VMware vCloud® Architecture Toolkit (vCAT)
Technical and Operational Guidance for Cloud Success

VMware vCAT Team
Foreword by Pat Gelsinger, CEO, VMware
VMware vCloud® Architecture Toolkit (vCAT)

Technical and Operational Guidance for Cloud Success
VMware Press is the official publisher of VMware books and training materials, which provide guidance on the critical topics facing today’s technology professionals and students. Enterprises, as well as small- and medium-sized organizations, adopt virtualization as a more agile way of scaling IT to meet business needs. VMware Press provides proven, technically accurate information that will help them meet their goals for customizing, building, and maintaining their virtual environment.

With books, certification and study guides, video training, and learning tools produced by world-class architects and IT experts, VMware Press helps IT professionals master a diverse range of topics on virtualization and cloud computing and is the official source of reference materials for preparing for the VMware Certified Professional Examination.

VMware Press is also pleased to have localization partners that can publish its products into more than 42 languages, including Chinese (Simplified), Chinese (Traditional), French, German, Greek, Hindi, Japanese, Korean, Polish, Russian, and Spanish.

For more information about VMware Press, visit vmwarepress.com.
VMware® Press is a publishing alliance between Pearson and VMware, and is the official publisher of VMware books and training materials that provide guidance for the critical topics facing today’s technology professionals and students.

With books, certification and study guides, video training, and learning tools produced by world-class architects and IT experts, VMware Press helps IT professionals master a diverse range of topics on virtualization and cloud computing, and is the official source of reference materials for completing the VMware certification exams.

Make sure to connect with us!
informit.com/socialconnect
This page intentionally left blank
VMware vCloud®
Architecture Toolkit (vCAT)

Technical and Operational Guidance
for Cloud Success

VMware vCAT Team
# Contents

1 Introduction 1

1.1 Overview ................................................................. 1

1.2 Using the vCAT Documentation Set .......................... 2

1.2.1 Recommended Reading Order .......................... 5

1.3 Cloud Computing and VMware vCloud .................. 5

1.3.1 VMware vCloud Requirements ......................... 6

1.3.2 VMware Alignment to Standards .................... 6

1.3.3 vCloud Definitions ........................................ 7

1.3.4 Solution Area to Technology Mapping ................ 8

1.4 Journey to a Mature vCloud Implementation .......... 11

1.4.1 Stage 1: Standardize .................................. 12

1.4.2 Stage 2: Service Broker .................................. 13

1.4.3 Stage 3: Strategic Differentiator ................. 14

2 Service Definitions 15

2.1 Introduction .......................................................... 15

2.1.1 Audience ....................................................... 16

2.1.2 Deployment Model ........................................ 16

2.1.3 Service Model .................................................. 17

2.1.4 Technology Mapping ........................................ 18

2.1.5 Service Characteristics ..................................... 18

2.1.6 Service Development Approach ..................... 20

2.1.7 Concepts and Terminology .............................. 21

2.2 Service Definition Considerations ......................... 22

2.2.1 Service Objectives .......................................... 22

2.2.2 Use Cases ...................................................... 23

2.2.3 User Roles ...................................................... 25

2.2.4 Metering and Service Reporting ..................... 26

2.2.5 Security and Compliance .............................. 26

2.2.6 Capacity Distribution and Allocation Models .... 29

2.2.7 Applications Catalog ..................................... 30

2.2.8 Interoperability .............................................. 31

2.2.9 Service-Level Agreement ................................ 31

2.3 Service Offering Examples ................................. 32

2.3.1 Service Offering—Basic .................................. 34

2.3.2 Service Offering—Committed ......................... 37

2.3.3 Service Offering—Dedicated ......................... 40
3 Architecting a VMware vCloud

3.1 Overview .............................................................................. 45
  3.1.1 Audience ........................................................................ 46
  3.1.2 Scope ............................................................................ 46
  3.1.3 Chapter Topics ............................................................... 46

3.2 vCloud Architecture ............................................................ 47
  3.2.1 Technology Mapping ....................................................... 47
  3.2.2 vCloud Suite Components ............................................... 48
  3.2.3 vCloud Infrastructure Logical Design ............................... 50

3.3 vCloud Management Architecture ............................................ 52
  3.3.1 Management Cluster ....................................................... 53
  3.3.2 Compute Layer ............................................................. 55
  3.3.3 Network Layer ............................................................. 56
  3.3.4 Storage Layer .............................................................. 56
  3.3.5 vCenter Linked Mode .................................................... 57
  3.3.6 Cell Load Balancing ....................................................... 57
  3.3.7 vCenter Operations Manager .......................................... 58

3.4 Resource Group Architecture .................................................. 58
  3.4.1 Compute Resources ....................................................... 59
  3.4.2 Network Resources ....................................................... 60
  3.4.3 Storage Resources ....................................................... 63
  3.4.4 vCloud Resource Sizing .................................................. 69

3.5 vCloud Resource Design .......................................................... 72
  3.5.1 vCloud Director Constructs ............................................. 72
  3.5.2 Organizations ............................................................... 74
  3.5.3 Provider Virtual Datacenter ............................................ 76
  3.5.4 Organization Virtual Datacenters .................................... 78
  3.5.5 vCloud Networking ....................................................... 87
  3.5.6 Networking—Public vCloud Example ............................... 102
  3.5.7 Networking—Private vCloud Example ............................ 104
  3.5.8 vApp ................................................................. 106
  3.5.9 Snapshots ................................................................. 108
  3.5.10 Storage Independent of Virtual Machines ..................... 111
  3.5.11 vApp Load Balancing ................................................... 113

3.6 vCloud Metering ................................................................. 117
  3.6.1 vCenter Chargeback Manager ...................................... 117
  3.6.2 Maximums ................................................................. 120
  3.6.3 Cost Calculation .......................................................... 120

3.7 Orchestration and Extension .................................................... 122
  3.7.1 vCloud API ................................................................. 122
  3.7.2 Cloud Provisioning with vFabric Application Director ....... 123
  3.7.3 vCloud Messages ......................................................... 127
3.7.4 vCenter Orchestrator ........................................... 128
3.7.5 vCenter Orchestrator Examples ............................. 135

3.8 Multisite Considerations .......................................... 137
3.8.1 Multisite Availability Considerations ....................... 139
3.8.2 Distributed Cloud Deployments Use Cases ............... 139
3.8.3 Multisite Terminology ........................................... 141
3.8.4 Deployment Options ............................................. 142
3.8.5 Supportability Considerations for Single-Site Deployments .................................................. 145
3.8.6 Multisite Supportability Considerations .................... 146

3.9 Hybrid vCloud Considerations .................................... 147
3.9.1 vCloud Connector .................................................. 148

3.10 References .............................................................. 154

4 Operating a VMware vCloud ........................................ 157
4.1 Overview ............................................................... 157
4.1.1 Audience .......................................................... 158
4.1.2 Scope ............................................................... 158

4.2 Cloud Computing ..................................................... 158
4.2.1 vCloud Operations Framework ............................... 159

4.3 Process Maturity for vCloud Operations ...................... 161
4.3.1 Traditional versus Maturity Models Specific to VMware ................................. 161
4.3.2 Process Maturity Scale Specific to VMware ................. 162
4.3.3 Evolution of vCloud Operations ............................... 163

4.4 Changing Role of Information Technology Organizations ....... 166
4.4.1 IT and Business Relationship ................................. 166
4.4.2 Rethink IT ........................................................ 167

4.5 Organizing for vCloud Operations ............................... 167
4.5.1 Organizational Overview ....................................... 167
4.5.2 vCloud Infrastructure Operations ......................... 169
4.5.3 vCloud Tenant Operations .................................... 175
4.5.4 Evolution of Organizational Structure for vCloud ........ 180

4.6 vCloud Business and Consumer Control ...................... 182
4.6.1 Introduction to IT Business Management .................. 182

4.7 vCloud Service Control ............................................ 185
4.7.1 vCloud Service Governance and Lifecycle Management ................................. 185
4.7.2 vCloud Service Design and Development Management .................. 195

4.8 vCloud Operations Control ....................................... 200
4.8.1 Provisioning Management ..................................... 200
4.8.2 Capacity Management ......................................... 204
4.8.3 Performance Management .................................... 209
4.8.4 Event, Incident, and Problem Management .............. 217
4.8.5 Configuration and Compliance Management ............. 223
4.8.6 Orchestration Management .................................................. 228
4.8.7 Availability Management .................................................... 231
4.8.8 Continuity Management ..................................................... 232
4.8.9 Access and Security Management ...................................... 236
4.9 vCloud Infrastructure Control ................................................. 239
4.9.1 Monitoring ..................................................................... 240

5 Consuming a VMware vCloud .................................................... 243
5.1 Overview ............................................................................. 243
5.1.1 Audience ....................................................................... 244
5.1.2 Scope ............................................................................ 244
5.2 vCloud Consumption Approach ............................................. 244
5.2.1 vCloud Consumer Resources ........................................... 244
5.2.2 vCloud Consumer Resource Capacity ............................... 246
5.3 Choosing a vCloud Consumption Model ............................... 247
5.3.1 Consuming vCloud Services ............................................ 247
5.3.2 vCloud Director Allocation Models ................................. 247
5.4 Organization Catalogs ............................................................ 249
5.4.1 Understanding Catalogs .................................................. 250
5.4.2 Populating a Catalog ...................................................... 252
5.4.3 Working with Catalogs ................................................... 255
5.5 Creating and Managing vApps ................................................. 259
5.5.1 Migrating Workloads to a vCloud .................................... 259
5.5.2 Using vCloud Workloads ................................................ 264
5.5.3 Directory Services in vCloud ........................................... 273
5.5.4 vApp Deployment Readiness ......................................... 276
5.5.5 Updating vApps ............................................................ 293
5.5.6 Establishing Service Levels ............................................ 297
5.6 Consuming vCloud with the API .......................................... 299
5.6.1 Characteristics of the API ................................................ 299
5.6.2 API Functions ................................................................ 300
5.6.3 What’s New in the vCloud 5.1 API ................................. 300
5.6.4 vCloud SDK .................................................................. 301
5.7 Consuming vCloud with vFabric Application Director .......... 301
5.8 References ........................................................................... 303

6 Implementation Examples ....................................................... 305
6.1 Overview ............................................................................. 305
6.1.1 Implementation Examples Structure ................................. 305
6.1.2 vCloud Suite Components ............................................. 306
6.2 vCloud Cell Design Examples .............................................. 308
6.2.1 Load-Balanced Cell Configuration .................................. 308
6.2.2 Secure Certificates ........................................................ 314
Contents xi

6.3 Organization Virtual Datacenter Examples ................................... 324
   6.3.1 Pay As You Go Allocation Model ..................................... 325
   6.3.2 Reservation Pool Model ................................................... 328
   6.3.3 Allocation Pool Model .................................................... 331
   6.3.4 Service Provider Performance Offerings ............................ 334
6.4 Networking Examples ............................................................. 338
   6.4.1 vApp Load Balancing with vCloud Networking and
       Security Edge ........................................................................ 338
   6.4.2 Static Routing ................................................................ 345
   6.4.3 vCloud Networking and Security Edge Gateway Setup ....... 350
   6.4.4 Public vCloud External Network ...................................... 361
   6.4.5 VXLAN Implementation ................................................. 364
   6.4.6 VXLAN ORG Network for Disaster Recovery ..................... 371
   6.4.7 VCDNI-Backed Organization Network .............................. 388
   6.4.8 VLAN ORG Network ....................................................... 393
6.5 Storage Design Examples ............................................................ 397
   6.5.1 vApp Snapshot ............................................................... 397
   6.5.2 Storage DRS with vCloud Director .................................... 402
6.6 Catalog Design Example ............................................................ 410
   6.6.1 vCloud Public Catalog .................................................... 410
6.7 vCloud Security Examples .......................................................... 416
   6.7.1 Single Sign-On (SSO)—Provider ....................................... 416
   6.7.2 Single Sign-On (SSO): Consumer ...................................... 423
   6.7.3 Implementing Signed Certificates from a Certificate
       Authority ............................................................................... 433
6.8 vCloud Integration Examples ..................................................... 434
   6.8.1 vCenter Operations Manager ........................................... 434
   6.8.2 AMQP Messages ............................................................. 464
   6.8.3 AMQP Blocking Tasks ..................................................... 469

7 Workflow Examples 479

7.1 Overview .................................................................................. 479
    7.1.1 Audience ....................................................................... 479
    7.1.2 Scope ............................................................................ 480
    7.1.3 Launching Workflows ..................................................... 480
7.2 Triggering Workflows with vCloud Notifications .................... 482
    7.2.1 Prerequisites ................................................................... 483
    7.2.2 Workflow Folders ........................................................... 483
    7.2.3 Workflow: Create a vCloud Director Notification
       Subscription ........................................................................... 483
    7.2.4 Workflow: Create a vCloud Director Notification Policy ..... 487
    7.2.5 Process Notifications and Trigger Workflows .................... 488
    7.2.6 Triggered Workflow Examples ......................................... 490
### Appendix A  Availability Considerations  
**vCloud Director Cell Load Balancing**

### Appendix B  Security  
**VMware Security Certifications**
- Common Criteria
- Federal Information Processing Standards
- Security Content Automation Protocol
**Network Access Security**
- Two-Factor Authentication
**Secure Certificates**
- Secure Certificates Example
**Single Sign-On**
- Use Case 1
- Use Case 2
- Use Case 3
- Use Case 4
**Consumer SSO Architecture Example**
**vCloud Provider SSO Architecture Example**
**SSO Authentication Workflow**
**DMZ Considerations**
**Port Requirements**

### Appendix C  vCloud Suite Disaster Recovery  
**Using VXLAN to Simplify vCloud Disaster Recovery**
**Background**
- VXLAN for DR Architecture
- Logical Infrastructure
**VXLAN for DR Design Implications**
**Reference**

### Appendix D  vCloud Director Upgrade Considerations  
**Background**
**Phase 1 Impact**
**Upgrade Considerations**
**Phase 1 Process**
- Preupgrade Considerations
- Upgrade Considerations
- Post-Upgrade Considerations
**Upgrade Advantages**

### Appendix E  vCloud Director Cell Monitoring
Appendix F  Compliance Considerations

Use Cases: Why Logs Should Be Available .......................................................... 621
  Log Purposes .................................................................................................. 621
  Frequency of Review .................................................................................... 622
  Minimum Data Types .................................................................................... 622
  Retention ........................................................................................................ 623
Example Compliance Use Cases for Logs ........................................................ 623
  VMware vCloud Log Sources for Compliance .............................................. 624
vCloud Director Diagnostic and Audit Logs ...................................................... 628

Appendix G  Capacity Planning

vCloud Administrator (Service Provider) Perspective ......................................... 630
  Calculating Redundancy Ratio from Minimal Level of Redundancy .............. 631
  CPU Resources Per Cluster ........................................................................ 632
  Pay As You Go Model .................................................................................. 632
  Allocation Pool Model .................................................................................. 633
  Reservation Pool Model ............................................................................... 635
  Storage ........................................................................................................... 635
Network Capacity Planning .............................................................................. 636

Appendix H  Capacity Management

Capacity Forecasting Specific to vCloud—Demand Management ...................... 637
Capacity Monitoring and Establishing Triggers ............................................... 638
Customer (Organization) Administrator Perspective ....................................... 640
Organization Virtual Datacenter-Specific Capacity Forecasting ....................... 642
  Collect Organization Virtual Datacenter Consumption Information Regularly 643
  Determine Trending Variables ..................................................................... 643
  Determine the Automatic Point of Expansion .............................................. 645
Capacity Management Manual Processes—Organization Virtual Datacenter ........ 645

Appendix I  Integrating with Existing Enterprise System Management

vCloud Director Notifications and Blocking Tasks Messages ......................... 647
  Message Publication ...................................................................................... 648
  Routing ......................................................................................................... 648
  Extension ...................................................................................................... 648
# Contents

vApp Backup/Restore .............................................................. 655
  Manage Credentials ............................................................ 656
  Protect vApps and Create Backup Jobs ............................... 656
  Execute Backup Jobs ......................................................... 657
Recovery .................................................................................... 657
Infrastructure Backup/Restore .................................................. 658

Appendix K  Upgrade Checklists ................................................. 661
Phase 1 ...................................................................................... 661
  Upgrade vCloud Director Cells ............................................ 661
  Upgrade vCloud Networking and Security Manager and
  Edge Devices ...................................................................... 662
  Upgrade Validation ............................................................ 662
Phase 2 ...................................................................................... 662
  Upgrade vCenter Server ..................................................... 662
  vCenter Upgrade Validation ................................................. 663
Phase 3 ...................................................................................... 663
  Upgrade Hosts ..................................................................... 663
  Host Upgrade Validation ..................................................... 663
Phase 4 ...................................................................................... 663
  Additional Upgrades .......................................................... 663

Appendix L  Custom Workflow Development Guidelines .............. 665
Workflow Development Lifecycle .............................................. 665
  Requirements Gathering ....................................................... 665
  Functional Specifications and Effort Estimate ....................... 666
  Design ................................................................................. 666
  Development ....................................................................... 666
  Test .................................................................................... 666
  Implementation .................................................................... 666
  Support ............................................................................... 666
Orchestration Content Lifecycle .................................................. 666
Orchestrated vCloud Environments ............................................ 668
  Developer Environment ...................................................... 668
  Test Environment ................................................................ 669
  Preproduction Environment .............................................. 669
  Production Environment .................................................... 669
  Support Environment ........................................................ 669

Index ......................................................................................... 671
About the Contributors

The following product owners have led the vCAT 3.x development effort upon which this VMware Press release is based.

**John Arrasjid**—John Arrasjid is a Principal Architect at VMware, Inc., where he started in 2003. John is part of the Global Technology Solutions team, is a VMware Ambassador, and is part of the Field Office of the CTO. John was awarded the vExpert 2012 designation, given to the top VMware evangelists in the industry, for his work on vCAT and the VCDX program. As lead architect and chief product owner of vCAT, John has led the development and release of vCAT since 2011. In his 10 years at VMware, John has co-authored four other books; *VCDX Boot Camp, Cloud Computing with vCloud Director, Foundation for Cloud Computing with vSphere 4, and Deploying the VMware Infrastructure*. John regularly presents at VMworld, VMware Partner Exchange, VMware vForum, USENIX LISA, and other industry conferences. His VCDX Boot Camp has been taught to more than 800 individuals since 2008. John holds a bachelor of science in computer science from SUNY at Buffalo and holds VCDX, ITIL Foundations, and CSPO certifications. He is a founding member of the Elastic Sky band, developer of the original vmsnap/vmres tool, and developer of several consulting engagements for security, business continuity, and performance. Find John on Twitter at @vcdx001.

**Matthew Wood**—Matthew Wood is an independent technical writer. Matthew has been a senior technical writer, editor, and manager for VMware Technical Services, and he was the lead editor for the vCAT project from 2010 until 2013. Matthew works with architects and consultants to produce IP for services kits and solutions kits related to all aspects of VMware technology. He also has written original documentation for the VMware Services Software Solutions group to support tools such as VMware HealthAnalyzer and Migration Manager. Matthew has 38 years of experience working with technology companies, focusing especially on UNIX, virtualization, and applications that support enterprise IT environments.
Wade Holmes—Wade Holmes is a Staff Solutions Architect at VMware, Inc., and holds VCDX, CISSP, CCSK, and CSPO certifications. He has more than 16 years of experience planning, teaching, and presenting on the architecture, design, and implementation of complex computing environments of all scopes and sizes. Wade has presented and taught at conferences such as VMworld, SXSW, USENIX LISA, and VMware User Group meetings. Wade was awarded the vExpert 2012 designation, given to the top VMware evangelists in the industry. He holds a bachelor’s degree in information technology and a master's degree in information assurance. Find him on Twitter at @wholmes; he also maintains a blog at www.vwade.com.

Joe Sarabia—Joe Sarabia is a Cloud Architect at VMware, Inc., and holds industry certifications that include VCAP-DCD, VCAP-DCA, MCSE, NCDA, ITIL, and CSPO. Joe has had various roles in the information technology field. He initially focused on operational roles in areas of organizations that consumed services from the business. About 10 years ago, Joe’s role pivoted to architecting and providing services on behalf of the business for business units and end users to consume. He has spent the last several years of his career as one of the leading hybrid cloud and SDDC architects in the industry, focusing on delivering business value to the globe’s largest organizations through complex software systems. Joe has particularly established himself as a thought leader in the areas of component integration and end user portal experience. Find him on Twitter at @joesarabia.

Rohan Kalra—Rohan Kalra is a Business Solutions Architect who brings more than 14 years of IT service management consulting experience, including global operations process re-engineering for Fortune 500 clients (EMC, Kellogg’s, Banco Santander, Goldman Sachs, Ricoh, and more). Rohan led the creation and release of operational readiness related IP assets available through VMware’s professional services, partner channels, and Accelerate Strategy teams. Formerly an executive technology adviser at Accenture, he led the development of operational readiness and governance components of its next-generation infrastructure solution blueprint, focused on cloud computing and delivery of IT as a Service. Rohan holds ITIL and CSPO certifications. Find him on Twitter at @kalrarohan.
Rupen Sheth—Rupen Sheth is a Senior Solutions Engineering Manager on the Global Services team at VMware, Inc., where he is responsible for monetizing and scaling the Software Defined Data Center (SDDC) portfolio of solutions and services. Rupen holds VCDX, ITIL, CSPO, and TOGAF certifications. He has extensive experience in delivering enterprise business and virtualization/cloud solutions through the effective application of information technology, process management, and coordination and management of multidisciplinary teams. Rupen started as a consultant at VMware and now leads a team of solution architects responsible for SDDC solutions and services kits that are used by VMware field and partners worldwide. Rupen has presented and taught at VMworld, VMware Partner Exchange, and USENIX conferences. Find him on Twitter at @rupensheth.

Ian Perez-Ponce—As Senior Product Manager for VMware’s vCloud Hybrid Service, Ian is responsible for service-creation and monetization efforts for the company’s Infrastructure as a Service (IaaS) cloud solutions portfolio. With more than 14 years of service provider and information technology experience, Ian helps define VMware’s premium hybrid cloud service strategy and oversees the development of the vCloud Service Provider partner ecosystem. Find him on Twitter at @iperezponce.

Christophe Decanini—Christophe Decanini is a Consulting Architect at VMware, Inc., where he started in 2007; currently, he is the technical lead for cloud orchestration. Based in Gland, Switzerland, Christophe is a global resource supporting customers in their orchestration and automation needs. He has presented orchestration solutions at conferences such as VMworld and is the main contributor on the www.vcoteam.info blog and in the official VMware Orchestrator community. Christophe was awarded the vExpert designation in 2011, given to the top VMware evangelists in the industry. He has 18 years of experience in IT automation and holds a bachelor’s degree in computer science. Find him on Twitter at @vCOTeam.

Burke Azbill—Burke Azbill has been working in IT since the mid-1990s and for VMware since 2007. He has been an active member of the VMworld Hands On Labs and a leading contributor to the vCenter Orchestrator community with both his own blog (www.vcoteam.info) and his contributions to the Official VMware Orchestrator blog and the community in the VMware forums. Burke was awarded the vExpert designation in 2011 and 2012, given to the top VMware evangelists in the industry. His industry certifications include MCP+I, MCSE, MCSD, CNE, CCA, LPIC-1, and VCP. Find him on Twitter at @TechnicalValues.
Michael Haines—Michael Haines is a Senior Cloud Networking and Security Architect and Engineer for the Global Services Engineering team at VMware, Inc. He leads the security architecture and development of VMware’s cloud solutions for service providers, enterprise customers, and partners throughout Europe and Asia Pacific. Michael is responsible for providing deep technical expertise and interfacing directly with Engineering and Product Management to support and develop current and future vCloud products and initiatives. He is also involved in prototyping vCloud solutions and frequently presents on VMware’s vCloud vision. This includes presentations at VMworld, where he also acts as one of the Security Lab captains. Michael is the co-author of the following publications: Cloud Computing with VMware vCloud Director, LDAP in the Solaris Operating Environment: Deploying Secure Directory Services, and Deploying LDAP in the Enterprise: Sun BluePrints Publications. Find him on Twitter at @michaelahaines.

Dave Richey—Dave Richey holds a degree from Harvard and has developed software training materials for more than a decade, including a full curriculum for Mac programmers. He draws on his experience in software development and technical management to edit technical documentation at VMware, Inc., in the fields of virtualization and cloud computing.

Ben Lin—Ben is a Staff Systems Engineer for the Networking and Security Business Unit (NSBU) at VMware, Inc. He holds VCDX3/4/5 certifications and actively participates in VCDX panels and development activities. Ben graduated from the University of California, Berkeley with a bachelor of science in electrical engineering and computer science. Ben co-authored the book Cloud Computing with VMware vCloud Director and was closely involved with cloud designs and deployments since the inception of vCloud Director. He is also co-author of VCDX Boot Camp. He regularly presents at conferences such as VMworld, VMworld Europe, Partner Exchange, USENIX LISA, USENIX HotCloud, and vForum. Find him on Twitter at @blin23.
Christopher Knowles—Chris Knowles is a Staff Architect within the Global Center of Excellence (CoE) at VMware, where he works on hybrid cloud and Software Defined Datacenter architecture and integration. Within the CoE, Chris translates complex business requirements into real-world highly integrated infrastructure solutions. Chris leads the VMware LiVeFire program, which enables VMware specialists and industry partners to deliver these advanced solutions in the field. When not balancing work and life with his wife, Erin, and two boys, Evan and Spencer, Chris is a regular speaker at VMworld and other industry events. Find him on Twitter at @sugeknowles.

Thomas Kraus—Thomas Kraus works as a Solution Architect in the VMware Networking and Security Business Unit (NSBU) at VMware, Inc., where he helps VMware’s largest customers rationalize, understand, and deploy network virtualization and Software Defined Datacenters. Thomas is primarily focused on the architecture, troubleshooting, and optimization of complex cloud environments, with a focus on automation and integration. In addition to being a VCDX, his relevant certifications are RHCE and NetApp SVAP. Find him on Twitter at @tkrausjr.

David Hill—David Hill is an experienced entrepreneur, IT consultant, and architect who has worked in the IT industry for more than 16 years on projects across the public sector and financial institutions. David joined VMware in 2010 and is a Senior Solutions Architect in the Professional Services Engineering (PSE) team. There he develops cutting-edge technology best practices, design guidelines, and intellectual property for the company and partners. David holds VCP 3/4/5 and VCAP-DCD4 certifications. David is the author and owner of the cloud technical blog www.virtual-blog.com. Find him on Twitter at @davehill99.
This book is dedicated to our families, friends, co-workers, customers, and partners. With you, we have found the time, energy, and enthusiasm to raise the bar and produce something to educate many on the concepts, technology, and operations for cloud computing and the software-defined data center.

—The vCAT Team
“Design is the fundamental soul of a human-made creation that ends up expressing itself in successive outer layers of the product or service.”

—Steve Jobs

“I am constantly thinking about new and simple approaches to solving problems. As Albert Einstein said, ‘Any intelligent fool can make things bigger and more complex. It takes a touch of genius to move in the opposite direction’. vCAT is a huge enabler for your service-oriented transformation efforts.”

—Rupen Sheth, VCDX, ITIL, TOGAF certified
Acknowledgments

The vCATs

vCAT 3.1 Team members

Chief Product Owner
John Yani Arrasjid, Principal Architect

Project Leadership Team
Matthew Wood, Wade Holmes, Joe Sarabia, Rohan Kalra, Nira Metcalf, John Callaghan, Donna Colborn

Product Owners
John Arrasjid, VCDX
Burke Azbill
Christophe Decanini
Michael Haines
David Hill
Wade Holmes, VCDX
Rohan Kalra
Christopher Knowles
Thomas Kraus, VCDX
Ian Perez-Ponce
Joe Sarabia
Rupen Sheth, VCDX
Matthew Wood

Contributors
Deji Akomolafe
Richard Anderson
Kalen Arndt
Richard Benoit
Bill Call
Philip Callahan
Chris Colotti, VCDX
Aidan Dalgleish, VCDX
Massimo Re Ferre
Greg Herzog, VCDX
Bill Keenan
Kevin Lees
Ben Lin, VCDX
Matthew Meyer, VCDX
Hugo Phan, VCDX
Prasad Pimplaskar
Mahesh Rajani, VCDX
Tom Ralph, VCDX
Alan Renouf
Rawlinson Rivera, VCDX
Heman Smith
Tima Sugiliani
Andy Troup
Raman Veeramraju

vCAT team logo concept by Catherine Arrasjid

Technical Publications
Matthew Wood, David Richey,
Patrick Carri, Barbara Weinstein

Project Management
John Callaghan, Donna Colborn

Marketing & Web
Nira Metcalf, Kathleen Tandy, Adam Souza

Sponsors
Scott Bajtos, Michael ‘Dino’ Cicciarelli, Carl Eschenbach, Pat Gelsinger, Dr. Stephen Herrod,
Paul Maritz, Ray O’Farrell, Raghu Raghuram, Rajagopal Ramanujam, Matthew Stepanski,
Dan Smoot, Paul Strong, Yvonne Wassenar
The vCATs

Past vCAT Team members

The following are individuals who have worked on past releases of the vCloud Architecture Toolkit. This includes releases 1.6, 2.0, 2.0.1, and 3.0. Current vCAT 3.1 members have also participated in developing past releases.

As with the current vCAT team, we recognize the value in everyone’s contribution, the dedication, and the sacrifices made to deliver this highly used resource.

As of pre-release, vCAT has had over 100,000 downloads used by architects, administrators, operators, consumers, customers, consultants, and vendors.

Product Owners
David Baldwin
Russell Callan
Pang Chen, VCDX
Chris Colotti, VCDX
Aiden Dalgleish, VCDX
Michael DiPetrillo
Ford Donald
Massimo Re Ferre
Jason Barnes
Kevin Lees
Ben Lin, VCDX
Mahesh Rajani, VCDX
Kamau Wangugu, VCDX

Project Management
Darrel Carson
Bernie Clarke
Mary Toman
John McGinn
Monte Kingstone
Jamal Abdul Kadar

Marketing
Suzanne Ambiel

Contributors
Jason Carolan
Andrew Hald, VCDX
Jeremy Hunt
Randy Keener
Hany Michael
Phillipe Michel
Alex Mitfell
Srinivas Muthu
Dushyanth Nataraj
Chirag Patel
Melanie Spencer
John Stanford
Hugo Strydom
Ben Thomas
Patrick Thomas
TJ Vatsa
One thing I’ve learned in my career is that architecture really matters. Bad implementations can be thrown away, but architectures last a long time—sometimes forever! Having a framework and set of principles to both guide and enable innovation can determine success, and a lack thereof almost certainly signals failure. An example I’m intimately familiar with is Intel’s x86 architecture. Putting the right framework in place has allowed the X86 design team to continue to create value and introduce new innovations to hundreds of millions of users to this day.

The VMware vCloud Architecture Toolkit (vCAT) serves a similar role for VMware. It provides the best of best practices that guide customers in assembling and operating a Cloud-capable, modern platform based on the Software Defined Data Center (SDDC).

The insight behind the software-defined strategy is that cloud-scale economics and agility require a radically simpler and more flexible approach to managing the hardware, network, storage, and security elements of the data center. This kind of agility requires that every technology layer be software defined and automatable. Networking, storage, compute, and security need to be abstracted, pooled, and made reconfigurable through instructions that are not bound to physical hardware. In a word, they need to be virtualized. VMware is applying its virtualization engineering capability to all the physical layers of the datacenter and extending these capabilities across multiple clouds. This gives our customers the most choice and control in how they deliver IT.

This latest vCAT release guides our customers in moving configuration management, policy management, and provisioning into the software layer. This simplifies the challenges companies increasingly face as software development and IT teams work together and the line between their roles becomes less distinct. vCAT also now supports *hybrid cloud deployments on partners’ clouds or on the VMware Hybrid Cloud Service* so that customers can *deploy workloads on hardware they rent or own*. vCAT can also guide customers in laying the foundation for Desktop as a Service and Platform as a Service.

vCAT and other VMware reference architectures are developed as part of the VMware Validated Architecture program. Our engineering, support, and other technical teams review and validate these reference architectures in our labs and directly through our customers’ deployments.

Each day, our customers and our partners come to depend more on VMware technology. This is both exciting and humbling for our company. As VMware continues to play a more central role in the IT industry, we’ve recognized the need to provide deep technical guidance that helps our customers realize success. We also recognize that our customers need to support existing investments and want to have the option to choose the best technology for their needs. To this end, we’ve created a way for other industry players to extend vCAT and integrate their products into the SDDC architecture. This also allows
partners to publish their own vCAT-compatible blueprints and design templates that guide our mutual customers in implementation and operation of solutions that incorporate those products. We believe that vCAT will continue to provide necessary and extensible architectural blueprints for the IT industry as it transitions to a software-defined approach to computing.

I heartily recommend this reference as a roadmap for anyone tasked with simplifying IT infrastructure and as an indispensable guide for those developing Software Defined Data Centers and vSphere/vCloud solutions.

Pat Gelsinger
Chief Executive Officer, VMware
Preface

“Technical skill is mastery of complexity, while creativity is mastery of simplicity.”

Erik Christopher Zeeman

“What is to be sought in designs for the display of information is the clear portrayal of complexity. Not the complication of the simple; rather, the task of the designer is to give visual access to the subtle and the difficult—that is, revelation of the complex.”

Edward Tufte

This book represents the work of more than 100 architects, consultants, administrators, engineers, project managers, technical editors, partners, and customers over multiple releases starting in 2010. A handful of people built the 1.x releases. For the 2.x release, approximately 72 individuals spent nearly 1,200 hours to produce 600 pages of content across eight documents. The 3.x releases saw about 42 individuals spend approximately 1,400 hours to produce 750 pages of content across nine documents. In your hands, you hold a compendium of these individual components in a single book format.

vCAT was created first as a reference architecture based on a limited set of use cases. The current release supports multiple use cases and, as such, has turned into a reference architecture toolkit that is part of a series titled VMware Validated Architectures (VVA).

The following sections present information on the owners of the product sections and a list of the contributors involved in the vCAT project since its inception. Approximately 50% of the development team holds VCDX certification. This material is thus not only a reference for SDDC and vCloud, but also a reference for those planning to achieve VCAP and VCDX certification.

You will notice our internal logo, a black cat on a white cloud. Catherine Arrasjid created this graphic to represent the project and the team of vCATs, as we are affectionately called. Our marketing team digitized it, and has become our internal team mascot.

It has been my pleasure to work on these releases—and to work with such an exceptional team of individuals, who are all recognized in the industry in their fields of specialization.

I want to call out the value of vCAT beyond just the cloud space. As you hear more about the Software Defined Data Center (SDDC) and related Software Defined components in networking, security, storage, and other areas, vCAT can provide the guidance you need. vCAT includes many of the components of SDDC—so what do you need to be aware of? We hope to include that in an addendum to vCAT that provides extensions in the SDDC area. Software Defined Networking and Security cover the areas currently represented by vCloud Networking and Security. Software Defined Storage will add relevant components on virtualization of storage. We expect a few other areas to come as the SDDC space continues to evolve.
VMware Validated Architectures, similar to vCAT, are designed to be easily integrated with third-party reference architectures. You will find references to these on the vendor sites. The goal is to allow ease of plug-and-play with other solutions, VMware, and third-party offerings.

As of publication, the vCAT site at www.vmware.com/go/vcat has more than 200,000 accesses and more than 100,000 downloads. These downloads were created by architects, administrators, operators, developers, project managers, solutions architects, and managers. The feedback has shown how vCAT is used and turned up suggestions to improve what we are producing. If you have input on improving this material, send your suggestions to IPfeedback@vmware.com. Please note that this book is printed in black and white to minimize cost and allow for wider adoption. Color versions of the original documentation in electronic and PDF format can be found at www.vmware.com/go/vcat in the Document Center tool.

We want to thank all participants on this project, with a special callout to our stakeholders who have supported this project and recognize the value it provides to our customers.

As you peruse this material, start by reading the Introduction, a guide to the material included in this book.

I wish you the best in your design and deployment of cloud and software-defined datacenters.

John Yani Arrasjid, VCDX-001
Principal Architect
The VMware® vCloud® Architecture Toolkit (vCAT) provides modular components so that you can design a vCloud reference architecture that supports your cloud use case. It includes design considerations and design patterns to support architects, operators, and consumers of a cloud computing solution based on VMware technologies.

For additional vCAT supporting material, visit the vCloud Architecture Toolkit page at vmware.com (www.vmware.com/go/vCAT). This is also where updates to vCAT will be posted.

vCAT 3.1 Documentation Packages

The following vCAT 3.1 packages are available:

- PDF package (~25MB)
- Documentation Center package (~50MB)

PDF Package

The PDF package is a zipped package that contains PDFs of all the documents in the toolkit. Use WinZip or a similar application to unzip the package, and use a PDF reader such as Adobe Reader to display and read the documents. You can print hard-copy documents from the PDFs.

Documentation Center Package

For a video overview on the Documentation Center packaging of vCAT, see the SME videos at www.vmware.com/go/vcat.

The documentation center package is a zipped package that contains a complete online help system that you can use to view all the documents in the toolkit from an easy-to-use interface. It offers powerful features such as the capability to search through the collection of vCAT documents, display a pregenerated PDF of a document, and, when served from a web server, access Google Translate to translate displayed pages into dozens of languages.

The vCAT 3.1 Documentation Center is also served from a website on vmware.com.
Browsers

The documentation center works with the following browsers:

- Google Chrome (preferred)
- Safari
- Internet Explorer (Search operates differently. Click the magnifying glass to search, enter a search term in the resulting text field, and press Enter or click Go).
- Firefox (works well except with Google Translate)

Installing the Documentation Center

The Documentation Center package is large, so it is recommended that you download the package over a high-speed link.

To install and display the vCAT 3.1 documentation center:

1. Download and unzip the package.
2. Double-click the index.html file to run it.
3. Allow blocked content, if prompted.

Offline Versus Online Capabilities

- If you install the Documentation Center package on your machine, you can use the toolkit offline. For example, you can install it on your laptop computer and review the documents while you are not connected to the Internet.

- If you install the Documentation Center package on a web server, the interface provides additional capabilities, such as access to Google Translate.

- The Documentation Center also optimizes the display for mobile devices. For example, using Safari on an iPad to access the documentation center works well.

Using the Documentation Center

- Click the folder icon to toggle display of the navigation pane on or off.

- Enter text in the search field and click the search icon (magnifying glass) to search for it. This is a client-side search implementation that can be used online or offline. It does not allow Boolean expressions.
If the documentation center is served from an Internet-connected web server, click the globe to display Google Translate. Select the language you want and click Translate. Each page is translated as it is displayed.

► Click a document in the navigation pane to display the sections in the document. Click a section to display content.

► Click the Page Forward or Page Back arrows to move from page to page.

► Click the Print icon to print the selected page to a printer.

► Select any document section and click the PDF icon to view a pregenerated PDF for the selected document. You can print the entire document from the PDF.

► Click the Email (envelope) icon or the link by the logo to send feedback to ipfeedback@vmware.com. The URL of the currently displayed page is automatically populated in the email Subject line.

vCAT 3.1.1 Changes and VMware Press Book Release

This book release combines all separate documents for vCAT 3.1 into one document. Each chapter in this book represents the nine separate documents. When we reference separate sections, see the associated chapter in the book format. We have not made specific updates to these release notes, to allow the material here and the material in Document Center to be synchronized.

There are several updates in this book that will apply to the updated web release.

► General
  ► Updated graphics and screenshots.
  ► Updated SSO material throughout.

► Chapter 1, Introduction:
  ► Removed references to VMware Service Manager.

► Appendix D
  ► Removed references to VMware Service Manager.
vCAT 3.1 Changes

For vCAT 3.1, most documents received additional edits, and graphics were improved for many figures. Content was updated as follows:

► **Chapter 1, Introduction:**
  ► Links to brief video presentations were added for each document and topic area.
  ► Figure 1.3 was updated.

► **Chapter 2, Service Definitions:**
  ► The service offering examples were changed because of allocation model changes in vCloud Director 5.1.1.
  ► Minor updates were made to the other service offering examples.
  ► Other minor edits include the following:
    ► The technology-mapping diagram was updated to show VMware vCloud Automation Center™.
    ► vCloud API changed to VMware APIs.
    ► VMware vCenter Operations Management Suite™ components are enumerated.

► **Chapter 3, Architecting a VMware vCloud:**
  ► Information was added about vCloud Automation Center (a component of the vCloud Suite).
  ► Section 3.8, “Multisite Considerations,” was updated.
  ► Allocation models guidance was updated.
  ► Information about VMware metering was updated in Section 3.6, “vCloud Metering.”
  ► Hybrid vCloud considerations were updated in Section 3.9, “Hybrid vCloud Considerations.”

► **Chapter 4, Operating a VMware vCloud:** Information was added about organizational structure and its evolution for vCloud in Section 4.5, “Organizing for vCloud Operations.”

► **Chapter 5, Consuming a VMware vCloud:**
  ► Updates were made to reflect the new network terminology in vCloud Director 5.1.
  ► The text was updated to reflect new storage capabilities in vCloud Director 5.1.
  ► Section 5.3.2, “vCloud Director Allocation Models,” was updated to reflect changes in vCloud Director 5.1.
Updates and clarifications were made to Section 5.4.3, “Working with Catalogs.”
Updates were made to Section 5.5.1.3, “vApp Migration,” to reflect new capabilities in vCloud Director 5.1.
Updates were made to Section 5.6.3 “What’s New in the vCloud 5.1 API.”
Chapter 6, Implementation Examples: The following sections were extensively updated with the latest available information:
- Section 6.3, “Organization Virtual Datacenter Examples”
- Section 6.4.5, “VXLAN ORG Network for Disaster Recovery”
- Section 6.7.3, “Implementing Signed Certificates from a Certificate Authority”
Chapter 7, Workflow Examples: No content changes were made.
Chapter 8, Software Tools: No content changes were made.
Chapter 9, Cloud Bursting: No content changes were made.

Security information in Appendix B, “Security,” was updated.

vCAT 3.0 Changes (Previous Release)
This section provides information on the changes that were made for the vCAT 3.0 release.

New documents were added to the toolkit, and in two cases, multiple documents were consolidated into one guide. Information about new components has been added, and information about other components has been updated.

New and Consolidated Documents
Workflow Examples, Software Tools, and Cloud Bursting are new documents with all new content.

The vCAT 2.x Public VMware vCloud Service Definition and Private VMware vCloud Service Definition have been consolidated into one Service Definitions document that covers public, private, and hybrid cases.

The vCAT 2.x documents, Public VMware vCloud Implementation Examples, Private VMware vCloud Implementation Examples, and Hybrid Use Cases, have been consolidated into one document titled Implementation Examples that covers public, private, and hybrid use cases. Many new implementation examples are provided.
New and Updated Components

vCAT 3.0 provided new and expanded coverage for architects, operators, and consumers.

▶ VMware vSphere®
▶ VMware vCloud Director®
▶ VMware vCenter™ Operations Management Suite™ (new):
  ▶ VMware vCenter Chargeback Manager™
  ▶ VMware vCenter Operations Manager™ (new)
  ▶ VMware vCenter Infrastructure Navigator™ (new)
  ▶ VMware vCenter Configuration Manager™ (new)
▶ VMware vCloud Networking and Security™ (formerly VMware vShield™):
  ▶ VMware vCloud Networking and Security Edge™
  ▶ VMware vCloud Networking and Security App™ (new)
  ▶ VMware vCloud Networking and Security Data Security™ (new)
  ▶ VMware vShield Endpoint™ (new)
▶ VMware vCloud Connector™
▶ VMware vCenter Orchestrator™
▶ VMware vSphere Service Manager™—Cloud Provisioning (new)
▶ VMware vCenter Site Recovery Manager™ (new)
▶ VMware vFabric™ RabbitMQ™ (new)
▶ VMware vFabric Application Director™ (new)
▶ VMware vFabric Application Performance Manager™ (new)
  ▶ VMware vFabric Hyperic® (new)
  ▶ VMware vFabric AppInsight™ (new)
VMware vCloud Networking and Security

VMware vShield has been renamed to VMware vCloud Networking and Security™. Note the following changes:

▶ VMware vShield Edge™ is now VMware vCloud Networking and Security Edge.
▶ VMware vShield App™ is now VMware vCloud Networking and Security App.
▶ VMware vShield Manager™ is now VMware vCloud Networking and Security Manager™.

The vCAT documents usually refer to vCloud Networking and Security, but some links to reference documents might still link to vShield documents on vmware.com. The vShield documents are being updated to reflect the new name.

Known Issues

Firefox generally works with the vCAT Documentation Center, but Google Translate does not work properly.

Providing Feedback

The usefulness of this architecture toolkit depends on feedback from customers and our network of partners. Send all feedback and IP submissions to ipfeedback@vmware.com.

From the documentation center interface, you can click the link next to the logo or click the Email (envelope) icon to send feedback.
Reader Services

Visit our website at www.informit.com/title/9780321912022 and register this book for convenient access to any updates, downloads, or errata that might be available for this book.
1.1 Overview

A reference architecture is an architecture template solution that addresses one use case in a particular domain. The VMware® vCloud® Architecture Toolkit (vCAT) provides modular components and documents to support multiple use cases, including design considerations and design patterns to support architects, operators, and consumers of cloud computing solutions based on VMware technologies.

vCAT is the first of several VMware Validated Architectures (VVA) VMware has released for customers, partners, vendors, and our internal teams. As a VVA, vCAT is supported by VMware and our support organization.

vCAT is vendor agnostic, but it does share vendor details when providing implementation examples. Vendors provide information about the use of their products with vCloud, including integration with vCAT, on the VMware Solutions Exchange (https://solutionexchange.vmware.com/store).

vCAT design guidelines cover multiple use cases. Instead of referring to best practices (a term subject to misinterpretation because best practices depend on use cases and are subject to many variables, including change over time), vCAT provides design guidelines. Architects must determine which design guidelines apply to the requirements, constraints, and characteristics of their projects and chosen technologies. When using the toolkit, consider the use case that best applies to your situation, and choose the design guidelines that support your design implementation.
This document covers the following topics:

- The vCAT documentation set
- Cloud computing and the VMware vCloud
- The journey to a mature vCloud implementation

For additional vCAT supporting material, visit the vCloud Architecture Toolkit page on vmware.com (www.vmware.com/go/vCAT). This is also where updates to vCAT are posted.

### 1.2 Using the vCAT Documentation Set

The vCloud Architecture Toolkit provides a set of documents to support the design of complex, integrated reference architectures for architects, operators, and consumers. Figure 1.1 shows the documents, and Table 1.1 briefly describes them.

![VMware vCloud Architecture Toolkit document map](image)

Table 1.1 shows check marks in the first column to represent existence of an online video providing a brief presentation (<10 minutes) about a document and topic area.
TABLE 1.1 VMware vCloud Architecture Toolkit Documents

<table>
<thead>
<tr>
<th>Video</th>
<th>Document</th>
<th>Description</th>
<th>Audience</th>
</tr>
</thead>
<tbody>
<tr>
<td>✓</td>
<td>Release Notes</td>
<td>Includes information about the VMware Architecture Toolkit, toolkit packages, how to use the documentation center, and information about changes since the vCAT 3.0 release.</td>
<td>All</td>
</tr>
</tbody>
</table>
| ✓     | Introduction            | Covers the following topics:  
  - A brief summary of vCAT documents  
  - Suggested reading order, depending on audience or role  
  - Introduction to cloud computing and basic cloud computing requirements and definitions                                                                 | All                    |
| ✓     | Service Definitions     | Discusses service definition lifecycles, including specific considerations for private, public, and hybrid vCloud instances, and examples of service offerings designed to help you create service definitions that meet specific business objectives.   | All                    |
| ✓     | Architecting a VMware vCloud | Details design considerations for architecting and building a VMware vCloud, including the basis for a reference architecture and guidance on requirements for implementing a VMware vCloud infrastructure. | Architects, IT operations |
| ✓     | Operating a VMware vCloud | Introduces high-level operational areas and discusses the evolution to support vCloud dynamics. Provides information about operational procedures, roles and responsibilities, setup, management, and monitoring of a vCloud. Also covers VMware management tools that support vCloud operations. | Architects, IT operations |
| ✓     | Consuming a VMware vCloud | Answers consumer questions such as the following:  
  - How do I handle the application lifecycle in a vCloud?  
  - How do I protect my workloads?  
  - How do I guarantee that workload resource requirements are met?  
  Provides the consumer’s perspective.                                                                 | Architects, IT operations, consumers, end users |
| ✓     | Implementation Examples | Provides examples of how to build a vCloud.                                                                                                                                                                | Architects              |
Video | Document | Description | Audience
---|---|---|---
✓ | Workflow Examples | Provides a description of useful scripts and workflows for VMware vCenter™ Orchestrator™. Other examples use technologies such as PowerCLI. Includes references to where these scripts can be found. | Architects, IT operations
✓ | Software Tools | Includes information about software that can benefit architects and operators. Provides information about freely available technologies that have been created and used to assist in vCloud design, deployment, and operations. Also includes information about several powerful tools that are available only as part of a service engagement with VMware Professional Services or a VMware partner. | Architects, IT operations
✓ | Cloud Bursting | Provides the theory behind autoscaling an enterprise cloud environment by using multiple cloud locations, including those owned by an enterprise and/or a service provider. This theory leverages VMware technologies but applies to other cloud technologies as well. This material is based on VMware field experience with customers and service providers. | Architects

Table 1.2 lists the typographical conventions used in all vCAT documents.

**TABLE 1.2** Document Typographical Conventions

| **Emphasis** | Emphasizes information, introduces new terms, and identifies document and workflow names. |
| **Command** | Identifies system commands, filenames, and Registry keys. |
| **Code** | Indicates code snippets and scripts. |
| **User Interface** | Identifies UI objects such as tabs, buttons, and field labels with bold text. |
| **Hyperlink** | Uses blue, underlined text to indicate an active link (URL). |
| **Note, Caution** | Notes contain information related to the topic that is of possible interest to the reader. Cautions highlight important information on potential problems or actions that might cause unexpected results. A Caution alerts the user and indicates the possibility of significant data loss. |
1.2.1 Recommended Reading Order

The documents can be read in the order shown in the document map or in the order recommended for a particular audience or role, such as one of the following:

- **vCloud providers** who offer the vCloud infrastructure and services. An architect has overall control over how a solution is designed and implemented in the environment.
- **vCloud operators** who are responsible for operation of the cloud. Operators are involved with the day-to-day running and administration of the vCloud environment. They need to understand operational procedures and how the vCloud components fit together.
- **vCloud consumers** who use cloud provider resources for application deployment. A consumer (organization or individual) is someone who consumes vCloud resources. Consumers want to run their workloads in the vCloud environment without concern for the underlying infrastructure or day-to-day administration.

Table 1.3 identifies the recommended documents for each role.

<table>
<thead>
<tr>
<th>VMware vCloud Architecture Toolkit (vCAT) Reading Recommendations</th>
<th>Architect</th>
<th>Admin/Operator</th>
<th>Consumer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introduction</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Service Definitions</td>
<td>✓</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Architecting a VMware vCloud</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Consuming a VMware vCloud</td>
<td>✓</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Implementation Examples</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Workflow Examples</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Software Tools</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cloud Bursting</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1.3 Cloud Computing and VMware vCloud

Cloud computing leverages the efficient pooling of an on-demand, self-managed, virtual infrastructure that is consumed as a service. VMware vCloud is the VMware solution for cloud computing that enables delivery of *Infrastructure as a Service* (IaaS). Additional “as a Service” reference architectures can be layered on top of a VMware vCloud built using vCAT.
1.3.1 VMware vCloud Requirements

According to the National Institute of Standards and Technology (NIST), the key components of a cloud are on-demand self-service, broad network access, resource pooling, rapid elasticity, and measured service. VMware aligns with the definition of cloud as elastic, lightweight entry and exit, available over Internet protocols, and running on a shared infrastructure.

A cloud always starts with a shared, virtual infrastructure. If any resource is dedicated to only one customer, you have a managed hosting platform, not a cloud infrastructure. Similarly, it is not considered a cloud if the cloud administrator or service provider must perform manual procedures to provision cloud resources following a consumer request. This is why workflow automation and orchestration are included as part of a vCloud solution.

The VMware vCloud blueprint follows these basic NIST requirements as the foundation for an IaaS cloud:

▶ A cloud must be built on a pooled, virtual infrastructure. Pools include not only CPU and memory resources, but also storage, networking, and associated services.

▶ The cloud should provide application mobility between clouds, allowing the consumer to enter and leave the cloud easily with existing workloads. The ability to use existing consumer tools to migrate workloads to or from the cloud is highly desirable. Mobility of workloads between clouds requires cross-cloud resource management.

▶ The cloud should be open and interoperable, allowing the consumption of cloud resources over open, Internet-standard protocols. Access to cloud resources does not require any other specific network protocols or clients.

▶ Cloud consumers should pay only for resources they consume or commit to consuming.

▶ The cloud should be a secure, trusted location for running cloud consumer workloads.

▶ Cloud consumers should have the option and capability to protect their cloud-based workloads from data loss.

▶ Cloud consumers are not responsible for maintaining any part of the shared infrastructure and do not need to interact with the cloud provider to maintain the infrastructure. They are not responsible for storage and network maintenance, ongoing cloud infrastructure patches, or business continuity activities. The cloud should be available to run high-availability workloads, and any faults occurring in the cloud infrastructure should be transparent to cloud consumers as a result of built-in availability, scalability, security, and performance guarantees.

1.3.2 VMware Alignment to Standards

VMware continues to develop technologies that align with evolving cloud standards as defined by NIST and other global standards organizations.
vCloud solutions focus on the following areas:

- **People**: People who develop solutions, architect the design, operate the implementation, and consume the resources. (See *Operating a VMware vCloud* and *Consuming a VMware vCloud*.)
- **Process**: Processes for architects, operators, and consumers.
- **Technology**: Alignment with successful design, deployment, and integration considerations. VMware technologies address the relevant areas within the standards.

Standards are still evolving for private, public, community, hybrid, and other types of clouds. vCAT focuses on the most common core design areas. The technology is the same, but operations and vCloud resource consumption vary according to the type of vCloud, the type of vCloud provider, and specific consumer requirements.

- A **private vCloud** is operated by an organization and secured behind a firewall.
- A **public vCloud** is generally accessible to users on the Internet.
- A **community vCloud** is a specific public vCloud use case in which access is limited to specified groups that share a common set of requirements.
- A **hybrid vCloud** is characterized by a connection among multiple vCloud instances. Typically, a bridge between two private vCloud instances has a dedicated and secured connection. The underlying network resides behind an Internet-facing firewall.

As cloud computing continues to evolve, many cloud definitions will arise. The information in this toolkit is a valuable aid in support of your vCloud projects, regardless of your chosen definition.

### 1.3.3 vCloud Definitions

vCAT uses the terms **private vCloud**, **public vCloud**, and **hybrid vCloud**, based on a specific set of definitions that NIST provides.

- **Private cloud**:

  A **private vCloud** (also known as an **internal vCloud**) operates on private networks, where a single company maintains accessible resources behind the firewall. In many cases, all the tenants share one legal entity. For example, a university might offer IaaS to its medical and business schools, or a company might do the same for various groups or business units. The private vCloud can be managed by the enterprise and hosted on-premises or operated on a dedicated infrastructure provided by a vCloud service provider or systems integrator. In any case, a private vCloud must conform to the organizational security constraints.
Public cloud:

A public vCloud offers IT resources as a service through external service providers and is shared across multiple organizations or the Internet. This can be viewed as a vCloud infrastructure that one organization operates and that multiple, legally separated organizations use.

A public vCloud is provisioned for open access and might be owned, managed, and operated by one or more entities.

A public vCloud provider might also support a private, community, or hybrid vCloud.

Hybrid cloud:

A hybrid vCloud combines the benefits of the private and public vCloud, with flexibility and choice of deployment methods.

A hybrid vCloud consists of multiple, linked vCloud infrastructures. These distinct vCloud infrastructures can be private, community, or public; but they must meet a set of requirements that the providers define and the consumers agree to. Connecting these vCloud instances requires data and application mobility, as well as management.

When load-balancing between vCloud instances (cloud bursting), use a consistent monitoring and management approach when migrating an application or data workload. For the theory behind cloud bursting, see the Cloud Bursting document.

Community cloud:

A community vCloud is a specific public vCloud use case in which the cloud is shared, and typically owned, by a group of organizations with a common set of requirements. In many cases, the organizations also include some level of legal separation. Community vCloud resources are shared, with some parts under central control and other parts with defined autonomy. A vCloud built for government, education, or healthcare is an example of a community vCloud.

A community vCloud can be offered by a traditional service provider, by a member of the community, or by a third-party vendor and hosted on one or more sites. It can be placed on-premises at one or more of the organizations’ sites, off-premises at a vCloud provider site, or both on- and off-premises.

1.3.4 Solution Area to Technology Mapping

When considering various technology solutions for your vCloud architecture, evaluate the solution and operational requirements to provide justification for the proposed solution. As VMware continues to develop Software Defined Data Center (SDDC) technologies, we will update the matching Infrastructure as a Service component. Figure 1.2 shows the categories of design considerations for building both a cloud and the underlying SDDC, with the related product technology that is used.
1.3 Cloud Computing and VMware vCloud

<table>
<thead>
<tr>
<th>Category</th>
<th>Product Technology</th>
</tr>
</thead>
<tbody>
<tr>
<td>Virtualization Layer</td>
<td>vSphere Suite</td>
</tr>
<tr>
<td>Cloud Layer</td>
<td>vCloud Director</td>
</tr>
<tr>
<td>Financial Management</td>
<td>Chargeback Manager</td>
</tr>
<tr>
<td>Cloud Monitoring and Management</td>
<td>Operations Manager</td>
</tr>
<tr>
<td>Application Dependency Mapping</td>
<td>Infrastructure Navigator</td>
</tr>
<tr>
<td>Compliance and Configuration Management</td>
<td>Configuration Manager</td>
</tr>
<tr>
<td>Cloud Networking</td>
<td>vCloud Networking and Security</td>
</tr>
<tr>
<td>Cloud Security</td>
<td>vCloud Networking and Security</td>
</tr>
<tr>
<td>Workload Mobility</td>
<td>vCloud Connector</td>
</tr>
<tr>
<td>Workflow Orchestration and Automation</td>
<td>vCloud Orchestrator</td>
</tr>
<tr>
<td>Enterprise Message Bus</td>
<td>vFabric RabbitMQ</td>
</tr>
<tr>
<td>Self-service Portal</td>
<td>vCloud Director and vCloud Orchestrator</td>
</tr>
<tr>
<td>Performance Management</td>
<td>vFabric Applications and Performance</td>
</tr>
<tr>
<td>Infrastructure Resiliency</td>
<td>VMware HA, VMware SRM</td>
</tr>
<tr>
<td>Application Deployment</td>
<td>vFabric Applications Director</td>
</tr>
<tr>
<td>Cloud Provisioning</td>
<td>vCloud Automation Center</td>
</tr>
<tr>
<td>IT Business Management</td>
<td>VMware ITBM</td>
</tr>
</tbody>
</table>

FIGURE 1.2 Technology areas

Figure 1.3 shows the technologies this vCAT release covers.
FIGURE 1.3 Technology areas in vCAT

NOTE
Except for the gray components, components that touch each other are integrated.

1.3.4.1 VMware Professional Services
VMware offers professional services that align with vCloud use cases. These range from a proof of concept (POC) that might be used as a demonstration environment, to a production deployment that requires management, workflow automation, compliance enforcement, and validation. The following services are available:

- **VMware vCloud POC Jumpstart Service**: Provides knowledge transfer workshops and hands-on product installation, configuration, and use demonstrations for the vCloud solution.
VMware vCloud Accelerator Service: Rapidly delivers a functioning VMware vCloud implementation suitable for deploying applications in a limited-scale preproduction environment. If all prerequisites are met, this service engagement can be completed in fewer than 30 business days.

VMware vCloud Design and Deploy Service: Provides a comprehensive architectural design for VMware vCloud that addresses the customer’s unique business requirements and operational demands, helping to pave the way to vCloud computing. This service is designed for enterprises that have a well-established, vSphere-based virtualization strategy for production workloads and that are ready to take the next step toward building their production vCloud infrastructure.

VMware Operational Readiness for Cloud Computing Service: Offers a four- to six-week engagement in which VMware consultants examine existing operational practices to evaluate performance across more than 150 attributes in five key areas. They uncover unknown or hidden barriers to success and highlight areas in which additional focus on people or process can deliver increased productivity, streamline operations, and improve overall vCloud solution results.

Services can be combined or customized to meet your specific requirements.

1.4 Journey to a Mature vCloud Implementation

At every stage in the processes leading to a mature vCloud implementation, financial transparency, process maturity, organizational setup, and technology implementation are critical factors for success.

VMware defines three stages on the journey to a mature vCloud: Standardize, Service Broker, and Strategic Partner. Figure 1.4 depicts these, and the following sections describe them.
1.4.1 Stage 1: Standardize

Stage 1 often coincides with a more mature server virtualization environment, and the focus is on creating a working vCloud solution with an on-demand service catalog end users can directly access. The service catalog provides rapid deployment services for non-business-critical, development, and test environments, as well as for externally sourced applications. Implementing the service catalog promotes cloud acceptance by business users and also outlines a long-term vCloud implementation strategy with planning for operational and organizational change. The following capabilities are important for this stage:

- **Financial model and measurement**: Awareness and understanding of the costs of assets and underlying infrastructure capacity.

- **People and organization**: Specialized but shared roles for managing virtualized environments.

- No explicit virtualization Center of Excellence established.

**NOTE**

See “Organizing for vCloud Operations” in *Operating a VMware vCloud* for information about the Center of Excellence.

- **Process and control**:
  - IT processes are adapted for virtualization but are largely manual, with specific, customized interprocess integration.
  - The focus is on limited, continuous improvement.
1.4 Journey to a Mature vCloud Implementation

Tools and technology:

▶ Online, self-service capability for development and test provisioning
▶ Online, self-service capability for Software as a Service (SaaS)–based applications
▶ Operational tools defined for virtualization environments
▶ Some business workloads run in a virtualized environment, whether internal or provided by third parties

1.4.2 Stage 2: Service Broker

Stage 2 is the first service-driven stage for a vCloud. At this stage, IT has transformed from traditional models and is focused on delivering business services within a vCloud environment. This represents a cultural shift within the organization. To be successful, it requires enhanced IT operational maturity, an optimized IT organizational structure, and supporting cloud-management tools.

The term service broker implies that IT is organized at this stage to source internally and externally, such as adding external infrastructure capacity or providing access to vendor-based SaaS applications. The business is not necessarily aware of how the services are made available, but dramatically decreased development and provisioning times support business needs with increased quality of service and greater agility.

This stage focuses on the following goals:

▶ Gaining alignment and buy-in from key business stakeholders
▶ Creating service governance, lifecycle and service design, and development processes
▶ Providing service-based financial transparency
▶ Automating and integrating tools and technology in internal and external systems

Key capabilities for this stage include the following:

▶ Financial model and measurement:
  ▶ Using usage metering and cost showback
  ▶ Applying granular costing of underlying infrastructure assets
  ▶ Educating IT customers about paying for services as an operating expense
  ▶ Changing from project-based budgeting to demand-based budgeting
▶ People and organization: Establishing the Center of Excellence with dedicated, experienced, and knowledgeable staff

▶ Process and control:
  ▶ Fully integrated IT operational processes adapted for virtualization and vCloud
  ▶ Agile-based service design and development processes established
  ▶ Service-level financial transparency
Tools and technology:

- Services defined and offered through an online consumer portal for self-service access to the service catalog
- vCloud-level disaster recovery
- Blueprint and policy-driven service development and provisioning
- Purpose-built management tools for proactive vCloud operations

1.4.3 Stage 3: Strategic Differentiator

This stage is the final stage for a mature cloud. At this point, a highly efficient, scalable cloud with hybrid capability is available for an organization. IT is delivered as a service. Automated, policy-driven governance and control applies across the vCloud environment, with zero-touch operations supported by predictive and self-healing operational tool capabilities. True application mobility and device-independent access is available. The vCloud is considered to be the de facto model within the organization. The term strategic differentiator implies that IT has changed roles and become a business differentiator by increasing agility, resulting in faster time to market; increasing efficiency, resulting in reduced costs; and increasing reliability, resulting in dramatically increased quality of service. The following are key capabilities for this stage:

- Financial model and measurement:
  - Usage-based pricing and chargeback for services provided to business customers
  - Service demand–based budgeting
  - Priced catalog of service offerings

- People and organization: The Center of Excellence manages all elements of infrastructure, end-user, and application operations.

- Process and control:
  - Optimized, integrated, and fully automated IT processes that enhance business agility and efficiency
  - Continuous process, service, and performance improvements based on predictive capabilities

- Tools and technology:
  - Full hybrid capabilities
  - Tools that support single-pane-of-glass management across private and public vCloud environments
  - Service-level disaster recovery
  - Tools that support automated corrective actions for self-healing
This page intentionally left blank
Index

A
abstraction layer (vCloud Director), 306
abstraction mapping, 71
Accelerator Service, 11
access
access management, 236-237
catalogs, 256
Active Directory Branch Office Guide Series, 303
adaptive infrastructure, 19
Add External Network and Org VDC Network workflow, 505-506
adding resources, 563-564
administrative APIs, 300
administrative organization, 75
Advanced Message Queuing Protocol (AMQP) exchange, 648
allocation models
allocation pool (committed), 29, 79-81, 248, 331-334, 629, 633-634
consumption models, 247-248
defined, 79, 247-248
mixed, 82
pay as you go, 29, 81-82, 248, 325-328, 629, 632-633
reservation pool (dedicated), 29, 79, 249, 328-331, 629, 635
service offerings, 247
storage, 249, 635-636
allocation pool (committed) allocation model, 29, 79-81, 248, 331-334, 629, 633-634
AMQP blocking tasks, 467-477
AMQP broker, 127, 466-467
AMQP messages, 464-469
API
administrative APIs, 300
API extensions, 301
API proxy, 123
block tasks, 301
characteristics, 299
defined, 49, 122-123, 307
developer communities, 123
documentation, 155
functions, 300
language bindings, 301
metadata tagging, 301
metering, 122-123
notifications, 301
query service, 301
self-service APIs, 300
vCloud API Programming Guide, 647
vCloud API Specification, 647
vCloud Director, 122-123, 299
vCloud SDK, 301
what's new, 300-301
Application Director. See vFabric Application Director
application framework, 31
application monitoring, 553-554
applications catalog, 30-31
Approve Add Move or Delete VM from vApp workflow, 490
Approve Build vApp workflow, 490
Approve Delete vApp workflow, 490
Approve Modify VM Configuration workflow, 490
Approve vApp (AD) workflow, 490
Approve vApp (Simple) workflow, 490-494
architecture
independent disk architecture, 111-113
Infrastructure as a Service (IaaS)
logical design, 50-52
overview, 45-47
technology mapping, 46-48
VMware vCloud Architecture Toolkit (vCAT), 46
load balancing, 113
logs, 238
resource groups, 58-59
security, 28
Single Sign-On (SSO)
consumer SSO architecture example, 587
vCloud provider SSO architecture example, 587
snapshots, 108-109
vCloud management architecture, 52-58
archives of logs, 623
attacks on security, 581
audit concerns, 619-620
audit logs, 628
audit trail entries, required details, 622
Authenticated Configuration Scanner (SCAP certification), 575
Authenticated Vulnerability and Patch Scanner (SCAP certification), 575
authentication
authentication services, 273
security certificates, 581
Single Sign-On (SSO), 588
two-factor authentication, 579-580
automated infrastructure, 20
automation
provisioning process automation, 201-203
task automation, 479
Automation Center
defined, 49
documentation, 155
hybrid vCloud, 147
autoscaling
benefits, 547
closed-loop systems, 548-549
comparison of closed-loop and open-loop systems, 550-551
controlled scaling, 555-556
defined, 547
monitoring, 551-556
open-loop systems, 548-550
process, 547-548
triggering the scale event, 554
uncontrolled scaling, 554
availability (DMZ firewall), 591
availability considerations, 565-567
availability management, 231-232
B
backups
credentials, 656
execute backup jobs, 657
infrastructure, 658-659
vApps, 234, 655-657
vCloud, 234-236
bandwidth (DMZ firewall), 590
basic service offering
defined, 32-33, 247
design parameters, 33-35
metering, 36-37
resource allocation and catalogs, 35-36
blocking task messages
administrator resume, 474
approval process implementation, 474
background, 469
blocking message, 473
deploying a vApp, 474
deployment models, 469, 647-653
design considerations, 128
enable blocking tasks, 472
example, 469-470
example components, 469
exchange configuration, 470
exchange routing, 471
extension (script), 648
failed/aborted task, 477
handling blocked task message, 649-650
message bus configuration, 472
publication, 648
RabbitMQ Queue Configuration, 471
resuming a blocked task, 474
routing, 648
subscribing to an AMQP queue, 649
support for, 647
triage for consumed messages, 649
use cases, 650-651
vCloud API, 301
vCloud API resume, 475-477
vCloud Director configuration, 472
broad network access, 18
browsing catalogs, 255
business agility, 159
Business and Consumer Control, 160, 182-185
business applications, 31
business continuity, 655
business service catalog, 21

capacity monitoring
metrics, 638-639
triggers, 638-639
Capacity Planner tool
alignment with Agile vCloud delivery methodology, 537-538
capabilities, 515, 534-538
dashboard portal, 536
data analyzer, 536
data collector, 535
data manager, 535
information warehouse, 535
support, 534
capacity planning
benefits of, 629
consumption models
allocation pool (committed), 29, 629, 633-634
pay as you go, 29, 629, 632-633
reservation pool (dedicated), 29, 629, 635
manual processes, 639
network capacity planning, 636
sizing for workload resource group clusters, 629
storage, 635-636
capacity provisioning, 643
Capacity Remaining Scoreboard Dashboard, 459
catalogs
access, 256
browsing, 255
catalog items, 252-253
cost, 254
defined, 74, 249-250
global catalog, 254
how they are used, 250-251
media files, 249-251, 257
networks, 258
populating, 252-255
public catalogs, 410-416
publishing, 256-257
searching, 255
sharing, 256
use cases, 253-254
vApps, 252
vFabric Application Director, 255
CC (Common Criteria) certification, 573-574
cell load balancing, 57, 570-571
cell monitoring, 611-613
Center of Excellence (COE), 164
Certificate Authority (CA), 314, 433-434, 583
Certificate Signing Request (CSR), 315-317, 318-322
certificates, 314-324, 433-434, 581-584
certifications
  Common Criteria (CC) certification, 573-574
  Federal Information Processing Standards (FIPS) certification, 573-575
  ISO 27001 certification, 27
  Security Content Automation Protocol (SCAP) certification, 573-575
  SSAE 16, SOC 2 report, 27
changing MAC addresses, 293-297
chargeback
  accountability, 117
  cost transparency, 117
  policies, 24
  procedures, 117
Chargeback Manager
  architecture, 117-119
  capabilities, 18, 117, 307
  cost calculation, 120
  data collectors, 119-120
  database, 119
  documentation, 121
  load balancing, 118
  maximums, 120
  pricing models, 121-122
  reporting, 122
  user roles, 120
closed-loop systems
  versus open-loop systems, 550-551
  overview, 548-549
cloud bursting
  benefits, 547
  closed-loop systems, 548-549
  comparison of closed-loop and open-loop systems, 550-551
  controlled scaling, 555-556
  defined, 547
  monitoring, 551-556
  open-loop systems, 548-550
  process, 547-548
  triggering the scale event, 554
  uncontrolled scaling, 554
cloud computing
  business agility, 159
  cloud components, 6
  cost efficiency, 159
  deployment models, 16-17
  IT strategy, 15
  monitoring consumer workloads, 241
  quality of service, 21, 159
  service characteristics, 18-20
  service development approach, 20-21
  service layers, 17, 158-160
  standards, 6-7
CloudCleaner, 519-534
code signing certificate, 582
COE (Center of Excellence), 164
committed service offering
  defined, 32, 37-38, 247
  design parameters, 38-39
  metering, 40
  resource allocation and catalogs, 39
Common Criteria (CC) certification, 573-574
community vCloud, 8, 17
compliance, 24-28
compliance concerns, 619-620
compliance management, 223-228
compliance use cases for logs, 623-627
component failure and availability considerations, 565-567
component logs, 626-625
components of vCloud, 48
composite metrics, 552
compute layer (vCloud management cluster), 55-56
compute resources
  defined, 59
  stateless ESXi, 59-60
configuration management, 223-228
Configuration Manager, 18, 307
Configure vCloud Director AMQP Subscription workflow, 487
Connector
  architecture, 148-149
  datacenter extension, 150
  defined, 49, 307
  hybrid vCloud, 147-154
  limitations, 153-154
  multitenant vCloud Connector node, 152
  placement, 148-149
  use cases, 150
constructs
  catalog, 74
  external network, 74
  external networks, 88
  network pool, 74
  organization, 74, 306
  organization virtual datacenter, 74, 306
  organization virtual datacenter network, 74, 92-93
  organization virtual datacenter networks, 91-92
  organization virtual datacenters, 78-87
  organizations, 73-75
  overview, 71-73
  provider virtual datacenter, 74-78, 306
  vApp network, 74
vApp networks, 93-102
vApps, 74
consumer (defined), 21
Consumer Manager, 179
Consumer Organization Administrator user role, 26
Consumer Organization Author user role, 26
Consumer Organization User user role, 26
customer resource capacity, 245-247
customer resources, 244-246
customer self-service portal, 200-201
customer SSO architecture example, 587
consumption
  approach, 244
  consumer resources, 244-246
  overview, 243-244
  workflows, 131
consumption models
  allocation models, 247-248
  allocation pool (committed), 29, 79-81, 248, 331-334, 629, 633-634
  mixed, 82
  pay as you go, 29, 81-82, 248, 325-328, 629, 632-633
  reservation pool (dedicated), 29, 79, 249, 328-331, 629, 635
  service offerings, 247
continuity management, 232-236
cost efficiency, 159
Control, 27
controlled scaling, 555-556
CPU Dashboard, 442-444
Create a vCloud Director Notification Subscription workflow, 483-490
Create External Networks and Org VDC Networks from VMs List workflow, 505
Create External Networks and Organization VDC Networks from a VM Folder workflow, 502-504
Create External Networks and Organization VDC Networks from Resource Pool VMs workflow, 502-504
credential management workflow, 656
CSR (Certificate Signing Request), 315–322
cURL, 379
Custom Deploy vApp workflow
  initialization process, 508-510
  inputs, 509
  instantiation process, 508-510
  operations, 506
  outputs, 508
  prerequisites, 507-508
  schema, 507
  steps, 508-513
  usage, 508
  workflow folders, 508
custom workflow development guidelines, 665-669
customer (defined), 21
customer demand pipeline (capacity forecasting), 637-638
Customer Manager, 176
Customization Config workflow, 491
Customize VM Names and IP workflow, 490

dead connection detection or equivalent (DMZ firewall), 590
dedicated service offering
  defined, 247
  defined, 33, 40
  design parameters, 40-41
  metering, 43
  resource allocation and catalogs, 41-42
demand pipeline (capacity forecasting), 637-638, 642
deploying vApps, 258, 266-268
deployment models, 16-17
deployment options, 142-145
deployment readiness for vApps, 276-297
derived metrics, 552
Desktop as a Service (DaaS), 17, 159
developer communities, 123
developer environment for orchestrated vCloud environments, 668-669
diagnostic logs, 628
digital certificates, 581-584
direct organization virtual datacenter network, 92
direct vApp network, 94-95
Director. See vCloud Director
directory services
  Active Directory, 273
  authentication services, 273
  hosting locations, 274-275
  location, 274
  Microsoft Active Directory, 273-274
  placement, 274
  Single Sign-On (SSO), 274-275
disaster recovery
  management cluster, 233
  vApps, 283
  vCloud Director
    considerations, 595-596
    design implications, 596
    infrastructure resiliency case study, 595
    logical infrastructure, 598-599
event notifications, 647-653

evolution of organizational structure, 180-182

evolution of vCloud operations
  people, 164
  process governance and implementation, 164-165
  tools, 165-166

expandable static port bindings, 636

Extended Validation (EV) SSL certificate, 582

extending the lease of a running vApp, 271-273

extension (script), 128, 648

external networks, 74, 88, 361-364

F

fast provisioning, 82-84

Federal Information Processing Standards (FIPS) certification, 573-575

fenced vApp network, 95-96

firewalls
  DMZ firewall, 590-591
  logs, 28, 590
  security, 591

FISMA certification, 28

fixed scaling, 556-557

forecast metrics, 552

forecasting capacity
  capacity trending, 637-638, 642-645
  demand pipeline, 637-638, 642
  overview, 637-638

fully authenticated SSL certificate, 582

functional specifications and effort estimate (workflow development lifecycle), 666

G-H

global catalog, 254

Handle vCloud Director Message Notifications policy, 488-489
handling
  blocking tasks messages, 649-650
  notification messages, 649
hardware load balancers, 114
Health Status Dashboard, 456-458
HealthAnalyzer tool
  capabilities, 515, 538-540
  requirements, 539-540
  support, 534
Heat Map widget, 442
HIPAA/HITECH, 24
holistic infrastructure, 19
hosts in upgrade process for vCloud Director, 663
hybrid vCloud, 8, 16-17, 147-154

IaaS (Infrastructure as a Service)
  architecture
    logical design, 50-52
    overview, 45-47
    technology mapping, 46-48
    VMware vCloud Architecture Toolkit (vCAT), 46
  closed loop, 548-549
  comparison of closed-loop and open-loop systems, 550-551
  defined, 5, 17, 157-159
  monitoring, 551-556
  open loop, 548-550
  service-level agreements, 298
idle session timeouts (DMZ firewall), 590
IKE Phase 1 parameters, 576
IKE Phase 2 parameters, 578
implementation (workflow development lifecycle), 666
Import a Folder Virtual Machines to a Virtual Datacenter workflow, 495-497
Import a Resource Pool VMs to a Virtual Datacenter workflow, 495-497
Import a VM with Remapping Networks workflow, 499-502
Import VMs to VDC workflow, 497-499
importing virtual machines, 494-506
incident management, 217-223
independent disk architecture, 111-113
information technology (IT)
  changing role of IT organizations, 166-167
  IT as a Service (ITaaS), 167
  server virtualization, 167
  service catalog, 21
  shadow IT, 166
infrastructure applications, 31
Infrastructure as a Service (IaaS)
  architecture
    logical design, 50-52
    overview, 45-47
    technology mapping, 46-48
    VMware vCloud Architecture Toolkit (vCAT), 46
    closed loop, 548-549
    comparison of closed-loop and open-loop systems, 550-551
    defined, 5, 17, 157-159
    monitoring, 551-556
    open loop, 548-550
    service-level agreements, 298
infrastructure backup/restore, 658-659
Infrastructure Control, 160, 239-241
infrastructure monitoring, 553-554
Infrastructure Navigator, 18, 307
Infrastructure Operations, 167-169
Infrastructure Operations Center of Excellence (COE) model, 169-175
infrastructure scaling
  adding/removing resources, 563-564
  connectivity, 564
  defined, 556
  fixed scaling, 556-557
  foundational requirements, 561-564
  intelligent scaling, 556-560
localization, 556
scale everything, 556-558
scaling management, 562-563
installing
CloudCleaner, 526-527
SSL certificates, 322-324
vCloud, 158
vCloud Provisioner, 521
integrating with existing enterprise system management
available mechanisms, 647
vCloud API Programming Guide, 647
vCloud API Specification, 647
intelligent scaling, 556-560
interacting with vApps, 268-271
internal vCloud, 7, 16-17
Internet Protocol version 6 (IPv6), 61-62
interoperability, 30
IP addresses, 636
IPsec, 575-576
ISO 27001 certification, 27
isolated organization virtual datacenter network, 93
isolated vApp network, 98
IT as a Service (ITaaS), 157-159, 167
IT Business Management (ITBM), 182-185
IT strategy, 15

J-K
JMX Beans monitoring, 240

key performance indicators (KPIs), 21
keystores, 584

L
LAMP stack, 252
launching workflows, 480-482
Layer 2 site-to-site connectivity, 143, 576
Layer 3 site-to-site connectivity, 143, 576
lease policies, 75
legacy deployments with vFabric Application Director, 302
limiting the number of workflows, 131
load balancing
architecture, 113
hardware load balancers, 114
load-balanced cell configuration, 308-314
vApps, 113-117
vCloud Director, 113-117, 570-571
vCloud Network and Security Edge, 116, 338-345
virtual load balancers, 115
localization (infrastructure scaling), 556
location (defined), 141
Log All workflow, 490
log management, 237-239
logging as a service, 239
logging into vCloud Director, 263-265
logs
architecture, 238
archives, 623
audit logs, 628
compliance use cases, 623-627
component logs, 626-625
diagnostic logs, 628
firewall connections, 28
firewalls, 590
frequency of review, 622
logical business layers, 625-627
minimum data types, 622
purpose of, 621-622
retention, 623
shared accounts, 623
sources, 624-627
unauthorized software, 623
user account changes, 623
user activities, 28
visibility, 28

How can we make this index more useful? Email us at indexes@samspublishing.com
MAC addresses, 293-297
man-in-the-middle (MITM) attacks, 581
management cluster
  cell load balancing, 57
  component sizing, 54-55
  compute layer, 55-56
  dashboard, 460-463
  defined, 240
  disaster recovery, 233
  network layer, 56
  overview, 53-54
  storage layer, 56
  vCenter linked mode, 57
manual processes for capacity management, 639-640, 645-646
Mass VM Import package, 494-495
mature vCloud implementation
  journey states defined, 11
  Service Broker, 13-14
  Standardize, 12-13
  Strategic Differentiator, 14
MBeans and cell monitoring, 611-613
measured service, 19, 199
media files, 249-251, 257
Memory Dashboard, 446
messages
  AMQP broker, 127
  AMQP messages, 464-469
  blocking task messages, 647-653
defined, 127
design considerations, 128
extension (script), 128
handling blocking tasks messages, 649-650
handling notification messages, 649
notifications, 647-653
publishing, 127
routings, 127, 648
subscribing to an AMQP queue, 649
triage for consumed messages, 649
metadata tagging (vCloud API), 301
metering
  reporting, 24
  service showback and metering process, 199
vCloud API, 122-123
metrics
  capacity monitoring, 638-639
  composite metrics, 552
derived metrics, 552
  forecast metrics, 552
Microsoft Active Directory, 273-274
migrating vApps, 261-264
migrating workloads
  existing workloads to a private vCloud, 540-541
  Migration Manager tool, 540-541
  physical workloads to vSphere, 259
P2V methodology, 541
vApps, 261-264
virtual workloads to vCloud Director, 259-261
Migration Manager tool
  capabilities, 515, 540-541
  requirements, 541
  sample screens, 541
  support, 534
  workflows, 541
minimum data types, 622
MITM (man-in-the-middle) attacks, 581
mixed allocation models, 82
models of consumption
  allocation pool (committed), 29, 629, 633-634
  pay as you go, 29, 629, 632-633
  reservation pool (dedicated), 29, 629, 635
monitoring
  application, 553-554
cloud consumer resources and workloads, 241
cloud consumer workloads, 241
criteria, 552-553
end user, 553
infrastructure, 553-554
Infrastructure as a Service (IaaS), 551-556
management cluster, 240
metrics
  composite metrics, 552
derived metrics, 552
  forecast metrics, 552
polled monitoring, 551-552
process, 551
stream monitoring, 552
tCloud Director, 240-241
VMware vCloud Networking and Security
  Edge, 241
monitoring capacity
  metrics, 638-639
triggers, 638-639
multisite considerations
  availability, 139
  overview, 137-139
multisite vCloud
  defined, 141
  support, 146

N
NAT traversal (NAT-T), 576
National Institute of Standards and Technology (NIST)
  cloud components, 6
  service characteristics, 18-20
  service layers, 17, 158-159
NcpuUC (new CPU units) variable, 643
network access security
  NAT traversal (NAT-T), 576
two-factor authentication, 579-580
use cases, 575-579
VPN connectivity
  remote access, 576-577
  site-to-site VPN connectivity, 576-579
Network Dashboard, 452-453
network layer (vCloud management cluster), 56
Network Operations Center (NOC), 167-168
network pools, 74, 88-90
network resources
  defined, 60
  I/O controls, 61
  Internet Protocol version 6 (IPv6), 61-62
  vCloud Networking and Security App, 62
  vCloud Networking and Security Data Security, 63
  vCloud Networking and Security Edge, 62
  Virtual eXtensible LAN (VXLAN), 62
  vShield Endpoint, 63
Networking and Security Data Security, 63
Networking and Security Edge
  defined, 49, 307
documentation, 155
gateway, 91
load balancing, 116, 338-345
monitoring, 241
network resources, 62
setup, 350-361
static routing, 345-350
networks
  capacity planning, 636
  external networks, 88, 361-364
  organization catalogs, 258
  organization virtual datacenter network, 92-93
  organization virtual datacenter networks, 91-92
  overview, 87-88
  private vCloud, 104-106
  public vCloud, 102-104, 361-364
  vApp networks, 93-102
  VCDNI-Backed Organization Network, 388-393
  vCloud network isolation-backed considerations, 91

How can we make this index more useful? Email us at indexes@samspublishing.com
vCloud Networking and Security Edge gateway, 91
VLAN-backed considerations, 91
VLAN ORG Network, 393-397
vSphere port group-backed considerations, 89
VXLAN-backed considerations, 89-91
NIAP Common Criteria Evaluation and Validation Scheme for IT Security (CCEVS), 573-574
NIST (National Institute of Standards and Technology)
  cloud components, 6
  service characteristics, 18-20
  service layers, 17, 158-159
NmemUC (new memory units) variable, 643
NOC (Network Operations Center), 167-168
notification package (vCloud Director), 483
notifications
  design considerations, 128
  extension (script), 648
  handling, 649
  publication, 648
  routing, 648
  subscribing to an AMQP queue, 649
  support for, 647
  triage for consumed messages, 649
  use cases, 650-651
  vCloud API, 301
NUC, cpu (CPU units of consumption) variable, 643
NUC, mem (memory units of consumption) variable, 643
NVGB (new storage GB) variable, 643

O
OLA (operational-level agreement), 20-22
on-demand self-service, 19, 199
open-loop systems
  versus closed-loop systems, 550-551
  overview, 548-550
Open Virtualization Format (OVF), 260-261
operating systems, 31
operational-level agreement (OLA), 20-22
Operational Readiness for Cloud Computing Service, 11
Operations
  Infrastructure Operations, 167-169
  Infrastructure Operations Center of Excellence (COE) model, 169-175
  Network Operations Center (NOC), 167-168
  non-vCloud environments, 168
  organizational overview, 167
  service offerings, 168
  Tenant Operations, 167-168, 182-180
  vCloud environments, 168
Operations Control
  access management, 236-237
  availability management, 231-232
  capacity management, 204-209
  compliance management, 223-228
  configuration management, 223-228
  continuity management, 232-236
  defined, 160, 200
  event management, 217-223
  incident management, 217-223
  log management, 237-239
  orchestration management, 228-231
  overview, 200
  performance management, 209-217
  problem management, 217-223
  provisioning management, 200-204
  security management, 236-239
Operations Management Suite, 49, 209, 223, 307
Operations Manager
  defined, 18, 307
  documentation, 223
  integration with vCloud Director, 58
orchestrated vCloud environments
developer environment, 668-669
illustration, 668
preproduction environment, 669
production environment, 669
support environment, 669
test environment, 669
orchestration
adding/removing resources, 563-564
connectivity, 564
defined, 556
fixed scaling, 556-557
foundational requirements, 561-564
intelligent scaling, 556-560
localization, 556
orchestration content lifecycle, 666-667
orchestration management, 228-231
scale everything, 556-558
scaling management, 562-563
organization catalogs
access, 256
browsing, 255
catalog items, 252-253
cost, 254
defined, 249-250
global catalog, 254
how they are used, 250-255
media files, 249-251, 257
networks, 258
populating, 252-255
public catalogs, 410-416
publishing, 256-257
searching, 255
sharing, 256
use cases, 253-254
vApps, 252
vFabric Application Director, 255
organization virtual datacenter
allocation models, 79-82, 324-337
defined, 74, 78-79, 306
fast provisioning, 82-84
mixed allocation models in a provider virtual
datacenter, 82
private vCloud considerations, 87
public vCloud considerations, 86-87
thin provisioning, 82
vApp placement, 84-85
organization virtual datacenter networks
defined, 74, 91-92
direct, 92
isolated, 93
routed, 92
organizational structure, 180-182
organizations
administrative organization, 75
defined, 73-74, 306
policies, 75
standard organization, 75
orgvirtual datacenter (organization virtual data-
base) variable, 643
OVF (Open Virtualization Format), 260-261

P
PaaS (Platform as a Service)
defined, 17, 159
service-level agreements, 298
packages for workflow examples, 513
panic buying, 629
pay as you go allocation model, 29, 81-82,
248, 325-328, 629, 632-633
Payment Card Industry (PCI)
requirement #10.3, 27
PCI DSS, 24
people, 164
performance
performance management, 209-217
service provider performance offerings, 334-337
snapshots, 111
Plan and Design Service, 11
planning capacity. See capacity planning
Platform as a Service (PaaS)
defined, 17, 159
service-level agreements, 298
POC Jumpstart Service, 10
policies
  organizations, 75
vApps, 75
polled monitoring, 551-552
populating a catalog, 252-255
port requirements, 591-592
preproduction environment in orchestrated vCloud environments, 669
pricing models, 121-122
private vCloud
  defined, 7, 16-17
  migrating existing workloads, 540-541
    networks, 104-106
virtual datacenters, 87
problem management, 217-223
process governance and implementation, 164-165
process maturity, 161-166
process maturity scales, 161-163
production environment in orchestrated vCloud environments, 669
professional services, 10-11
proliferation of virtual machine templates and customization scripts, 302
provisioning automation, 201-203
capacity, 643
consumer self-service portal, 200-201
fast provisioning, 82-84
management, 200-204
managing, 200-204
process analyst, 203-204
thin provisioning, 82
workflow, 201-203

Provisioning Accelerator Service, 14
public catalogs, 410-416
public vCloud
  defined, 8, 16-17
  networks, 102-104, 361-364
virtual datacenters, 86-87
publishing
  catalogs, 256-257
  vCloud messages, 127
P2V methodology, 541

Q
quality of service, 21, 159
query service (vCloud API), 301
queue routing key, 649
QuoVadis, 314

R
RabbitMQ Queue Configuration, 471
rapid elasticity, 18, 199
recommended protection policies, 658-659
recovery
  vApps, 657
  VMware Data Recovery, 234-236
Red Hat patches for vCloud Director upgrade process, 603
redundancy overhead, 631-632
regulatory compliance logs
  minimum data types, 622
  retention, 623
remote access, 576-577
removing resources, 563-564
reporting, 24, 122
requirements gathering (workflow development lifecycle), 665
reservation pool (dedicated) allocation model, 29, 79, 249, 328-331, 629, 635
resilient infrastructure, 20
resource design
constructs
catalog, 74
external network, 74
external networks, 88
network pool, 74
organization, 74, 306
organization virtual datacenter networks, 74, 91-93
organization virtual datacenters, 74, 78-87, 306
organizations, 73-75
overview, 71-73
provider virtual datacenter, 74-78, 306
vApp network, 74
vApp networks, 93-102
vApps, 74
overview, 71
resource groups
architecture, 58-59
compute resources
defined, 59
stateless ESXi, 59-60
defined, 58-59
network resources
defined, 60
I/O controls, 61
Internet Protocol version 6 (IPv6), 61-62
vCloud Networking and Security App, 62
vCloud Networking and Security Data Security, 63
vShield Endpoint, 63
storage resources
defined, 63-64
storage I/O control (SIOC), 66
storage tiering, 64-66
vSphere Storage APIs—Array Integration (VAAI), 66-67
vSphere Storage DRS, 67-69
vSphere Storage vMotion, 66
vSphere Client, 59
resource metering, 24
resource pooling, 19, 199
resource sizing, 69-71
resources
adding, 563-564
network resources
vCloud Networking and Security Edge, 62
Virtual eXtensible LAN (VXLAN), 62
removing, 563-564
REST API, 482
restoring
infrastructure, 658-659
vApps, 234, 655-657
vCloud, 234-236
retention of logs, 623
roles, 24-26
routed organization virtual datacenter network, 92
routed vApp network, 96-97
routing keys, 485-487
routing messages, 127, 648
runtime leases, 271-273
S
SaaS (Software as a Service)
defined, 17, 159
service-level agreements (SLAs), 298
SAN (Subject Alternative Name) SSL certificate, 582
scalability (DMZ firewall), 591
scale everything approach, 556-558
scaling infrastructure
adding/removing resources, 563-564
connectivity, 564
defined, 556
fixed scaling, 556-557
foundational requirements, 561-564
intelligent scaling, 556-560
localization, 556

How can we make this index more useful? Email us at indexes@samspublishing.com
scale everything, 556-558
scaling management, 562-563
scaling management, 562-563
SCAP (Security Content Automation Protocol) certification, 573-575
SDDC (Software Defined Data Center), 8
searching catalogs, 255
Secure Sockets Layer (SSL), 434, 581
security
architecture, 28
attacks, 581
certificates, 581-584
certifications, 573-575
compliance controls, 27
compliance definition, 27
compliance visibility and transparency, 28
control, 24
DMZ firewall, 590-591
firewalls, 591
network access, 575-580
port requirements, 591-592
signed certificates, 433-434
Single Sign-On (SSO)
consumer, 423-433
provider, 416-423
use cases, 584-586
snapshots, 110
transparency, 24
security attacks
MITM (man-in-the-middle) attacks, 581
side channel attacks, 581
Security Content Automation Protocol (SCAP) certification, 573-575
security management, 236-239
self-service APIs, 300
self-signed SSL certificate, 582-583
Server Gated Cryptography (SGC)-enabled SSL certificate, 582
Server Resource Kit, 515-534
server virtualization, 167
service (defined), 21
Service Administrator, 178-179
Service Analyst, 178
Service Architect, 177-179
Service Catalog Manager, 177, 194
service characteristics, 18-20
service classes, 247
Service Control
capabilities, 160, 185
roles and responsibilities, 193-195
service catalog components, 186
service catalog evolution, 187-188
service governance and lifecycle management, 185
service interrelationships, 187
service levels
establishing, 189
management, 190
service-level agreement (SLA), 190-193
service types, 186-187
staffing considerations, 195
standardization of service offerings, 188-189
service definition
applications catalog, 30-31
capacity distribution and allocation models, 29-30
compliance, 24-28
considerations, 22
interoperability, 30
metering, 24
reporting, 24
security, 24-28
service objectives, 22-23
use cases, 23
user roles, 24-26
Service Design and Development Management, 195-199
Service Developer, 177-179
service development approach, 20-21
service layers, 17, 158-160
Service Leader, 175-176
service-level agreements (SLAs)
  defining, 20-21, 30-32, 190, 297-299
  vCloud layers, 190-193, 297-299
Service Level Manager, 194-195
service-level objective (SLO), 22
service-level target (defined), 21
service mobility, 199
service models, 17
service offerings
  basic, 32-37
  basic service offering, 247
  committed, 32-33, 37-40
  committed service offering, 247
  consumption models, 247
  dedicated, 33, 40-43
  dedicated service offering, 247
  examples, 32-34
  matrix, 34
  vCloud Operations, 168
service orchestration
  adding/removing resources, 563-564
  connectivity, 564
  defined, 556
  fixed scaling, 556-557
  foundational requirements, 561-564
  intelligent scaling, 556-560
  localization, 556
  management, 228-231
  orchestration content lifecycle, 666-667
  scale everything, 556-558
  scaling management, 562-563
Service Owner, 176, 179, 194
Service Portfolio Manager, 177-179, 193-194
service provider performance offerings, 334-337
Service QA, 178
service reporting, 24
service showback and metering process, 199
services automation tools. See Services Software Solutions
Services Software Solutions
  subscriptions, 534
  support, 534
VMware Capacity Planner
  capabilities, 515, 534-538
  support, 534
VMware HealthAnalyzer
  capabilities, 515, 538-540
  support, 534
VMware Migration Manager
  capabilities, 540-541
  defined, 515
  support, 534
VMware Partner Central, 534
shadow IT, 166
shared accounts, 623
sharing catalogs, 256
side channel attacks, 581
single points of failure (SPOF), 565
Single Sign-On (SSO)
  authentication, 588
  authentication workflow, 588
  consumer SSO architecture example, 587
  design considerations, 589-590
  directory services, 274-275
  security
    consumer, 423-433
    provider, 416-423
    use cases, 584-586
  use cases, 584-586
  vCloud provider SSO architecture example, 587
single site vCloud
  defined, 141
  support, 145-146
SIOC (storage I/O control), 66
Site Recovery Manager (SRM), 233, 596-597
site-to-site VPN connectivity, 576-579
sizing for workload resource group clusters, 629
sizing for workload virtual machine, 24, 30

How can we make this index more useful? Email us at indexes@samspublishing.com
SLAs (service-level agreements)
  defining, 20-21, 30-32, 190, 297-299
  vCloud layers, 190-193, 297-299
SLO (service-level objective), 22
SMART (Specific, Measurable, Actionable, Realistic, Time-bound), 21
SMTP filtering (DMZ firewall), 590
snapshots, 108-111, 397-402
SOAP API, 482
Software as a Service (SaaS), 17, 159
  service-level agreements (SLAs), 298
Software Defined Data Center (SDDC), 8
software logs, 623
software tools
  Capacity Planner, 515
  HealthAnalyzer, 515
  overview, 515-516
  Server Resource Kit, 515-534
SOX, 24
SPOF (single points of failure), 565
SRM (Site Recovery Manager), 233, 596-597
SSAE 16, SOC 2 report certification, 27
SSL certificates, 322-324, 581-584
SSL (Secure Sockets Layer), 434, 581
SSO (Single Sign-On)
  authentication, 588
  authentication workflow, 588
  consumer SSO architecture example, 587
  design considerations, 589-590
  directory services, 274-275
  security
    consumer, 423-433
    provider, 416-423
    use cases, 584-586
  use cases, 584-586
  vCloud provider SSO architecture example, 587
standard organization, 75
standardized infrastructure, 19
standards, 6-7
stateless ESXi, 59-60
static routing, 98-102, 345-350
steady state application, 30
storage allocation, 249, 635-636
Storage Dashboard, 449
storage design
  snapshots, 110, 397-402
  storage DRS with vCloud Director, 402-410
storage I/O control (SIOC), 66
storage independent of virtual machines, 111-113
storage layer (management cluster), 56
storage leases, 271-273
storage resources
  defined, 63-64
  storage I/O control (SIOC), 66
  storage tiering, 64-66
  vSphere Storage APIs—Array Integration (VAAI), 66-67
  vSphere Storage DRS, 67-69
  vSphere Storage vMotion, 66
Storage vMotion, 287-291
stream monitoring, 552
stretched clusters, 146
stretched Layer 2 networks, 596-599
Subject Alternative Name (SAN) SSL certificate, 582
subscriber compliance, 28
subscriptions
  AMQP queue, 649
  VMware Services Software Solutions, 534
support
  multisite vCloud, 146
  Services Software Solutions, 534
  single site vCloud, 145-146
  workflow development lifecycle, 666
support environment for orchestrated vCloud environments, 669
symmetric encryption, 581
T
T (time) variable, 643
tagging (vCloud API), 301
task automation, 479
technology mapping, 18, 46-48
Tenant Operations, 167-168, 182-180
test environment for orchestrated vCloud environments, 669
test (workflow development lifecycle), 666
thin provisioning, 82
threats to business continuity, 655
TLS (Transport Layer Security), 434, 581
Tpurchase (organization virtual datacenter expansion purchase time) variable, 643
transient application, 30
transparency, 24-28
Transport Layer Security (TLS), 434, 581
triage for consumed messages, 649
triggers
capacity monitoring, 638-639
scale event, 554
workflows, 482-494
two-factor authentication, 579-580

U
Ubuntu Linux vApp, 411-414
unauthorized software logs, 623
uncontrolled scaling, 554
updating
vApp templates, 257
vApps, 293-297
vCAT (vCloud Architecture Toolkit), 2
upgrade checklists, 661
upgrade process for vCloud Director
advantages of upgrading, 608-609
backup considerations, 604
cells, 661-662
components to backup, 603-604
downtime for specific components, 602-603
edge devices, 662
general considerations, 603
hosts, 663
non-vCloud components, 604-603
phase 1, 601-606, 661-662
phase 2, 601, 662-663
phase 3, 601, 663
phase 4, 603, 663
phases, 601
planning, 601
post-upgrade considerations, 606
preupgrade considerations, 605
step-by-step directions, 605-607
validation, 662, 663
vCenter Server, 662-663
vCloud Networking and Security Manager, 662
use cases
accessing network resources on an external network, 99
allocation pool model, 331
blocking tasks, 650-651
catalog entities, 253-254
changing MAC addresses, 293
distributed vCloud, 139-140
enabling vApp networks connected to an organization virtual datacenter network to communicate directly, 99
network access security, 575-579
notifications, 650-651
pay as you go allocation model, 325
public catalogs, 411
reducing layers of NAT from external networks to vApp networks, 100
reservation pool model, 328-329
service definitions, 23
Single Sign-On (SSO), 584-586
snapshots, 109, 398
static routing, 99-102

How can we make this index more useful? Email us at indexes@samspublishing.com
vApp migration, 287
vCenter Operations Manager, 435
vCloud Connector, 150
user account changes, 623
user activities, 28
user roles, 24-26, 120

V
VAAI (vSphere Storage APIs—Array Integration), 66-67
VADP (VMware vSphere Storage APIs—Data Protection), 657
validation of upgrade process for vCloud Director, 662, 663
vApp networks, 74, 93-102
vApps
backups, 234, 655-657
blocking task messages, 474
defined, 74, 106, 259
deploying, 258, 266-268
deployment readiness, 276-297
design considerations, 106-107, 276
differences between vSphere and vCloud Director vApps, 107-108
disaster recovery, 283
extending the lease of a running vApp, 271-273
interacting with, 268-271
lifecycle considerations, 284-285
limitations within vCloud, 282-283
load balancing, 113-117
migration, 261-264
moving a vApp between organization virtual datacenters, 291-293
network design considerations, 277-281
Open Virtualization Format (OVF), 260-261
organization catalogs, 249-252
OVF package upload latency considerations, 286
OVF properties, 285-286
parameters, 263-264
placement algorithm, 84-85
policies, 75
provisioning time, 286-287
public catalogs, 410-416
recovery, 657
restoring, 234, 655-657
runtime leases, 271-273
storage efficiency, 286-287
storage leases, 271-273
Storage vMotion, 287-291
template management, 123-125
Ubuntu Linux vApp, 411-414
updating, 293-297
updating vApp templates, 257
use cases for migration of vApps, 287
validations, 283-284
virtual hardware, 107
virtual machine hardware version considerations, 276-277
vCAT (vCloud Architecture Toolkit)
defined, 2, 46
design guidelines, 1-2
documentation, 2
overview, 1-2
updates, 2
vendors, 1
VCDNI-Backed Organization Network, 388-393
vCenter Chargeback Manager
architecture, 117-119
capabilities, 117
cost calculation, 120
data collectors, 119-120
database, 119
defined, 307
documentation, 121, 155
load balancing, 118
maximums, 120
pricing models, 121-122
reporting, 122
user roles, 120
vCenter Configuration Manager, 307
vCenter Infrastructure Navigator, 307
vCenter linked mode, 57
vCenter Operations Management Suite, 49, 209, 223, 307
vCenter Operations Manager
  background, 434-435
dashboards, 440-463
database connection configuration, 440
defined, 18, 307
deployment models, 434
documentation, 223
example, 435
example components, 434
Hyperic adapter, 439
Hyperic HQ database, 439-440
integration with vCloud Director, 58
use case, 435
vCenter Operations Manager and vFabric
Hyperic Integration, 438
vFabric Hyperic
  agent, 437
  component, 436
database, 437
server, 437
user interface, 437
widget configuration, 441-442
vCenter Orchestrator
  blocking tasks, 651-653
blog, 513
capabilities, 49, 128-129, 307
client, 133, 480-482
community, 513
configuration elements, 666-667
design considerations, 129-130
documentation, 155, 482
examples, 135-137
notifications, 651-653
port requirements, 592
resources, 513
scalability, 130-131
solution guidelines, 132-133
task automation, 479
vCloud Director Plug-In, 133-135
VMware Solution Exchange (VSX), 513
workflow design, 131-132
Workflow Engine, 131
workflows
  launching, 480-482
  overview, 479-482
  packages for workflow examples, 513
vCenter Server, 662-663
vCenter Site Recovery Manager (SRM), 233, 596-597
vCloud
  abstraction mapping, 71
  alignment to standards, 6-7
  availability considerations, 565-567
  backups, 234-236
  community vCloud, 8, 17
  compliance considerations, 619-620
  consumer resource capacity, 245-247
  consumer resources, 244-246
  consumption models, 247-249
  defined, 21-22
  deployment options, 142-145
documentation, 158
evolution of organizational structure, 180-182
evolution of vCloud operations
  people, 164
  process governance and implementation, 164-165
tools, 165-166
hybrid vCloud, 8, 16-17, 147-154
Infrastructure as a Service (IaaS), 5, 157
installing, 158
IT as a Service (ITaaS), 157
load-balanced cell configuration, 308-314

How can we make this index more useful? Email us at indexes@samspublishing.com
logical architecture design, 50-52
management architecture, 52-58
management cluster
cell load balancing, 57
component sizing, 54-55
compute layer, 55-56
network layer, 56
overview, 53-54
storage layer, 56
vCenter linked mode, 57
mature vCloud implementation
journey states defined, 11
Service Broker, 13-14
Standardize, 12-13
Strategic Differentiator, 14
metering, 24
migrating workloads to a vCloud, 259-264
multisite vCloud
defined, 141
support, 146
operations guidelines, 157-158
organizational structure, 180-182
private vCloud
defined, 7, 16-17
migrating existing workloads, 540-541
networks, 104-106
virtual datacenters, 87
process maturity scales, 161-163
public vCloud
defined, 8, 16-17
networks, 102-104, 361-364
virtual datacenters, 86-87
relationship among components, 48
requirements, 6
resource sizing, 69-71
restoring, 234-236
service classes, 247
service-level agreements (SLAs), 299
service offerings
basic service offering, 247
committed service offering, 247
consumption models, 247
dedicated service offering, 247
single site vCloud
defined, 141
support, 145-146
solution area to technology mapping, 8-10
suite components, 48
vCloud Accelerator Service, 11
vCloud API
administrative APIs, 300
API extensions, 301
API proxy, 123
block tasks, 301
characteristics, 299
defined, 49, 122-123, 307
developer communities, 123
documentation, 155
functions, 300
language bindings, 301
metadata tagging, 301
metering, 122-123
notifications, 301
query service, 301
self-service APIs, 300
vCloud Director, 122-123, 299
vCloud SDK, 301
what’s new, 300-301
vCloud API Programming Guide, 647
vCloud API Specification, 647
vCloud Architecture Toolkit (vCAT)
defined, 2
design guidelines, 1-2
documentation, 2
overview, 1-2
updates, 2
vendors, 1
vCloud Automation Center
   defined, 49
documentation, 155
hybrid vCloud, 147
vCloud Business and Consumer Control, 160, 182-185
vCloud Connector
   architecture, 148-149
   content sync, 151
datacenter extension, 150
defined, 49, 307
hybrid vCloud, 147-154
limitations, 153-154
multitenant vCloud Connector node, 152
placement, 148-149
use cases, 150
vCloud Director
   abstraction layer, 306
   abstraction mapping, 71
   audit logs, 628
   best practices, 303
   blocking task messages, 647-653
   cell load balancing, 57, 570-571
   cell monitoring, 611-613
   certificates, 314-324
   constructs, 71-73
   Create a vCloud Director Notification Subscription workflow, 483-490
database, 49
defined, 49, 307
diagnostic logs, 628
disaster recovery
   logical infrastructure, 598-599
   overview, 283, 595-596
   stretched Layer 2 networks, 596-599
   vCenter Site Recovery Manager, 596-597
   VXLAN, 597-600
documentation, 155, 303
Handle vCloud Director Message Notifications policy, 488-489
Home view, 265
importing virtual machines, 494-506
Installation and Configuration Guide, 662
integration with vCloud Operations Manager, 58
load-balanced cell configuration, 308-314
load balancing, 113-117
logging into, 263-265
logical constructs, 245-246
logs, 28, 628
MAC address reset procedures, 293-297
Mass VM Import package, 494-495
migrating virtual workloads, 259-261
monitoring, 240-241
multisite considerations, 137-146
notification package, 483
notifications, 647-653
organization, 306
organization virtual datacenter, 306
performance, 303
port requirements, 591-592
provider virtual datacenter, 306
Security Hardening Guide, 155, 303
server, 49
Server Resource Kit, 515-534
snapshots, 111
upgrade process
   advantages of upgrading, 608-609
   backup considerations, 604
   cells, 661-662
   components to backup, 603-604
   downtime for specific components, 602-603
   edge devices, 662
   general considerations, 603
   hosts, 663
   non-vCloud components, 604-603
   phase 1, 601-606, 661-662
   phase 2, 601, 662-663
   phase 3, 601, 663

How can we make this index more useful? Email us at indexes@samspublishing.com
phase 4, 603, 663
phases, 601
planning, 601
post-upgrade considerations, 606
preupgrade considerations, 605
step-by-step directions, 605-607
validation, 662, 663
vCenter Server, 662-663
vCloud Networking and Security Manager, 662
vApps, 107-108
vCenter Operations Manager
background, 434-435
deployment models, 434
example components, 434
vCloud API, 122-123, 299
virtual datacenter, 306
VM Storage Profiles, 402-410
vCloud Director 5.1 Documentation Center, 600
vCloud Director Adapter, 58
vCloud Director Audit, 516-518
vCloud Infrastructure Control, 160, 239-241
vCloud messages
AMQP broker, 127
defined, 127
design considerations, 128
extension (script), 128
publishing, 127
routing, 127
vCloud Network and Security Edge
load balancing, 116, 338-345
static routing, 345-350
vCloud Networking and Security App, 62
vCloud Networking and Security Data Security, 63
vCloud Networking and Security Edge
defined, 49, 241, 307
documentation, 155
gateway, 91
load balancing, 116, 338-345
monitoring, 241
network resources, 62
setup, 350-361
static routing, 345-350
vCloud Networking and Security Manager, 662
vCloud Operations
Infrastructure Operations, 167-169
Infrastructure Operations Center of Excellence (COE) model, 169-175
Network Operations Center (NOC), 167-168
non-vCloud environments, 168
organizational overview, 167
service offerings, 168
Tenant Operations, 167-168, 182-180
vCloud environments, 168
vCloud Operations Control
access and security management, 236-239
access management, 236-237
availability management, 231-232
capabilities, 160, 200
capacity management, 204-209
compliance management, 223-228
configuration management, 223-228
continuity management, 232-236
event management, 217-223
incident management, 217-223
log management, 237-239
orchestration management, 228-231
overview, 200
performance management, 209-217
problem management, 217-223
provisioning management, 200-204
security management, 236-239
vCloud Operations Framework, 157-160
vCloud Operations Manager, 58
vCloud Orchestrator, 482-494
vCloud Plan and Design Service, 11
vCloud POC Jumpstart Service, 10
vCloud provider SSO architecture example, 587
vCloud Provisioner, 519-522
vCloud Provisioning Accelerator Service, 14
vCloud SDK, 301
vCloud Service Administrator, 178-179
vCloud Service Analyst, 178
vCloud Service Architect, 177-179
vCloud Service Catalog Manager, 177
vCloud Service Control
capabilities, 160, 185
roles and responsibilities, 193-195
service catalog components, 186
service catalog evolution, 187-188
service governance and lifecycle management, 185
service interrelationships, 187
service levels
establishing, 189
management, 190
service-level agreement (SLA), 190-193
service types, 186-187
staffing considerations, 195
standardization of service offerings, 188-189
vCloud Service Design and Development Management, 195-199
vCloud Service Developer, 177-179
vCloud Service Leader, 175-176
vCloud Service Owner, 176, 179
vCloud Service Portfolio Manager, 177-179
vCloud service provider (defined), 21
vCloud Service QA, 178
vCloud Services
defined, 22
user roles, 24-26
VDDK (VMware Virtual Disk Development Kit), 657
vendors (VMware Solutions Exchange), 1
vFabric Application Director
capabilities, 123, 301-302
catalogs, 255
defined, 49, 307
design implications, 126-127
disconnected application operations, 302
legacy deployments, 302
proliferation of virtual machine templates and customization scripts, 302
security, 126-127
software repository, 126
vApp template management, 123-125
vCloud networks, 125
vFabric Hyperic, 222-223
virtual datacenters
capacity management, 640-642, 645-646
capacity thresholds, 640
capacity trending, 643-645
consumption information, 643-645
defined, 306
private vCloud, 87
public vCloud, 86-87
sample resource allocation, 641-642
units of consumption, 640
Virtual eXtensible LAN (VXLAN), 62
Virtual eXtensible LAN (VXLAN) implementation, 364-370
virtual load balancers, 115
virtual machines
importing, 494-506
MAC addresses, 293-297
storage independent, 111-113
virtualization, 15, 167
Virtualizing a Windows Active Directory Domain Infrastructure white paper, 273
visibility, 28
VLANs
network capacity planning, 636
VLAN ORG Network, 393-397
VM Storage Profiles, 402-410
VMware Capacity Planner
alignment with Agile vCloud delivery methodology, 537-538
capabilities, 515, 534-538
dashboard portal, 536
data analyzer, 536
data collector, 535
information warehouse, 535
support, 534
VMware Data Recovery, 234-236
VMware HealthAnalyzer
capabilities, 515, 538-540
requirements, 539-540
support, 534
VMware Migration Manager
capabilities, 515, 540-541
requirements, 541
sample screens, 541
support, 534
workflows, 541
VMware Operational Readiness for Cloud Computing Service, 11
VMware Partner Central, 534
VMware professional services, 10-11
VMware Services Software Solutions
subscriptions, 534
VMware Partner Central, 534
VMware Solution Exchange (VSX), 513
VMware Solutions Exchange, 1
VMware Validated Architectures (VVA), 1
VMware vCenter CapacityIQ™, 639
VMware vCenter Operations Management Suite, 49, 209, 223, 307
VMware vCenter Orchestrator, 49, 307
VMware vCenter Orchestrator Blog, 513
VMware vCenter Site Recovery Manager (SRM), 233
VMware vCloud
alignment to standards, 6-7
availability considerations, 565-567
community vCloud, 8, 17
compliance considerations, 619-620
consumer resource capacity, 245-247
consumer resources, 244-246
consumption models, 247-249
defined, 21-22
deployment options, 142-145
documentation, 158
hybrid vCloud, 8, 16-17, 147-154
Infrastructure as a Service (IaaS), 5, 157
installing, 158
IT as a Service (ITaaS), 157
logical architecture design, 50-52
management architecture, 52-58
management cluster
cell load balancing, 57
component sizing, 54-55
compute layer, 55-56
network layer, 56
overview, 53-54
storage layer, 56
vCenter linked mode, 57
mature vCloud implementation
journey states defined, 11
Service Broker, 13-14
Standardize, 12-13
Strategic Differentiator, 14
metering, 24
multisite vCloud
defined, 141
support, 146
operations guidelines, 157-158
private vCloud, 7, 16-17
public vCloud, 8, 16-17
relationship among components, 48
requirements, 6
service classes, 247
service offerings
basic service offering, 247
committed service offering, 247
consumption models, 247
dedicated service offering, 247
single site vCloud
defined, 141
support, 145-146
solution area to technology mapping, 8-10
suite components, 48
VMware vCloud Accelerator Service, 11
VMware vCloud Architecture Toolkit (vCAT)
  defined, 46
design guidelines, 1-2
documentation, 2
overview, 1-2
updates, 2
vendors, 1
VMware vCloud Automation Center, 49
VMware vCloud Connector, 307
VMware vCloud Director. See vCloud Director
VMware vCloud Networking and Security, 49, 307
VMware vCloud Networking and Security
App, 62
VMware vCloud Networking and Security Data
Security, 63
VMware vCloud Networking and Security Edge
defined, 49, 241, 307
documentation, 155
gateway, 91
load balancing, 116, 338-345
monitoring, 241
network resources, 62
setup, 350-361
static routing, 345-350
VMware vCloud Plan and Design Service, 11
VMware vCloud POC Jumpstart Service, 10
VMware vCloud Provisioning Accelerator
Service, 14
VMware vCloud Services, 22
VMware vFabric Application Director
capabilities, 301-302
catalogs, 255
defined, 49
disconnected application operations, 302
legacy deployments, 302
proliferation of virtual machine templates
and customization scripts, 302
VMware vFabric Hyperic, 222-223
VMware Virtual Disk Development Kit
(VDDK), 657
VMware vShield Endpoint, 63
VMware vSphere
catalogs, 250-251
defined, 49, 307
documentation, 303
VMware vSphere Storage APIs—Data Protection
(VADP), 657
VPN connectivity
  remote access, 576-577
  site-to-site VPN connectivity, 576-579
vShield Administration Guide, 662
vShield Endpoint, 63
vSphere
catalogs, 250-251
defined, 49
documentation, 155, 303
migrating physical workloads to vSphere,
259-263
resource groups, 59
vApps, 107-108
workflows, 482
vSphere host variables, 630
vSphere Storage APIs—Array Integration (VAAI),
66-67
vSphere Storage DRS, 67-69
vSphere Storage vMotion, 66
VSX (VMware Solution Exchange), 513
VVA (VMware Validated Architectures), 1
VXLAN for DR, 596-600
VXLAN implementation, 364-370
VXLAN ORG network for disaster recovery,
371-388
W-Z
  widgets
    configuration, 441-442
    Heat Map widget, 442
wildcard certificate, 582
workflow design, 131-132
Workflow Runner workflow, 488-491
workflows
  Add External Network and Org VDC Network workflow, 505-506
  Approve Add Move or Delete VM from vApp workflow, 490
  Approve Build vApp workflow, 490
  Approve Delete vApp workflow, 490
  Approve Modify VM Configuration workflow, 490
  Approve vApp (AD) workflow, 490
  Approve vApp (Simple) workflow, 490-494
  Configure vCloud Director AMQP Subscription workflow, 487
consumption, 131
Create a vCloud Director Notification Subscription workflow, 483-490
Create External Networks and Org VDC Networks from VMs List workflow, 505
Create External Networks and Organization VDC Networks from a VM Folder workflow, 502-504
Create External Networks and Organization VDC Networks from Resource Pool VMs workflow, 502-504
credential management workflow, 656
Custom Deploy vApp workflow, 506-513
custom workflow development guidelines, 665
Customization Config workflow, 491
Customize VM Names and IP workflow, 490
Import a Folder Virtual Machines to a Virtual Datacenter workflow, 495-497
Import a Resource Pool VMs to a Virtual Datacenter workflow, 495-497
Import a VM with Remapping Networks workflow, 499-502
Import VMs to VDC workflow, 497-499
launching, 480-482
limiting the number of workflows, 131
Log All workflow, 490
orchestrated vCloud environments, 668-669
orchestration content lifecycle, 666-667
overview, 479-482
packages for workflow examples, 513
provisioning, 201-203
triggers, 482-494
VMware Migration Manager, 541
workflow development lifecycle, 665-666
Workflow Runner workflow, 488-490, 491
workload migration
  existing workloads to a private vCloud, 540-541
  Migration Manager tool, 540-541
  physical workloads to vSphere, 259
  P2V methodology, 541
  vApps, 261-264
  virtual workloads to vCloud Director, 259-261
workload virtual machine
costing, 24
sizing, 24, 30
utilization, 30