaces became popular in PCs. Client-server computing arose as a method to meld interactive local user-interfaces (either on a PC or a thin client) with a central server. The desktop PC architecture evolved into business-class servers, offering inexpensive commodity-based pricing for systems that have many of the capabilities of mini or mainframe computers. Client-server computing faded away as centralized Web-based systems started to take over, and the pendulum started to swing back towards centralized computing.

At the same time, the processors were increasingly underutilized as servers had multiple processors, each with multiple cores, and software demands flagged behind hardware capabilities. The proliferation of computers spread the workload to ever more distributed yet underutilized systems. Even desktop PCs were underutilized, because they also used faster processors.

Systems proliferated, but centralized computing continued to regain popularity as Web-based computing took hold. But unlike the central mainframes of the 1970s, the new model of centralization often consisted of a complex mesh of servers, frequently configured as multi-tiered systems.

Yet these systems were becoming harder to manage. Not only were there more of them, but they came from many vendors (not just IBM anymore), and the pace of change accelerated, which put higher demands on the need to rapidly test and deploy systems. The proliferation of desktop PCs continues to pose complex management problems.

Some concepts from the past have returned to help with this situation. Virtual machines, which were almost forgotten in the 1990s, re-emerged as a method to install and consolidate many server systems into one physical machine. Many virtual machines can run on

one host. Fast networks and CPUs now enable PCs to be hosted as virtual machines in central servers accessed from thin clients, just like the old time-sharing terminals, which improves the manageability of desktop computing. Complex, multi-tiered systems can be tested and deployed using virtual machines, which helps bring a wide array of configurations to the fingertips of developers, with no need to configure them by hand. Virtual machines present a common platform that simplifies software distribution for software developers—this helps tame the headaches of software installation and returns us to the simplicity of the “good old days” when there were few target platforms to worry about. Finally, the rise of Web-based systems has led to another reason to move back to the datacenter: cloud computing. Virtual machines offer a great solution for treating an entire cluster of servers as a single shared resource, sliced and diced according to the computing needs of the moment, not unlike the central mainframes of the past.

For the first-time user of virtualization, John Arrasjid and his co-authors have outlined and discussed the world of virtualization in layman’s terms. Along with explaining how virtualization can be applied to today’s businesses, they have shown how incredible the return on investment can be in terms of resource utilization and staff productivity. For Privacy Networks, as a software company, the ability to use virtualization has increased our sales-demo capabilities, engineering test productivity, and deployment of email archiving software for customers as a virtual appliance in a VMware environment. I (Todd Massey) am continually amazed at the uses we come up with for virtualization in our company. As you learn more about deploying enterprise-class virtualization, think outside the box—for business today, virtualization can increase productivity in ways that seem almost limitless.

Todd Massey
CTO, Privacy Networks

Daniel Conde
VCI, VMware, Inc.