Conquer Windows Server 2012 R2 virtualization—from the inside out!

Dive into Windows Server 2012 R2 virtualization—and really put your systems expertise to work. Focusing on both virtual desktop infrastructure and virtualized applications, this supremely organized reference packs hundreds of timesaving solutions, tips, and workarounds. Discover how the experts tackle Windows virtualization—and challenge yourself to new levels of mastery.

• Use virtualization to prevent business disruption, help improve security, simplify upgrades, and support mobile users
• Plan and deploy User State Virtualization for a consistent experience across locations and devices
• Define users, applications, and scenarios for any virtualization project
• Compare and deploy both session-based and virtual machine–based (VM-based) desktops
• Configure Client Hyper-V and work with VMs in a Client Hyper-V environment
• Install, design, configure, and administer Microsoft Application Virtualization (App-V) infrastructure and clients
• Sequence applications for efficient and reliable deployment
• Help secure remote access to virtual desktops with Remote Desktop Gateway (RD Gateway)
• Plan and implement pooled and personal desktops
• Monitor virtualized apps and desktops for health and performance

About the Authors

Byron Wright, MVP (Microsoft Exchange Server), is a consultant specializing in Windows Server, Exchange Server, and Microsoft Office 365 solutions. He teaches Management Information Systems (MIS) and networking at the University of Manitoba’s Asper School of Business and has coauthored Microsoft official curricula and the Windows Server 2008 Active Directory Resource Kit.

Brian Svidergol, MCSE, specializes in infrastructure and cloud solutions built with Windows Server, Active Directory Domain Services, Microsoft Exchange Server, Microsoft System Center, virtualization, and Microsoft Desktop Optimization Pack (MDOP). He was the MCT Ambassador at TechEd North America 2013 and authored Exam Ref 70-695 Deploying Windows Devices and Enterprise Apps.

Virtualizing Desktops & Apps with Windows Server 2012 R2

Microsoft Press

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Virtualizing Desktops & Apps with Windows Server 2012 R2 Inside Out

Byron Wright
Brian Svidergol
Chapter 1
Desktop and application virtualization ........ 1

Chapter 2
Planning and implementing user
state virtualization.......................... 31

Chapter 3
Configuring Client Hyper-V.................. 95

Chapter 4
Planning and implementing App-V............ 157

Chapter 5
Planning and deploying App-V clients........ 213

Chapter 6
Managing and administering
Application Virtualization................. 277

Chapter 7
Application sequencing........................ 319

Chapter 8
Planning and deploying session-based
virtual desktops............................... 387

Chapter 9
Configuring RemoteApp programs and
client connectivity............................ 451

Chapter 10
Planning and implementing pooled and
personal virtual desktops.................... 481

Chapter 11
Implementing Remote Access for VDI........ 541

Chapter 12
Performance and Health Monitoring of
Virtual Desktop Infrastructure............... 565

Index............................................. 591
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## Table of contents

**Introduction** ................................................................. xiii
  - System requirements ........................................... xiii
  - Acknowledgments ................................................ xiv
  - Free ebooks from Microsoft Press ............................... xiv
  - Errata, updates, & book support ................................ xiv
  - We want to hear from you ......................................... xv
  - Stay in touch .............................................................. xv

**Chapter 1**

**Desktop and application virtualization** ......................... 1
  - Overview of virtualization technologies ....................... 1
    - User state virtualization .................................... 3
    - Application virtualization .................................. 4
    - Desktop Virtualization ....................................... 6
    - Storage virtualization ....................................... 11
  - Usage scenarios for desktop virtualization .................. 12
    - Meeting legal and security requirements ................... 13
    - Supporting desktop management tasks ....................... 14
    - Improving application compatibility ....................... 15
    - Implementing desktop as a service .......................... 16
    - Supporting the mobile user experience ..................... 16
  - Considerations for implementing virtualization .............. 17
    - User experience ................................................ 17
    - Network connectivity .......................................... 18
    - Infrastructure .................................................. 20
    - Licensing requirements ....................................... 22
    - Challenges for implementing desktop and application virtualization ......................... 24
  - Identify virtualization technologies for business needs .... 25
    - Improve roaming experience for users ....................... 26
    - Improve performance of apps for mobile users ............ 26
    - Provide remote access to apps and data .................... 27
Table of contents

Chapter 2  **Planning and implementing user state virtualization**  31

- Understanding user state and user profiles  31
- User profile creation  32
- User profile content  34
- Understanding and planning user state virtualization  35
- Assess user data requirements  38
- Assess user settings requirements  39
- Evaluate compatibility considerations  40
- Evaluate infrastructure and manageability requirements  40
- Evaluate usage scenario considerations  41
- Configuring user state virtualization technologies  44
- Configuring roaming user profiles  44
- Mandatory user profiles  52
- Configuring Folder Redirection  53
- Configuring Offline Files  59
- Using the Primary Computer setting  66
- Enabling user profile disks  70
- Configuring User Experience Virtualization  70
- UE-V architecture  72
- Comparing user state virtualization options  75
- Preparing to deploy UE-V  77
- Deploying the UE-V agent  78
- Managing the UE-V agent  81
- Managing default settings location templates  84
- Creating and managing custom settings location templates  87

Chapter 3  **Configuring Client Hyper-V**  95

- Understanding Hyper-V  95
- Client Hyper-V architecture  97
- Installing Client Hyper-V  100
- Hyper-V management tools  104
- Managing virtual switches  108
- Creating virtual machines  112
- Virtual machine settings  121
- Generation 2 virtual machines  124
- Controlling virtual machines  125
- Managing virtual machine files  130
- Processing  135
- Dynamic memory  137
- Integration services  138
- Managing virtual hard disks  141
- Virtual hard disk formats  141
- Fixed and dynamically expanding disks  143
- Differencing disks  145
<table>
<thead>
<tr>
<th>Chapter 4</th>
<th>Planning and implementing App-V</th>
<th>157</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overview of App-V</td>
<td>157</td>
<td></td>
</tr>
<tr>
<td>Benefits of App-V</td>
<td>157</td>
<td></td>
</tr>
<tr>
<td>Differences between standard and virtualized applications</td>
<td>159</td>
<td></td>
</tr>
<tr>
<td>Placing and functionality of the virtualization engine</td>
<td>160</td>
<td></td>
</tr>
<tr>
<td>Application virtualization infrastructure</td>
<td>161</td>
<td></td>
</tr>
<tr>
<td>App-V application life cycle</td>
<td>161</td>
<td></td>
</tr>
<tr>
<td>App-V technologies</td>
<td>177</td>
<td></td>
</tr>
<tr>
<td>App-V deployment models</td>
<td>184</td>
<td></td>
</tr>
<tr>
<td>Planning App-V infrastructure</td>
<td>187</td>
<td></td>
</tr>
<tr>
<td>App-V infrastructure requirements</td>
<td>187</td>
<td></td>
</tr>
<tr>
<td>App-V deployment possibilities</td>
<td>189</td>
<td></td>
</tr>
<tr>
<td>Service disruption impact</td>
<td>193</td>
<td></td>
</tr>
<tr>
<td>Functional and physical placement</td>
<td>194</td>
<td></td>
</tr>
<tr>
<td>Sizing and performance</td>
<td>195</td>
<td></td>
</tr>
<tr>
<td>High availability for App-V</td>
<td>197</td>
<td></td>
</tr>
<tr>
<td>Disaster recovery</td>
<td>199</td>
<td></td>
</tr>
<tr>
<td>Deploying App-V infrastructure</td>
<td>200</td>
<td></td>
</tr>
<tr>
<td>App-V infrastructure requirements</td>
<td>201</td>
<td></td>
</tr>
<tr>
<td>Installing management databases</td>
<td>201</td>
<td></td>
</tr>
<tr>
<td>App-V Management Server configuration</td>
<td>204</td>
<td></td>
</tr>
<tr>
<td>App-V publishing server deployment and configuration</td>
<td>208</td>
<td></td>
</tr>
<tr>
<td>App-V for Remote Desktop Services client</td>
<td>210</td>
<td></td>
</tr>
<tr>
<td>Integrating App-V with System Center Configuration Manager</td>
<td>211</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Chapter 5</th>
<th>Planning and deploying App-V clients</th>
<th>213</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overview of App-V client configuration</td>
<td>213</td>
<td></td>
</tr>
<tr>
<td>App-V desktop client</td>
<td>213</td>
<td></td>
</tr>
<tr>
<td>How the App-V client accesses applications</td>
<td>215</td>
<td></td>
</tr>
<tr>
<td>Storage locations for App-V client data</td>
<td>216</td>
<td></td>
</tr>
<tr>
<td>Planning for App-V 5.0 shared content store</td>
<td>220</td>
<td></td>
</tr>
<tr>
<td>Methods for deploying the App-V client</td>
<td>224</td>
<td></td>
</tr>
<tr>
<td>App-V client for Remote Desktop</td>
<td>227</td>
<td></td>
</tr>
<tr>
<td>Installing and configuring the App-V client</td>
<td>227</td>
<td></td>
</tr>
<tr>
<td>Prerequisites for App-V client installation</td>
<td>228</td>
<td></td>
</tr>
<tr>
<td>Installing the client by using Configuration Manager</td>
<td>230</td>
<td></td>
</tr>
<tr>
<td>Installing the App-V for Remote Desktop Services client</td>
<td>247</td>
<td></td>
</tr>
<tr>
<td>Configuring the App-V client for stand-alone mode</td>
<td>250</td>
<td></td>
</tr>
<tr>
<td>App-V and Virtual Desktop Infrastructure (VDI) solution</td>
<td>252</td>
<td></td>
</tr>
</tbody>
</table>
# Table of contents

App-V 5.0 and third-party production integration .................................................. 252
Benefits of App-V and VDI integration ................................................................. 253
Building images with App-V .................................................................................... 254
Managing App-V client properties ......................................................................... 259
Managing virtual applications .................................................................................. 264
Managing file type associations .............................................................................. 265
Managing server connections .................................................................................. 266
Using Windows PowerShell to configure the App-V client ................................... 267
Using Group Policy to manage the App-V client .................................................... 270
Autoload .................................................................................................................... 273
Registry settings for the App-V client ...................................................................... 273

## Chapter 6 Managing and administering Application Virtualization .................. 277
Using the Application Virtualization Management Console ................................ 277
Managing App-V administrators ............................................................................. 281
Registering and unregistering servers ..................................................................... 282
Managing application packages ............................................................................. 284
Connection groups ................................................................................................... 287
Managing management servers by using Windows PowerShell .............................. 289
Modifying and upgrading published applications .................................................. 297
Update an application .............................................................................................. 297
Copy access and configuration ............................................................................... 303
Update a connection group ...................................................................................... 304
Remove applications ............................................................................................... 305
Edit the default configuration for a package .......................................................... 306
Exporting the configuration ..................................................................................... 307
Assignment of applications ...................................................................................... 308
Naming conventions ............................................................................................... 309
Enabling scripting for dynamic configuration ....................................................... 310
App-V reporting ........................................................................................................ 312
How App-V reporting works .................................................................................. 312
Data collected by App-V reporting ......................................................................... 314
App-V client configuration for reporting ............................................................... 315
Generating App-V reports ....................................................................................... 317

## Chapter 7 Application sequencing ........................................................................ 319
Overview of application sequencing ....................................................................... 319
App-V Sequencer ..................................................................................................... 319
The sequencing process .......................................................................................... 321
Items to document in a recipe ................................................................................ 322
Portions of a sequenced application ....................................................................... 324
Planning for application sequencing ....................................................................... 326
Sequencer configuration .......................................................................................... 326
Best practices for application installation ............................................................... 330
Best practices for package configuration ............................................................... 331
Applications that cannot be sequenced ................................................................... 332
Sequencing an application ...................................................................................... 333
### Table of contents

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Types of applications that can be sequenced</td>
<td>333</td>
</tr>
<tr>
<td>Preparing for sequencing</td>
<td>335</td>
</tr>
<tr>
<td>Sequencing tasks</td>
<td>337</td>
</tr>
<tr>
<td>Customizing the package</td>
<td>344</td>
</tr>
<tr>
<td>Package editor</td>
<td>345</td>
</tr>
<tr>
<td>Windows PowerShell</td>
<td>351</td>
</tr>
<tr>
<td>Deploying Office 2013 by using App-V</td>
<td>351</td>
</tr>
<tr>
<td>Advanced application sequencing</td>
<td>357</td>
</tr>
<tr>
<td>Package accelerators</td>
<td>357</td>
</tr>
<tr>
<td>Creating a package accelerator</td>
<td>358</td>
</tr>
<tr>
<td>Options for updating packages</td>
<td>378</td>
</tr>
<tr>
<td>Sequencing for connection groups</td>
<td>380</td>
</tr>
<tr>
<td>Dynamic configuration and targeted scripting</td>
<td>381</td>
</tr>
<tr>
<td><strong>Chapter 8</strong> Planning and deploying session-based virtual desktops</td>
<td>387</td>
</tr>
<tr>
<td>Understanding RDS</td>
<td>387</td>
</tr>
<tr>
<td>Comparing RDS and the Remote Desktop feature</td>
<td>389</td>
</tr>
<tr>
<td>RDS architecture</td>
<td>390</td>
</tr>
<tr>
<td>Connecting to virtual desktops and RemoteApp programs</td>
<td>392</td>
</tr>
<tr>
<td>RDS functionality that enhances the client experience</td>
<td>395</td>
</tr>
<tr>
<td>RemoteFX</td>
<td>397</td>
</tr>
<tr>
<td>Remote Desktop Connection configuration options</td>
<td>399</td>
</tr>
<tr>
<td>RDS licensing</td>
<td>401</td>
</tr>
<tr>
<td>Planning infrastructure for session-based desktops</td>
<td>403</td>
</tr>
<tr>
<td>Assessing RDS infrastructure requirements</td>
<td>403</td>
</tr>
<tr>
<td>Planning for the RD Session Host role service</td>
<td>406</td>
</tr>
<tr>
<td>Planning for the RD Connection Broker role service</td>
<td>408</td>
</tr>
<tr>
<td>Planning for the RD Web Access role service</td>
<td>410</td>
</tr>
<tr>
<td>Planning for preserving user state</td>
<td>411</td>
</tr>
<tr>
<td>Deploying session-based virtual desktops</td>
<td>415</td>
</tr>
<tr>
<td>Understanding the session-based desktop deployment process</td>
<td>415</td>
</tr>
<tr>
<td>Understanding session collections</td>
<td>422</td>
</tr>
<tr>
<td>Configuring session collections</td>
<td>426</td>
</tr>
<tr>
<td>Configuring RD Licensing servers</td>
<td>434</td>
</tr>
<tr>
<td>Understanding high availability for RDS</td>
<td>438</td>
</tr>
<tr>
<td>Understanding load balancing</td>
<td>439</td>
</tr>
<tr>
<td>High availability for RD Session Host servers</td>
<td>441</td>
</tr>
<tr>
<td>High availability for the RD Connection Broker role service</td>
<td>443</td>
</tr>
<tr>
<td>High availability for the RD Web Access role service</td>
<td>447</td>
</tr>
<tr>
<td>High availability for the RD Licensing role service</td>
<td>447</td>
</tr>
<tr>
<td><strong>Chapter 9</strong> Configuring RemoteApp programs and client connectivity</td>
<td>451</td>
</tr>
<tr>
<td>Publishing and configuring RemoteApp programs</td>
<td>451</td>
</tr>
<tr>
<td>Understanding RemoteApp programs</td>
<td>453</td>
</tr>
<tr>
<td>Installing applications on RD Session Host servers</td>
<td>454</td>
</tr>
<tr>
<td>Publishing RemoteApp programs</td>
<td>457</td>
</tr>
<tr>
<td>Configuring RemoteApp programs</td>
<td>458</td>
</tr>
<tr>
<td>Chapter 10</td>
<td>Planning and implementing pooled and personal virtual desktops</td>
</tr>
<tr>
<td>------------</td>
<td>-------------------------------------------------------------</td>
</tr>
<tr>
<td>Understanding pooled and personal virtual desktops</td>
<td>481</td>
</tr>
<tr>
<td>Using pooled virtual desktops</td>
<td>483</td>
</tr>
<tr>
<td>Using personal virtual desktops</td>
<td>484</td>
</tr>
<tr>
<td>Comparing virtual desktop options</td>
<td>484</td>
</tr>
<tr>
<td>High availability for pooled virtual desktops</td>
<td>485</td>
</tr>
<tr>
<td>High availability for personal virtual desktops</td>
<td>486</td>
</tr>
<tr>
<td>Planning and creating virtual desktop templates</td>
<td>489</td>
</tr>
<tr>
<td>Selecting an operating system</td>
<td>490</td>
</tr>
<tr>
<td>Activating the operating system</td>
<td>491</td>
</tr>
<tr>
<td>Updating applications and the operating system</td>
<td>494</td>
</tr>
<tr>
<td>Eliminating the system partition</td>
<td>495</td>
</tr>
<tr>
<td>Optimizing operating system configuration</td>
<td>497</td>
</tr>
<tr>
<td>Optimizing App-V</td>
<td>500</td>
</tr>
<tr>
<td>Optimizing antivirus software</td>
<td>500</td>
</tr>
<tr>
<td>Using Sysprep to prepare a virtual desktop template</td>
<td>501</td>
</tr>
<tr>
<td>Planning storage for pooled and personal virtual desktops</td>
<td>503</td>
</tr>
<tr>
<td>Using local storage for pooled and personal virtual desktops</td>
<td>503</td>
</tr>
<tr>
<td>Using a SAN for pooled and personal virtual desktops</td>
<td>505</td>
</tr>
<tr>
<td>Using scale-out file servers for pooled and personal virtual desktops</td>
<td>506</td>
</tr>
<tr>
<td>Using additional Windows Server 2012 R2 storage technologies</td>
<td>508</td>
</tr>
<tr>
<td>Capacity planning for pooled and personal virtual desktops</td>
<td>511</td>
</tr>
<tr>
<td>Capacity planning for storage</td>
<td>512</td>
</tr>
<tr>
<td>Capacity planning for memory</td>
<td>513</td>
</tr>
<tr>
<td>Capacity planning for networking</td>
<td>514</td>
</tr>
<tr>
<td>Capacity planning for processing</td>
<td>515</td>
</tr>
<tr>
<td>Capacity planning example</td>
<td>517</td>
</tr>
<tr>
<td>Implementing pooled and personal virtual desktops</td>
<td>518</td>
</tr>
<tr>
<td>Deploying RD Virtualization Host servers</td>
<td>519</td>
</tr>
<tr>
<td>Understanding user profile disks for VM-based virtual desktops</td>
<td>523</td>
</tr>
<tr>
<td>Creating a virtual desktop collection</td>
<td>524</td>
</tr>
<tr>
<td>Updating pooled virtual desktops</td>
<td>533</td>
</tr>
<tr>
<td>Implementing RemoteApp for Hyper-V</td>
<td>535</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Chapter 11</th>
<th>Implementing Remote Access for VDI</th>
<th>541</th>
</tr>
</thead>
<tbody>
<tr>
<td>Extending VDI outside the organization</td>
<td>541</td>
<td></td>
</tr>
</tbody>
</table>
Table of contents

Why remote access is important for VDI .............................................. 541
Methods for securing remote access to VDI ................................. 542
Network configuration for RD Gateway ..................................... 543
Configuration options for RD Gateway ...................................... 548
Controlling RD Gateway access .................................................. 557
Overview of controlling RD Gateway access ............................... 557
RD CAPs .................................................................................................. 557
RD RAPs .................................................................................................. 559
Central RD CAP store ............................................................................ 560
Integrating Microsoft Azure Multi-Factor Authentication .............. 561

Chapter 12 Performance and Health Monitoring of Virtual Desktop Infrastructure ............................................................................................................. 565
Monitoring desktop and application virtualization ....................... 565
Understanding monitoring for desktop and application virtualization ......................................................................................... 565
Event monitoring for desktop and application virtualization .............. 566
Performance monitoring tools for desktop and application virtualization ......................................................................................... 569
Using Process Monitor to identify application issues ....................... 571
Using Operations Manager for monitoring ....................................... 572
Parts of an Operations Manager implementation ............................. 573
Understanding management packs and overrides ............................ 579
Management packs for monitoring application and desktop virtualization ......................................................................................... 581
Installing management packs ............................................................. 583
Monitoring desktop virtualization infrastructure ............................ 585
Understanding resource bottlenecks .................................................. 585
Considerations for monitoring desktop virtualization ..................... 586
Monitoring RD Session Host server performance ............................. 587
Optimizing RD Session Host server performance ............................. 588

Index ........................................................................................................... 591

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Introduction

If you want to learn about using Microsoft technologies to implement application and desktop virtualization, then this book is for you. If you need to support users who roam among multiple computers and platforms, then this book will help you identify, select, and implement options for user state virtualizations. If you are implementing application virtualization by using Microsoft Application Virtualization (App-V), then this book will help you learn how to design and configure an App-V deployment. It also will teach you how to sequence applications for deployment. If you want to implement virtual desktops to simplify hardware upgrades and support mobile users, then this book will teach you about both session-based virtual desktops and virtual machine–based (VM-based) virtual desktops. It also will teach you how to secure remote access to virtual desktops by using Remote Desktop Gateway (RD Gateway). Finally, to ensure that your application and desktop virtualization meets the performance requirements of your users, you will learn about monitoring application and desktop virtualization.

This book assumes that you have a working knowledge of Windows client and server administration or have access to that information. So, we assume that you understand basic facts like how to connect a computer to a domain, how to create and apply Group Policy, and how to work with management tools. This book focuses on implementing the application and desktop virtualization technologies that layer on top of Microsoft Windows Server 2012 R2. Each of the technologies covered in the book is examined from a real-life perspective. This book provides examples and recommendations for implementation.

System requirements

The following are the recommended system requirements necessary to implement the technologies described in this book in a development environment:

- A processor with Second Level Address Translation (SLAT) support
- Windows 8.1 (Enterprise edition recommended, Professional edition minimum)
- Windows Server 2012 R2
- Microsoft Desktop Optimization Pack (MDOP)
- At least 8 GB of random access memory (RAM)
- A hard drive with at least 128 GB of free space
- A CD-ROM or DVD-ROM drive
- A mouse or other pointing device
- A 1024 x 768 or greater monitor display
Acknowledgments

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Virtualization usage has been expanding throughout the last several years. Although many IT administrators are now familiar with desktop and server virtualization, application virtualization is a lesser-known technology that is expanding rapidly. Simply put, application virtualization is a technology that delivers applications to computing devices in isolated containers without the need to perform a standard application installation on each computing device.

App-V provides a new way to deliver applications to users, a new way to centrally manage applications, and additional application capabilities for complex environments. Virtualizing applications, when appropriately planned and implemented, is an effective supplement to desktop and server virtualization and can help organizations move closer to cloud computing.

Overview of App-V

Microsoft Application Virtualization (App-V) is Microsoft’s application virtualization technology. It is part of the Microsoft Desktop Optimization Pack (MDOP). MDOP is available to Microsoft Software Assurance customers and to Microsoft MSDN subscribers. It is a suite of desktop optimization applications that help IT administrators deploy, manage, and troubleshoot desktop computing environments. The newest version, at the time of this writing, is App-V 5.0 Service Pack 3.

Benefits of App-V

You know that App-V is Microsoft’s application virtualization technology, and you have an idea of how to access it. But, to fully appreciate it, you should have a good understanding of its capabilities. The core capabilities that you can deliver with App-V are the following:

- **Run multiple versions of applications at the same time** You can use App-V to run different versions of applications concurrently on the same computer. For example, it’s possible to run Internet Explorer 9, Internet Explorer 10, and Internet Explorer 11 concurrently if they all are set up as App-V applications; otherwise, you can’t run multiple versions of Internet Explorer side by side on the same computer. It’s also possible to
use App-V in conjunction with Remote Desktop Services (RDS). This allows users to run applications side by side on Remote Desktop Session Host (RD Session Host) servers.

- **Minimize application conflicts** Sometimes two or more applications conflict with one another because of dynamic-link library (DLL) or application programming interface (API) conflicts. When you deliver these applications as App-V applications, however, there isn’t a conflict because each App-V application runs in its own isolated environment.

- **Simplify application removal** App-V applications do not install locally, which makes it easier to remove them. Clean removal isn’t always possible with applications that install directly on Windows-based clients, even if an application has been designed to remove all files and settings when it uninstalls. Virtualized applications are removed easily after a user signs out from a computer.

- **Simplify application upgrades** Instead of upgrading a locally installed application on all computers in your organization with a hotfix, service pack, or new version, the modular nature of virtualized applications means that you can replace one version of an application with an updated version with less effort. You only need to update an application on the App-V server(s), and clients receive the latest version of the application from the publishing server the next time they launch the application.

- **Minimize license-compliance risks** App-V has application metering functionality that enables you to detect every use of a virtualized application to ensure license compliance.

- **Scale infrastructure** You can add publishing servers to an App-V deployment as necessary to ensure that service levels are maintained as demand grows.

- **Take advantage of client hardware resources** Even though App-V applications do not install locally, they can use a local computer’s processor and RAM resources. In environments where client computers have adequate hardware resources, this can create a better experience for users than running applications on an RD Session Host server would.

- **Allow users to use roaming applications** If applications stream with App-V rather than install locally, users can sign in to any computer that has an App-V client and quickly access their applications. You also can configure App-V to work with user virtualization to allow users to have application settings and data for App-V applications that roam across client computers.

- **Give users quick access to their applications** Imagine a scenario in which a user needs to have an application installed. In many environments, a routine application installation requires several steps, such as copying the installation files to the client
computer, manually performing the installation, manually performing application updates, and cleaning up the installation files. With App-V, you can just add the users to a group, and they can immediately run the application through App-V.

**Differences between standard and virtualized applications**

In a traditional IT environment, applications are installed on each computing device. For this discussion, we'll refer to the traditional installed application as a standard application. During a standard application installation, the computing device is modified to meet the application’s requirements. For example, a common installation of a standard application would include the following steps:

- **The application’s files are copied**  
  During the installation, the installer copies the necessary application files to a specified folder. During this process, the files often are uncompressed first.

- **The registry is modified to support the application**  
  Most applications add to the registry to support the installation and running of the application. In addition, it's common for existing registry keys and values to be modified to support automatic application startup on boot and to set any required dependencies.

- **DLL files are registered**  
  Often, .dll files must be registered during the installation.

- **Permissions are configured**  
  You often need to set permissions to configure which user(s) can run the application, which profiles the shortcuts are added to, and which users can modify configuration files.

- **Shortcuts are added to the device**  
  Many applications add a shortcut to the Start screen, desktop, and taskbar. Additionally, it is common for applications to add a tray icon for quick user access.

App-V applications, which are virtualized, aren’t installed onto computing devices. Instead, they are packaged for deployment. In App-V, packaging an application for deployment is known as sequencing an application. Later in this chapter, we’ll discuss sequencing further. For now, let’s examine the differences between an App-V application deployed to a computing device and a standard application installed locally on a computing device. For applications deployed with App-V, the following characteristics highlight the different methods by which applications interact with the computing device:

- **App-V applications run in their own isolated environment**  
  This reduces application conflicts and application crashes impacting other applications or the operating system and provides the foundation to allow multiple versions of applications to run at the same time.
**App-V applications use a virtual registry**  This reduces installation difficulties and application conflicts and improves the stability of a client computer because applications aren’t sharing a single registry.

**App-V applications use virtual file systems**  This reduces conflicts by ensuring that applications don’t overwrite shared files.

**App-V applications use virtual services**  This also reduces conflicts because virtual services do not have dependencies on other non-virtual services and provide isolation from other virtual services.

App-V applications are installed by being packaged and delivered to computing devices. App-V applications only need to be updated once, by updating the application’s package on the App-V server. By reducing the number of times you have to install and update an application, you can greatly reduce the number of hours required to manage your application infrastructure.

**Placing and functionality of the virtualization engine**

Virtual applications require access to resources on a host computer. Access typically uses a system request that a virtualization engine needs to intercept. The engine provides functions for capturing an application’s system call and manipulating it where needed.

**Interception in user mode**

Applications run in user mode and perform operations on system services that reside in kernel mode. When an interception occurs in user mode, the virtualization engine must be placed over the native API layer. Some applications call the functions of the native API directly instead of by using Windows API.

One advantage of the user mode strategy is that the virtualization engine doesn’t have to filter between system calls of different applications. The virtualization engine only works with an application that it built for the virtual environment.

**Interception in kernel mode**

In contrast, if the virtualization engine operates in kernel mode, it can intercept all system calls before they reach Windows executive services. The advantage is that it is easy to loosen the isolation of applications and let them share the same virtual environment. This enables you to create dependencies between packages, similar to working with middleware or plug-ins. However, the agent that builds the virtual environment must install natively on a computer to gain the required privileges for an interception in kernel mode. In this case, all applications that run on the host machine are affected. Furthermore, the virtualization layer captures system calls from all applications and must filter the processes to respond to every call correctly.
App-V implements a hybrid approach by identifying the locations of resources that the application requires. While the application is running, the virtualization engine ensures that function calls are modified only if they request a path inside the virtual file system or a key inside the virtual registry. When the engine runs in kernel mode, it also must check which package to consult to find the rules, because it will receive function calls from several running applications that belong to different packages.

The virtualization layer must intercept and redirect requests to the file system and registry to virtual counterparts that contain the files and keys that belong to a certain application. To decide which function calls to intercept and which to handle as usual, the virtualization layer needs rules. These rules generate when the App-V Sequencer, which collects all the files and registry keys that the installer creates or modifies, monitors an application’s installation. Then, at the application’s runtime, the virtualization engine ensures that function calls are modified only if they request a path inside the virtual file system or a key inside the virtual registry.

**Application virtualization infrastructure**

The infrastructure technologies of an App-V deployment are extensive, based on the deployment model that you choose. They work together to provide the complete suite of App-V technologies. It is important to familiarize yourself with all of the technologies, the typical life cycle of a virtual application, the deployment models, and some of the characteristics of packages and content packages.

**App-V application life cycle**

To effectively manage your virtual application infrastructure, you need to plan for the life cycle of your virtual applications. Without an effective life cycle, you may end up with application sprawl—a situation in which you have too many applications to manage. To avoid this, you should spend ample planning time designing and documenting an operational framework for your virtual application life cycle. In this section, we’ll discuss the four phases of the virtual application life cycle: sequencing, publishing and deployment, updating, and termination.

**Application sequencing**

The App-V Sequencer is one of the primary applications of an App-V deployment. You use it to create virtual application packages. Then, you deploy the packages to your App-V clients. It is important to consider the following before you begin deploying the sequencer and sequencing applications:
• **Prerequisites** If the computer that runs the sequencer isn’t running Windows 8 or newer or Windows Server 2012 or newer, then it must have the following software installed prior to installing the sequencer. Note that the App-V client installation automatically will install the Visual C++ prerequisites.
  - Visual C++ Redistributable Package for Visual Studio 2013
  - Visual C++ 2005 Redistributable
  - Microsoft .NET Framework 4
  - Windows PowerShell 3.0
  - Microsoft KB2533623 hotfix

• **Windows 8 or newer or Windows Server 2012 or newer** If the computer that runs the sequencer is running Windows 8 or newer or Windows Server 2012 or newer, it already has the prerequisite software.

• **Match the hardware and software** The computer that runs the sequencer should have a hardware and software configuration that matches the App-V client computers. For example, if all of your App-V client computers run Windows 8.1, you should install the sequencer on similar computer hardware that runs Windows 8.1.

• **Use a virtual machine** When possible, use a virtual machine (VM) as the computer that runs the sequencer. This allows you to take a snapshot of the VM prior to sequencing an application. Then, after you finish sequencing an application, you should revert the VM to the snapshot. This allows you to sequence an application with the same baseline configuration, which minimizes issues. Although the sequencer will allow you to sequence multiple applications without reverting the sequencer to a baseline configuration, it will warn you that you may encounter issues.

• **Multiple sequencers** If you have multiple operating system versions running the App-V client, you seriously should consider having multiple sequencers. This enables you to sequence applications on the same operating system to which you will deploy or stream the applications.

**Application publishing and deployment**

After you sequence an application, you need to publish it and deliver it to the clients. Publishing a virtual application makes the application available to App-V clients. Before the actual publishing process, you need to be aware of the different methods that you can use based on the type of App-V deployment you have.
Stand-alone deployment model

In the stand-alone model, you need to add the App-V package of the application to clients. You can do this by using the Add-AppVClientPackage Windows PowerShell cmdlet. For example, if you have an App-V package named 7-Zip.appv located at `\tt-util-01\share\7-Zip.appv`, you can run the following command to add the package:

```
Add-AppVClientPackage –Path `\tt-util-01\share\7-Zip.appv`
```

After running the command, the output will show the details of the package added. In fact, the output is the same as if you were to run the Get-AppVClientPackage –Name 7-Zip Windows PowerShell command. The output is shown in Figure 4-1.

```
PackageId : 30252a91-5cc5-419a-bcfb-645c942df001
VersionId : 5c57388f-d692-49f0-a609-25dcb6e3e90
Name : 7-Zip
Version : 0.0.0.1
Path : `\tt-util-01\share\7-Zip.appv`
IsPublishedToUser : False
UserPending : False
IsPublishedGlobally : False
GlobalPending : False
InUse : False
InUseByCurrentUser : False
PackageSize : 4872031
PercentLoaded : 10
IsLoading : False
HasAssetIntelligence : False
```

Figure 4-1 Adding a package

In the output, notice that the IsPublishedToUser property is set to False. This is an important detail because while it is set to False, the user won’t see or be able to use the virtual application. After you’ve added the package, the client will begin receiving the files that make up the package. The data will be stored locally on the client. You can look at the `%ProgramData\%\App-V` directory to see data from the package.

The next step is to publish the application. However, you can’t publish an application until the application has been added to the client. Once you are ready to publish, you can use the Publish-AppVClientPackage Windows PowerShell cmdlet. For example, if you added a package named 7-Zip, you can publish it to the client by running the following Windows PowerShell command:

```
Publish-AppVClientPackage –Name 7-Zip
```

Once you run that, the output will be similar to when you added the package. The key difference is that the IsPublishedToUser property will be updated to a value of True, as shown in Figure 4-2.
After you publish the package, the application becomes available to the user. If shortcuts are configured for the package, they will begin to be displayed after publishing the package.

**Full infrastructure model**

In the full infrastructure model, the publishing process is a bit more automated, especially when you are dealing with a large number of virtual applications. The high-level process to publish an application is shown below. Note that the first step involving Group Policy is a one-time step in a new full infrastructure model and would not need to be performed for each application that you want to publish.

1. Create a new Group Policy Object (GPO) and modify the App-V–related GPO settings for your environment. Link it to the computers that have the App-V client software. At a minimum, you should configure an App-V publishing server in the GPO so that App-V clients will automatically be configured for a publishing server.

2. Add the application package on the App-V management portal. Configure the settings based on your environment. At a minimum, you need to ensure that the users have access to the application and that the application is published. You can configure access by right-clicking the application and then clicking Edit Active Directory Access.

3. Publish the application. To publish an application from the management portal, right-click it and then click Publish. You also can publish an application by using Windows PowerShell. For example, to publish an App-V package named 7-Zip, you can run the `Publish-AppvServerPackage -Name 7-Zip` command.

4. Sync the clients or wait for the next automatic sync. To immediately sync a client with an App-V publishing server named TT-UTIL-01, run the `Sync-AppvPublishingServer -Name TT-UTIL-01` Windows PowerShell command.
Configuration Manager model

If you use App-V and Configuration Manager to manage and deliver applications, then the steps to publish an application are different from other App-V models. The following high-level steps describe the process of publishing by using Configuration Manager.

1. In the Configuration Manager console, create a new application.

2. On the General page of the Create New Application Wizard, configure the application type to be Microsoft Application Virtualization (App-V) Client 5.0. Then, browse to the location of the .appv package that you want to publish. Also, ensure that the user and deployment .xml configuration files are in the same location as the .appv file. By default, the name of the user configuration file is <app>_UserConfig.xml. For example, if the name of the .appv file is 7-Zip.appv, then the name of the user configuration file is 7-Zip_UserConfig.xml. By default, the name of the deployment configuration file is <app>_DeploymentConfig.xml. For example, if the name of the .appv file is 7-Zip.appv, then the name of the deployment configuration file is 7-Zip_DeploymentConfig.xml.

3. Complete the Create New Application Wizard by specifying application details or maintaining the default values.

4. Distribute the application to Configuration Manager distribution points so that clients can obtain the application from the nearest distribution point.

5. Deploy the application to clients. You can deploy the application as a streaming application if you have a full infrastructure App-V deployment model. Otherwise, you can opt for the download and execute method. Each method has pros and cons. See http://technet.microsoft.com/en-us/library/jj822982.aspx for more information on the two deployment methods.

Application update

One ongoing maintenance task that you’ll need to perform is updating applications. An application update, sometimes called an application upgrade, occurs when a software company releases a newer version of the application. Often, companies release newer versions of software to fix security issues or provide new or enhanced functionality. In a standard application deployment, in which applications are installed on every computer, you need to perform the update on every computer. In a virtualized application deployment, in which applications are packaged and delivered by App-V, you only need to update the packaged application on the App-V Sequencer and then update the distribution method with the updated package.

To update an existing App-V application with the App-V Sequencer, perform the following steps:

1. Run the App-V Sequencer on the client computer that you use for sequencing.
2. Click the Modify An Existing Virtual Application Package option, shown in Figure 4-3.

![Figure 4-3 App-V Sequencer](image)

3. On the Select Task page, shown in Figure 4-4, keep the Update Application In Existing Package option selected and then click Next.
4. On the Select Package page, shown in Figure 4-5, click Browse and navigate to the existing App-V package file (.appv), click the file, click Open, and then click Next.
5. On the Prepare Computer page, shown in Figure 4-6, if the computer is ready to create a package, click Next. If issues are listed, remediate the issues if necessary and then click Refresh until the computer is ready to create a package. Click Next.
6. On the Select Installer page, shown in Figure 4-7, click Browse and navigate to the install file for the application update. Click the installer file, click Open, and then click Next.
7. The application update installation will begin. Update the application based on the installation program. When finished, select the I Am Finished Installing check box, as shown in Figure 4-8, and then click Next.
On the Installation Report page, shown in Figure 4-9, if the update was successful, the App-V wizard should report that there weren’t any issues detected. Click Next.
9. On the Prepare For Streaming page, shown in Figure 4-10, click Run All. Then, perform any needed first-run application configurations. When finished, close the updated application and then click Next in the App-V wizard.
Figure 4-10  App-V Sequencer Prepare For Streaming page

10. On the Create Package page, shown in Figure 4-11, enter a location to save the updated application package and then click Create.
11. After the package creation completes, click Close. Next, you need to make the updated .appv package available to publishing servers, App-V clients, or Configuration Manager, depending on your App-V deployment model.

**Application termination**

As part of your routine application maintenance, you’ll need to temporarily and permanently remove applications from your environment. Sometimes, you’ll need to remove applications from specific users. Other times, you’ll need to permanently remove an application from all of your users. You should understand the options available to you for handling these tasks. Let’s look at a few scenarios and walk through the process.

**Removing an application from a small number of users**

There are many situations in which you will need to remove an application from one user or a small group of users. For example, if you were running end user pilot testing for a new application, you may want to remove users after they’ve completed their testing. There are multiple methods for doing this, but we’ll focus on one of the most common methods in an environment with the App-V full infrastructure deployment model. In this model, you should be assigning application access based on Active Directory Domain Services (AD DS) security.
groups. When it is time to remove one or more users, the simplest method is to remove those users from the security group. The virtual application remains available in App-V, but only for users with the appropriate access rights. In situations in which you are completely and permanently removing an application from all users, you have a few options:

In the App-V Management Console, you can delete the application by right-clicking it and then clicking Delete, as shown in Figure 4-12.

![Figure 4-12 App-V Management Console showing Packages workspace with two published applications](image)

From that point on, new App-V clients can’t launch the deleted application. Users who already have the application or have used the application will still see it and be able to launch it. You should be aware of a couple of things that cause this. You delete apps from the App-V Management Server. The publishing server, by default, refreshes the list of published applications every 10 minutes. Clients get the list of applications from the publishing server. This 10-minute refresh occurs even if the management server and publishing server run on the same server! Even if you sync the App-V client with the publishing server immediately following an application deletion, it won’t matter because the publishing server isn’t yet aware that the application was deleted. In most production environments, this 10-minute refresh cycle is
okay. However, if you need to reduce the amount of time between refreshes or manually perform an immediate refresh, you have the following options:

On the publishing server, stop the AppVPublishing application pool, shown in Figure 4-13, in Internet Information Server (IIS).

![Figure 4-13 IIS application pools for App-V](image)

Then, start the AppVPublishing application pool. This kicks off an immediate refresh of the published apps. Thereafter, you should perform a client sync to complete the removal process. Otherwise, you must wait until the next client sync.

Alternatively, you can adjust the refresh intervals in the registry on the publishing server. To do this, go to the HKEY_LOCAL_MACHINE\SOFTWARE\Microsoft\AppV\Server\PublishingService key and reduce the value of the PUBLISHING_MGT_SERVER_REFRESH_INTERVAL entry. The default is 600 seconds. You can reduce it to something much smaller, such as 10 seconds, as shown in Figure 4-14.
App-V technologies

An App-V 5.0 deployment includes a number of technologies, some of which must be present in all App-V 5.0 models, and some of which are used by only specific App-V deployments. These technologies are the management server, publishing server, management server database, reporting server, reporting server database, Sequencer, and App-V client.

From the Feature Selection page of the Microsoft Application Virtualization (App-V) Server 5.0 Setup Wizard, you can select which servers and databases you want to install, as shown in Figure 4-15.
Chapter 4  Planning and implementing App-V

Figure 4-15  The Feature Selection page showing the available App-V server features

Management server and management server database

The management server hosts a Microsoft Silverlight–enabled web application that App-V administrators use to manage an App-V infrastructure. When you use App-V 5.0, all management occurs through the web console or Windows PowerShell, unlike previous versions of App-V. A computer must have Silverlight installed to access the console.

You can use the management server to work with the following objects:

- **Packages**  You can import packages in the App-V file format, which uses the .appv file extension. You then can publish the packages to App-V publishing servers. You also can use the console to configure package security. In Figure 4-16, the management console shows the Packages workspace with a couple of published applications.

- **Connection groups**  Connection groups make it possible for virtual applications to interact with one another. You also can use the console to configure security for connection groups.
• **Publishing servers**  You can authorize publishing servers. You perform this task from the Servers node. You must specify publishing servers in the `domain\computername` format.

• **Administrators**  You can add and manage App-V administrators. Administrators are able to import and publish packages, configure connection groups, and add publishing servers.

![Figure 4-16  App-V Management Console showing Packages workspace with two published applications](image)

The management server database stores the App-V configuration and data settings. The database is hosted on a Microsoft SQL Server instance that is running SQL Server 2008 Service Pack 2 (SP2), SQL Server 2008 R2, or SQL Server 2012. You should install the management server database separately from the management server, and if you do, you need to deploy the database first and then specify its location when you deploy the management server.

**Publishing server, sequencer, and App-V client**

The publishing server is a web server, built on IIS, which hosts and deploys applications for App-V clients. In previous versions of App-V, a publishing server was called a streaming server.
You deploy App-V applications to a publishing server in the App-V full infrastructure model by using the App-V Management Server console or by using Windows PowerShell.

You can deploy a management server and a publishing server on the same computer. You also can deploy a publishing server on a separate computer as long as you already have deployed an existing management server. This is different from previous versions of App-V, in which it was possible to deploy App-V streaming servers without having deployed a management server.

Previous versions of App-V streamed applications by using the Real-Time Streaming Protocol (RTSP). App-V 5.0 applications stream from a publishing server by using HTTP, HTTPS, or SMB. When you configure a publishing server, you specify a TCP/IP port that is used to stream applications. You subsequently use this port address when you configure Group Policy for use with App-V clients so that clients can access published App-V applications.

Publishing servers are useful in environments that have multiple geographic locations and are connected by wide area network (WAN) links. If you have the App-V full infrastructure model with a management server, publishing server, and database server at the headquarters office, clients outside the headquarters office likely would have a degraded experience compared to having App-V publishing servers locally at their office. In this case, you should deploy publishing servers at branch offices so that clients at those branch offices would be able to receive applications directly from the publishing server in the branch office, rather than across a WAN link from a publishing server in another office.

You can configure a client with the addresses of up to five publishing servers when you use Group Policy, as shown in Figure 4-17.
When configuring Group Policy to support clients in branch offices, provide the address of both the local publishing server and a second publishing server to use in case the local publishing server fails. The diagram in Figure 4-18 represents an App-V environment with a headquarters office and two branch offices. Each App-V client is configured to use the local App-V publishing server in its local office and also is configured with a secondary App-V publishing server in an alternate site.
You can use the Sequencer to create applications that can run under the App-V client. You should sequence an application on a Sequencer that is configured on the operating system on which the application will run. This helps minimize compatibility issues for your virtualized applications.

The App-V 5.0 Sequencer can install only on computers that run Windows 7 Service Pack 1 (SP1), Windows Server 2008 R2 SP1, Windows 8, Windows 8.1, Windows Server 2012, or Windows Server 2012 R2. In most cases, you should configure a client operating system as a sequencer. This is because most of your virtualized apps likely will be on a client operating system.

The App-V Sequencer has the following requirements:

- Microsoft .NET Framework 4 or 4.5
- Windows PowerShell 3.0 or newer
- Update for Windows KB2533623

The App-V client must be installed on computers before those computers can run virtualized applications. The App-V client supports both x86 and x64 operating system architectures.
On x86 operating system architecture, only x86 applications are supported.

On x64 operating system architecture, both x86 and x64 applications are supported.

You need to deploy a separate App-V client on RD Session Host servers. We look at that client in an upcoming section in this chapter titled “App-V for Remote Desktop Services client.”

**Reporting server and reporting server database**

The App-V reporting server, an optional feature, is the built-in reporting feature that you can use for reporting on virtual application usage. The reporting server records the following information:

- Application use, including launch status, startup times, and shutdown times
- Client information such as the host name, client version, operating system version and type, processor architecture, and operating system service pack level
- Package information, such as the package name, version, source, and the percentage cached

You configure the address of the reporting server when you use App-V Group Policy settings, as shown in Figure 4-19. Clients forward data to this address, which the reporting server then forwards to the reporting server database. You can install the reporting server separately from the reporting server database, though if you do this, you already must have deployed the database on another server.
The reporting server database stores all the information that is forwarded to the reporting server. The instance that hosts the reporting server database must meet the same requirements as the instance that hosts the management server database. You can host both databases on the same server. You don’t have to install SQL Server Reporting Services to deploy an App-V reporting server, but it is helpful because the App-V product doesn’t include report generation.

**App-V deployment models**

There are three deployment models that you can use to deploy App-V. Each model and its characteristics are described below:

- **Full infrastructure model**  This is the most complete deployment of App-V and also is the most commonly deployed model. It offers the most services and functionality and has the largest footprint. The key technologies of the full infrastructure deployment are the App-V Management Server, the App-V Publishing Server, the App-V client, and an
Application virtualization infrastructure

App-V Sequencer. SQL is required on the back end, and the solution ties into AD DS. Optional technologies are the reporting server and associated reporting database. This model offers streaming of applications without requiring a System Center Configuration Manager environment. An example of a typical full infrastructure model deployment is shown in Figure 4-20.

Figure 4-20 Technologies of a typical full infrastructure model

- **App-V integration with Configuration Manager model** This is an implementation of App-V that, at a minimum, includes App-V clients, an App-V Sequencer, and System Center Configuration Manager 2012 or later. The App-V Management Server isn’t part of this deployment model, the App-V Publishing Server isn’t part of this deployment model, there isn’t a desktop configuration service, and you can’t track licensing or perform metering. The desktop configuration service is used by App-V clients to find out information about available virtual applications. This deployment model doesn’t require SQL or AD DS, but it requires System Center Configuration Manager, which enables you to stream App-V applications from Configuration Manager distribution points and automatically deploy the App-V client to computers.

- **Stand-alone deployment model** This is a small implementation of App-V. This deployment model has only App-V clients and an App-V Sequencer, which enables you to create .appv files or .msi files for delivery via a separate application delivery solution such as Group Policy or network file shares. The .appv files and the .msi files can be run only by the App-V client. This model isn’t used often but can be valuable for a test environment or an environment with a lot of users who do not routinely connect to the network.
App-V packages

An App-V package comprises several files that have specific functionality. The primary package file is the .appv file that contains the captured assets and state information. Additional files provide custom integration information for publishing applications, detailed sequencing reporting, and, optionally, sequencing templates and package accelerators. You can use the following files to provide custom integration:

- The .appv file contains the captured files and state from the sequencing process in a single file. This file includes the architecture of the package file, publishing information, and registry settings in a tokenized form that can reapply to a machine and to a specific user on delivery.
- The .msi file is used in stand-alone deployments or, optionally, when deploying by using Configuration Manager or other deployment platforms.
- The _DeploymentConfig.xml file contains default publishing parameters for all applications in the package, and it can be modified to support customization.
- The _UserConfig.xml file allows customization of publishing parameters for specific domain users. You can customize items such as shortcuts and file associations with this config file.
- The Report.xml file contains diagnostic information, how sequencing is done, and what files are excluded from a package. It also contains the messages that are displayed in the Sequencer after you finish sequencing an application.
- The .cab file is an optional package accelerator file that speeds up the creation of sequenced virtual application packages.
- The .appvt file is an optional Sequencer template file that retains commonly reused Sequencer settings.

Contents of an .appv package

An .appv file is a compressed file that contains the contents of a virtual application package. It is based on the Open Packaging Conventions standard. It is used to store a combination of XML and non-XML files in a single entity. You can view .appv file contents by renaming the file with a .zip extension and exploring its contents.

The following list describes the primary .appv file contents:

- **StreamMap.xml** Contains Feature Block 0, also named the Publishing Feature Block.
- **PackageHistory.xml** Contains information about the origin of a package, for example, which user sequenced the package, on which machine, and at what time.
Planning App-V infrastructure

When introducing a new technology, such as App-V, planning and designing the infrastructure are fundamental to a successful implementation. As we’ll discuss in this section, a reliable App-V environment depends heavily on the design and infrastructure. The process for implementing application virtualization is flexible and scalable, with larger deployments requiring more planning and different technologies.

Some key areas of interest when planning your App-V infrastructure include the following:

- The App-V infrastructure requirements
- The various App-V deployment models
- Sizing and performance
- High availability and disaster recovery

App-V infrastructure requirements

Before deploying App-V in your environment, you must ensure that the supporting infrastructure is in place and configured. App-V 5.0 has the following infrastructure requirements:

- **Active Directory Domain Services**  AD DS is required for authentication and authorization of applications and connection groups. AD DS is needed only if you plan to deploy an App-V server, such as in a full infrastructure deployment model.

- **Installation service account**  A service account in AD DS is required for the initial installation of the App-V server, presuming that your deployment is a full infrastructure model. This account needs Read permission to query AD DS and local Administrators group access on the server on which you perform the App-V installation. Following the installation of the management server, you can transition this to a security group in
AD DS, allowing you to easily add users who require administrative access to the management console.

- **Package repository** This is the location where package files will be stored for delivery to App-V clients.

The servers in an App-V environment have the following requirements:

- **Management server** Supported on Windows Server 2008 R2 with SP1 and newer. It requires the following technologies:
  - Microsoft .NET Framework 4.0 or newer
  - Windows PowerShell 3.0
  - Microsoft Visual C++ 2010 SP1 Redistributable Package (x86/x64)
  - Microsoft SQL Server 2008 Standard, Datacenter, or Developer edition (32-bit or 64-bit) or newer

- **Reporting server** Supported on Windows Server 2008 and newer. It requires the following:
  - Microsoft .NET Framework 4.0 or newer
  - Microsoft Visual C++ 2010 SP1 Redistributable Package (x86/x64)
  - Windows Web Server with the IIS role installed
  - Common HTTP Features (static content and default document)
  - Application Development (ASP.NET, .NET Extensibility, ISAPI Extensions, and ISAPI Filters)
  - Security (Windows Authentication, Request Filtering)
  - Management Tools (IIS Management Console)
  - 64-bit ASP.NET
  - Microsoft SQL Server 2008 Standard, Datacenter, or Developer edition (32-bit or 64-bit) or newer

- **Publishing server** Supported on Windows Server 2008 and newer. It requires the following:
  - Microsoft .NET Framework 4.0 or newer
  - Microsoft Visual C++ 2010 SP1 Redistributable Package (x86/x64)
  - Windows Web Server with the IIS role installed
  - Common HTTP Features (static content and default document)
Planning App-V infrastructure

- Application Development (ASP.NET, .NET Extensibility, ISAPI Extensions, and ISAPI Filters)
- Security (Windows Authentication, Request Filtering)
- Management Tools (IIS Management Console)
- 64-bit ASP.NET

Although the design of an App-V environment is very flexible, certain scenarios are not supported:

- Installation on domain controllers isn’t supported for any App-V server technology.
- Installation isn’t supported on Server Core installations of Windows Server.
- App-V 5.0 can’t be installed on a system that has a previous version of the App-V Management Server.
- Microsoft SQL Server Express as a database engine isn’t supported.

App-V deployment possibilities

Distributing virtual applications requires the App-V client software on the target computer. As you design your server infrastructure, you’ll need to review the four main deployment models that we introduced earlier in this chapter. Each model has its own strengths, and the model you choose will determine which type of server infrastructure you deploy.

App-V full infrastructure model

The full infrastructure model provides all of the management server capabilities that App-V offers, including application streaming, authentication, security, licensing, and metering.

When planning for the full infrastructure model, you’ll need AD DS and Microsoft SQL Server. The App-V Management Server should be on the same LAN segment hosting the database. Publishing servers are used in this model to publish content from a file server share to a distributed environment’s remote locations by providing streaming capabilities close to the clients that are using the applications. This reduces latency and improves the end-user experience.

System Center 2012 Configuration Manager–integrated model

If you have an existing System Center 2012 Configuration Manager infrastructure, or you are looking to implement one, you can leverage Configuration Manager to distribute virtual applications in the same way that you distribute traditional application packages. You can add virtual applications to a Configuration Manager environment by using the same Create Application Wizard, as shown in Figure 4-21.
Many of the advanced capabilities that are available for managing a traditional application—such as using task sequences and building queries in collections to define which devices are targeted—also are available for a virtual application. You can target both users and computers to deliver an application in a more intelligent way, expanding on capabilities of the App-V full infrastructure model. For example, when you use a primary device as one of the possible rule requirements, you can identify which deployment type is used based on whether the user is working on his or her primary device.

The Configuration Manager–integrated model requires both the App-V client and the Configuration Manager client on each managed system. It doesn't use any server technologies of the full App-V infrastructure to deliver virtual applications; instead, it uses existing Configuration Manager distribution points to deliver the virtual application to client devices. Note that some reporting capabilities aren't available in the integrated model when compared to the full infrastructure model. For example, if you use local delivery where clients download and execute the application, you only can report if the application has been used and the
last application usage time. In the full infrastructure model with reporting, you can report the number of times an application has been used.

Application delivery to a Configuration Manager client works differently from the App-V full infrastructure scenario. In the full infrastructure model, the App-V client manages its own content, and it can refresh instantly against the publishing server. In the Configuration Manager–integrated scenario, the Configuration Manager client manages the App-V client.

Configuration Manager supports two types of delivery methods for virtual applications:

- **Streaming delivery** You can enable streaming delivery on Configuration Manager distribution points. This option streams a virtual application to a client through HTTP or HTTPS.

- **Local delivery** This delivery first uses the Configuration Manager client to download all the files needed for the application through Background Intelligent Transfer Service (BITS). After downloading the files, the package fully loads into the App-V client cache.

**Electronic software distribution model**

The electronic software distribution (ESD) model is ideal for environments in which you prefer to leverage an existing software distribution solution. In this case, most distribution systems can use the virtual .msi file produced by the App-V Sequencer for delivery with an .appv package.

Planning considerations for the ESD model include the following:

- **Existing software distribution system** An existing software distribution system that can recognize and distribute .msi packages to client devices.

- **App-V Sequencer** A system deployed in your environment with the App-V Sequencer installed for building and managing virtual applications.

- **Windows PowerShell** The ability to deploy a script that contains the App-V client module for Windows PowerShell cmdlets. This provides the ability to add and publish packages in ESD mode.

- **Connection groups** Designating connection groups (grouping one or more App-V packages to enable interaction with one another) requires manually creating a connection group XML file and deploying it by using a custom Windows PowerShell script.

- **Group Policy** Having Group Policy available simplifies the task of configuring the App-V client. Alternatively, a manual or scripted configuration is possible through the Windows Registry. In Figure 4-22, a GPO named App-V settings provides several App-V settings to computers.
The App-V stand-alone model consists of the App-V Sequencer and an App-V client, and it requires no additional App-V infrastructure. The Sequencer has an option to create a virtual .msi file during the sequencing process. The virtual .msi file invokes Windows PowerShell commands and then publishes and loads the application to the App-V client cache.

The App-V Sequencer packages publication information, shortcuts, and the installation routines into an .appv file package, and the Sequencer generates virtual .msi files that you can execute manually. When executed, the installer adds the virtual application package to the App-V client and configures publication information to load applications from a local location rather than stream them across a WAN.

Stand-alone deployments require an App-V client on the computers, which allows a virtual .msi file to publish and load virtual applications or enables management through Windows PowerShell. You don’t configure an App-V client to connect to any App-V server.
The stand-alone delivery scenario enables an organization to deploy virtual applications in situations where no servers are available to support other deployment methods for virtual applications. Use stand-alone deployments in the following scenarios:

- There are remote users who can’t connect to an App-V infrastructure.
- Software management systems, such as Configuration Manager or another electronic software distribution system, already are in place.
- Network bandwidth limitations prevent electronic software distribution. In this case, you can use virtual application delivery on physical media.

Because the stand-alone model employs an .msi file, you can distribute the file if you use an existing software distribution infrastructure, such as GPOs, shared folders, optical media such as CDs and DVDs, USB flash drives, or others.

**Service disruption impact**

One of the common design steps in implementing App-V is to make the infrastructure highly scalable, which limits the impact of service disruption. The App-V infrastructure is highly dependent on AD DS. Therefore, it is recommended that you carefully plan your AD DS architecture to avoid unwanted service disruptions.

It’s important to point out that from a client perspective, once an application is loaded on a computer, that device can run the application independently from the server. A previously published package can have different states on client computers:

- **Not Available**  In this state, the package isn’t registered or isn’t available on the client.
- **Registered**  In this state, the package is registered to the computer, but it still is not registered for the user.
- **Published**  In this state, the application is registered and published on the client, and the user can start using it.
- **Partially Loaded**  In this state, the application can be started because the client already has downloaded the initial feature block. Depending on which portion is missing, the rest of the files can download over the network, so the file server repository is the critical technology that provides that functionality.
- **Fully Loaded**  In this state, the application downloads and extracts entirely onto a client machine, and it can be used in an offline scenario.

The following areas will be a concern if the virtual applications aren’t configured to fully load on the client machine or aren’t already published on the publishing server:
The most critical technology that influences an application’s functionality will be the file server repository. Storage availability and AD DS will need extra planning considerations in this scenario.

If the management server or the management database is down, adding new packages, updating existing packages, or managing connection groups won’t be possible.

Publishing server failure affects the ability to make changes to the publishing list that clients previously received, which is for non-persistent Virtual Desktop Infrastructure (VDI) and RDS scenarios.

Reporting server or reporting database failure isn’t critical to running App-V applications; the only functionality that might not work is reports that a client sends about usage statistics for virtual applications, which are stored in the reporting database.

Organizations might plan different App-V infrastructure deployments based on their needs. When you start to plan for your App-V environment, you should try to answer the following questions to help with your design and implementation:

- Are there requirements that all roles must live on a single server? Decide whether you want to combine or cohost functionality.
- Do you need centralized or decentralized roles in a distributed environment?
- What are the requirements for high availability?
- Are the virtualized application users located in all of your office locations?
- Is your virtualization environment able to virtualize your entire App-V deployment?

Based on the answers to these questions, there are several design scenarios:

- **Small and midsize deployments** For small and midsize scenarios, which commonly address an environment with a small number of users and few packages in a single geographical site, you might cohost all of the roles on a single server.

- **Midsize and large deployments** For midsize and large deployments, which commonly require a flexible and scalable environment, you might consider a more complex design in which all services implement individually. In this scenario, every connection addresses a virtual IP address and machine name, and no services cohost on any given computer.
- **Distributed deployments**  For distributed deployments, which commonly need to support a large number of users in different locations with many different requirements, you should implement a scenario that can address locations with no datacenter and weak Internet connectivity. For this type of design, all configuration data that is stored in a management database should be located in a major datacenter. Because the management server communicates with the management database, it should be located close to the SQL server because SQL communication is time-sensitive and network-sensitive. The file server repository share that holds the application should be located close to clients, and interval refreshes can be adjusted according to the actual network capabilities.

- **High availability deployments**  In this scenario, you must have two identical machines (physical or virtual) that are configured in NLB mode (or behind a third-party hardware load balancer), where the following services are installed:
  - App-V management
  - App-V publishing
  - App-V reporting

Even if you don’t start with a highly available environment, you should consider using load balancing. It can simplify scaling out later and provide some additional capabilities such as drainstopping a server.

It is recommend that you host the SQL Server database separately from the App-V services. This consideration is made for performance, security, and scalability. For highly available designs, you should consider implementing a SQL Server cluster.

**Sizing and performance**

Actual sizing and performance planning depends on multiple factors, such as scaling an App-V infrastructure properly to lower the round-trip response time and providing proper package optimization for streaming across slow networks.

Round-trip response time on a publishing server is the time that is needed for the publishing server to receive a successful package metadata update from the management server. Round-trip response time on a client is the time the App-V client computer takes to receive a successful notification from the publishing server.

If you have increased internal demand, you can implement an additional management server behind your load balancers.

Often, users might demand external scalability based on the location you must support. A design should include a content repository in each location to provide conveniently located packages to clients. Additionally, you might consider implementing a publishing server and a management server to lower the round-trip response time on clients. Capacity planning
should be included to evaluate future demands in planned growth to meet expected performance levels.

A few factors influence round-trip response time on a publishing server. Some of these include the number of:

- Publishing servers that make simultaneous requests.
- Connection groups that are configured on a management server.
- Access groups that are configured on a management server.
- A single management server can simultaneously respond to up to 320 publishing servers with a round-trip response time of approximately 40 seconds; a single management server with fewer than 50 publishing servers results in a round-trip response time of less than 5 seconds.
- The number of connection groups starts to influence round-trip response time after more than 400 are created.
- The number of access groups increases the round-trip response time as it grows.

The number of publishing servers that simultaneously connect to a management server does not influence central processing unit (CPU) utilization and SQL database transactions per second; batches per second are identical, regardless of the number of publishing servers.

For App-V, reporting server capacity planning should focus on the number of clients that simultaneously send reporting information to a reporting server. Round-trip response time increases linearly with an increased number of clients. For example, round-trip response time is 2.6 seconds with 500 clients and 5.2 seconds with 1,000 clients.

Capacity planning for the publishing server influences the round-trip response time on an App-V 5.0 client computer to send a publishing refresh request and to receive a response.

The following are the main factors that influence capacity planning of an App-V publishing server:

- The number of clients that simultaneously connect to a single publishing server.
- The number of packages in each refresh.
- A publishing server with a dual-core processor can respond to up to 5,000 clients that simultaneously request refreshes. From 5,000 through 10,000 clients, a publishing server should have a quad-core processor at minimum. Increasing the number of packages increases response time by 40 percent, and network bandwidth has a major influence on
response time. For example, clients that run on slow networks—less than 1.5 megabits per second—will have a significantly slower response time than the same number of clients that run on LAN networks.

**High availability for App-V**

You should plan for a highly available App-V infrastructure in organizations where App-V is important. The high availability strategy for the App-V infrastructure depends on the App-V deployment model, because different procedures and settings for high availability are needed for different App-V deployment models.

**Stand-alone deployment model**

The stand-alone deployment model only requires an App-V Sequencer and client computers that have an installed App-V client. In the stand-alone deployment model, the App-V Sequencer is used only when a new application needs to be sequenced. Because the App-V Sequencer installs only when a new application needs to be sequenced, it isn’t necessary to make the Sequencer highly available. If you stream from a central share, this share can deploy on a clustered file system or on an NLB web farm. In cases where you require access to sequencing, even in a disaster recovery (DR) scenario, you can deploy multiple sequencing computers.

**App-V full infrastructure model**

From a planning perspective, the App-V full infrastructure model requires the most attention. Because there are a multitude of technologies with differing high availability models, you should spend time looking at the options available and decide which one makes the most sense for your environment. The following are some questions that you should answer to help you plan for high availability:

- Does the reporting service need to be highly available?
- Does the sequencing computer need to be highly available?
- Are there infrastructure technologies outside App-V that may impact the high availability of App-V, such as load balancers, switches, virtualization servers, or storage?
- Which secondary site should each office use in the case of a publishing server failure at the office?

The answers to the above questions will help you plan the services, the number of servers required, and the high-level design of your highly available environment.

The App-V full infrastructure model stores all configuration and application information in the management server database and stores all utilization data in the reporting server database,
so each of these databases is a single point of failure in this model. Therefore, when you are configuring the App-V full infrastructure model to be highly available, you need to ensure that the management server database and the reporting server database remain accessible. You can do this by deploying these two databases on an instance that is installed on a highly available VM or on a clustered SQL Server instance.

App-V 5.0 supports multiple management, reporting, and publishing servers. You can configure the App-V 5.0 management and reporting server databases to work with multiple management servers and reporting servers by using a security group when specifying the computer account location during setup. At any time, you can add publishing servers to an existing App-V full infrastructure model deployment.

Consider Figure 4-23, which shows what can happen when the application team provides high availability for its services but another team isn’t engaged in the project and is unaware of potential impacts.

![Figure 4-23 A diagram of an App-V full infrastructure deployment model](image)

In the diagram above, although all of the App-V technologies are highly available, there is only one load balancer. It represents a single point of failure. Instead of this scenario, the availability of all services on which App-V is dependent should match the App-V availability.

**Integrated Configuration Manager model**

For the integrated Configuration Manager model to be made highly available, you should look at all of the options to meet your high availability requirements and figure out if any infrastructure changes are required:
● Are highly available VMs available in your environment? If so, you can use one or more for your Configuration Manager servers.

● Is your existing SQL environment highly available?

● Is the storage that the virtual environment uses highly available?

● Do you have distribution points in all of the locations to which you plan to deliver virtual applications? If so, you need to plan for scenarios in which a distribution point becomes unavailable. In environments with an existing Configuration Manager deployment, it isn’t unusual to have sites with a single distribution point. You should consider multiple distribution points if your requirements include immediate access to virtual applications, especially for new App-V clients.

● You also may want to look at the overall high availability of the Configuration Manager environment. Is there an existing hierarchy with a central administration site?

Similar to other App-V deployment models, you should look at all aspects of your environment and ensure that all of the services involved are configured for high availability.


**Disaster recovery**

A disaster recovery plan should include a proper backup of critical technologies to respond to a service outage. In addition, regular testing of restore operations will help ensure that the backups are functional and that the operational procedures are adequate to recover from a disaster. At a minimum, an App-V infrastructure backup should protect the management database and the package repository that contains the App-V packages. Outside App-V, you should ensure that the services on which App-V depends also are backed up and restored first after a disaster. For example, you need to ensure that AD DS, SQL, Server virtualization, and the core networking services are up and running before you can successfully recover App-V.

In an App-V backup and recovery scenario, each role has different requirements:

● A management server does not hold any unique data other than the registry configuration of the database source, so you can easily re-create this role in case of a disaster.

● A publishing server contains a registry value that indicates the host name of the management server to contact and a cached copy of the latest publishing data, which you need to back up.

● The reporting server has a registry value that indicates the name of the reporting database.
There are two different scenarios for recovery procedures:

- If a server that contains all of the roles fails, administrators should perform standard image recovery procedures that are defined by organizational policy. This often means restoring the VM or physical server to the most recent backup.

- If an App-V service fails, administrators should perform a recovery by installing the App-V technologies and prerequisites, such as installing and configuring Internet Information Services (IIS) and installing SQL Server on the database server.

When you restore the management server, it enables this service to become operational as soon as the service can contact the App-V database. When you complete the restoration of publishing servers, client requests will be serviced as soon as the service contacts the publishing servers (from 1 to 10 minutes). After the App-V services are restored, the reporting server starts accepting client connections.

**Deploying App-V infrastructure**

After you determine which application virtualization model to use, you need to deploy the appropriate roles to support that model. In most production environments, you should host the management server database and the reporting server database separately from the management server and the reporting server. It isn’t uncommon to see the management database and reporting database also separated, depending on the database infrastructure you have. Before a deployment, you need to understand the order in which to deploy App-V technologies. In this section, we will explain the following:

- App-V infrastructure requirements
- Installing management databases
- App-V Management Server configuration
- App-V Publishing Server deployment and configuration
- App-V for Remote Desktop Services clients
- Integrating App-V with System Center Configuration Manager
App-V infrastructure requirements

The technologies of App-V should be deployed in a specific order. If you deploy all roles on the same server when you deploy the App-V full infrastructure model, the installation wizard automatically deploys them in the correct order. If you deploy the roles on more than one server, you should deploy them in the following order:

1. Management server database
2. Management server
3. Publishing server
4. Reporting server database (optional)
5. Reporting server (optional)

When you configure management server database settings, you need to specify the security account of the computer that will access the database. This can be a security group account or the computer account of the server that will function as the management server. When you install a management server separately, you need to specify the instance location and credentials that will be used to access the management server database.

When you deploy a publishing server, you need to specify the network address of the management server. You can’t deploy a publishing server without having a management server already deployed, unless you deploy all of the roles at the same time.

You must deploy a reporting server database before deploying a reporting server. The reporting server doesn’t have dependencies on any other services in the App-V full infrastructure model.

You don’t need to install the App-V Sequencer when deploying the App-V full infrastructure model. However, it is a good idea to deploy a sequencer as soon as possible to begin testing the deployment. The App-V client usually is the last application to be deployed.

Installing management databases

The management server stores all of the configuration data in an App-V management database, which includes all application metadata, the deployment configuration, the relationships, and the security assignments. The management server only communicates with the management database, and it is the first technology that should be installed in the App-V full infrastructure model. When you add management servers for a scalable deployment, you only need to allow Read and Write permissions to the database. You don’t have to provide additional configurations.
The minimum supported database platform is Microsoft SQL Server 2008 R2 Standard, Enterprise, Datacenter, or Developer edition (32-bit or 64-bit). The Developer edition should not be used in a production environment. Additional prerequisites include the installation of the following:

- .NET Framework 4 (Full Package)
- Microsoft Visual C++ 2010 SP1 redistributable package (x86)
- Windows Server 2008 or newer

In the deployment scenario in which you install all of the technologies on the same computer, the App-V server setup GUI-based installation first installs the App-V management database and then installs the management server and the publishing server. Finally, if selected, the reporting database and reporting server are installed.

If you are implementing scalable deployment, you should run the GUI installation on a server that hosts the management database because remote SQL database creation isn’t supported in the installer.

As an alternative, you can install the SQL database when you execute SQL Server scripts that are extracted from the server setup, as shown in Figure 4-24. SQL Server scripts extract from the setup with the following command: `appv_server_setup.exe /layout /layoutdir=c:\ extract`.

![Figure 4-24 Example appv_server_setup.exe command](image)

In the destination folder, you must modify two of the six scripts to provide the appropriate Read and Write permissions for the domain accounts or domain groups that you need to manage an App-V infrastructure. The first modification must be done to the Permissions.sql
deploying app-v infrastructure

script to replace the entry for [ManagementDBWriteAccessAccountSid] and for [ManagementDBWriteAccessAccountName] with the security identifier (SID) and the name for the domain group that requires Write permissions to the database. This group should include the App-V administrator account and all management servers in the environment. If you use the same account for installation and App-V administration, then you should use the same entries for [ManagementDBPublishAccessAccountSid] and [ManagementDBPublishAccessAccountName]. Otherwise, you should enter the correct SID and name for the installation account. In Figure 4-25, the Permissions.sql file has been modified and is ready for use.

Figure 4-25 An example Permissions.sql file

Modification of the second script, Database.sql, is optional and has to be done only if you plan to replace the default database name AppVMangement with a unique name. In Figure 4-26, the Database.sql file has been updated to create a database named CustomDB.
A SQL Server administrator must run prepared SQL scripts against a computer that is running SQL Server that will host the database. SQL Sysadmin permissions are required. You can run the script if you first open the SQL Server Management Studio console and run it as a query, but you need select the proper database. The second method that you can use is the OSQL command-line application. The switches /E, /i, and /d are case-sensitive. Reporting database setup is identical to a management database and can be done with the App-V setup installer, or it can be pre-created with SQL scripts. The following commands can be used:

OSQL -E -i database.SQL
OSQL -E -d MS_Appv5_Management -i CreateTables.sql
OSQL -E -d MS_Appv5_Management -i CreateStoredProcs.sql
OSQL -E -d MS_Appv5_Management -i UpdateTables.sql
OSQL -E -d MS_Appv5_Management -i insertversionInfo.sql
OSQL -E -d MS_Appv5_Management -i Permissions.sql

**App-V Management Server configuration**

An App-V Management Server provides a centralized location to manage an App-V 5.0 infrastructure for delivering virtual applications to both an App-V client and an RDS (formerly Terminal Services) client. Unlike previous versions of App-V, a web application that runs on Silverlight manages the App-V 5.0 infrastructure. You configure this web application’s address...
Deploying App-V infrastructure

205

when you install a management server. The installation of an App-V Management Server creates a dedicated IIS website, for which you can specify the name during the installation setup. By default, it is called the Microsoft App-V Management Service. The App-V Management Service will be configured to listen on a dedicated port number, which can be provided during setup.

App-V server features can install on multiple servers to provide scalability and high availability; however, all App-V server features would need a common way to be accessed, such as by using a load balancer. Each management server node needs connectivity to the database on the computer that is running SQL Server. If a single server hosts multiple technologies, they can use different ports, or you can configure them to share a single port.

Preinstallation tasks include configuring appropriate user and administrative groups that can install and administer a management server. A management server requires that an IIS server is installed and configured to be trusted for delegation. If you plan to support Secure Sockets Layer (SSL) for connectivity to a management server, you also need a server certificate that is issued from either an internal or a public certification authority.

Installing an App-V Management Server at the command line requires elevated privileges. You can display the installation parameters, shown in Figure 4-27, by running the following command:

appv_server_setup.exe /?

![Figure 4-27 App-V setup command-line parameters](image)
The following commands provide an example of an App-V Management Server installation, as shown in Figure 4-28. You can verify the output of the installation in the log file appv_server_datetime.log in the %temp% directory.

```
```

![Command-line setup of an App-V server](image)

**Figure 4-28** Command-line setup of an App-V server

Common postinstallation tasks include sharing the content folder that is used to store the App-V package. It also is common to enable firewall rule exceptions.

You can install a management server by using a very basic GUI, but for enterprise deployment, we recommend script-based installation. Management servers and publishing servers have a dependency on IIS with the following features:

- Common HTTP features: static content and default document
- Application development features: Microsoft ASP.NET, Microsoft .NET Extensibility, and Internet Server API (ISAPI) extensions and filters
- Security features: Windows authentication and request filtering
- Management tools features: IIS Manager

One common method for proper installation of IIS and all required services is to use the Deployment Image Servicing and Management (DISM) tool, which you can use to create a script by saving the following commands in a text editor with the .cmd extension:

```
dism /Online /Enable-Feature /FeatureName:llS-ApplicationDevelopment
```
A management server has the following requirements:

- 1-gigahertz (GHz) or faster x64 processor; two cores Intel Xeon 2.0 GHz or faster recommended
- 2 gigabytes (GB) or more of RAM; 4 GB of RAM recommended
- 200 megabytes (MB) of free disk space (does not include content); 40 GB recommended
- Windows Server 2008 R2 SP1 or newer.NET Framework 4 Extended
- .NET Framework 3.5.1 Features (or 4.5)
- Visual C++ 2010 SP1 Redistributable Package (64-bit)
- Visual C++ 2010 SP1 Redistributable Package (32-bit)
- Silverlight
- Windows PowerShell 3.0
App-V publishing server deployment and configuration

When you deploy an App-V publishing server, you must specify the location of an existing App-V Management Server. This is different from previous versions of App-V, in which it was possible to deploy a stand-alone streaming server without having to configure a management server.

Publishing servers function as distribution points for virtualized applications when you use the App-V full infrastructure model. Applications stream from these servers to clients. The entire application doesn’t need to stream before a user can start interacting with it; therefore, you won’t need as much bandwidth as you would with other deployment methods. Nonetheless, you still need to provision adequate bandwidth for the connection between a publishing server and the client.

To install a publishing server by using a GUI installer, you must follow the same steps as installing the management server. You have to point to an existing management server, and if these two roles coexist on the same computer, you must choose a different port for the website.

When you perform a command-line installation, you can use the help that the installer provides, which presents examples and definitions that construct the following command:

```
appv_server_setup.exe /?
```

You can use the following commands to perform publishing server installation at the command line:

```
/PUBLISHING_WEBSITE_NAME="Microsoft Appv Publishing service" /PUBLISHING_WEBSITE_PORT="80
/EXISTING_MANAGEMENT_DB_REMOTE_SQL_SERVER_NAME="SQLSRV.adatum.com" /EXISTING_MANAGEMENT_DB_SQLINSTANCE_USE_DEFAULT /EXISTING_MANAGEMENT_DB_NAME="AppVManagement"
```

As a best practice, when you install on the same server as the management server, use port 80 for the publishing server and an alternate port for the management server.

After you deploy both the management server and the publishing server, you need to configure them with appropriate firewall rules to provide management and client connectivity.

A publishing server is a web application that is hosted on IIS, and any configuration changes can be done through IIS Manager or by using the HKLM\Software\Microsoft\APPV\Server\PublishingService\PUBLISHING_MGT_SERVER registry settings to point to the protocol and port that establish connectivity with the App-V Management Server. The PUBLISHING_MGT_SERVER_REFRESH_INTERVAL registry setting specifies how often a publishing server queries a management server for packages. The default value is 600 seconds (10 minutes), and for testing purposes, you can shorten the interval to propagate changes to
clients more quickly. Any registry changes will become effective when the application pool
restarts or IIS restarts.

You also can configure management server settings in IIS and the registry, as shown in
Figure 4-29.

![Registry Editor](image)

**Figure 4-29** App-V registry settings for the management server

HKLM\Software\Microsoft\APP\Server\ManagementService contains configura-
tion data for a management server. From this registry location, you can identify or change a
connection string to the management database (*MANAGEMENT_SQL_CONNECTION_STRING*)
or identify the port and name for the management website.

In addition to the registry, some configuration settings are stored in the files in the
INSTALLDIR. The AdminGroup.xml file contains information to recover access to an App-V
console when you remove the last administrator from the console.

A publishing server has the following requirements:

- 1 GHz or faster x64 processor; two cores Intel Xeon 2.0 GHz or faster recommended
- 2 GB or more of RAM; 4 GB of RAM recommended
- 200 MB of free disk space (does not include content); 40 GB recommended
● Windows Server 2008 R2 SP1 or newer
● .NET Framework 4 Extended
● Visual C++ 2010 SP1 Redistributable Package (32-bit)
● Windows PowerShell 3.0
● The Web Server role with the following features:
  ■ Common HTTP features: static content and default document
  ■ Application development features: ASP.NET, .NET Extensibility, ISAPI extensions and filters
  ■ Security features: Windows authentication and request filtering
  ■ Management tools features: IIS Manager

App-V for Remote Desktop Services client

App-V 5.0 has a separate, special client that makes it possible to run virtualized applications on RD Session Host servers. With this client, you can run applications on RD Session Host servers that might not otherwise run on an RD Session Host server.

The App-V for RDS client has the following system requirements:

● 1.4 GHz or faster x86 or x64 processor
● Windows Server 2008 R2 SP1 or Windows Server 2012
● .NET Framework 3.51 and 4 (Full)
● Windows PowerShell 3.0
● Microsoft KB2533623 (Windows Server 2008 R2)
● Visual C++ 2008 redistributable (if installing by using an executable file)

You must configure Windows Server 2008 R2 or Windows Server 2012 as an RD Session Host server before you install the App-V for RDS client.

You can use the App-V for RDS client with the App-V full infrastructure, stand-alone, and Configuration Manager–integrated models. The App-V for RDS client uses the same Group Policy settings as the normal App-V client.
Integrating App-V with System Center Configuration Manager

The Configuration Manager–integrated model requires that you have an existing Configuration Manager or newer deployment. This model allows you to deploy sequenced App-V applications as one of many different application deployment types.

Before deploying sequenced App-V applications, you should configure App-V client software as an application that you can deploy. You then can specify the App-V client as a requirement when deploying any sequenced App-V application.

You can create the App-V client as an application by performing the following procedure:

1. Copy the App-V client installation file, corecli_amd64.msi or corecli_i386.msi, to a shared folder. In the Configuration Manager console, in the Software Library workspace, under the Application Management node, click Applications.

2. On the ribbon, click Create Application.

3. On the General page of the Create Application Wizard, set the type to Windows Installer (*.msi file) and then click Browse.

4. Browse to the shared folder where you copied the App-V client installation file. Finish the wizard and then click Close.

To create an App-V application in Configuration Manager, perform the following procedure:

1. In the Configuration Manager console, in the Software Library workspace, under the Application Management node, click Applications.

2. On the ribbon, click Create Application.

3. On the General page of the Create Application Wizard, set the type to Microsoft Application Virtualization 5 and then click Browse to go to the network location that hosts the file in .appv file format.

4. Finish the wizard and then click Close.
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Session-based virtual desktops are widely used by organizations to provide remote access to data and applications in a centralized and controlled environment. In Windows Server 2012 R2, Remote Desktop Services (RDS) provides the infrastructure to implement session-based virtual desktops and virtual machine (VM)–based virtual desktops.

In older versions of Windows Server, session-based desktops were provided by a feature named Terminal Services. Terminal Services had the same basic functionality for session-based desktops as RDS, but RDS has been extended with additional functionality to improve the user experience and manageability.

**Understanding RDS**

RDS is a Windows Server role that provides much more than just remote desktops. RDS includes six role services that enable you to create a scalable and fault-tolerant RDS deployment. You can manage an RDS deployment centrally and in the same way, regardless of the number of servers in an RDS deployment. This makes RDS very scalable.

One of the most common uses for RDS is the deployment of session-based virtual desktops. In a session-based virtual desktop, all processing is performed on a Remote Desktop Session Host (RD Session Host) server, and the results are displayed on a Remote Desktop client. The communication between the client and the RD Session Host server uses Remote Desktop Protocol (RDP).

RDP is a very efficient protocol and sends a limited amount of data over the network. This makes it possible to use RDS to provide desktops and applications for users over a LAN, from branch locations over a WAN, or over the Internet.

RDS includes the following functionality:

- **Provides users with a full desktop** Whether you use session-based virtual desktops or VM-based virtual desktops, you can provide users with access to a full remote
desktop that you can access from almost anywhere if you configure the necessary infrastructure.

- **Provides users with access to applications** You can use RemoteApp to provide users with access to applications running on an RD Session Host server. These applications run in a window just as regular applications do on users’ desktops. From the user’s perspective, applications delivered by RemoteApp function as if they are installed locally.

- **Allows secure remote access without using a virtual private network** The Remote Desktop Gateway (RD Gateway) role service is used as a proxy for accessing session-based virtual desktops or VM-based virtual desktops. This is suitable for securing access from the Internet.

The Terminal Services functionality found in older versions of Windows Server had only session-based virtual desktops and applications. In Windows Server 2012 R2, you also can use RDS to deploy VM-based virtual desktops. Connectivity to the VMs is done by using RDP, just as in a session-based deployment.

Some benefits of using RDS for virtual desktops and applications include the following:

- **Easier application deployment and updates** A typical application deployment requires you to install and update the application on each client computer. In all but the smallest environments, this requires you to implement some type of automated deployment tools for applications. With RDS, you only need to install and update applications on the central servers. This is significantly less work than installing and updating applications on individual client computers.

- **Simplified access to data and applications** When you implement RDS, applications and their data can be accessed from anywhere. You can allow users to use applications from a computer in the office, a home computer, and mobile devices.

- **Faster access to remote data** Access to data over a virtual private network (VPN) or WAN links often results in poor application performance. For example, an application that requires access to a SQL server may be very slow if the connectivity to the SQL server has high latency. When you use RDS, you place the central servers with the application installed close to the application data, and network latency is removed as a performance problem.

- **Higher data security for mobile users** Without RDS, mobile users copy data onto a mobile computer and take it with them. Or, in some cases, they use a VPN to access data remotely while offsite. In both cases, there is a risk that the mobile computer could be lost or stolen and the data accessed by unauthorized users. When you use RDS for remote access to data, there is no need to copy data to the remote device. This mitigates the risk that your organization will lose control of the data.
**Simplified client hardware management**  Using RDS to provide virtual desktops reduces the effort to manage client device computers because the devices are performing much less work. Computers used to access virtual desktops become essentially disposable because the only configuration information they contain is the connection information to the remote desktop. In some cases, you may be able to extend hardware life because the client device is performing very little work.

### Comparing RDS and the Remote Desktop feature

Remote Desktop is a feature in Windows 8.1 and Windows Server 2012 R2 that enables you to connect to a computer remotely and to view its desktop, just as when you sign in to that computer locally. The primary intention of the Remote Desktop feature is remote administration. That is why, when you enable the feature, by default only the administrator who enables it can connect to the remote desktop. Other users can connect to the remote desktop only if you grant them permission.

RDS is a Windows Server role that is available only in the Windows Server operating system. To deploy RDS, you need to install at least three role services and perform an additional configuration. RDS provides a similar experience to the Remote Desktop feature, but the primary intention of RDS is to enable users to have a standard remote environment that is available from any device and to use remote resources while integrating remote applications on the local user desktop. Table 8-1 compares RDS and the Remote Desktop feature.

**Table 8-1  Comparing RDS and the Remote Desktop feature**

<table>
<thead>
<tr>
<th>RDS</th>
<th>Remote Desktop Feature</th>
</tr>
</thead>
<tbody>
<tr>
<td>Can support many simultaneous users.</td>
<td>Desktop operating systems are limited to one simultaneous user. Server operating systems are limited to two simultaneous users.</td>
</tr>
<tr>
<td>Proper licensing must be purchased and configured.</td>
<td>No additional licensing is required.</td>
</tr>
<tr>
<td>Used to access a full remote desktop or remote applications (RemoteApp).</td>
<td>Used to access the full remote desktop.</td>
</tr>
<tr>
<td>Supports advanced features such as RemoteFX USB Redirection and multimedia redirection.</td>
<td>Does not support advanced features.</td>
</tr>
<tr>
<td>Requires an infrastructure of multiple servers that has been properly planned and deployed.</td>
<td>Is enabled on a single computer.</td>
</tr>
</tbody>
</table>
RDS architecture

There are six RDS service roles that can be included in an RDS deployment. At minimum, you need to have the Remote Desktop Connection Broker (RD Connection Broker) role service, the Remote Desktop Web Access (RD Web Access) role service, and either the RD Session Host or Remote Desktop Virtualization Host (RD Virtualization Host) role service. You can install individual RDS role services, but you won’t be able to manage them unless they are part of an RDS deployment. Depending on your implementation goals, an RDS deployment can include additional RDS role services, and RDS role services can be installed on multiple servers for scalability and high availability.

Windows Server 2012 R2 RDS includes the following role services:

- **RD Session Host**  This role service configures a server to provide session-based desktops and applications. Users can connect to an RD Session Host server and then run applications and use the network resources that the RD Session Host offers. RD Session Host is a required role service in a session-based desktop deployment of RDS.

- **RD Virtualization Host**  This role service integrates with the Hyper-V role in Windows Server 2012 R2 to provide VMs that can be used as virtual desktops. The RD Virtualization Host role service also monitors and reports on established client sessions to the RD Connection Broker role service. This role service is responsible for managing the VMs that function as pooled and personal virtual desktops. If VMs are in a saved state, the RD Virtualization Host role service starts the VMs to prepare them for a user connection. For pooled virtual desktops, the RD Virtualization Host role service reverts the VMs to their initial state when users sign out. The RD Virtualization Host role service is required in a VM-based deployment of RDS.

- **RD Connection Broker**  This role service manages connections to RemoteApp programs and virtual desktops, and it directs client connection requests to an appropriate endpoint. The RD Connection Broker role service also provides session reconnection and session load balancing. For example, when a user disconnects from a session and later establishes a connection, the RD Connection Broker role service ensures that the user reconnects to his or her existing session. This role service is mandatory in all RDS deployments, but it does not require large amounts of server resources.

- **RD Web Access**  This role service provides a web-based interface to RemoteApp programs, session-based virtual desktops, or VM-based virtual desktops. A webpage provides each user with a customized view of all RDS resources that have been published to that user. This role service supports organizing resources in folders, which enables administrators to group remote applications in a logical manner. It also publishes
available RDS resources in an RDWeb feed, which can integrate with the Start screen on client devices. RD Web Access is a mandatory role service for each RDS deployment.

- **Remote Desktop Licensing (RD Licensing)** This role service manages RDS client access licenses (RDS CALs) that are required for each device or user to connect to an RD Session Host server. You use RD Licensing to install, issue, and track RDS CAL availability on an RD Licensing server. You are not required to install this role service during an initial RDS deployment, but an RDS deployment without proper licensing ceases to function after 120 days.

- **RD Gateway** This role service allows authorized remote users to connect securely to RemoteApp programs and virtual desktops from outside the organization over the Internet. An RD Gateway server acts as a proxy for external users to connect to internal RDS resources. To increase compatibility with firewalls in public locations such as hotels, RDP traffic is encapsulated in Hypertext Transfer Protocol Secure (HTTPS) packets. Access is controlled by configuring Remote Desktop connection authorization policies (RD CAPs) and Remote Desktop resource authorization policies (RD RAPs). An RD CAP specifies who is authorized to make a connection, and an RD RAP specifies to which resources authorized users may connect.

All deployment and management of RDS is done by using Server Manager, as shown in Figure 8-1. Server Manager provides an overview of all servers in an RDS deployment and a management interface for each server. RDS in Server Manager uses a discovery process to detect the role services that are installed on each machine that is added to Server Manager.
Chapter 8  Planning and deploying session-based virtual desktops

Figure 8-1  RDS configuration in Server Manager

NOTE

Legacy Remote Desktop administration tools such as Remote Desktop Services Manager and RD Session Host Configuration, which were used for configuring and administering RDS in Windows Server 2008 R2, are replaced with RDS in Server Manager in Windows Server 2012 and Windows Server 2012 R2.

Connecting to virtual desktops and RemoteApp programs

Windows client operating systems include Remote Desktop Connection (RDC), which is used to connect to virtual desktops and applications. Microsoft also provides Microsoft Remote Desktop for iOS and Android devices. All of these applications use RDP to connect to virtual desktops and RemoteApp programs.

When you use RDC to access a computer with the Remote Desktop feature enabled, you enter the IP address or DNS name of the remote computer, as shown in Figure 8-2. This type of direct connectivity doesn’t work when connecting to RDS because you are connecting through
the RD Connection Broker and need to be directed to a specific collection for the RemoteApp program or virtual desktop.

![Remote Desktop Connection (RDC)](image)

**Figure 8-2 Remote Desktop Connection (RDC)**

After you implement servers for the RDS infrastructure, you need to create collections that define what the clients are connecting to and how it is configured. There are two types of collections:

- **Virtual desktop collections**  This type of collection contains VMs hosted on RD Virtualization Host servers.

- **Session collections**  This type of collection contains RD Session Host servers that provide session-based virtual desktops or RemoteApp programs.

To connect to collections in RDS, you need to have an .rdp file with the correct connectivity information for the RD Connection Broker and the collection to which you are connecting. RDC uses the connectivity information in the .rdp file.

You can create an .rdp file manually and make it available to users. When the user opens the .rdp file, RDC launches and connects to the RD Connection Broker. This method is functional but relatively complex because you need to learn the syntax for creating .rdp files and need to update them if your infrastructure changes.

The simplest way to provide user connectivity to RDS is by using RD Web Access, shown in Figure 8-3. When users connect to RD Web Access, they are provided with a list of collections to which they have access. When they click the appropriate collection, an .rdp file with the correct configuration information is generated, and RDC launches using the information in the .rdp file. This provides a consistent access method even if the RDS deployment is modified.
The following process, shown in Figure 8-4, is used when clients connect to a session collection by using RD Web Access:

1. Users connect to the RD Web Access portal and identify the RDS resource to which they want to connect.

2. Users click the link on the RD Web Access portal for the RDS resource they want to access. This downloads the .rdp file, which contains information about the resource to which the user wants to connect.

3. RDC is launched, and it uses the information in the .rdp file to initiate a connection with the RD Connection Broker role service. After users authenticate to the RD Connection Broker role service, the RDC passes the request about the RDS resource to which the user wants to connect.

4. The RD Connection Broker role service examines the request to find an available RD Session Host server in the desired collection and sends the connection information back to the RDC client. If the request matches a session that already is established for the associated user, RD Connection Broker redirects the client to the server in the collection where the session was established. If the user doesn't have an existing session in the collection, the client redirects to the server that is most appropriate for the user.
connection, based on the RD Connection Broker load balancing algorithm—for example, weight factor, fewest connections, and least utilized.

5. The RDC client establishes a session with the RD Session Host server that RD Connection Broker provided.

![Figure 8-4 Connectivity for session collections](image)

**RDS functionality that enhances the client experience**

RDC uses the RDP protocol to connect to RDS servers. The following are some of the specific features available that enhance the client experience:

- **Bandwidth reduction features**  When an RDP connection is established, various methods to reduce network bandwidth are used, such as data compression and caching. Caching enables an adaptive user experience over LANs and WANs. Clients can detect available bandwidth and adjust the level of graphic detail that is used.

- **Full desktop or application window only**  When a client connects to RDS, it can display either a full remote desktop or only the window of a remotely running application (RemoteApp program). With full desktops, users can perform remote administration or run multiple applications. However, the user must deal with two desktops: local and
remote. RemoteApp programs integrate with local desktops, but they still require network connectivity to RDS.

- **RemoteApp programs that look and feel like locally installed applications** The window displayed when you connect to a RemoteApp program looks like a locally installed application. Links to RemoteApp programs can be added to a client's Start screen. RemoteApp program icons support pinning, tabbed windows, live thumbnails, and overlay icons. RemoteApp windows can be transparent, and the content of a RemoteApp window displays while you are moving it.

- **Reconnection to existing sessions** If a user disconnects from a remote desktop session, the user can reconnect to the session and continue to work from the point at which he or she disconnected. The user can connect from the same device or from a different client device. If a session disconnects for a different reason, for example, because network connectivity is lost, the user automatically reconnects to the disconnected session when network connectivity is restored.

- **Redirection of local resources** Client resources such as drives, printers, the Clipboard, smart card readers, and USB devices can redirect to a remote desktop session. This enables you to use locally attached devices while working on RDS and to use the Clipboard to copy content between a local and remote desktop. You even can redirect USB devices that you plug in when the remote desktop connection already is established.

- **Windows media redirection** This feature provides high-quality multimedia by redirecting Windows media files and streams from RDS to a client. When Windows Media Player is used in a session-based virtual desktop, the multimedia file is not rendered on the RD Session Host. Instead, the multimedia stream is redirected to the RDC client and is rendered on the client. This reduces load on the RD Session Host and provides higher quality audio and video playback on the client. If the RDC client does not have the necessary codec for the multimedia content, then the content is rendered on the RD Session Host.

- **Multi-monitor support** This feature enables support for up to 16 monitors of any size, resolution, and layout. Applications function just as they do when you run them locally in multi-monitor configurations.

**NOTE**

Multi-monitor support requires RDC version 7.0 or later. This software is included with Windows 7 and later. If you are connecting to a computer running Windows 7, multi-monitor support is available only for the Ultimate and Enterprise editions. If you are connecting to a computer running Windows 8 or Windows 8.1, multi-monitor support is available only for the Professional and Enterprise editions.
● **Single sign-on (SSO)**  When users connect to RDS, they have to provide their credentials again. With SSO, a user can connect to a remote desktop or start a RemoteApp program as the user who signed in to the local computer, without reentering credentials.

● **CPU, disk, and network Fair Share**  Fair Share features are enabled by default on RD Session Host servers to ensure even resource distribution among users. One user can’t monopolize resources or negatively affect the performance of other users’ sessions. Fair Share can distribute network, disk, and CPU resources dynamically among user sessions on the same RD Session Host server. You can control Fair Share settings through Group Policy.

**RemoteFX**

RemoteFX introduces a set of enhancements to RDP that enables rich graphics and video capabilities within a remote desktop session, regardless of whether you are connecting to a session-based virtual desktop, running a RemoteApp program, or connecting to a VM-based virtual desktop. In all three cases, the user experience is almost identical to using a local physical desktop. RemoteFX is included in RDS, and you don’t need to enable it explicitly unless you want to use the RemoteFX virtual graphics processing unit (vGPU) on a VM-based virtual desktop. In that case, you must add hardware to the VMs that are used for the virtual desktop.

The following is a list of some RemoteFX features:

● **RemoteFX for WAN**  This feature delivers an improved user experience over lower-speed networks, such as at a branch office, on a wireless device, or working from home over a WAN connection. RemoteFX for WAN combines the RemoteFX Adaptive Graphics feature with intelligent WAN-aware transports. TCP and UDP can be used for remote desktop connections. The protocol that is better suited for the current connection is selected automatically, and automatic detection of network conditions to adjust the encoding of content is available.

● **RemoteFX Adaptive Graphics**  This feature dynamically adapts to changing network conditions and optimizes encodings based on the content delivered. RemoteFX Adaptive Graphics use multiple codecs, which are optimized for different types of content, such as text, images, and video.

● **RemoteFX Media Streaming**  This feature provides redirection of multimedia content. When a user attempts to play multimedia content in a remote session, the content is intercepted and redirected to the client. The client receives the compressed content, decodes the content, and plays it back locally.

● **RemoteFX Multi-Touch**  This feature extends the Windows 8.1 touch experience to devices on which multi-touch is the primary means of user interaction. Windows 8.1 users are able to interact with remote desktop sessions in the same way as
a local desktop, including support for multi-touch gestures and the ability to navigate between local and remote sessions by using touch.

- **RemoteFX USB Redirection**  This feature enables devices to redirect at the USB level. Because of this, no device drivers are required on the client computer, and any USB device—including audio, storage, all-in-one printers, and scanners—can be redirected.

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**Inside OUT**

*vGPU for VM-Based Virtual Desktops*

An RD Virtualization Host server can suffer from high processor utilization due to graphics processing in the VMs it’s hosting. This occurs because the processors in the RD Virtualization Host server do the graphics processing for each VM. This can limit the scalability of the RD Virtualization Host server.

One solution for reducing processor load on the RD Virtualization Host server is to use the vGPU functionality that is available in Windows Server 2012 R2. When you use the vGPU functionality, the VMs can use a dedicated graphics processor in the RD Virtualization Host server for graphics processing. From a performance perspective, this is like putting a more advanced video card in a desktop computer.

To use vGPU on an RD Virtualization Host server, you must meet the following requirements:

- **Second Level Address Translation (SLAT) support**  The processor in the RD Virtualization Host server must include support for SLAT. For Intel processors, this is called Extended Page Tables. For AMD processors, this is called Nested Page Tables.

- **Supported video adapter**  The video adapter in the RD Virtualization Host server must be DirectX 11-capable with a Windows Display Driver Model (WDDM) 1.2–compatible driver. WDDM 1.2 was introduced with Windows 8.

- **Windows 7 Enterprise with SP1 or Windows 8 Enterprise**  Only the Enterprise editions of Windows 7, Windows 8, and Windows 8.1 support the use of vGPU in the VM.

- **Generation 1 VMs**  The vGPU functionality isn’t supported for generation 2 VMs in Hyper-V. You must configure VMs as generation 1 VMs.

If you meet the requirements for using vGPU, then you can add a RemoteFX 3D Video Adapter to VMs. In the configuration for the RemoteFX 3D Video Adapter, you can configure a maximum number of monitors and maximum monitor resolution.
Remote Desktop Connection configuration options

When you connect to a virtual desktop through RDS, RDC is configured automatically by using an RDP file that is provided by the RD Web Access server. When you use RDC to connect to a server or client with the Remote Desktop feature enabled, you can configure the connectivity settings manually. The configuration options are grouped on several different tabs. Microsoft Remote Desktop for iOS and Android have similar configuration options but different user interfaces.

On the General tab, you can specify the computer to which you want to connect by using RDC and user credentials. You also can save RDC settings in a text file with an .rdp file name extension to initiate a connection later without configuring RDC settings again.

The Display tab is shown in Figure 8-5. On this tab, you can choose the size of the remote desktop window, including the option to run the remote desktop in full-screen mode. You can select to use all local monitors for a remote session, select color depth, and enable a connection bar when the remote desktop is running in full-screen mode.

Figure 8-5 Remote Desktop Connection, Display tab

The Local Resources tab is shown in Figure 8-6. On this tab, you can set remote audio settings, such as whether you want to enable remote audio playback and recording. You also can specify a location where Windows key combinations, such as Alt+Tab, are applied and whether local devices and resources in remote sessions are available. For example, you can enable the
option to make the Clipboard, local drive, printers, and devices that you plug in later available in a remote session.

**Figure 8-6** Remote Desktop Connection, Local Resources tab

On the Programs tab, you can specify a program that starts automatically in a remote desktop session when you connect to a remote computer. If you configure this option, when you close the program, your session is signed out automatically.

On the Experience tab, you can select a connection speed to optimize performance. You can enable different features, such as the following:

- Desktop background
- Font smoothing or visual styles in RDC
- Show window contents while dragging

By default, RDC automatically detects connection quality and configures connection quality–dependent features accordingly. On this tab, you also can configure persistent bitmap caching and automatic reconnection if a connection drops.

RDC displays the bandwidth with an icon on the connection bar (top of the window) that is similar to a signal strength meter. The meter is based only on bandwidth and does not take
latency into account. The number of bars in the icon identify the bandwidth, as show in Table 8-2.

**Table 8-2** RDC bandwidth values

<table>
<thead>
<tr>
<th>Icon</th>
<th>Bandwidth</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 bars</td>
<td>10 megabits per second (Mbps) and higher</td>
</tr>
<tr>
<td>3 bars</td>
<td>2000–9999 kilobits per second (Kbps)</td>
</tr>
<tr>
<td>2 bars</td>
<td>512 Kbps - 19999 Kbps</td>
</tr>
<tr>
<td>1 bar</td>
<td>Less than 512 Kbps</td>
</tr>
<tr>
<td>No icon shown</td>
<td>No bandwidth detected or older remote desktop host</td>
</tr>
</tbody>
</table>

On the Advanced tab, you can configure server authentication and Connect From Anywhere settings. The server authentication options allow you to define what should be done if the certificate provided by the server during authentication isn’t valid. By default, a warning is displayed and you have the option to continue. If desired, you can configure this setting to connect without warning or prevent connections.

The Connect From Anywhere settings allow you to configure connectivity through an RD Gateway server. You can configure the alternate credentials for authentication to the RD Gateway server and the location of the RD Gateway server.

**RDS licensing**

If you want to use RDS, you need to purchase additional RDS CALs for each user or device that uses RDS. This is in addition to the typical licensing that is required for desktop computers. For example, in an environment where users have desktop computers and some applications are delivered by RemoteApp, you would need the following licenses:

- Operating system license for the desktop computer
- Server licenses for the Windows-based servers that deliver the RemoteApp programs
- Windows CALs for each user or computer that accesses the Windows servers
- RDS CALs for each user or desktop that uses RemoteApp programs
- Application licenses for each user or desktop that uses RemoteApp programs

RDS CALs provide users with access to session-based virtual desktops or RemoteApp programs. Licensing for VM-based virtual desktops is slightly more complex because the operating system for the VM also needs to be licensed. If you connect to a VM-based virtual desktop from a device that is covered by a Microsoft Software Assurance agreement, then the license
includes rights to use that same operating system in a VM-based virtual desktop. If the device isn’t covered by a Microsoft Software Assurance agreement, then you need to purchase Windows Virtual Desktop Access (Windows VDA) licenses.

➤ For more information about licensing VM-based virtual desktops, see Chapter 10, “Planning and implementing pooled and personal virtual desktops.”

When a client attempts to connect to an RDS deployment, the server that accepts the connection determines if an RDS CAL is needed. If an RDS CAL is required, then the server requests the RDS CAL on behalf of the client that is attempting the connection. If an appropriate RDS CAL is available, it is issued to the client, and then the client can connect to RDS.

RD Licensing manages the RDS CALs that are required for each device or user to connect to an RD Session Host server. You use RD Licensing to install, issue, and track the availability of RDS CALs on an RD Licensing server. At least one RD Licensing server must be deployed in the environment. The role service can be installed on any server, but for large deployments, the role service should not be installed on an RD Session Host server.

After an RDS installation, there is an initial grace period of 120 days. This grace period begins after the RD Session Host accepts the first client connection. If you have not installed valid licenses by the time the grace period expires, clients will not be able to sign in to the RD Session Host.

Inside Out

Licensing modes

Each RD Session Host server is configured with a licensing mode. The licensing mode determines the type of RDS CALs that an RD Session Host server requests from an RD Licensing server on behalf of a client that is connecting to an RD Session Host server. There are two licensing modes:

- **Per User**  This gives one user the right to access any RD Session Host server in an RDS deployment from an unlimited number of client computers or devices. You should use RDS Per User CALs when the same user connects to RDS from many devices.

- **Per Device**  This gives any user the right to connect to any RD Session Host server in an RDS deployment from a specific device. When a client connects to an RD Session Host server for the first time, a temporary license is issued. When the client computer or device connects to an RD Session Host server for the second time, if the license server is activated and enough RDS Per Device CALs are available, the license server issues the client computer or device a permanent RDS Per Device CAL. You should consider RDS Per Device CALs when multiple users use the same device for connecting to RDS, for example, a point-of-sale device that is used by different clerks.
A single RDS deployment can be configured with only one licensing mode. If you need a mix of Per User and Per Device RDS CALs, then you need to implement two RDS deployments.

**NOTE**

A permanent RDS Per Device CAL is valid for a randomly selected number of days between 52 and 89. If the RDS Per Device CAL isn’t renewed, then it is returned to the available licenses on the RD Licensing server. You can revoke RDS Per Device CALs before they expire and return them immediately to the available licenses. You are limited to revoking a maximum of 20 percent of the RDS Per Devices CALs.

If you need to provide access to RDS for multiple external users who are not employees of your organization, then you should consider using an RDS External Connector License. An RDS External Connector License allows an unlimited number of nonemployees to connect to a specific RD Session Host. If you have multiple RD Session Host servers, you need multiple RDS External Connector Licenses in addition to any required Windows Server External Connector Licenses.

### Planning infrastructure for session-based desktops

The planning for implementing RDS for session-based desktops can be fairly complex compared to other Windows-based role services. Most Windows-based role services require only one server. RDS requires at least three role services and, in most cases, the role services are spread across multiple servers. You should be aware of the functionality that each role service provides. You also should be aware of how an RDS deployment uses each role service. You need to know role service requirements and which hardware resources are most critical for each role service.

### Assessing RDS infrastructure requirements

Before you implement RDS, you must determine your organization’s requirements. To do so, you first must evaluate if RDS is the appropriate solution for your needs, and then you must choose between session-based and VM-based desktop deployments. If necessary, an RDS deployment can include both session-based and VM-based desktop deployments. You also must evaluate the existing server infrastructure and estimate the required server hardware, network bandwidth, client types and requirements, and connectivity needs for a successful RDS deployment.

### Determine your RDS needs

To determine if RDS is an appropriate solution for your needs, you should assess and analyze the types of users, hardware, and applications in your organization. Areas of consideration include the following:
• **User types** Do you have users in remote locations, single-task users, contractors, and other types of users who would benefit from remote applications or virtual desktops?

• **Hardware** What client hardware currently is deployed in your organization? Would it be beneficial to move from traditional desktops to thin clients for some users? Do you allow users to bring their own devices into the organization’s network? Do users wish to use mobile devices to run certain applications?

• **Application compatibility** Can the applications run in a multiuser environment? If not, will the applications run in a virtual environment?

• **Application performance** How do the applications perform in a remote or virtual environment? Keep in mind that many applications perform better as RemoteApp programs on RDS because processing takes place on a server.

• **Application support** Do vendors support the applications in a virtual or multiuser environment? Do vendors provide support to multiple users?

• **Licensing** Can the applications be licensed for a virtual or multiuser environment?

• **Business benefits** Are there justifiable business reasons to implement this solution? Potential benefits include cost savings, reduced deployment time, centralized management, and reduced administration costs.

• **Legal requirements** Because of financial and legal requirements, some organizations mandate that applications and data remain on-premises. RDS enables users to connect to a standard virtual desktop to use familiar applications and to work with data from almost any device, while organizational data stays in the data center.

### Choosing between session-based and VM-based desktop deployments

RDS has two deployment types:

- **Session-based virtual desktop deployment** This provides users the ability to connect to an RD Session Host and use a full desktop or run remote applications and present them on a client as if they were installed locally.

- **VM-based virtual desktop deployment** This provides users with access to a full Windows client operating system that runs on a VM, for example, Windows 7 or Windows 8.1.

You need to decide which RDS deployment type is best for your environment based on various requirements. For example, you must consider if users must be completely isolated or if they must have administrative access. You should consider whether the applications work properly in a multiuser environment. In addition, you must consider whether you can install and run
applications on Windows Server. Remember that a VM-based virtual desktop deployment typically requires a more powerful server infrastructure and more disk storage than a session-based virtual desktop deployment for the same number of users. For some applications, VM-based virtual desktops might be the only viable solution.

Generally, you should choose session-based virtual desktops if possible. Session-based virtual desktops support a larger number of users than VM-based virtual desktops on the same hardware.

**Determine server hardware and network resource requirements**

Once you determine the RDS deployment benefits for your organization, you must consider the hardware requirements to support your users, including the following:

- **Number of users**  How many users will use RDS, and where are they located?

- **User types**  How many users run CPU-intensive and bandwidth-intensive applications? Will you have to provide more bandwidth and server hardware to support expected usage?

- **Connection characteristics**  How many concurrent connections do you expect? Can your server and bandwidth resources handle peak usage times?

- **Application silos**  Will you have to create multiple server collections to support different applications that might not be able to run on the same server?

- **Load balancing**  Will you have to include multiple servers in a collection to spread the load among the servers? This increases available resources and provides redundancy.

- **High availability**  What is the organization’s tolerance for downtime? Do you need close to zero downtime, or could your organization tolerate the time it would take to restore from backups?

- **Expansion considerations**  What are the growth expectations? At what point will new resources need to be brought online?

**Determine user requirements**

Another aspect to consider is user requirements. A large organization with multiple locations might have a number of mitigating factors to consider, such as the following:

- **Languages**  Organizations with a global presence need to support multiple languages. You might need to install language packs on all of your RDS servers.
● **Profile management**  How will you store user states? Do users require the same user state when they sign in locally and to an RDS session? Which type of Windows user state virtualization will be used?

● **Printing**  Will existing printers function properly in a remote desktop environment? Will there be problems finding printer drivers to support existing printers? Is there a budget to replace older printer models?

**Determine how clients access RDS**

Clients can connect to RDS in various ways. You probably will need to provide different access methods for different groups of users. Areas to consider include the following:

● Will you allow users to connect over the Internet from remote locations? If so, you will need to set up an RD Gateway and obtain certificates.

● How will you handle Secure Sockets Layer (SSL) certificates—by using certificates from non-Microsoft certification authorities (CAs) or by using certificates that an internal CA issues?

Based on your assessment results, start designing your RDS deployment. You should identify RDS role services that are required and that you will deploy. You also should determine the number and hardware configuration of servers that are required, in addition to planning required storage, connectivity, and firewall configuration.

**Planning for the RD Session Host role service**

The RD Session Host role service provides Windows-based apps or full Windows desktops for RDS clients. This role service is mandatory for every RDS deployment that provides users with session-based desktops or RemoteApp programs. An RD Session Host server accepts incoming RDP requests, and after a client authenticates, it provides a desktop-based or application-based session to the client. An RD Session Host server is the central location where remote applications are installed, accessed, and maintained.

To plan the deployment of an RD Session Host server, you must consider the number of installed applications, the type of applications, resource use, the number of connected clients, and the type of user interaction. While connected to one RD Session Host, users might run a simple application that has low resource utilization and rarely runs, for example, an old data entry application. On another RD Session Host, users often might run a resource-intensive graphical application that requires many CPU resources, a considerable amount of RAM, intensive disk I/O operations, and that causes a lot of network traffic. If the hardware configuration on both of the RD Session Hosts is the same, the second server is considerably more utilized and can accept fewer user connections.
RD Session Host planning focuses on the number of concurrent users and the workload they generate. A server with a particular hardware configuration might support many simultaneous users or only a few, depending on their usage patterns and the applications that they are running on the RD Session Host.

The following are the main resources that you should consider when estimating RD Session Host utilization:

- **CPU** Each remote application that users start runs on an RD Session Host and utilizes CPU resources on the RD Session Host. In an environment where many users are connected to the same host, CPU and memory typically are the most critical resources.

- **Memory** Additional memory must be allocated to an RD Session Host for each user who connects to the RD Session Host, whether connecting to a full Windows desktop or running a RemoteApp program.

- **Disk** Because user state typically isn’t stored on an RD Session Host, disk storage usually isn’t a critical resource. However, many applications run simultaneously on an RD Session Host, and the disk subsystem should be able to meet their disk I/O needs.

- **Network** The network should provide enough bandwidth for connected users and for the applications that they run. For example, applications that use a SQL database use the network to connect to that SQL database. Also remember to consider the network bandwidth required to support the user connectivity to the RD Session Host server.

- **GPU** Applications that are graphically intensive, especially those that include three-dimensional graphics, might require vGPU support and RemoteFX to perform well. Without such support, graphics render on the server’s CPU and may limit the number of users on the RD Session Host to a relatively small number.

When estimating the required resources for an RD Session Host, you can use one of the following methods:

- **Pilot deployment** This is a common and a simple approach. You first need to deploy RDS in a test environment and capture its initial performance. After that, you start increasing server load by increasing the number of users and monitoring response times and user feedback. You can find out how many users can connect to an RD Session Host and still have an acceptable user experience based on the number of users and the system response time. Based on the findings, you can estimate the number of servers that are needed for a production environment. This approach is reliable and simple, but it requires initial investments for the pilot deployment.

- **Load simulation** This method also uses an initial RDS deployment in a test environment. You need to gather information about applications that users operate and how
users interact with the applications. After that, you can use load simulator tools to generate various levels of typical user loads against an RDS deployment. When a load simulator tool runs, you need to monitor server utilization and responsiveness. This method is similar to the pilot deployment method, but it uses a load simulation tool instead of real users to generate user load. It also requires an initial investment, and its results depend on the initial estimation of actual user usage.

- **Projection based on single-user systems**  
  This method uses data that is collected from a single-user system for projecting expected utilization on an RD Session Host with multiple user sessions. This method requires detailed knowledge of applications that are used, and it usually is not very reliable because a single-user system has a different overhead than a multiuser system.

It is critical that you plan for future scalability of an RDS deployment. User needs for applications will change over time, and you need to be ready to expand your RDS deployment to meet those needs. In some cases, you may be able to scale up the capacity of the individual servers with additional processors or additional memory. Scaling up by using more powerful servers tends to be expensive. Scaling out by adding servers generally is less expensive.

Fortunately, you can scale out an RDS deployment for session-based virtual desktops and RemoteApp programs by adding RD Session Host servers. For example, if you have an RDS deployment for session-based virtual desktops that uses two RD Session Host servers, and those two servers are experiencing frequent peaks of 100 percent CPU utilization, you can add a third RD Session Host server. The RD Connection Broker then automatically load balances the connections across three servers instead of two and reduces the CPU utilization on the two existing servers.

**Planning for the RD Connection Broker role service**

During RDS deployment planning, you must designate a server on which to install the RD Connection Broker role service. The RD Connection Broker role service is required in each RDS deployment. It provides users with access to RemoteApp programs, session-based virtual desktops, and VM-based virtual desktops. The RD Connection Broker role service manages all aspects of session connectivity. Functions performed by the RD Connection Broker role service include the following:

- **Routes connection requests**  
  Determining the most appropriate RD Session Host or virtual desktop to which to send a connection request, based on a user’s identity and the current load on RD Session Host or RD Virtualization Host servers.

- **Stores information about connections to VMs and sessions**  
  By default, connection information is stored in the Windows Internal Database (WID) on an RD Connection Broker server. By storing this information, the RD Connection Broker role
service can reconnect users to the same session in an RDS deployment with multiple RD Session Host servers.

- **Configures RDS servers in the same group (collection)** You configure settings—for example, session settings or certificates—once, and RD Connection Broker applies the settings to servers in the collection.

- **Manages VM creation and deletion** In VM-based desktop deployments, RD Connection Broker manages VM creation and deletion for managed collections, and it assigns personal virtual desktops to users.

- **Provides information to RD Web Access servers** The RD Connection Broker role service gathers collection information about RemoteApp programs, session-based virtual desktops, and VM-based virtual desktops.

When a user initiates a session, the session request is received by the RD Connection Broker role service, which queries the database to determine if there is an existing disconnected session for that user. If so, the user is directed to the disconnected session. If not, the RD Connection Broker role service determines the server in the collection that is best able to handle the new connection, based on the load-balancing algorithm.

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**Inside OUT**

*RD Connection Broker scalability*

Performance for an RD Connection Broker server depends on the number of requests it receives in a given time frame. Users generate a load on the RD Connection Broker server only when they perform the initial connection to a RemoteApp program or a session-based virtual desktop. This makes it different from an RD Session Host server, for which performance depends on the number of simultaneous users.

A single RD Connection Broker server with four processor cores and four gigabytes (GB) of RAM can process approximately 10 connections per second with a maximum processing time of 1 second. If you are willing to increase the maximum processing time to 12 seconds, that same server can process approximately 60 connections per second. For more detailed information about RD Session Broker scalability, see the white paper "RD Connection Broker Performance and Scalability" at [http://go.microsoft.com/fwlink/?LinkID=510038&clcid=0x409](http://go.microsoft.com/fwlink/?LinkID=510038&clcid=0x409).

When you consider the number of connections per second to which your RD Connection Broker server will be subject, you need to consider peak utilization times. First thing in the morning when users arrive and after lunch likely are peak times when users are connecting.
A single RD Connection Broker server can handle a large number of connection requests, and for performance, your RDS deployment may require only one. A more critical consideration for the RD Connection Broker role service is availability.

The RD Connection Broker role service is an entry point to an RDS deployment, and it is critical that it is available all the time. If the RD Connection Broker role service isn’t available, then clients can’t connect to RemoteApp programs or virtual desktops, but existing connections to RemoteApp programs and virtual desktops continue to function properly. When an RDS deployment only has one RD Connection Broker server, the server represents a single point of failure. To make the RD Connection Broker role service highly available or to increase scalability, you can add RD Connection Broker servers.

➤ Configuring high availability for the RD Connection Broker role service is covered in more detail later in this chapter in the section titled “Understanding high availability for RDS.”

Planning for the RD Web Access role service

The RD Web Access role service is a mandatory part of each RDS deployment, and it installs the Web server role, Internet Information Services (IIS), as its prerequisite. The benefits of RD Web Access include the following:

- From almost anywhere, authorized users quickly can access a list of available RemoteApp programs, remote desktops, and virtual desktops on a webpage.

- A list of available RDS resources publishes automatically via an RDWeb feed, and it can integrate with the Start screen on the client.

- Changes in available RDS resources update automatically on clients that have subscriptions to an RDWeb feed.

- Users can launch the RDC client from the RD Web Access portal, which enables them to connect remotely to the desktop of any computer on which they have Remote Desktop access.

- RD Web Access and RDWeb feeds are personalized and show only RDS resources for which users have permissions.

- Administrators can customize an RD Web Access portal without programming.

➤ More information about customizing RD Web Access is provided in Chapter 9, “Configuring RemoteApp programs and client connectivity.”

It’s important to remember that the RD Web Access role service only provides a link to launch RemoteApp programs or to connect to a Remote Desktop session. The RD Web Access role
service doesn’t proxy client requests. When a user connects to a RemoteApp program or a
virtual desktop, the client establishes a direct connection to the target server.

Performance considerations for an RD Web Access server are similar to those for an
RD Connection Broker server because the RD Web Access role service provides only initial
connectivity to RemoteApp programs and virtual desktops. After users are connected to
requested resources, the RD Web Access role service is no longer used. Therefore,
RD Web Access server performance needs to be designed to accommodate usage at peak
times like morning arrivals and after lunch. If required for high availability or scalability, you
can implement multiple RD Web Access servers and load balance them.

Planning for preserving user state

In a session collection with multiple RD Session Host servers, the connections from clients are
load balanced across the RD Session Host servers by the RD Connection Broker server.
By default, when a user connects to a specific RD Session Host server, a local profile is
created for that user on the RD Session Host server. The next time a user connects, the
RD Connection Broker may direct the client to a different RD Session Host server, where a
different local profile is created. Each time users sign in, they may be using a different profile
on a different RD Session Host server. This means that user state information such as applica-
tion configuration, Desktop configuration, Favorites, and Documents are not the same across
sessions. To provide a consistent user experience, you should preserve user state across mul-
tiple RD Session Host servers.

If users have desktop computers and session-based virtual desktops, you also need to consider
whether you want user state to be preserved between desktop computers and the virtual
desktops. This can be complicated by the fact that session-based virtual desktops may not
have the same configuration as the desktop computers, and, consequently, it may not make
sense to synchronize all of the user state information. For example, synchronizing Desktops
may result in desktop shortcuts appearing that point to applications that are not available on
the RD Session Host servers.

Roaming profiles

Roaming user profiles can be used to synchronize user state, but they synchronize entire user
profiles. This typically is not desired for session-based desktops because not all user state infor-
mation needs to be synchronized between desktop computers and RD Session Host servers.
If you use roaming profiles for the desktop computers in your organization and you want to
ensure that roaming profiles are not used on the RD Session Host servers, then you can config-
ure the msDS-PrimaryComputer attribute for users and enable the Download Roaming Profiles
On Primary Computers Only Group Policy setting.

You also can set user properties for roaming user profiles that are specific to RD Session Host
servers, as shown in Figure 8-7. If you configure the Profile Path, then a user connecting to
a session-based virtual desktop uses the specified profile path rather than a roaming profile configured on the Profile tab. Effectively, the RDS user profile becomes a roaming profile used only when connected to an RD Session Host server.

![User Properties, Remote Desktop Services Profile tab](image)

**Figure 8-7** User Properties, Remote Desktop Services Profile tab

Instead of configuring individual user accounts with RDS-specific profiles, you can use Group Policy. In a Group Policy object that applies to the RD Session Host servers, you can configure settings in Computer Configuration\Policies\Administrative Templates\Windows Components\Remote Desktop Services\Remote Desktop Session Host\Profiles. There are two relevant settings:

- **Set Path For Remote Desktop Services Roaming User Profile** Specify a UNC path for storing all user profiles. A subfolder for each user is created automatically.

- **Use Mandatory Profiles On The RD Session Host Server** Indicates that the path specified in the Set Path For Remote Desktop Services Roaming User Profile setting contains a mandatory profile that can’t be modified. When this setting is enabled, the UNC path for profiles does not contain subfolders for each user.

**Folder redirection**

Folder redirection also is an option for users with session-based virtual desktops. You can redirect only the folders that are suitable for use on the virtual desktops and desktop computers. Commonly redirected folders include Documents, Favorites, and AppData\Roaming.
If you use folder redirection for desktop computers and don’t want folder redirection used when users sign in to the RD Session Host servers, you can use the msDS-PrimaryComputer attribute in user accounts just as you can for roaming profiles. In addition to configuring the attribute, you need to enable the Redirect Folders On Primary Computers Only Group Policy setting.

**User profile disks**

RDS in Windows Server 2012 and newer offers the option to configure user profile disks to preserve user state across sessions. A user profile disk is a VHDX file that is mounted to the user’s profile path at C:\Users\%username% on the RD Session Host. The user profile disk is mounted during sign in. During a user’s session, all changes to the profile write in his or her VHDX file, and when the user signs out, his or her profile disk is unmounted. The administrator specifies the maximum size of user profile disks and can limit which folders in a user profile are included in or excluded from a user profile disk.

User profile disks are configured individually for each session collection and can’t be shared among collections. A share is specified in the collection configuration to store the user profile disks. All RD Session Host servers in the collection have access to the user profile disks in the share. This provides users with consistent user state from any RD Session Host server in the collection.

User profile disks can be used in conjunction with folder redirection and roaming user profiles. Folder redirection will reduce the size of user profile disks and allow the redirected folders to be accessed from desktop computers. Roaming user profiles are synchronized with the user profile disk.

From a server management perspective, one benefit of user profile disks is controlling the amount of data stored on the C drive of RD Session Host servers. Large user profiles stored on RD Session Host servers can cause the C drive to run low on space and cause performance issues. Because user profile disks are stored on a network share and mounted in C:\Users, the C drive never is used to store profile data.

The primary consideration when planning user profile disks is ensuring that the necessary disk space is available for network storage. To ensure that network storage is sufficient, you need to determine the average user profile size. The amount of storage that you need to allocate for user profile disks is the average user profile size times the number of users plus an allowance for growth in both the number of users and the average profile size.

User profile disks are dynamically expanding VHDX files. By default, the maximum size of a user profile disk is 20 GB, but you can set this to be larger or smaller depending on the needs of your users.
When you configure the share for user profile disks, all RD Session Host servers need to have Full Control permissions. This allows the RD Session Host servers to create and manage the user profile disks. When you configure a collection with user profile disks, these permissions are assigned automatically.

Inside OUT

Infrastructure testing prior to rollout

After you assess RDS infrastructure requirements and familiarize yourself with RDS and its role services, you should perform a proof-of-concept (POC) deployment. POC deployment is critical for a successful RDS deployment. It enables you to evaluate whether all the requirements are met and to perform a load simulation, which simulates typical user actions and validates your estimates for capacity, application workloads, and usage patterns by performing a test run in a controlled environment. During testing, you should find answers to the following questions:

- **How many users can connect, and what is an average response time?** Can POC deployment support the expected number of RD users, and is the response time acceptable? How utilized are servers, how long do user sign-in and sign-out take, and is the user experience as expected?

- **How does the application consume system resources?** Does it do so in accordance with documented estimates? If the application uses hardware as expected, the rest of the deployment can continue based on initial estimates. If it doesn’t use hardware as expected, you must recalculate capacity requirements to ensure accurate estimates.

- **Are all of the potential user environment scenarios being tested?** You should test the application by accessing it in all the ways a user might use it. If there are access methods that you can’t replicate in a POC environment, these access methods should be implemented in a controlled manner when performing the final deployment.

- **Are the applications and hardware running as expected?** Is additional performance tuning required? Do you need to perform any additional application configuration to run as expected in an RDS environment? Also, confirm that hardware performance is within estimated parameters.

- **Are there any unexpected changes in usage or access?** If any part of the presentation virtualization POC deployment does not reflect your production environment, alter the POC deployment so that it is as similar as possible to your final, planned infrastructure.
Using testing to eliminate errors in a deployment is important because problems with a presentation virtualization environment are much easier to resolve during testing than during full deployment.

Windows Server 2012 R2 includes a Best Practices Analyzer (BPA) for the Remote Desktop Services server role. BPA for RDS can analyze an RDS environment and check for changes that need to be made for RDS to perform optimally. You can access BPA in Server Manager or by running the `Invoke-BpaModel` cmdlet.

Deploying session-based virtual desktops

RDS includes multiple role services. If you use Server Manager for RDS deployment, you should be aware that if you use role-based or feature-based installation, you can install individual RDS role services. However, if you install an RDS role service in this way, you can’t manage it. If you want to manage RDS, a deployment must have at least three role services: RD Connection Broker, RD Web Access, and either RD Session Host or RD Virtualization Host. Individual RDS role services can’t be managed if they are not part of an RDS deployment.

Understanding the session-based desktop deployment process

You can deploy RDS by using Server Manager or Windows PowerShell. Server Manager has the ability to install the necessary server roles, role services, and features on multiple servers that are part of an RDS deployment. All management of RDS also can be done from Server Manager.

Inside Out

Adding servers to Server Manager for RDS deployment

Server Manager can be used to manage the local server and remote servers, but you need to add the remote servers manually before they can be managed. A typical RDS deployment has multiple servers, and you should add each of the servers to Server Manager before you begin the deployment process.

To add a server to Server Manager, perform the following steps:

1. In Server Manager, click Manage and click Add Servers.
2. In the Add Servers window, on the Active Directory tab, in the Name (CN) box, type the name of the server and click Find Now.
3. Double-click the server you want add and then click OK.
The high-level steps for deploying session-based virtual desktops are as follows:

1. **Start the RDS installation** In Server Manager, use the Add Roles And Features Wizard to select the Remote Desktop Services Installation option, shown in Figure 8-8. This option configures the wizard to collect the information necessary to perform a deployment of RDS across multiple servers.

![Figure 8-8 Add Roles And Features Wizard, Select Installation Type page](image)

2. **Select the RDS deployment type** On the Select Deployment Type page, shown in Figure 8-9, select the appropriate deployment type. The Quick Start option installs the required role services on a single server and creates a session collection with several sample RemoteApp programs (Calculator, Paint, and WordPad). You only should use the Quick Start option for testing. In most cases, you want to select the Standard Deployment option because this allows you to customize the deployment for your environment.
3. Select the RD deployment scenario  On the Select Deployment Scenario page, shown in Figure 8-10, select the Virtual Machine–Based Desktop Deployment option or the Session-Based Desktop Deployment option. A VM-based desktop deployment is used to deploy personal and pooled virtual desktops on computers running Hyper-V. A session-based desktop deployment uses RD Session Hosts.
4. **Select servers for RDS role services**  In the Add Roles And Features Wizard, select the servers on which you want to install the RD Connection Broker, RD Web Access, and RD Session Host role services. As part of making RDS highly available, you can install each role service on multiple servers. In most RDS deployments, the RD Session Host role service isn’t combined with other role services. The RD Connection Broker and RD Web Access role services can be combined in smaller RDS deployments.

During the deployment, the servers on which you installed the RD Session Host role are restarted. After the installation, you can perform initial configuration of the RDS deployment. You also can add servers to the deployment. At minimum, you should add RD Licensing, because you can’t connect to an RD Session Host without valid RDS CALs after the initial grace period of 120 days expires. You also should consider installing multiple instances of the RDS role services for high availability.
Inside OUT

Using Windows PowerShell to deploy RDS


To install a session-based deployment of RDS, perform the following steps:

1. In Server Manager, click Manage and then click Add Roles And Features.

2. In the Add Roles And Features Wizard, on the Before You Begin page, click Next.

3. On the Select Installation Type page, click Remote Desktop Services Installation and click Next.

4. On the Select Deployment Type page, click Standard Deployment and click Next.

5. On the Select Deployment Scenario page, click Session-Based Desktop Deployment and click Next.

6. On the Review Role Services page, click Next. This page provides a brief description of each role service, but there is nothing to configure. The currently logged-on account is being used to create the deployment and is displayed here as a reminder.

7. On the Specify RD Connection Broker Server page, shown in Figure 8-11, in the Server Pool box, double-click the server on which you wish to install the RD Connection Broker role service and click Next.
8. On the Specify RD Web Access Server page, shown in Figure 8-12, select the Install The RD Web Access Role Service On The RD Connection Broker Server check box and click Next. Alternatively, you can select another server on which to install the RD Web Access role service.
9. On the Specify RD Session Host Servers page, shown in Figure 8-13, double-click the server on which you wish to install the RD Session Host role service and click Next.
10. On the Confirmation page, review the selected servers, select the Restart Destination Server Automatically If Required check box, and click Deploy.

11. On the Completion page, wait for the installation of the RDS role services to complete and click Close. If you are installing roles on the server from which you started the installation, the server may restart and require you to sign in again.

**Understanding session collections**

Session collections enable you to organize and control user connectivity to RDS. Each session collection contains either RD Session Host servers for session-based virtual desktops or VMs on Hyper-V for pooled or personal virtual desktops.

Collections simplify the administration process by enabling you to manage all collection members as a unit instead of managing them individually. For example, after you configure a collection with session settings, those settings automatically apply to all the servers in the collection. If you add a server to a collection, session settings also automatically apply to the added server.
When you add multiple RD Session Host servers to a collection, connections automatically are load balanced among them. The RD Connection Broker server uses the collection configuration information to identify that there are multiple RD Session Host servers and connects an equal number of clients to each. If an RD Session Host server in a collection fails, the RD Connection Broker connects all users to the remaining RD Session Host servers in the collection.

When there are multiple RD Session Host servers in a collection, they need to be configured with identical applications. Users expect the same applications to be available each time they sign in. If RD Session Host servers have different applications installed, it will appear to users that applications are randomly appearing and disappearing with each connection.

To create a session collection, perform the following steps:

1. In Server Manager, in the navigation pane, click Remote Desktop Services.
2. In Remote Desktop Services > Overview, click Create Session Collections.
3. In the Create Collection Wizard, on the Before You Begin page, click Next.
4. On the Name The Collection page, in the Name box, type the name of the collection and click Next. Make the name something that accurately describes how the collection will be used. You also can type in a more detailed description.
5. On the Specify RD Session Host Servers page, shown in Figure 8-14, double-click the RD Session Host server you want to add to the collection and click Next. Only RD Session Host servers already added to the RDS deployment appear in the Server Pool box. An RD Session Host server can be added to only one collection.
Figure 8-14 Create Collection Wizard, Specify RD Session Host Servers page

6. On the Specify User Groups page, shown in Figure 8-15, remove the Domain Users group, add the groups you want to have access to the collection, and then click Next. The Domain Users group is listed by default and would allow any user in your organization to access the collection. In most cases, you want to restrict collection access to a specific group of users.
7. On the Specify User Profile Disks page, shown in Figure 8-16, select the Enable User Profile Disks check box if you have decided to implement user profile disks for users. If you select this option, you need to enter the UNC path where the user profile disks will be stored in the Location Of User Profile Disks box. You also need to specify a size in the Maximum Size (In GB) box.
Chapter 8  Planning and deploying session-based virtual desktops

8. On the Confirm Selections page, click Create.

9. On the View Progress page, wait until all tasks are complete and then click Close.

Configuring session collections

The user interface for creating a session collection allows you to configure only a few of the configuration options for a session collection. After the session collection is created, you can edit the session collection and configure many more options.

To edit a session collection, perform the following steps:

1. In Server Manager, in the navigation pane, click Remote Desktop Services.

2. In Remote Desktop Services, in the navigation pane, click the collection you want to edit.

3. While viewing the collection, next to the Properties box, click Tasks and click Edit Properties.

4. In the CollectionName Properties window, edit the properties as required and click OK.
When you are editing the properties of a session collection, the editing window is divided into pages with groups of related options. The General page, shown in Figure 8-17, has the Name and Description that you entered during creation. The Show The Session Collection In RD Web Access check box was not available during creation. It is selected by default. Consider disabling this option during scheduled outages when you are performing maintenance on a session collection, for example, when you are upgrading an application on the RD Session Hosts in the collection.

The User Groups page in the properties of a session collection allows you to configure which groups of users can connect to the session collection. This is the same as the user groups configured during creation.

The Session page, shown in Figure 8-18, has a number of settings that control session limits and temporary folders.
Table 8-3 describes the session settings available on the Session page.

**Table 8-3** Session settings for a session collection

<table>
<thead>
<tr>
<th>Session setting</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>End A Disconnected Session</td>
<td>Controls when a session is ended after a user disconnects. You can select to never end disconnected sessions or select a value ranging from one minute to five days. The default value is Never. A session is disconnected when there is a network connectivity issue or when a user closes the Remote Desktop Connection window without signing out. A disconnected session keeps all of the applications open and continues to use memory on the RD Session Host. Users can reconnect to the session and resume working where they left off, but if there are too many disconnected sessions, the RD Session Host may not have enough memory.</td>
</tr>
</tbody>
</table>
### Active Session Limit
Controls how long an active session can be before it is disconnected or ended. To allow active sessions with no limit, select Never. To limit active sessions, select a time value ranging from one minute to five days. The default value is Never. Users receive a warning two minutes before the active session limit is reached. This provides users with time to save their work. An active session is one in which the user is performing a task. An active session is identified by mouse movement or keyboard input. There is seldom a need to limit active sessions, but you could limit them if you are concerned that unauthorized users are accessing a session. This will force the user to reconnect and provide authentication credentials when the limit is reached.

### Idle Session Limit
Controls how long an idle session can be idle before it is disconnected or ended. To allow idle sessions with no limit, select Never. To limit idle sessions, select a time value ranging from one minute to five days. The default value is Never. Users receive a warning two minutes before the idle session limit is reached. This provides users with an opportunity to move the mouse or press a key to make the session active and avoid the idle session limit. An idle session is one in which the user isn’t performing a task. An idle session is identified by a lack of mouse movement or keyboard input. Most organizations configure an idle session limit. This has a similar effect on security as having the screen lock on a desktop computer. If a session is connected but unused, it may mean that the user has left his or her connection unattended.

### When A Session Limit Is Reached Or A Connection Is Broken
Controls the action that is taken when the active session limit is reached, the idle session limit is reached, or a network problem disconnects a client. You can choose Disconnect From The Session or End The Session. In most cases, you will select Disconnect From The Session to prevent users from losing their work when they are disconnected. When you select this option, you also can select Enable Automatic Reconnection. This allows the RDC client to reconnect automatically after short network interruptions. If you do not select this option, the users must provide authentication credentials to reconnect to their disconnected session. By default, Disconnect From The Session and Enable Automatic Reconnection are selected.

### Delete Temporary Folders On Exit
Configures temporary folders to be deleted when a session ends. This ensures that temporary files do not consume unnecessary disk space. This option is enabled by default.
Use Temporary Folders Per Session

Configures each session for a user to have separate temporary folders on RD Session Host servers where a single user account is allowed to have multiple simultaneous sessions. This option is enabled by default to ensure that multiple sessions on an RD Session Host server do not conflict. However, it isn’t relevant in most deployments because users typically are limited to a single session.

The Configure Security Settings page, shown in Figure 8-19, allows you to configure the Security Layer and the Encryption Level to use for the session. The Security Layer defines encryption methods that are used to encrypt communication between the RDC client and the RD Session Host. The available options for security layer are as follows:

- **RDP Security Layer**  This is the weakest option for the security layer. It is available to support older RDP clients. This security layer does not support the use of Network Level Authentication.

- **SSL (TLS 1.0)**  This is the strongest security layer. This security layer supports the use of network-level authentication. When this security layer is used, a certificate on the RD Session Host is used to establish the encryption channel. If the name on the certificate does not match the name used when connecting to the RD Session Host, then a warning is displayed on the client. This is supported by Windows XP SP3 and newer operating systems.

- **Negotiate**  This is the default selection for security layer. SSL (TLS 1.0) is used if available on the server and client. If SSL (TLS 1.0) can’t be used, then RDP Security Layer is used.
Network Level Authentication is an authentication method that requires clients to enter authentication credentials before they are connected to the RD Session Host server. The credentials are passed by the RDC client to the RD Session Host server, and if the credentials are valid, the sign-in process is performed. When Network Level Authentication isn’t used, clients can connect to the RD Session Host server and interact with the sign-in screen on the RD Session Host before they are authenticated. This is a security risk because it is possible for unauthenticated clients that have access to RD Session Host servers to see recently used user names and the operating system version.

You can force all clients to use Network Level Authentication by selecting the Allow Connections Only From Computers Running Remote Desktop With Network Level Authentication check box. This is enabled by default.

The Encryption Level setting allows you to configure the number of bits used for encryption. This setting applies for both security layers, and more bits provide stronger encryption. The options for Encryption Level are as follows:
• **Low** Uses 56-bit encryption for data sent from the client to the server. Data sent from the server to the client isn’t encrypted. This option is provided to support older clients and typically isn’t required.

• **High** Uses 128-bit encryption for all data sent between the client and server. This option can be used by Windows XP and newer operating systems. This is the preferred option.

• **FIPS Compliant** Uses encryption algorithms that are FIPS 140-1 or FIPS 140-2 compliant for all data sent between the client and server. Federal Information Processing Standards (FIPS) is a United States government standard for data encryption. This option typically isn’t used unless requested specifically by an organization that needs to meet FIPS requirements.

• **Client Compatible** Negotiates the highest level of encryption supported by the client and uses that. This is the default configuration, but it can be considered a security risk because it allows 56-bit encryption for clients that request it. Use this option only if you need to support clients that can’t use 128-bit encryption.

➤ The Configure Load Balancing Settings page in the properties of a session collection is covered later in this chapter in the section titled “High availability for RD Session Host servers.”

The Configure Client Settings page has settings for device redirection and monitors. By default, redirection is enabled for all available options. If desired, you can select to enable or disable redirection for the following:

• Audio And Video Playback
• Audio Recording
• Smart Cards
• Plug And Play Devices
• Drives
• Clipboard
• Printers

➤ You can find more information about the client settings in Chapter 9.
The User Profile Disks page, shown in Figure 8-20, allows you to configure all of the information entered during collection creation and to define what data is stored on the user profile disks. There are two options for user profile disks data settings:

- **Store All User Settings And Data On The User Profile Disk**  
  Specifies that the complete user profile is stored on the user profile disk. You can add specific folders and files within the profile to exclude.

- **Store Only The Following Folders On The User Profile Disk**  
  Specifies that only selected folders in the user profile are stored on the user profile disk. The folders available for selection are Contacts, Desktop, Documents, Downloads, Links, Music, Pictures, Roaming User Profile Data, and User Registry Data. You also can add specific files and folders within the profile to include.

![Figure 8-20 Properties of a session collection, User Profile Disks page](image-url)
Configuring RD Licensing servers

The initial configuration of RDS doesn’t configure licensing. However, a functional RDS deployment in production must have licensing properly configured to ensure that users can connect. To configure licensing for RDS, you need to complete the following tasks:

- Set the licensing mode
- Install an RD Licensing server
- Activate an RD Licensing server
- Install and activate CALs

To install an RD Licensing server, perform the following steps:

1. In Server Manager, in the navigation pane, click Remote Desktop Services.
2. On the Overview page, in the Deployment Overview area, click RD Licensing.
3. In the Add RD Licensing Servers Wizard, on the Select A Server page, double-click the server you want to configure as an RD Licensing server and click Next.
4. On the Confirmation page, click Add.
5. Wait until the installation is complete and click Close.

To set the licensing mode for an RDS deployment, perform the following steps:

1. In Server Manager, in the navigation pane, click Remote Desktop Services.
2. On the Overview page, in the Deployment Overview area, click Tasks and click Edit Deployment Properties.
3. In the Deployment Properties window, in the navigation pane, click RD Licensing.
4. On the RD Licensing page, select Per Device or Per User and click OK.

The Microsoft Clearinghouse is the service that is used to activate RD Licensing servers and RDS CALs. When you install an RD Licensing server, you need to activate it before it can begin servicing clients. To do this, you use Remote Desktop Licensing Manager (RD Licensing Manager), shown in Figure 8-21. RD Licensing Manager is installed on each RD Licensing server.
When you activate an RD Licensing server, you need to exchange information with the Microsoft Clearinghouse. You can choose from the following connection methods:

- **Automatic Connection (Recommended)** Transfers the necessary information between the RD Licensing server and the Microsoft Clearinghouse over the Internet. The RD Licensing server must have connectivity to the Internet.

- **Web Browser** Requires you to enter a Product ID at the website https://activate.microsoft.com. Then, you type the license server ID provided by the website into the Activate Server Wizard. Use this connection method if the RD Licensing server does not have access to the Internet.

- **Telephone** Requires you to phone the Microsoft Clearinghouse and provide the Product ID for your server. You are then given a license server ID, which you need to enter into the Activate Server Wizard. Use this connection method if you have no access to the Internet.

Installing RDS CALs is a similar process to activating an RD Licensing server. The same connectivity methods to the Microsoft Clearinghouse are supported. The installation process automatically uses the method that you used when activating the server. You can change the connectivity method in the Properties of the server if required.
To activate an RD Licensing server over the Internet, perform the following steps:

1. In Server Manager, click Tools, point to Terminal Services, and click Remote Desktop Licensing Manager.

2. Right-click the licensing server and click Activate Server.

3. In the Activate Server Wizard, on the Welcome To The Activate Server Wizard page, click Next.

4. On the Connection Method page, in the Connection Method box, select Automatic Connection (Recommended) and click Next.

5. If you have not already configured the company information for your server, you are prompted to do so. On the Company Information page, enter the required company information and click Next.

6. On the next Company Information page, if desired, enter the optional information and click Next.


8. Right-click the server and click Review Configuration.

9. In the Server Configuration window, shown in Figure 8-22, click Add To Group.
10. In the RD Licensing Manager window, click Continue to acknowledge the warning about requiring Domain Admin privileges.

11. In the RD Licensing Manager dialog box, click OK to acknowledge that the server has been added to the Terminal Server License Servers Group.

12. In the Server Configuration window, click OK.

To install RDS CALs over the Internet, perform the following steps:

1. In Server Manager, click Tools, point to Terminal Services, and click Remote Desktop Licensing Manager.

2. Right-click the license server and click Install Licenses.

3. In the Install Licenses Wizard, on the Welcome To The Install Licenses Wizard page, click Next.
4. On the License Program page, select the license program used to purchase your RDS CALs and click Next. Available license programs include Open License, Enterprise Agreement, Campus Agreement, and more.

5. Enter the information requested and click Next. The information requested varies depending on the licensing program used, but it will include either a license code or an agreement number.

6. On the Product Version And License Type page, enter the product version, license type, and number of RDS CALs based on your license and click Next.

7. Wait while the Microsoft Clearinghouse processes the request and the RDS CALs are installed and then click Finish.

Understanding high availability for RDS

A highly available service is one that is available almost all of the time. High availability often is expressed numerically as the percentage of time that a service is available. For example, a requirement for 99.9 percent availability allows 8.75 hours of downtime per year, or approximately 40 minutes of downtime every four weeks. With 99.999 percent uptime, the allowed service downtime is reduced to only 5 minutes per year.

To achieve high availability for a service such as RDS, you need to identify single points of failure in the infrastructure and work to eliminate them. For example, if you have only one RD Session Host server, that is a single point of failure. There will be a service outage if that server has hardware problems or is taken offline for maintenance.

To make infrastructure highly available, you need to make it redundant. For example, within a server, using mirroring (RAID 1) for disks ensures that that failure of a single hard disk does not cause the server to fail. This principle also can be applied at other levels of infrastructure such as networking, network services, and data center power. To make RDS highly available, you need multiple servers for each of the RDS role services, but not all RDS role services automatically become highly available just because you add more servers running the role service. Some RDS role services require you to implement load balancing.

Inside OUT

*Redundant hardware vs. redundant servers*

Within a server, two common hardware components for high availability are dual power supplies and hardware RAID cards. Combined, these options can add $1,000 to the cost of a server.
Understanding high availability for RDS

When you have highly available infrastructure with multiple servers, you can balance the high availability of components within a server with the high availability provided by having multiple servers. Instead of providing hardware redundancy in servers, you can provide the redundancy with additional servers. This can be a cost-effective way to provide high availability.

In the previous example, you could save $1,000 per server by not putting in dual power supplies and hardware RAID cards. In a large RDS deployment, if you are implementing eight RD Session Host servers, this would save $8,000 in hardware costs, which you could use to purchase two or three additional servers to provide high availability.

Most administrators want their individual servers to be highly available, but it’s really the services that need to be highly available. The key to making this strategy work is providing enough redundant servers and monitoring so that you can resolve issues quickly when a server fails.

Understanding load balancing

Load balancing is a technology that you can use to achieve high availability and scalability primarily for stateless services. The term stateless refers to workloads that respond to each request independently from previous requests and without keeping client state. For example, when a client requests a webpage, a Web server gathers all of the necessary information from the request and then returns a generated webpage to the client. When the client requests another webpage, it might request the webpage from the same Web server or from any other identically configured Web server in a load-balancing cluster.

The servers that are part of a load balancing cluster are referred to as nodes. Each node is configured with the same software so that clients can connect with any node and obtain the intended service. For example, each node would have the same website configured.

Clients connect to a virtual IP address that is used to access all nodes in the cluster. To the clients, the virtual IP address behaves the same way that an IP address configured on a physical server would. Only one cluster node responds to each client request.

If a node in the cluster fails, the remaining nodes continue to service clients. This makes a load balancing cluster highly available. Adding nodes to the cluster increases the capacity of the cluster. Adding nodes is scaling out.

Windows Network Load Balancing

Windows Network Load Balancing (NLB) is a software solution for load balancing that is included in Windows Server operating systems. NLB creates a virtual IP address that all of the
nodes in the load balancing cluster share. When a request comes in to virtual IP, the request is received by all nodes, but only one node responds. The nodes determine the appropriate node to respond based on an algorithm that they all use.

The most common reason organizations consider using NLB is the cost. Because it is included in Windows Server operating systems, it is effectively free. However, there are a few drawbacks to using NLB:

- **It is not service aware** NLB is capable of identifying when a server is no longer responding but not when a service is no longer responding. This means that some types of failures result in clients being directed to a nonresponsive service on a partially functional node.

- **Scalability is limited** NLB supports up to 32 nodes in a cluster, but performance peaks at 8 nodes.

- **Network hardware configuration may be required** Some network switches need additional configuration to work with NLB. This is required because multiple devices are sharing the same virtual IP address but are connected to different switch ports.

**Hardware-based load balancing**

Most large organizations use specialized hardware load balancers instead of using NLB. Hardware load balancers are more scalable than NLB, but they also are significantly more expensive. The least expensive hardware load balancers are about $2,000, and they can cost more than $40,000.

The configuration of a hardware load balancer varies depending on the vendor, but all of them provide the same basic functionality. The virtual IP address for the load balancing cluster is assigned to the load balancer, and the load balancer receives requests from the clients. The load balancer then forwards each request to a single node.

The load balancer is responsible for identifying failed nodes. Node failure can be identified at the node level, as NLB does, or at the service level. If service-level failure is used, the load balancer monitors the service on each node and stops sending client requests if the service stops responding.

**Inside OUT**

*DNS round robin*

An alternate method for load balancing is DNS round robin. This method is implemented entirely by using DNS records and does not require any additional software or hardware. The main concern with DNS round robin is that it can be less reliable than NLB or hardware-based load balancing.
In DNS, a host (A) record is used to identify the IP address to which a name should resolve. For example, a host (A) record identifies the IP address to which www.microsoft.com resolves. If you create multiple host (A) records for a name, then it resolves to multiple IP addresses. When a client resolves the name, the DNS server provides IP addresses from all of the host (A) records for that name. This configuration is called DNS round robin.

When a client receives multiple IP addresses from a DNS server, the typical behavior is to contact the first IP address in the list. If the first IP address in the list doesn’t respond, then the client contacts the second IP address in the list. This process continues until the client successfully connects to an IP address or the list is exhausted.

The main drawback to DNS round robin is that it’s unpredictable. The client is in control of the process for managing server failure and the list of IP addresses. If the software developer for the client software does not manage server failure well, then users experience poor performance. For client software that is designed to use DNS round robin, it is a simple and effective load balancing mechanism.

High availability for RD Session Host servers

When an RDS deployment has a single RD Session Host server, that server becomes a single point of failure. When it fails, the failure will affect all users who are connected to it and who run RemoteApp programs on that server. You must consider the possibility of failure or the lack of RD Session Host server availability in your disaster recovery plan.

You can take several steps to improve RD Session Host availability. You can use reliable and redundant hardware from respected vendors to minimize the probability of hardware failure. You also should make sure that the network is reliable and that there are multiple network paths to an RD Session Host server. You should be aware, however, that failures are unavoidable, and no single server can always be available without downtime. For example, after you install Windows updates, computer restart is often required, which causes server downtime.

To make the RD Session Host server role highly available, you should have multiple RD Session Host servers in each collection. The RD Connection Broker role service automatically load balances connections to the RD Session Host servers. If the RD Connection Broker role service identifies that an RD Session Host server is unavailable, clients are not directed to the failed RD Session Host server. Clients are directed only to the remaining functional RD Session Host server.

As a best practice, all RD Session Host servers should have a similar hardware configuration. This ensures that all RD Session Host servers have similar performance and can handle a similar
number of clients. The default configuration of load balancing for a collection, shown in Figure 8-23, is best suited for this scenario.

![Figure 8-23 Session Collection Properties page, Configure Load Balancing Settings page](image)

You can adjust the ratio of sessions allocated to an RD Session Host server by adjusting the Relative Weight value for that server. The default value for all servers is 100. When all servers have the same value, they all receive the same number of sessions. If you have one server with significantly better hardware and give that server a Relative Weight of 200, then it will receive twice as many sessions as a server with a Relative Weight of 100.

You also can set a Session Limit for each server. The default value for the Session Limit is 999,999, which effectively is unlimited. If you have determined that users experience performance issues when more than 80 clients are connected, then you can set a session limit of 80 to ensure that performance is satisfactory for all users.

To add a second RD Session Broker server to an RDS deployment, perform the following steps:

1. In Server Manager, in the navigation pane, click Remote Desktop Services.
2. On the Overview page, click Add RD Session Host Servers.

3. In the Add RD Session Host Server window, on the Select A Server page, in the Server Pool box, double-click the server you want to configure as an RD Session Host server and click Next.

4. On the Confirm Selections page, select the Restart Remote Computers As Needed check box and click Add.

5. Wait until the RD Session Host role service is installed on the server and click Close.

To add an RD Session Host server to a session collection, perform the following steps:

1. In Server Manager, in the navigation pane, click Remote Desktop Services.

2. In the navigation pane, click the session collection.

3. Scroll down to the Host Servers box, click Tasks, and click Add RD Session Host Servers.

4. In the Add Servers To Collection Wizard, on the Specify RD Session Host Servers page, double-click the RD Session Host server that you want to add to the session collection and click Next.

5. On the Confirm Selections page, click Add.

6. Wait until the task is complete and then click Close.

High availability for the RD Connection Broker role service

The RD Connection Broker role service is responsible for directing clients to an available RD Session Host server. If the RD Connection Broker role service is unavailable, then users are not able to access session-based virtual desktops. Having a single RD Connection Broker server creates a single point of failure.

To make the RD Connection Broker role service highly available, you need to have multiple RD Connection Broker servers. The RD Connection Broker role service uses a SQL Server database to track sessions that have been allocated to RD Session Host servers. For multiple RD Connection Brokers servers to work together, they need to share a single SQL Server database.

NOTE

High availability for the RD Connection Broker role service in Windows Server 2012 and newer is active/active. This means that multiple RD Connection Broker servers can respond to client requests at the same time. Older implementations of the RD Connection Broker and Terminal Services (TS) Connection Broker high availability
were active/passive. A second server was used only when the first server failed. This provided high availability but not scalability.

To prepare the RD Connection Broker role service for high availability, you need to do the following:

- Configure a server running Microsoft SQL Server 2008 R2 or newer. The RD Connection Broker servers must have permission to create a database on the server.
- Install the SQL Server Native Client on all RD Connection Broker servers. The RD Connection Broker servers use this to connect to the SQL database.
- Configure a static IP address on all RD Connection Broker servers. This is required to implement DNS round robin for load balancing.
- Configure a DNS round robin record for the RD Connection Broker servers. Select a name that is meaningful, such as rds.adatum.com.

**Inside OUT**

*Configuring SQL permissions for RD Session Broker high availability*

To assign the necessary permissions for RD Session Broker servers on the SQL server, perform the following steps:

1. Create a security group in Active Directory Domain Services (AD DS) and add the computer accounts for the RD Connection Broker servers.
2. Restart the RD Connection Broker server so that the new group membership takes effect.
3. On the SQL server, open SQL Server Management Studio.
4. In the Connect To Server window, verify that the correct instance of SQL server is listed and click Connect.
6. Right-click Logins and click New Login.
7. In the Login – New window, on the General page, in the Login Name box, type Domain/GroupName.
8. Click the Server Roles page, select the Dbcreator check box, and click OK.
When you configure the RD Connection Broker role service for high availability, its database moves from a local WID to a computer that is running SQL Server. Even when an RDS deployment has multiple RD Connection Broker servers, SQL Server still can be a single point of failure. You should make sure that SQL Server is highly available by running it in a failover cluster.

When you configure high availability for the RD Connection Broker role service, you need to provide a Database Connection String that the RD Connection Broker servers use to connect to the SQL server. The Database Connection String has the following format:

```
DRIVER=SQL Server Native Client 11.0;SERVER=LON-SQL.Adatum.com;Trusted_Connection=Yes;APP=Remote Desktop Services Connection Broker;Database=RDS-DB
```

There are several things to note about the Database Connection String:

- **A SQL native client version is specified**  In this example, the SQL native client version is 11.0. This is used when your SQL server is SQL Server 2012. If your SQL server is SQL Server 2008 R2, then the SQL native client version is 10.0.

- **A server name is specified**  In this example, the server name is LON-SQL.Adatum.com. In your deployment, you should specify the name of the SQL server that will be hosting the database for the RD Connection Broker servers.

- **A database name is specified**  In this example, the database name is RDS-DB. This is the name of the database that will be created for the RD Connection Broker servers to use. You can select an alternate name, but it should be a meaningful name to make it easy to identify.

To configure the RD Connection Broker role service for high availability, perform the following steps:

1. In Server Manager, in the navigation pane, click Remote Desktop Services.

2. On the Overview page, in the Deployment Overview area, right-click RD Connection Broker and click Configure High Availability.

3. In the Configure RD Connection Broker For High Availability Wizard, on the Before You Begin page, click Next.

4. On the Configure RD Connection Broker For High Availability page, shown in Figure 8-24, in the Database Connection String box, type the appropriate Database Connection String for your environment.
5. In the Folder To Store Database Files box, type the path for the database on the SQL server. The database will be created in this location. This folder must already exist.

6. In the DNS Round Robin Name box, type the name of the DNS round robin record that you created for the RD Connection Broker servers and then click Next.

7. On the Confirmation page, click Configure.

8. On the Progress page, click Close.

After you have configured high availability for the RD Connection Broker role service, the RD Connection Broker icon in the Deployment Overview area is updated with the text (High Availability Mode). Now you can add another RD Connection Broker server by right-clicking the RD Connection Broker icon and clicking Add RD Connection Broker server. The new RD Connection Broker server will use the central SQL database that you have configured.
High availability for the RD Web Access role service

RD Web Access servers are a critical part of an RDS deployment. The RD Web Access servers are responsible for providing clients with an .rdp file that contains connectivity information to collections. If RD Web Access isn’t available, then clients can’t obtain the necessary configuration information to connect to session-based virtual desktops. You should make RD Web Access servers highly available.

Load balancing is used to make RD Web Access servers highly available. You can use NLB, hardware-based load balancing, or DNS round robin. If you are using NLB or hardware-based load balancing, you’ll need to create a DNS record for the virtual IP address used by the load balancing cluster. For example, you could create a host (A) record for RDWeb.adatum.com that resolves to the virtual IP address. If you are using DNS round robin, then you need to create multiple host (A) records for RDWeb.adatum.com that resolve to the IP addresses of the RD Web Access servers.

To add an RD Web Access server, perform the following steps:

1. In Server Manager, in the navigation pane, click Remote Desktop Services.
3. In the Add RD Web Access Servers Wizard, on the Select A Server page, double-click the server you want to configure as an RD Web Access server and click Next.
4. On the Confirmation page, click Add.
5. Wait until the installation is complete and click Close.
6. Configure your load-balancing solution with the IP address of the new RD Web Access server.

High availability for the RD Licensing role service

The effect of the RD Licensing role service for an RDS deployment varies, depending on the licensing mode that has been selected. When an RDS deployment is configured for Per User licensing, the RD Session Host servers contact an RD Licensing server each time a client connects. If an RD Licensing server isn’t available, then users can’t connect.

Per User licensing isn’t enforced by RD Licensing servers. If an RD Session Host server can contact an RD Licensing server, that is sufficient to allow a connection. You are responsible for ensuring that you are in compliance with licensing requirements, but they are not enforced.
To make an RDS deployment with Per User licensing highly available, you need to install multiple RD Licensing servers. If the first RD Licensing server is unavailable, then the second is contacted.

Allocation of RDS User CALs among the RD Licensing servers does not matter because they are not enforced. To simplify license management, you can install and activate all RDS User CALs on a single RD Licensing server.

High availability for an RDS deployment configured for Per Device licensing also requires multiple RD Licensing servers, but configuration is more complex because RDS Device CAL usage is enforced. If an RDS Device CAL isn’t available, then connectivity can be blocked. Because of this, you need to consider how CALs are allocated among the RD Licensing servers.

RDS client behavior for Per Device licensing varies, depending on the state of the client:

- **First connection** The first time a device connects, it is issued a temporary CAL that can be used only once. If an RD Licensing server is unavailable, the temporary CAL can’t be issued, and new devices are unable to connect. The temporary CAL can be issued by any RD Licensing server even if no RDS Device CALs are available on that server.

- **Temporary license** The second time a device connects, it is issued a permanent RDS Device CAL. For a device to be issued a permanent RDS Device CAL, an RD Licensing server with unallocated Per Device CALs must be available. If an RD Licensing server with unallocated Per Device CALs isn’t available, then the temporary CAL remains valid for 90 days.

- **Permanent CAL** Devices with a permanent CAL can connect to an RD Session Host when no RD Licensing server is available. Permanent RDS Device CALs are valid for 52 to 89 days and can’t be renewed if no RD Licensing server is available.

- **Permanent CAL expired** If the permanent CAL has expired and an RD Licensing server isn’t available, the connection is blocked. An RD Licensing server with unused Per Device CALs must be available to issue a new permanent CAL.

The simplest way to configure high availability for the RD Licensing role service when using Per Device licensing is to put all RDS Device CALs on a single RD Licensing server. The second RD Licensing server has no CALs installed and issues only temporary licenses. In this configuration, failure of the RD Licensing server with CALs has no effect on devices with a permanent or temporary license, which typically are the majority of devices. Devices connecting for the first time are issued a temporary license from the remaining RD Licensing server without CALs. The only clients unable to connect are devices with an expired license, which should be a small number of devices.
A slightly more complex way to configure high availability for the RD Licensing role service when using Per Device licensing is to split RDS Device CALs among RD Licensing servers. Most CALs are installed on the primary RD Licensing server, but some are installed on a secondary RD Licensing server. This configuration is better because if the primary RD Licensing server fails, then CALs can be issued by the secondary RD Licensing server, and no devices should be prevented from connecting.

Splitting CALs between two RD Licensing servers is slightly more expensive because you need to purchase additional CALs for the secondary RD Licensing server. In a large deployment of RDS, this likely is worth the additional cost to avoid outages. In a small deployment of RDS, it may not be worth the cost because very few users would be affected.

When you have multiple RD Licensing servers, it is critical that you configure the RDS deployment to use the RD Licensing server you have configured with the CALs as the primary RD Licensing server.

To configure the order of RD Licensing servers, perform the following steps:

1. In Server Manager, in the navigation pane, click Remote Desktop Services.
2. On the Overview page, in the Deployment Overview area, click Edit Deployment Properties.
3. In the Deployment Properties window, in the navigation area, click RD Licensing.
4. Select the server you want to be primary, click Move Up until it is at the top of the list, and click OK.

To add an RD Licensing server, perform the following steps:

1. In Server Manager, in the navigation pane, click Remote Desktop Services.
2. On the Overview page, in the Deployment Overview area, right-click RD Licensing and click Add RD Licensing Servers.
3. In the Add RD Licensing Servers Wizard, on the Select A Server page, double-click the server you want to configure as an RD Licensing server and click Next.
4. On the Confirmation page, click Add.
5. Wait until the installation is complete and click Close.
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Numbers and Symbols
32-bit operating systems, 491
64-bit operating systems, 491
1670 error code, 255
1671 error code, 255
1672 error code, 255
1673 error code, 255
1674 error code, 255
1677 error code, 255

A
A (host) records, 441, 447
Access RemoteApp And Desktops Wizard, 464
Activate Server Wizard, 436
Active Directory
activating operating systems, 492–493
adding users or groups, 278
configuring Credential Roaming, 69
editing access, 164, 285, 289
managing checkpoints, 151
Primary Computer user attribute, 76
VM-based desktop deployments, 522
Active Directory Administrative Center, 48–49, 66–67
Active Directory Domain Services (AD DS)
App-V client and, 228
App-V infrastructure requirements, 187–188
dynamic configuration, 310, 382
high availability and, 21
personal virtual desktops, 492
pooled virtual desktops, 492
Primary Computer feature and, 66
RD CAPs, 557
RD Gateway configuration scenarios, 544, 546
RD RAPs, 559
security groups and, 174–175, 308–309, 444
Add-AppvClientConnectionGroup cmdlet, 295, 297
Add-AppvClientPackage cmdlet
adding packages, 163, 250–251, 269, 357
described, 295
elevated prompts, 297
Add-AppvPublishingServer cmdlet, 266–267, 295, 297
add-ons, 322–323, 334, 380
Add RD Licensing Servers Wizard, 434, 449
Add RD Web Access Servers Wizard, 447
Add Roles and Features Wizard
Confirm Selections page, 521
Confirmation page, 422
Microsoft Virtual Machine-Based Desktop Deployment scenario, 519–523
Review Role Services page, 419, 520
Select Deployment Scenario page, 417–419, 520
Select Deployment Type page, 416–417, 419, 519
Select Installation Type page, 416, 419, 519
Specify RD Connection Broker Server page, 419–420, 520
Specify RD Session Host Servers page, 421–422
Specify RD Virtualization Host Server page, 521
Specify RD Web Access Server page, 420–421, 521
Add Servers To Collection Wizard, 443
Admin event log, 256, 568
AdminGroup.xml file, 209
Administrative Events custom view, 566–567
.ADML files, 78
.ADMX files, 78
Advanced Group Policy Management (AGPM), 2
agents (Operations Manager), 574
AgentSetup32.msi file, 79
AgentSetup64.msi file, 79–80
AgentSetup.exe utility, 79–80
AGPM (Advanced Group Policy Management), 2
alerts (Operations Manager), 25, 572–575, 579–582
always roaming user scenario, 43–44
antivirus software, 500–501
App-V (Application Virtualization)
application compatibility, 5, 7, 15
application life cycle, 161–177, 297–303, 305–306, 312
benefits of, 157–159
building images, 254–259
deploying Office 2013, 351–357
deployment models, 184–187, 189–193
disaster recovery, 199–200
event logs, 568
functional and physical placement, 194–195
Group Policy support, 272–273, 384–385
high availability, 197–199
infrastructure requirements, 187–189, 200–201
installation error codes, 255
installing management databases, 201–204
integrating with System Center Configuration Manager, 211
licensing requirements, 24
management packs, 582
MDOP and, 2, 4–5
modifying and upgrading published applications, 297–312
optimizing, 500
Remote Desktop Services client and, 210
service disruption impact, 193–194
shared content store, 220–224
sizing and performance, 195–197
standard versus virtualized applications, 159–160
technologies supported, 177–184
third-party production integration, 252–253
UE-V Generator and, 88
unsupported applications, 324
VDI solution, 252–254
virtualization engine and, 160–161

**App-V client**
accessing applications, 215–216
autoload mechanism, 273
building images, 254–259
configuring for stand-alone mode, 250–252
data storage locations, 216–220
deployment methods, 224–227
described, 179–183, 213
.INI files and, 380–381
installation error codes, 255
installation prerequisites, 228–230
installing using Configuration Manager, 230–246
isolating applications, 214
managing file type associations, 265–266
managing properties, 259–266
managing server connections, 266–275
managing using Group Policy, 180–181, 191, 210, 221–222, 225–228, 270–273
managing virtual applications, 264
registry settings, 273–275
for Remote Desktop, 227, 247–250
reporting process overview, 312–318
requesting and executing applications, 213–214
shared content store, 220–224
shortcut support, 217–220
third-party production integration, 252–253
troubleshooting installation, 255–259
VDI solution, 252–254
Windows PowerShell support, 267–269, 294–296

**App-V client setup window**
Customer Experience Improvement Program page, 248–249
   described, 247
Software License Terms page, 247–248

**App-V client window**
App Connection Groups tab, 262–263
   described, 260
displaying Windows PowerShell cmdlets, 263–264
Overview tab, 260–261, 264
Virtual Apps tab, 261–262, 264

**App-V Management Console**
adding packages, 303–304
Administrators tab, 278, 281–282
   described, 277–280
granting access, 308–309
importing new versions of packages, 308–309
managing administrators, 281–282
managing application packages, 284–287
managing connection groups, 287–288
Overview tab, 277
Packages tab, 175, 278, 285–288, 304
registering and unregistering servers, 282–284
Servers tab, 278, 282–284

**App-V management servers**
accessing packages, 284
adding packages, 284
configuring, 204–207
described, 178–179, 282
disaster recovery and, 199–200
event logs, 568
IIS support, 205–206, 278
infrastructure requirements, 188
installing management databases, 201–204
managing by using Windows PowerShell, 289–297
publishing packages, 285
refreshed list of published applications and, 175
round-trip response time, 195–196
service disruption impact, 194
Windows PowerShell support, 294, 296

**App-V publishing servers**
App-V client and, 215, 295–296
capacity planning, 196–197
deploying and configuring, 208–210
described, 179–183
disaster recovery and, 199–200
displaying associated, 296
IIS support, 176, 179, 278
infrastructure requirements, 188–189
monitoring performance, 566
optimizing, 500–501
refreshed list of published applications and, 175–176
registering and unregistering, 282–284
round-trip response time, 195–196
service disruption impact, 193–194
App-V Sequencer

Add New Application option, 303
application sequencing, 161–162
application update, 165–174, 297–303
best practices, 330–332
Completion page, 302, 375–376
Configure Software page, 320, 341–342, 373–374
configuring, 326–330
connection groups and, 380–381
Create A New Virtual Application Package option, 337, 367
Create Package Accelerator page, 361–363, 365–366
creating package accelerators, 358–377
creating packages, 284, 310
Customize page, 344
deployment models and, 192
described, 161, 179–183, 319–321
editing packages, 302–303, 306–307
ESD model and, 191
Guidance page, 369–370
Installation Files page, 360–361
Installation page, 170–171, 300–301, 341, 379
Installation Report page, 171–172, 301, 343, 379
installing, 336
Local Installation page, 370–371
Modify An Existing Virtual Application Package option, 166
Package Name page, 338–339, 371–372
Packaging Method page, 337, 367–368
Prepare Computer page, 168–169, 299, 337, 378
Prepare For Streaming page, 172–173, 301–302
Run Each Program page, 374–375
Select Guidance page, 364–365
Select Package Accelerator page, 368–369
Select Package page, 167–168, 299, 359–360
Select Task page, 166–167, 298
sequencing process overview, 321–322
Streaming page, 379
Target OS page, 344–345
Update Application in Existing Package option, 166–167, 298–299
updating packages, 378–381
Verify Applications page, 363–364
virtual machines as, 328–329
Windows PowerShell support, 294–295, 351

Application event log, 368
application files
launching virtual applications, 321
in packages, 284
standard application installation, 159
streaming delivery, 216, 500
application life cycle (App-V)
application deployment, 162
application publishing, 162, 297–312
application removal, 305–306
application sequencing, 161–162
application termination, 174
application update, 165–175, 297–303
Configuration Manager model, 165
described, 161
full infrastructure model, 164
removing applications from users, 174–177, 305–306
script execution support, 312, 383–384
stand-alone deployment model, 163–164
application request process, 213–214
application sequencing. See also App-V Sequencer
application types supporting, 333–334
applications incompatible with, 332–333
best practices, 330–332
for connection groups, 380–381
customizing packages, 344–345
deploying Office 2013 by using App-V, 351–357
described, 161–162
dynamic configuration and targeted scripting, 381–385
described, 322–324
items to document in recipes, 322–324
package accelerators, 357–377
package editor, 345–350
planning, 326–333
portions of sequenced applications, 324–325
preparing for, 335–336
process overview, 321–322
sequencing tasks, 337–343
upgrading packages, 378–385
Windows PowerShell support, 351
application virtualization
App-V. See App-V
App-V client and, 214

App-V Sequencing Guide, 333
App-V_SSRS_Reports.exe utility, 317
AppData folder, 34–35, 53
Append Data NTFS permission, 47, 77
application compatibility
App-V, 5, 7, 15
comparing virtual desktop options, 484–485
improving, 15–16
operating system differences, 491
RD Session Host service, 455, 485
RemoteApp, 6, 15, 453
session-based desktops and, 9
user state virtualization, 40

Application event log, 368
application files
launching virtual applications, 321
in packages, 284
standard application installation, 159
streaming delivery, 216, 500
application life cycle (App-V)
application deployment, 162
application publishing, 162, 297–312
application removal, 305–306
application sequencing, 161–162
application termination, 174
application update, 165–175, 297–303
Configuration Manager model, 165
described, 161
full infrastructure model, 164
removing applications from users, 174–177, 305–306
script execution support, 312, 383–384
stand-alone deployment model, 163–164
application request process, 213–214
application sequencing. See also App-V Sequencer
application types supporting, 333–334
applications incompatible with, 332–333
best practices, 330–332
for connection groups, 380–381
customizing packages, 344–345
deploying Office 2013 by using App-V, 351–357
described, 161–162
dynamic configuration and targeted scripting, 381–385
described, 322–324
items to document in recipes, 322–324
package accelerators, 357–377
package editor, 345–350
planning, 326–333
portions of sequenced applications, 324–325
preparing for, 335–336
process overview, 321–322
sequencing tasks, 337–343
upgrading packages, 378–385
Windows PowerShell support, 351
application virtualization
App-V. See App-V
App-V client and, 214
described, 1, 4–6
implementation considerations, 17–25
infrastructure, 161–187
management packs, 581–583
monitoring, 565–572
RemoteApp. See RemoteApp
standard applications versus, 159–160
usage scenarios, 12–17
ApplySettingsTemplateCatalog.exe utility, 93
AppSense applications, 253
.APPV files
contents of, 186–187
described, 178, 186, 325
extracting virtual registry, 275
hosting on web servers, 217
saving packages as, 320, 355–356
sequenced applications, 321
stand-alone deployment model, 185, 192
version information, 298, 378
AppVClient module (PowerShell), 268–269, 294–296
appv_client_MSI_x64.msi file, 229
appv_client_MSI_x86.msi file, 229
appv_client_setup.exe command, 225, 228–229, 247
AppVManagement database, 281
AppVPackages directory, 355
AppVReporting database, 281
AppVSequencer module (PowerShell), 294, 296, 351
AppVServer module (PowerShell), 294–295
appv_server_setup.exe command, 202, 205–206, 208
.APPVT files, 186, 325
AppxManifest.xml file, 187, 310, 325, 381
asset folders, 219
assigned computer user scenario, 41–42
authentication
AD DS and, 187
App-V and, 188–189
certificates and, 68
Microsoft accounts and, 71, 76
multi-factor, 557, 561–564
Network Level Authentication, 431
RD CAPs, 558
RD Gateway, 549
scenario with unauthorized users, 544
Server Authentication, 552
wireless networks and, 111
authorization
AD DS, 187
RD Gateway, 391, 549–550, 557
Autoload registry key, 273–274
Autoruns program, 590
Azure Multi-Factor Authentication, 557, 561–564
B
Background Intelligent Transfer Service (BITS), 498
bandwidth
monitoring performance, 589
RDC detection, 400–401
RDS reduction, 395
Berson, Frank, 564
Best Practices Analyzer (BPA), 415
BitLocker Drive Encryption, 495
BITS (Background Intelligent Transfer Service), 498
Block-Level Backup Engine Services, 498
Bluetooth Support Service, 498
boot options (virtual machines), 124–125
BPA (Best Practices Analyzer), 415
branch office environment, 453
BranchCache feature, 63
Bring Your Own Device (BYOD), 17, 541
BYOD (Bring Your Own Device), 17, 541
C
.CAB files, 186, 325, 358, 376–377
CALs (client access licenses), 22–24, 401–403, 437–438, 448–449
capacity planning
described, 195–197, 511–512
high availability and, 21
for memory, 513–514
for networking, 514–515
for processing, 515–516
scenario for, 517–518
for storage, 512–513
CEIP (Customer Experience Improvement Program), 81, 272
CEIP node (App-V policies), 272
central RD CAP store, 560–561
certificates
common mistakes creating, 476
configuring, 472–479
Credential Roaming feature, 68–69
load-balanced environment, 280
RDS, 473–478
SAN, 473
self-signed, 476
server-based, 280, 473
SSL, 205, 278–280, 377, 475, 550–553
UCC, 473
wildcard, 279, 473
Certificates snap-in (MMC), 475
change user command
/execute options, 250, 456
/install option, 247, 456
/query option, 456
Checkpoint Name window, 328
Checkpoint-VM cmdlet, 152, 329
checkpoints (snapshots)
applying, 154
creating, 152–153, 328–329, 336
deleting, 154–155
described, 151–152, 328
exporting, 154
pooled virtual desktops, 533
renaming, 154
reverting to previous state, 154
SAN support, 505
troubleshooting, 329
usage considerations, 153–156
child partitions, 98–99
Citrix applications, 253
Clear-FileStorageTier cmdlet, 509
client access licenses (CALs), 22–24, 401–403, 437–438, 448–449
Client Coexistence node (App-V policies), 272
Client Hyper-V
architectural overview, 97–100
controlling virtual machines, 125–130
creating virtual machines, 112–121
described, 6–7, 95–97
dynamic memory, 137–138
Generation 2 virtual machines, 124–125
Hyper-V comparison, 99–100
installing, 100–104
integration services, 138–141
management tools, 104–107
managing checkpoints, 151–156
managing virtual hard disks, 141–151
managing virtual machine files, 130–135
managing virtual switches, 108–112
processing overview, 135–136
virtual machine settings, 121–124
Client registry key, 274
cluster shared volume (CSV), 488, 507–509, 525
cmdlets. See also specific cmdlets
described, 105–106
elevated prompts, 297
viewing, 263–264
COM objects, 214, 219
compacting VHD files, 149
Company Settings Center dialog box, 86
compatibility, application
App-V, 5, 7, 15
comparing virtual desktop options, 484–485
improving, 15–16
operating system differences, 491
RD Session Host service, 455, 485
RemoteApp, 6, 15, 453
session-based desktops and, 9
user state virtualization, 40
Computer And Device Management Wizard, 577–579
certificate, 553
computer images, deploying App-V client, 226–227
collection.
configuration files
App-V client, 217
collection.
control settings, 311, 382–383
customizing, 295
dynamic, 310–312, 349, 382
collection.
file name, 165
importing, 308
MDT supported, 495
post-installation steps, 323
usage considerations, 310
Windows PowerShell support, 295
Configuration Manager (System Center)
App-V and, 165, 185, 189–191, 198–199, 211
App-V client and, 226, 228, 230–246, 312
installing App-V client using, 230–246
personal virtual desktops, 494
pooled virtual desktops, 494
UE-V agent and, 79, 81
usage considerations, 228
Configuration.xml file, 352–353
configure function (ODT), 354
Configure RD Connection Broker For High Availability Wizard, 445–446
connection groups
adding packages to, 291–292
application sequencing, 380–381
creating, 290–294
described, 178, 214, 287
ESD model and, 191
granting access, 292–293
managing, 287–288, 290–296
ordering packages in, 292
publishing, 293–294
troubleshooting issues, 288
updating, 304–305
version considerations, 304
Contacts folder, 54
Content_Types.xml file, 310, 381
Control Panel, 456, 465
Convert-VHD cmdlet, 150
copy-on-write (CoW) roaming, 217
coreinfo tool, 102
cost of ownership, reducing, 254
CoW (copy-on-write) roaming, 217
Create A Settings Location Template Wizard
Edit Templates page, 91–92
Finish page, 92
Review Locations page, 90–91
Specify Applications page, 89–90
Create Application Wizard
Application Catalog page, 232–233
Completion page, 245–246
Deployment Types page, 233–234, 243–244
described, 189–190
General Information page, 232
General page, 190, 231
Summary page, 244–245
Create Collection Wizard
automatic VM creation, 525
Confirm Selections page, 426
described, 524
Name The Collection page, 423, 526
Specify RD Session Host Servers page, 423–424
Specify The Collection Type page, 526–527
Specify The Unattended Installation Settings page, 528–529
Specify The Virtual Desktop Settings page, 528
Specify The Virtual Desktop Template page, 527
Specify User Groups page, 424–425
Specify User Profile Disks page, 425–426, 532
Specify Users And User Groups page, 529–530
Specify Virtual Desktop Allocations page, 530–531
Specify Virtual Storage page, 531–532
View Progress page, 426
virtual desktop templates, 490
Create Deployment Type Wizard
Completion page, 242–243
Content page, 236–237
Create Requirement window, 239–240
Dependencies page, 240–241
described, 234
Detection Method page, 237–238
Detection Rule window, 237–238
General Information page, 235–236
General page, 234–235
Requirements page, 239–240
Summary page, 241–242
User Experience page, 238–239
Create Folders NTFS permission, 47, 77
Create New Application Wizard, 165
Create New Package Wizard
Completion page, 375–376
Configure Software page, 320, 341–342, 373–374
Create Package page, 345, 372–373
Customize page, 344
Guidance page, 369–370
Installation page, 341
Installation Report page, 343
Local Installation page, 370–371
Package Name page, 338–339, 371–372
Packaging Method page, 367–368
Prepare Computer page, 337
Run Each Program page, 374–375
Select Installer page, 338
Select Package Accelerator page, 368–369
Target OS page, 344–345
Create Package Accelerator Wizard
Create Package Accelerator page, 361–363, 365–366
Installation Files page, 360–361
Select Guidance page, 364–365
Select Package page, 359–360
Verify Applications page, 363–364
Create Requirement window, 239–240
Creator Owner account, 47, 77–78
Credential Roaming, 4, 68–69
CSV cache, 508–509, 511, 513
CSV (cluster shared volume), 488, 507–509, 525
Customer Experience Improvement Program (CEIP), 81, 272
customsettings.ini file, 495
DaRTRT (Diagnostics and Recovery Toolset), 2
Data Deduplication feature, 508, 510–511
data redundancy, 504–505
data warehouse database, 574
Database Connection String, 445
Database.sql file, 203–204
debug logs, 257–259
demonstrations, 7
deployment methods (App-V client)
deployment by imaging, 226
GPO deployment, 225–226
manual deployment, 225
stand-alone mode, 221, 250–252
deployment models (App-V)
Configuration Manager model, 165, 185, 189–191,
198–199, 312
described, 162
electronic software distribution model, 191–192
full infrastructure model, 164, 184–185, 187, 189,
197–198, 313
stand-alone, 163–164, 185, 192–193, 197, 312
DeploymentConfig.xml file
App-V client, 214
App-V packages, 186
application sequencing, 325, 355
Configuration Manager model, 165
dynamic configuration, 310, 382–383
Desktop folder, 35, 53
desktop virtualization
application compatibility, 15–16
Client Hyper-V. See Client Hyper-V
described, 2, 6
desktop as a service, 16
implementation considerations, 17–25
legal and security requirements, 13
management packs, 581–583
management task support, 14
mobile user experience, 16–17
monitoring, 565–572, 585–590
user profile disks, 70
virtual desktops. See virtual desktops
Detection Rule window, 237–238
device-based CALs, 22–24
device drivers, 323, 333
device emulation, 99, 112–113
device redirection, 467–469, 558, 590
Diagnostic Policy Service, 498
Diagnostics and Recovery Toolset (DaRTRT), 2
differencing disks, 145–147, 150, 152–153, 155
Disable-AppvClientConnectionGroup cmdlet, 295
disaster recovery, 100, 199–200
Disconnect option (connections), 471
Disconnect-RDUser cmdlet, 471
diskpart utility, 496
Dism.exe utility, 103
DLLs (dynamic-link libraries), 15, 158–159
DNS (Domain Name System), 21, 441, 493, 550
DNS round robin, 440–441, 444, 446, 486
document invocation, 462
Documents folder, 35, 39, 53, 58
Domain Admin group, 282
Domain Computers account, 78
Domain Name System (DNS), 21, 441, 493, 550
Domain Users group, 308
download function (ODT), 354
Downloads folder, 35, 54
Dsmod.exe utility, 68
dual booting, 96–97
dynamic configuration files
  disabling virtual services, 349
  enabling scripting, 310–312
  targeted scripting, 381–385
Dynamic CPU Fair Share feature, 589
Dynamic Disk Fair Share feature, 589
dynamic DNS, 493
dynamic-link libraries (DLLs), 15, 158–159
dynamic memory, 137–138, 156, 513–514
Dynamic Network Fair Share feature, 589
dynamical expanding VHDs, 143–145

E
Edit Virtual Hard Disk Wizard, 148–150
electronic software distribution (ESD) model, 191–192
emulated devices, 99, 112–113
Enable-AppvClientConnectionGroup cmdlet, 295
Enable-DedupVolume cmdlet, 510
Enable-UevTemplate cmdlet, 75
Enable-WindowsOptionalFeature cmdlet, 103
EnableCpuQuota registry key, 589
EnableFairShare registry key, 589
EnablePackageScript registry key, 275
Enhanced Session Mode, 129
enterprise user state virtualization, 38
environment variables, 50, 219
error codes (App-V installations), 255
ESD (electronic software distribution) model, 191–192
event logs, 255–256, 282, 499, 566–568
Event Viewer, 256–259, 555, 565–567
everyone account, 78
Exchange Server, 42–44, 579
Expand-AppvSequencerPackage cmdlet, 296
Export Virtual Machine dialog box, 132
exporting
  checkpoints, 154
  package configuration, 287, 307–308
  virtual machines, 132, 134
Extended Page Tables, 398
extension points, 219, 310, 381
external virtual switches, 109–110

F
failover clusters, 487–489, 506–507
Fair Share feature, 397, 588–589
Fault Streaming, 320–321
fault tolerance, 12, 387
Favorites folder, 35, 54
feature block maps, 320–321, 324
Fibre Channel, 100, 488, 506
File Explorer
  accessing Sysprep, 502
  browsing ODT logging path, 353
  browsing source path, 353, 355
  configuring offline files and folders, 61, 64–66
  creating Central Store, 271
file server repository, 193–195
file systems, 214
file type associations (FTAs)
  editing, 265–266, 306–307
  extension points as, 219
  package editor support, 350
  post-installation steps, 323
  RemoteApp programs, 454
  removing, 306–307
  viewing existing, 286–287
FilesSystemMetadata.xml file, 187, 325
fixed-size VHDs, 143–145
Folder Redirection feature
  configuring, 53–58
  described, 3, 53
  preserving user state, 412–413
  user profile disks and, 524
  user state virtualization and, 36, 39, 41–43
folders
  application sequencing, 324–325
  asset, 219
  configuring offline, 61, 64–66
  Folder Redirection. See Folder Redirection feature
  known, 53–54
  naming conventions, 309
  roaming user profiles, 48
  storing on user profile disks, 523
  user-specific data, 34–35
FQDN (fully qualified domain name), 473–475, 479, 552
FreeBSD operating system, 125, 139
FTAs (file type associations)
  editing, 265–266, 306–307
  extension points as, 219
  package editor support, 350
  post-installation steps, 323
RemoteApp programs, 454
removing, 306–307
viewing existing, 286–287
Full Control NTFS permission, 47–48, 77–78, 251
full infrastructure model
App-V infrastructure requirements, 187
deployment possibilities, 189
described, 164, 184–185
high availability and, 197–198
reporting process overview, 313
Fully Loaded state, 193
fully qualified domain name (FQDN), 473–475, 479, 552

g
gateway servers (Operations Manager), 575
generation 1 virtual machines, 121–124, 398
generation 2 virtual machines, 124–125
generic volume license key (GVLK), 492
Get-AppvClientApplication cmdlet, 295
Get-AppClientConfiguration cmdlet, 295
Get-AppvClientConnectionGroup cmdlet, 215, 295
Get-AppvClientMode cmdlet, 295
Get-AppvClientPackage cmdlet, 163
Get-AppvServer cmdlet, 215, 296
Get-AppvServerConnectionGroup cmdlet, 292, 294
Get-AppvServerPackage cmdlet, 291, 294
Get-AppvServerPackageDeploymentConfiguration cmdlet, 294
Get-AppvServerPackageUserConfiguration cmdlet, 295
Get-Cluster cmdlet, 105, 268, 461
Get-Command cmdlet, 106
Get-Event cmdlet, 267
Get-RDUserSession cmdlet, 471
Get-StorageTier cmdlet, 509
Get-UevAppxPackage cmdlet, 87
Get-UevConfiguration cmdlet, 83
Get-UevTemplate cmdlet, 83
Get-VMHost cmdlet, 106
Get-VMSnapshot cmdlet, 330
Get-VMSwitch cmdlet, 112
Get-WindowsOptionalFeature cmdlet, 103
GlobalEnabled registry key, 275
GlobalLogonRefresh registry key, 275
GlobalPeriodicRefreshInterval registry key, 275
GPOs (Group Policy Objects)
App-V and, 164, 191–192
App-V client and, 221–222, 225–226, 228, 282
Configure Background Sync setting, 60
configuring Folder Redirection, 55–56, 58
creating, 164
Enable Package Script setting, 384
managing user profiles, 50–51
modifying settings, 270–271
publishing server settings, 181
reporting server settings, 184
shared content store settings, 221–222
Group Policy
App-V administrator access, 282
App-V settings, 165, 181, 183–185
Central Store for, 270–271
configuring scripting, 384
Credential Roaming settings, 68–69
Ease of Access settings, 75
ensuring consistent configuration, 315
ESD model and, 191
Fair Share settings, 589
Folder Redirection settings, 41, 55
network latency configuration, 60
Offline Files settings, 60
Primary Computer setting, 66–67
settings storage location, 73
shared content store setting, 221–222
UE-V agent deployment, 78–79
UE-V agent management, 81–84
UE-V settings, 77–78, 86
user profile management, 50–52, 412–413
user state virtualization implementation, 41
Windows 8 app settings, 87
Group Policy Management Editor, 272–273
Group Policy Objects (GPOs)
App-V and, 164, 191–192
App-V client and, 221–222, 225–226, 228, 282
Configure Background Sync setting, 60
configuring Folder Redirection, 55–56, 58
creating, 164
managing user profiles, 50–51
modifying settings, 270–271
publishing server settings, 181
reporting server settings, 184
shared content store settings, 221–222
GVLK (generic volume license key), 492

H
hardware-based load balancing, 440
heartbeat networks, 489
hiberfil.sys file, 499
hibernate mode, 99
high availability
App-V, 197–199
deployment considerations, 195
load balancing and, 439–441
personal virtual desktops, 486–489
planning, 21–22
pooled virtual desktops, 485–486
RD Connection Broker service, 443–446
RD Licensing role service, 447–449
RD Session Host service, 21, 441–443
RD Web Access role service, 447
RDS support, 438–449
host (A) records, 441, 447
HTTP (Hypertext Transfer Protocol Service), 278
HTTPS binding, 278–279
Hyper-V
Client Hyper-V. See Client Hyper-V
Data Deduplication feature, 510
described, 95
event logs, 568
integration services, 138–141
management pack, 583
Storage Spaces and, 12
troubleshooting checkpoints, 329
unique IDs, 133–134
virtual process support, 135
Hyper-V Data Exchange Service, 140
Hyper-V Guest Service Interface, 140
Hyper-V Guest Shutdown Service, 139
Hyper-V GUI Management Tools feature, 105
Hyper-V Heartbeat Service, 140
Hyper-V-Hypervisor event log, 568
Hyper-V Manager
creating checkpoints, 328–329
creating external virtual switches, 109–110
creating virtual hard disks, 147–148
creating virtual machines, 113–120
described, 104–106
viewing checkpoints, 153–154
Hyper-V module (PowerShell), 105
Hyper-V Remote Desktop Virtualization Service, 140
Hyper-V Server, 507–508
Hyper-V Time Synchronization Service, 139
Hyper-V-VMMS event log, 568
Hyper-V Volume Shadow Copy Requestor, 140
Hyper-V-Worker event log, 568
Hypertext Transfer Protocol Service (HTTP), 278
building with App-V client, 228
building with App-V server, 228
reducing number of, 254
Sequencer configuration and, 326
Sysprep tool and, 503
Import-AppvServerPackage cmdlet, 289, 295
Import Certificates window, 551
Import Management Packs window, 584–585
Import-Module cmdlet, 268, 351, 356
Import Virtual Machine Wizard, 133–134
importing
collection files, 308
management packs, 583–585
packages, 178, 303–304
virtual machines, 133–135
inherited environments, 384
INI files, 380–381, 455
Install Licenses Wizard, 437–438
Installation Wizard, 331
Integration node (App-V policies), 272
integration services, virtual machines, 138–141
internal networks, 111–112
Internet Connection Sharing (ICS), 112
Internet Explorer, 333
Internet Information Server (IIS)
App-V management server and, 205–206, 278
App-V publishing server and, 176, 179, 278
App-V reporting server and, 278
RD Web Access role service and, 410, 466–467
reverse proxy servers, 548
Internet SCSI (iSCSI), 488, 506, 515
Invoke-RDUserLogoff cmdlet, 471
IOPS (I/O operations per second), 150, 512–513
IP addresses, 441
iSCSI (Internet SCSI), 488, 506, 515
IsPublishedToUser property, 163
K
kernel mode, 98, 160–161
Key Management Service (KMS), 492–493
killing processes, 306
KMS (Key Management Service), 492–493
known folders, 53–54
L
last access time stamp, 499
latency, network, 18–19, 66
LDIFDE.exe utility, 68
legal requirements
RDS, 404
Shadow option, 471
usage scenarios, 13
licensing
App-V considerations, 158
KMS support, 493
post-installation step, 323
RD Session Host servers, 22, 402, 448, 455
RDS, 401–403
virtualized environment requirements, 22–24

**Links folder, 54**

**Linux operating system**
- Citrix support, 253
- Client Hyper-V, 125
- integration services, 99, 139
- Operations Manager, 574, 577
- Secure Boot, 125

**List Folder Contents NTFS permission, 78**

**List Folder NTFS permission, 47, 77**

**Live Migration, 487**

**load balancing**
- described, 439
- DNS round robin, 440–441
- hardware-based, 440, 447
- high availability for server roles, 486
- RD Connection Broker service, 20
- RD Web Access service, 447
- SSL certificates and, 280
- Windows Network Load Balancing, 439–440

**load simulations, 511–512**

**Local folder (AppData), 34**

**LocalHelp setting, 466–467**

**LocalLow folder (AppData), 34–35**

**locally attached storage, 503–505**

**log files and logging**
- App-V, 282
- App-V client, 255–259
- monitoring performance, 566–568
- personal virtual desktops, 499
- pooled virtual desktops, 499
- RD Gateway, 554–555

**Log Off option (connections), 471**

**Login VSI, 512**

**M**

**MAC (media access control) addresses, 111**

**Mac OS X operating system, 8, 17**

**machine catalog, 217–218**

**machine configuration files, 217, 311, 382–383**

**mailto extension, 310, 381**

**management databases, 201–204**

**management networks, 489**

**management operating system, 98**

**management packs (Operations Manager)**
- described, 579–581
- importing, 583–585
- installing, 583–585
- monitoring application virtualization, 581–583
- monitoring desktop virtualization, 581–583

**management server database (App-V), 178–179**

**management servers (App-V)**
- accessing packages, 284
- adding packages, 284
- configuring, 204–207
- described, 178–179, 282
- disaster recovery and, 199–200
- event logs, 568
- IIS support, 205–206, 278
- infrastructure requirements, 188
- installing management databases, 201–204
- managing by using Windows PowerShell, 289–297
- publishing packages, 285
- refreshed list of published applications and, 175
- round-trip response time, 195–196
- service disruption impact, 194
- Windows PowerShell support, 294, 296

**management servers (Operations Manager), 574**

**mandatory user profiles, 52–53**

**manifest file, 310, 358, 382**

**Manifest.xml file, 214**

**manual deployment, 225**

**MBAM (Microsoft BitLocker Administration and Monitoring), 2**

**MDOP (Microsoft Desktop Optimization Pack), 2, 24, 88, 157**

**MDT (Microsoft Deployment Toolkit), 79, 495, 533**

**MED-V (Microsoft Enterprise Desktop Virtualization), 2**

**media access control (MAC) addresses, 111**

**memory management**
- capacity planning, 513–514, 517–518
- CSV cache, 508–509
- operating system differences, 491
- optimizing, 588
- user mode, 98
- virtual machines, 101, 137–138, 156

**Memory\Available MBytes counter, 588**

**Memory\Pages/sec counter, 586, 588**

**Merge-VHD cmdlet, 150**

**metered networks, 65–66**

**Microsoft accounts, 71, 75–76**

**Microsoft Advanced Group Policy Management (AGPM), 2**

**Microsoft Application Virtualization. See App-V (Application Virtualization)**

**Microsoft Application Virtualization (App-V) Server 5.0 Setup Wizard, 177–178**

**Microsoft Azure Multi-Factor Authentication, 557, 561–564**

**Microsoft BitLocker Administration and Monitoring (MBAM), 2**

**Microsoft Clearinghouse, 434–435, 438**

**Microsoft Deployment Toolkit (MDT), 79, 495, 533**

**Microsoft Desktop Optimization Pack (MDOP), 2, 24, 88, 157**

**Microsoft Diagnostics and Recovery Toolset (DaRT), 2**

**Microsoft Download Center, 317**

**Microsoft Enterprise Desktop Virtualization (MED-V), 2**

**Microsoft Exchange Server, 42–44, 579**
Microsoft Forefront Threat Management Gateway (TMG), 547
Microsoft Hyper-V. See Client Hyper-V; Hyper-V
Microsoft Intune, 79, 227
Microsoft Management Console (MMC), 475
Microsoft .NET Framework, 71, 229, 377
Microsoft Office 365, 16, 42–43, 351
Microsoft Office 2013, 85, 351–357, 493
Microsoft Outlook, user state virtualization and, 42–44
Microsoft SharePoint Server, 324
Microsoft Software Assurance (SA), 23
Microsoft SQL Server
  App-V compatibility and, 324
  configuring permissions, 444
  databases supported, 281, 443
  high availability for server roles, 486
  monitoring, 579
  scripting support, 202–204
Microsoft User Experience Virtualization. See UE-V (User Experience Virtualization)
MMC (Microsoft Management Console), 475
mirrored spaces, 12
MMC (Microsoft Management Console), 475
mobile devices
  compatibility considerations, 40
  identifying business needs, 26–27
  metered networks and, 65
  RD client, 542
  RDS support, 388
  remote access from, 555–557
  Remote Desktop support, 392, 399
  VPNs and, 8, 16–17
monitoring performance
  App-V considerations, 195–197
  application virtualization, 565–572
  desktop virtualization, 565–572, 585–590
  high availability and, 21
  network connectivity and, 19
  Operations Manager support, 572–585
  resource bottlenecks, 585–586
  roaming user profiles and, 46
  SPEC CPU2006 Results, 516
  storage virtualization and, 12
  virtual machine optimization, 156
  virtual machine storage speed, 101
  virtualization implementation and, 25
Mount-AppvClientConnectionGroup cmdlet, 296
Mount-AppvClientPackage cmdlet, 296
Move Wizard, 131–132, 153
Mozilla Firefox Setup Wizard, 340
msDS-PrimaryComputer attribute, 413
.MSI files
  creating package accelerators, 358
  described, 186, 325
  extracting from executables, 229
GPO deployment, 225
saving packages as, 320
sequenced applications, 321
stand-alone deployment model, 185–186, 192–193, 251
UE-V agent and, 79–80
multi-factor authentication, 557, 561–564
Multi-Factor Authentication Server, 563
Music folder, 35, 54

N
Name registry key, 274
naming conventions, 309
NAS (network attached storage), 36, 224
native installation path, 331–332
Nested Page Tables, 398
.NET Framework, 71, 229, 377
network attached storage (NAS), 36, 224
network bridges, 110–111
Network Connections window, 110
network interface card (NIC), 515
Network Interface\Bytes Total/sec counter, 586
Network Level Authentication, 431
Network Load Balancing (NLB), 439–440, 447
Network Policy Server (NPS), 550, 557, 560–561
network shares
  offline folders, 62–63
  redirecting folders in, 55
  roaming user profiles, 47–48
  user profiles disks, 523
networks and networking
  capacity planning, 514–515
  connectivity in virtualized environments, 18–20
  failover clusters and, 489
  network latency and, 18–19, 66
  Process Monitor support, 571–572
  RD Gateway configuration scenarios, 543–548
New-AppvPackageAccelerator cmdlet, 296, 366–367
New-AppvSequencerPackage cmdlet, 296, 351, 377
New-AppvServerConnectionGroup cmdlet, 291, 295
New-RDSessionDeployment cmdlet, 419
New-SessionDeployment cmdlet, 419
New-VHD cmdlet, 106, 148
New Virtual Hard Disk Wizard
  Choose Disk Format page, 142, 147
  Choose Disk Type page, 144, 147
  Configure Disk page, 145–148
  Specify Name And Location page, 147
New Virtual Machine Wizard
  Assign Memory page, 116–117
  Configure Networking page, 117–118
  Connect Virtual Hard Disk page, 118–119
  Installation Options page, 119–120
  Specify Generation page, 115–116
  Specify Name And Location page, 114–115
New-VirtualDisk cmdlet, 510
New-VM cmdlet, 120–121
New-VMSwitch cmdlet, 112
NIC (network interface card), 515
NIC Teaming feature, 515
NLB (Network Load Balancing), 439–440, 447
Not Available state, 193–194
notifications
App-V client, 195
IOPS value, 150
Operations Manager, 573
RD Session Host server, 590
RemoteApp, 454
Shell Hardware Detection, 498
UE-V, 82, 86
NPS (Network Policy Server), 550, 557, 560–561
NTFS permissions
roaming user profiles, 47–48
UE-V, 77–78
NTUSER.DAT file, 34, 46
NTUSER.MAN file, 52–53
O
Object Linking and Embedding Database (OLE DB), 380
occasionally roaming user scenario, 42–43
off state (VMs), 126
Office 365, 16, 42–43, 351
Office 2013, 85, 351–357, 493
Office Deployment Tool for Click-to-Run, 351–356
Offline Files dialog box, 64
Offline Files feature
configuring, 59–66
operating modes, 60–62
synchronization problems, 61–62
user state virtualization and, 36, 39, 41–43
offsite replication, 505
OLE DB (Object Linking and Embedding Database), 380
OOBE (out-of-box experience), 326, 502
Open Existing Package Wizard
Completion page, 302
Create Package page, 173–174, 302
Installation page, 170–171, 300–301
Installation Report page, 171–172, 301
Prepare Computer page, 168–169, 299
Prepare For Streaming page, 172–173, 301–302
Select Installer page, 169–170, 299–300
Select Package page, 167–168, 299
Select Task page, 166–167, 298
Open Packaging Conventions standard, 186
open software description (OSD) files, 219–220
operating system image, 228
Operational event log, 256, 568
Operations console (Operations Manager)
Administration Overview page, 576–577
described, 575–576
Monitoring Overview page, 583–584
Operations Manager (System Center)
described, 25, 565, 572–573
implementation components, 573–576
installing, 576–579
management packs, 579–585
Optimize-VHD cmdlet, 150
ordering packages in connection groups, 292
OSD (open software description) files, 219–220
OSQL command-line application, 204
out-of-box experience (OOBE), 326, 502
Outlook, user state virtualization and, 42–44
P
package accelerators
creating, 358–367
creating packages from, 367–376
described, 357–358
package editor
Advanced tab, 349–350
Change History tab, 347
Deployment tab, 346
described, 345
Package Files tab, 348
Properties tab, 346
Shortcuts and FTAs tab, 350
Virtual Registry tab, 347–348
Virtual Services tab, 348–349
package function (ODT), 354
package ID (applications), 216, 310
PackageHistory.xml file, 186, 325
PackageInstallationRoot registry key, 274
packages (App-V)
adding applications, 303, 379–380
adding by using Windows PowerShell, 289–290
adding to App-V Management Console, 303–304
adding to connection groups, 291–292
adding to management servers, 284
assigning, 308–309
best practices for configuring, 331–332
contents of, 186–187
creating, 284, 355–356
creating from package accelerators, 367–376
customizing, 344–345
data collection about, 314
described, 186
dynamic configuration, 310–312
editing, 379
editing default configuration, 286
editing existing, 302–303
exporting configuration, 287, 307–308
granting access, 284–286
importing, 178, 303–304
isolating, 287
managing, 284–287, 294–296
moving to repositories, 284
naming conventions, 309  
ordering in connection groups, 292  
publishing, 285  
publishing by using Windows PowerShell, 289–290  
removing, 251–252  
shared content store and, 220–224  
supported states, 193  
unpublishing, 285  
updating applications in, 298–302, 378–379  
version considerations, 308–309 
parent partitions, 98–99  
parity spaces, 12  
Partially Loaded state, 193  
partitions  
creating during manual install, 496  
eliminating system partition, 495–496  
modifying, 496–497  
pass-through disks, 143  
PasswordChangeEnabled setting, 466  
pause state (VMs), 126, 152  
Performance Monitor, 570–571, 586  
performance monitoring  
App-V considerations, 195–197  
application virtualization, 565–572  
desktop virtualization, 565–572, 585–590  
high availability and, 21  
network connectivity and, 19  
Operations Manager support, 572–585  
resource bottlenecks, 585–586  
roaming user profiles and, 46  
SPEC CPU2006 Results, 516  
storage virtualization and, 12  
virtual machine optimization, 156  
virtual machine storage speed, 101  
virtualization implementation and, 25  
Permissions.sql file, 202–203  
personal virtual desktops  
capacity planning, 511–518  
comparing options, 484–485  
creating virtual desktop collections, 524–533  
deploying RD Virtualization Host servers, 519–523  
described, 10–11, 481–484  
high availability, 486–489  
Implementing RemoteApp for Hyper-V, 535–539  
optimizing antivirus software, 500–501  
optimizing operating system configuration, 497–503  
planning and creating templates, 489–497  
planning storage, 503–511  
updating, 494–495  
user profile disks, 523–524  
virtual desktop collections, 525–526  
.PFX files, 475  
Physical Disk\Current Disk Queue Length counter, 586  
Pictures folder, 35, 54  
Ping command, 19  
PKI (Public Key Infrastructure), 550–552  
plug-ins, 322–323, 334, 380–381  
PnP device redirection, 469  
POC (proof-of-concept) deployment, 414  
pooled virtual desktops  
App-V optimizations, 500  
capacity planning, 511–518  
comparing options, 484–485  
creating virtual desktop collections, 524–533  
deploying RD Virtualization Host servers, 519–523  
described, 10–11, 481–483  
high availability, 485–486  
implementing RemoteApp for Hyper-V, 535–539  
optimizing antivirus software, 500–501  
optimizing operating system configuration, 497–503  
planning and creating templates, 489–497  
planning storage, 503–511  
supporting management tasks, 14  
upgrading, 494, 533–535  
user profile disks, 523–524  
user state, 25  
virtual desktop collections, 525–533  
port configurations, RD Gateway servers, 548–553  
PowerShell (Windows). See also specific cmdlets  
adding and publishing packages, 289–290  
AppVClient module, 268–269, 294–296  
AppVSequencer module, 294, 296, 351  
AppVServer module, 294–295  
bulk changes and, 68  
Client Hyper-V settings, 103  
configuring App-V client, 267–269  
configuring UE-V settings, 77–78  
creating and managing connection groups, 290–294  
creating package accelerators, 366–367  
creating packages from package accelerators, 377  
deploying RDS, 419  
deploying UE-V agent, 81  
elevated prompts, 297  
ESD model and, 191  
Hyper-V module, 105  
Integrated Scripting Environment, 106–107  
managing connections, 471  
managing management servers, 289–297  
managing UE-V agent, 83–84  
RemoteApp programs, 461  
removing applications, 305–306  
UE-V requirements, 71  
pre-publishing applications, 254  
Primary Computer feature, 66–68, 413  
Primary Feature Block, 321  
printer redirection, 469–470  
private key, 553  
private networks, 111
PrivateModeSessionTimeoutInMinutes setting, 466
process ID, 306
Process Monitor, 571–572
processing
application requests, 213–214
capacity planning, 515–518
identifying startup processes, 590
killing processes, 306
Processor Information\%Processor Time counter, 586
Process\Working Set counter, 588
ProfileImagePath registry key, 34
ProfileList registry key, 34
proof-of-concept (POC) deployment, 414
Properties dialog box
certificates, 476
Documents folder, 54–55, 58
Folder Redirection settings, 56–57
RD Gateway server, 548–557
RDS deployment, 477
RemoteApp programs, 458–461
session collections, 426–433, 442, 468–469
shared content store, 223–224
shared folders, 62
user accounts, 48–49
virtual hard disks, 146
ProPlusVolume_en-us_x86.appv file, 355
Public Key Infrastructure (PKI), 550–552
PublicModeSessionTimeoutInMinutes setting, 466
Publish-AppvClientPackage cmdlet
described, 296
-Global setting, 269, 357
-Name setting, 163, 251, 269
Publish-AppvServerConnectionGroup cmdlet, 293, 295
Publish-AppvServerPackage cmdlet, 164, 290, 295
Publish RemoteApp Programs Wizard
Select RemoteApp Programs page, 457–458, 537–538
Select Virtual Desktop page, 536–537
published applications
assignment of, 308–309
automatically loading, 273
copy access and configuration, 303–304
editing default configuration for packages, 306–307
enabling scripting for dynamic configuration, 310–312
exporting configuration, 307–308
global settings, 325
naming conventions, 309
removing, 305–306
updating, 297–303
updating connection groups, 304–305
viewing, 175–176, 178–179
Published state, 193
Publishing Feature Block, 321
Publishing node (App-V policies), 272
publishing servers (App-V)
App-V client and, 215, 295–296
capacity planning, 196–197
deploying and configuring, 208–210
described, 179–183
disaster recovery and, 199–200
displaying associated, 296
IIS support, 176, 179, 278
infrastructure requirements, 188–189
monitoring performance, 566
optimizing, 500
refreshed list of published applications and, 175–176
registering and unregistering, 282–284
round-trip response time, 195–196
service disruption impact, 193–194
PUBLISHING_MGT_SERVER_REFRESH_INTERVAL registry setting, 176, 208
PublishingService registry key, 176
PXE boot, 124
Q
QoS (Quality of Service), 20, 150–151
Quality of Service (QoS), 20, 150–151
R
RADC (RemoteApp and Desktop Connections), 462–465, 479
RAID (Redundant Array of Independent Disks), 12, 504–505
RD CAPs (Remote Desktop connection authorization policies), 391, 557–558, 560–561
RD Client, 542
RD Connection Broker - Enable Single Sign On certificate, 474
RD Connection Broker - Publishing certificate, 473–474
RD Connection Broker role service
described, 390, 482
event log, 568
high availability, 443–446, 486
load balancing, 20
monitoring performance, 566, 583
planning, 408–410
pooled virtual desktops, 483
RDS considerations, 393, 522
scalability, 409
session collection, 394–395
RD Gateway Manager
described, 548
logging, 554–555
remote access from mobile devices, 555–556
simultaneous connections, 554
SSL bridging, 553
TCP and UDP ports, 548–553
RD Gateway role service
certificate support, 475, 550–553
controlling access, 388, 482, 557–564
deployment settings, 521–522
described, 391, 542–543
Real-Time Streaming Protocol (RTSP), 180
rebooting, 331
recipes, items to document in, 322–324
Recreate All Virtual Desktops Wizard, 534–535
redirected folders. See Folder Redirection feature
redundancy, data, 504–505
Redundant Array of Independent Disks (RAID), 12, 504–505
Register-UEVT emplate cmdlet, 83, 93
Registered state, 193
registering publishing servers, 282–283
Registry Editor, 274–275
registry keys
  App-V client, 214, 218, 273–275
  App-V publishing server, 176
  disabling Fair Share, 589
  Process Monitor support, 571–572
  UE-V settings, 92–93
  user profile settings, 34–35
  virtualized applications, 159
Registry.dat file, 187, 275, 284, 325
Relative Weight processor setting, 136
Remote Desktop Gateway role service
certificate support, 475, 550–553
controlling access, 388, 482, 557–564
deployment settings, 521–522
described, 391, 542–543
monitoring performance, 566, 582
network configuration, 543–548
troubleshooting, 556–557
Remote Desktop Licensing Manager, 434–435, 437
Remote Desktop Licensing role service
configuring servers, 434–438
deployment settings, 522
described, 391
event logs, 568
high availability, 447–449
monitoring performance, 566, 582
Remote-Desktop-Management-Service event log, 568
Remote Desktop Protocol (RDP), 387, 453, 588
Remote Desktop resource authorization policies (RD RAPs), 557, 559–560
Remote Desktop Services (RDS)
App-V and, 204, 210, 253
App-V client and, 227, 247–250, 253
architectural overview, 390–392
assessing infrastructure requirements, 403–406
certificate support, 473–478
configuring and managing client connections, 461–472
configuring certificates and single sign-on, 472–479
deploying, 404–405, 519–523
described, 391–389
determining needs, 403–404
determining resource requirements, 405
determining user requirements, 405–406
event logs, 568
functionality enhancing client experience, 395–397
high availability, 438–449
licensing, 401–403
monitoring performance, 566
package configuration best practices, 332
RDC configuration options, 399–401
Remote Desktop comparison, 389
Remote Desktop Session Host role service
App-V client and, 183
App-V for RDS client and, 210
application compatibility, 485
application update support, 14
capacity planning, 21
described, 7–9, 387, 390
Fair Share feature, 397
high availability for, 21, 441–443
installing, 421–422
installing applications, 454–457
licensing considerations, 22, 402, 448, 455
Remote Desktop Gateway Manager
described, 548
logging, 554–555
remote access from mobile devices, 555–556
simultaneous connections, 554
SSL bridging, 553
TCP and UDP ports, 548–553
Remote Desktop Gateway role service
certificate support, 475, 550–553
controlling access, 388, 482, 557–564
deployment settings, 521–522
described, 391, 542–543
monitoring performance, 566, 582
network configuration, 543–548
troubleshooting, 556–557
Remote Desktop Licensing Manager, 434–435, 437
Remote Desktop Licensing role service
configuring servers, 434–438
deployment settings, 522
described, 391
event logs, 568
high availability, 447–449
monitoring performance, 566, 582
Remote-Desktop-Management-Service event log, 568
Remote Desktop Protocol (RDP), 387, 453, 588
Remote Desktop resource authorization policies (RD RAPs), 557, 559–560
Remote Desktop Services (RDS)
App-V and, 204, 210, 253
App-V client and, 227, 247–250, 253
architectural overview, 390–392
assessing infrastructure requirements, 403–406
certificate support, 473–478
configuring and managing client connections, 461–472
configuring certificates and single sign-on, 472–479
deploying, 404–405, 519–523
described, 391–389
determining needs, 403–404
determining resource requirements, 405
determining user requirements, 405–406
event logs, 568
functionality enhancing client experience, 395–397
high availability, 438–449
licensing, 401–403
monitoring performance, 566
package configuration best practices, 332
RDC configuration options, 399–401
Remote Desktop comparison, 389
Remote Desktop Session Host role service
App-V client and, 183
App-V for RDS client and, 210
application compatibility, 485
application update support, 14
capacity planning, 21
described, 7–9, 387, 390
Fair Share feature, 397
high availability for, 21, 441–443
installing, 421–422
installing applications, 454–457
licensing considerations, 22, 402, 448, 455
Remote Desktop Gateway Manager
described, 548
logging, 554–555
remote access from mobile devices, 555–556
simultaneous connections, 554
SSL bridging, 553
TCP and UDP ports, 548–553
Remote Desktop Virtualization Host service
- automating VM creation, 9
- capacity planning, 511, 513–518
- configuring storage, 503–504
- deploying servers, 519–523
- described, 482
- event log, 568
- failover clustering, 488
- high availability, 486
- monitoring performance, 566, 583
- network connectivity and, 18
- optimizing operating system configuration, 497
- video adapter support, 398
- virtual desktop templates, 525

Remote Desktop Web Access role service
- certificate support, 474
- customizing, 466–467
- deployment settings, 522
- described, 390–391, 482
- high availability, 447, 486
- monitoring performance, 583
- planning, 410–411
- RD Gateway server and, 543
- user connectivity support, 393–395
- web feed, 463

RemoteApp
- application compatibility, 6, 15
- configuring programs, 458–461
- configuring RADC, 462–465
- described, 5–6, 451–453, 490
- device redirection, 467–469
- managing connections, 470–472
- mobile devices, 556
- printer redirection, 469–470
- publishing programs, 457–458
- RD Session Host servers, 388, 451, 454–457
- RD Web Access customization, 466–467
- RDS connecting to, 392–396
- UE-V Generator and, 88
- understanding programs, 453–454

RemoteApp and Desktop Connection Management event log, 568
RemoteApp and Desktop Connections event log, 568
RemoteApp and Desktop Connections (RADC), 462–465, 479
RemoteApp for Hyper-V, 535–539
RemoteDesktopServices-RdpCoreTS event log, 568
RemoteDesktopServices-SessionServices event log, 568
RemoteFX features, 100, 397–398, 490–491, 583
Remove-AppvClientConnectionGroup cmdlet, 296–297
Remove-AppvClientPackage cmdlet, 251–252, 296–297, 305
Remove-AppvPublishingServer cmdlet, 296–297
Remove-AppvServerConnectionGroup cmdlet, 295
Remove-AppvServerPackage cmdlet, 295
Remove-VMSwitch cmdlet, 112
Rename-VMSwitch cmdlet, 112
renaming checkpoints, 154
Repair-AppvClientConnectionGroup cmdlet, 296
Repair-AppvClientPackage cmdlet, 296
Report Manager, 317–318
Reporting node (App-V policies), 272
reporting server database (App-V), 183–184
reporting servers (App-V)
- App-V client configuration, 315–317
- data collection, 314
- described, 183–184
- disaster recovery and, 199–200
- generating reports, 317–318
- IIS support, 278
- infrastructure requirements, 188
- reporting process overview, 312–313
- service disruption impact, 194

reporting servers (Operations Manager), 575
Report.xml file, 186, 324
Resize-VHD cmdlet, 150
resource bottlenecks, 585–586
Resource Monitor, 570
Restore-UevUserSetting cmdlet, 75, 83
reverse proxy servers, 547–548
Roaming folder (AppData), 35, 53
roaming user profiles
- configuring, 44–52
- configuring user object, 48–49
- described, 3
- folder names, 48
- managing by using Group Policy, 50–52
- managing user data requirements, 39
- mandatory, 52–53
- performance issues, 46
- preparing network shares, 47–48
- preserving user state, 411–412
- RemoteApp support, 453
- user profile disks and, 523–524
- user state virtualization and, 42–44, 75–76
- RODCs (read-only domain controllers), 546
Root (folder), 187, 284, 325, 380
dround-trip response time, 195–196
RTSP (Real-Time Streaming Protocol), 180
Run As profile, 580
running state (VMs), 126

SA (Software Assurance), 23
SAN (subject alternative names) certificates, 473
SANs (storage area networks)
capacity planning, 515
Client Hyper-V, 100
described, 505–506
failover clustering, 488
shared content store, 224
SAS (shared serial attached SCSI), 488
Saved Games folder, 54
saved state (VMs), 126
scale-out file servers, 488, 506–508, 515
scripting
enabling for dynamic configuration, 310–312
optimizing Windows 8.1, 499
SQL Server scripts, 202–204
targeted, 381–385
Scripting node (App-V policies), 272
Searches folder, 54
Second Level Address Translation (SLAT), 101–102, 398
Secondary Feature Block, 321
Secure Boot, 125
Secure Sockets Layer (SSL)
certificate support, 205, 278–280, 377, 550–553
RD Gateway network configuration, 547, 550–554
session collections and, 430
security considerations
HTTPS, 279
identifying business needs, 28–29
RDS, 388
signing .CAB files, 376–377
SSL inspection, 547
usage scenarios, 13
wildcards and FQDN, 479
security groups
App-V infrastructure requirements, 187–188
assigning packages, 308–309
creating, 444
NTFS permissions, 77
RD CAPs, 557
RD RAPs, 559
removing users from, 175
roaming user profiles and, 51
security identifier (SID), 203, 523
Select Existing Certificate dialog box, 478
Select Previous Version dialog box, 308
Send-AppvClientReport cmdlet, 296–297
Send Message option (connections), 471
Send-RDUserMessage cmdlet, 471
Sequencer (App-V)
Add New Application option, 303
application sequencing, 161–162
application update, 165–174, 297–303
Completion page, 302, 375–376
Configure Software page, 320, 341–342, 373–374
configuring, 326–330
connection groups and, 380–381
Create Package Accelerator page, 361–363, 365–366
creating packages, 284, 310
Customize page, 344
deployment models and, 192
described, 161, 179–183
editing packages, 302–303, 306–307
ESD model and, 191
Guidance page, 369–370
Installation Files page, 360–361
Installation page, 170–171, 300–301, 341, 379
Installation Report page, 171–172, 301, 343, 379
installing, 336
Local Installation page, 370–371
Modify An Existing Virtual Application Package option, 166
Package Name page, 338–339, 371–372
Packaging Method page, 337, 367–368
Prepare Computer page, 168–169, 299, 337, 378
Prepare For Streaming page, 172–173, 301–302
Run Each Program page, 374–375
Select Guidance page, 364–365
Select Package Accelerator page, 368–369
Select Package page, 167–168, 299, 359–360
Select Task page, 166–167, 298
sequencing process overview, 321–322
Streaming page, 379
Target OS page, 344–345
Update Application in Existing Package option, 166–167, 298–299
updating packages, 378–381
Verify Applications page, 363–364
virtual machines as, 328–329
Windows PowerShell support, 294–295, 351
sequencing applications. See also App-V Sequencer
application types supporting, 333–334
applications incompatible with, 332–333
best practices, 330–332
for connection groups, 380–381
customizing packages, 344–345
deploying Office 2013 by using App-V, 351–357
described, 161–162
dynamic configuration and targeted scripting, 381–385
items to document in recipes, 322–324
package accelerators, 357–377
package editor, 345–350
planning, 326–333
portions of sequenced applications, 324–325
preparing for, 335–336
sequencing tasks, 337–343
updating packages, 378–385
Windows PowerShell support, 351
Sequencing Wizard, 332
Server Authentication, 552
server-based certificates, 280, 473
Server Configuration window, 436–437
server connections (App-V client)
  Autoload mechanism, 273
  configuring by using Windows PowerShell, 267–269
described, 266–267
managing by using Group Policy, 270–273
registry settings, 273–275
Server Manager
  BPA support, 415
  client access licenses, 437–438, 475
described, 391–392
monitoring performance, 565–566
pooled virtual desktops, 526, 534
publishing RemoteApp programs, 457
RD Connection Broker role service, 445
RD Connection Broker servers, 442–443
RD Gateway servers, 548
RD Licensing servers, 434–436, 449
RD Session Host servers, 443
RD Virtualization Host servers, 519
RD Web Access server, 447, 467
RDS deployment, 415–416, 419, 473, 475, 519, 523
RemoteApp for Hyper-V, 536
session collection management, 423, 426
viewing collections, 470
Server Message Block (SMB), 488, 507
service resource (SRV) record, 493
session-based VDI, 12, 252, 587
session-based virtual desktops
  benefits of, 9
  comparing options, 484–485
deploying, 404, 415–422
described, 7–8, 387
high availability for RDS, 438–449
planning infrastructure, 403–415
preserving user state, 411–415
RD Connection Broker role service, 408–410
RD Licensing servers, 434–438
RD Session Host role service, 406–408
RD Web Access role service, 410–411
RDS considerations, 387–403
selecting, 11
session collections, 422–434
supporting management tasks, 14–15
user profile disks, 70
user state, 25
session collections
  configuring, 426–433
  configuring load balancing settings, 442
creating, 393, 423–426
described, 422–423
device redirection, 468–469
printer redirection, 469–470
user profile disks, 413
session ID, 471
Set-ADUser cmdlet, 68
Set-AppvClientConfiguration cmdlet
  -Autoload setting, 273
described, 296–297
  -EnablePackageScripts setting, 312, 356, 384
  -ReportingServerURL setting, 316
  -SharedContentStoreMode setting, 221
Set-AppvClientMode cmdlet, 296–297
Set-AppvClientPackage cmdlet, 296–297
Set-AppvPublishingServer cmdlet, 267, 296–297
Set-AppvServerConnectionGroup cmdlet, 291–292, 295
Set-AppvServerPackage cmdlet, 295
Set-ExecutionPolicy cmdlet, 268
Set-FileStorageTier cmdlet, 509
Set-UevConfiguration cmdlet, 74, 83
Set-VHD cmdlet, 150
Set-VMSwitch cmdlet, 106, 112
settings location templates
  custom, 87–93
described, 72–74
managing default, 84–87
Office 2013, 85
settings packages, 73
settings storage location, 72–73, 77, 80
settings template catalog, 72–73, 77–78, 93
Setup.exe utility, 352–353, 355
Shadow option (connections), 471–472
shared content store, 220–224, 254, 295, 500
shared SAS bus, 507
shared serial attached SCSI (SAS), 488
SharedContentStoreMode registry key, 274
SharePoint Server, 324
Shell Hardware Detection, 498
shortcuts (App-V), 217–220, 286, 350
ShowDesktops setting, 467
SID (security identifier), 203, 523
signtool.exe utility, 377
SIM (subscriber identity module) card, 65
single-root I/O virtualization (SR-IOV), 100
single sign-on (SSO), 397, 474, 478–479
SLAT (Second Level Address Translation), 101–102, 398
sleep mode, 99
SMB (Server Message Block), 488, 507
snapshots (checkpoints)
applying, 154
creating, 152–153, 328–329, 336
deleting, 154–155
described, 151–152, 328
exporting, 154
pooled virtual desktops, 533
renaming, 154
reverting to previous state, 154
SAN support, 505
troubleshooting, 329
usage considerations, 153–156
Software Assurance (SA), 23
Software Client extension point, 219
solid-state drives (SSDs)
  Data Deduplication feature, 510
  mobile devices, 101
  performance considerations, 147, 156, 513, 518
  storage tiers, 508–509, 513
  write-back cache, 509
SPEC CPU2006 Results, 516
SQL Server
  App-V compatibility and, 324
  configuring permissions, 444
  databases supported, 281, 443
  high availability for server roles, 486
  monitoring, 579
  scripting support, 202–204
SQL Server Management Studio, 444
SQL Server Reporting Services, 313, 317–318
SR-IOV (single-root I/O virtualization), 100
SRV (service resource) record, 493
SSDs (solid-state drives)
  Data Deduplication feature, 510
  mobile devices, 101
  performance considerations, 147, 156, 513, 518
  storage tiers, 508–509, 513
  write-back cache, 509
SSL Bridging, 553
SSL inspection, 547
SSL (Secure Sockets Layer)
  certificate support, 205, 278–280, 377, 550–553
  RD Gateway network configuration, 547, 550–554
  session collections and, 430
SSO (single sign-on), 397, 474, 478–479
stand-alone deployment model
  App-V client, 221, 250–252, 312
  deployment possibilities, 192–193
  described, 163–164, 185
  high availability and, 197
standard applications, 159–160, 334
Start-AppvVirtualProcess cmdlet, 295
Start Install Licenses Wizard, 436
Start Menu folder, 53
starting state (VMs), 126
startup processes, identifying, 590
startup sequence, 332–333
static memory, 137
Stokes, Jeff, 499
Stop-AppvClientConnectionGroup cmdlet, 296
Stop-AppvClientPackage cmdlet, 296
storage area networks (SANs)
  capacity planning, 515
  Client Hyper-V, 100
  described, 505–506
  failover clustering, 488
  shared content store, 224
storage planning and performance
  antivirus software and, 500–501
  capacity planning, 512–513, 517–518
  described, 503
  local storage, 503–505
  networking, 489
  optimizing operating system configuration, 499
  personal virtual desktops, 503–511
  pooled virtual desktops, 503–511
  SAN considerations, 100, 224, 488, 505–506
  scale-out file servers, 488–489, 506–508
  storage virtualization, 2, 11–12
  Windows Server, 508–511
storage Quality of Service, 150–151
Storage Spaces
  described, 2, 11–12, 510
  redundancy options, 505, 507
  storage tiers, 508, 513
storage tiers, 508–509, 513
storage virtualization, 2, 11–12
StoreMode registry key, 221
Streaming node (App-V policies), 272
streaming packages, 332
streaming server, 179
StreamMap.xml file, 186, 325
subject alternative names (SAN) certificates, 473
subscriber identity module (SIM) card, 65
Sync-AppvPublishingServer cmdlet, 164, 215, 296
Sync Controller Application task, 74
synchronization
  metered networks and, 65
  Offline Files problems, 61–62
  reducing frequency, 590
  UE-V and, 70–75, 84–87
Sysprep tool, 134, 490, 501–503, 525
System account, NTFS permissions, 47–48
System Center Configuration Manager
  App-V and, 165, 185, 189–191, 198–199, 211
  App-V client and, 226, 228, 230–246, 312
  installing App-V client using, 230–246
  personal virtual desktops, 494
  pooled virtual desktops, 494
  UE-V agent and, 79, 81
usage considerations, 228
System Center Operations Manager
- described, 25, 565, 572–573
- implementation components, 573–576
- installing, 576–579
- management packs, 579–585
System Configuration, 590
System event log, 568
System Preparation Tool 3.14 window, 502
System Restore, 499
systeminfo utility, 102

described, 25, 565, 572–573
implementation components, 573–576
installing, 576–579
management packs, 579–585
System Configuration, 590
System event log, 568
System Preparation Tool 3.14 window, 502
System Restore, 499
systeminfo utility, 102

Target Folder Location setting, 56
targeted scripting, 381–385
Task Manager, 568, 590
taskkill -PID command, 306
TCP ports, RD Gateway servers, 548–553
TechNet website
- App-V deployment methods, 165
- BranchCache, 63
- CopyProfile, 33
- coreinfo tool, 102
described, 376
- GVLKs, 492
- high availability with Configuration Manager, 199
- Hyper-V, 125, 135
- KMS, 493
- MDOP, 2
- MDT, 496
- optimization script, 499
- Process Monitor, 572
- RDS cmdlets, 419
- sequencing applications by using PowerShell, 351
- shadowing connections, 472
- Storage Spaces, 505
- UE-V agent, 80
- Windows SIM, 496
Template Auto Update task, 93
temporary files, 330
Terminal Services, 9, 204, 387–388, 443
TerminalServices-SessionBroker event log, 568
TerminalServices-TSV-VmHostAgent event log, 568
test environments, 7, 151
Test-VHD cmdlet, 150
third-party production integration, 252–253
Threat Management Gateway (TMG), 547
timeout settings, 558
TMG (Threat Management Gateway), 547
ToolsSetup.exe utility, 88
TPM (Trusted Platform Module), 495
troubleshooting
- App-V client installation, 255–259
- checkpoints, 329
- connection groups, 288
- creating certificates, 476
deleting user profiles, 33–34
enabling debug logs and, 259
examining virtual registry, 275
inherited environments and, 384
naming conventions and, 309
Offline Files synchronization problems, 61–62
performance issues, 571
RD Gateway servers, 556–557
removing applications, 306

Trusted Platform Module (TPM), 495

UAC (User Account Control), 326
UCC (unified communications certificate), 473
UDP ports, RD Gateway servers, 548–553
UE-V 2.0 template gallery, 88
UE-V agent
- deploying, 78–81
- managing, 81–84
- preparing to deploy, 77–78
UE-V Generator, 73–74, 87–93
UE-V (User Experience Virtualization)
- architectural overview, 72–75
- deploying UE-V agent, 78–81
described, 4, 31, 70–72
- licensing requirements, 24
- managing UE-V agent, 81–84
- MDOP and, 2
- operating system requirements, 71
- preparing to deploy UE-V agent, 77–78
UEFI firmware, 125
UNC (universal naming convention), 48, 507–508
unified communications certificate (UCC), 473
universal naming convention (UNC), 48, 507–508
UNIX-based operating systems, 574, 577
Unpublish-AppvClientPackage cmdlet, 251, 296, 305
Unpublish-AppvServerConnectionGroup cmdlet, 295
Unpublish-AppvServerPackage cmdlet, 295
unpublishing packages, 285
unregistering publishing servers, 282–283
Update-AppvSequencerPackage cmdlet, 296
Update-AppvServerConnectionGroup cmdlet, 295
updating applications
- App-V application life cycle, 165–175, 297–303
- App-V benefits, 158
- application sequencing and, 323
- best practices, 330
- identifying business needs, 28
- updating connection groups, 304–305
- updating integration services, 140–141
- updating personal virtual desktops, 494–495
- updating pooled virtual desktops, 494, 533–535
URL registry key, 275
usage scenarios
- application virtualization, 12–17
legal and security requirements, 13
management tasks, 14–15
user state virtualization, 41–44
virtualization technologies, 12–17
User Account Control (UAC), 326
user-based CALs, 22–24
user catalog, 217–218
user certificates, 553
user configuration files
   App-V client and, 217
   control settings, 311, 383
   customizing, 295
   dynamic deployment, 310–311, 382
   file name, 165
   importing, 308
   Windows PowerShell support, 295
user data
   assessing requirements, 38–39
   backing up, 36
   caching updates to, 37
   configuring Folder Redirection, 53
   configuring Offline Files, 59
   described, 3
   folders storing, 35
   UE-V synchronization and, 71
User Experience Virtualization (UE-V)
   architectural overview, 72–75
   deploying UE-V agent, 78–81
   described, 4, 31, 70–72
   licensing requirements, 24
   managing UE-V agent, 81–84
   MDOP and, 2
   operating system requirements, 71
   preparing to deploy UE-V agent, 77–78
user mode, 98, 160
user profile disks, 70, 413–414, 491, 523–524
user profiles
   creating, 32–34
   deleting, 33–34
   described, 32
   managing by using Group Policy, 50–52
   mandatory, 52–53
   modifying default, 33
   roaming. See roaming user profiles
   user data requirements assessment, 38–39
   user settings requirements assessment, 39
user settings
   assessing requirements, 39
   backing up, 36
   caching updates to, 37
   described, 39
   Folder Redirection and, 39
   migrating, 36
   personal virtual desktops and, 527
   roaming user profiles and, 39, 43, 253
   session-based virtual desktops and, 433
   UE-V and, 39, 71, 75, 82–83
user state
   described, 3, 31
   determining user requirements, 406
   managing, 35–36
   preserving, 411–415
user state virtualization
   assessing user data requirements, 38–39
   assessing user settings requirements, 39
   benefits of, 35–38
   challenges implementing, 25, 36–37
   comparing options, 75–76
   configuring technologies, 44–70
   Credential Roaming, 4, 68–69
   described, 1–3
   evaluating compatibility considerations, 40
   evaluating infrastructure and manageability requirements, 40–41
   evaluating usage scenario considerations, 41–44
   Folder Redirection. See Folder Redirection feature
   Offline Files. See Offline Files feature
   UE-V. See UE-V
   user profiles. See user profiles
_UserConfig.xml file
   App-V client, 214
   App-V packages, 186
   application sequencing, 325, 355
   Configuration Manager model, 165
   dynamic configuration, 310, 382–383
UVHD-Template.vhdx file, 524
V
VDA (Virtual Desktop Access), 23, 402
VDI (Virtual Desktop Infrastructure)
   App-V client, 252–254
   described, 12
   monitoring application virtualization, 565–572
   monitoring desktop virtualization, 565–572, 585–590
   Operations Manager monitoring support, 572–585
   RD Gateway access control, 557–564
   RD Gateway configuration, 541–557
   remote access, 541–543
   session-based, 12, 252
   user state virtualization and, 37–38
   VM-based, 10–12, 252
vGPU (virtual graphics processing unit), 397–398
VHD format, 141–142, 145, 148–149, 506
VHDs (virtual hard disks)
   compacting files, 149
   converting, 149
   creating, 147–148
   described, 141
   differencing disks, 145–147, 150, 152–153, 155
   dynamical expanding, 143–145
virtual hard disks (VHDs)
  compacting files, 149
  converting, 149
  creating, 147–148
  described, 141
  differencing disks, 145–147, 150, 152–153, 155
  dynamical expanding, 143–145
  editing, 148–150
  expanding, 149
  fixed-size, 143–145
  formats supported, 100, 141–143
  merging, 150
  shrinking, 149
  storage Quality of Service, 150–151
  user profile disks, 523–524

virtual machine bus (VMBus), 99

Virtual Machine Connection
  creating checkpoints, 152, 328–329
  described, 105, 126–130
  updating integration services, 140

Virtual Machine Limit processor setting, 136

time machine networks, 489

Virtual Machine Reserve processor setting, 136

virtual machines (VMs)
  App-V and, 162
  automatic creation, 525
  checkpoint limitations, 155
  Client Hyper-V and. See Client Hyper-V
  configuration information, 113–114
  controlling, 125–130
  copying exported, 134
  copying imported, 135
  creating, 112–121
  creating personal virtual desktops, 484
  described, 1, 96
  dynamic memory, 137–138
  exporting, 132, 134
  generation 1, 121–124, 398
  generation 2, 124–125
  importing, 133–135
  integration services, 138–141
  Live Migration, 487–488
  managing files, 130–135
  managing virtual hard disks, 141–151
  memory considerations, 101, 137–138
  migrating, 100
  modifying settings, 121–124
  moving files, 130–132
  optimizing performance, 156
  processing overview, 135–136
  replicating, 100
  as sequencers, 328–329
  states supported, 126
  storage considerations, 101, 253, 510
  Sysprep tool, 503
testing environments, 111
unique IDs, 133–134
virtual private networks (VPNs), 8, 388, 542
virtual processors, 135–136
virtual registry
App-V client support, 218, 275
App-V support, 160–161, 311
application sequencing, 347–348, 382
displaying keys, 347–348
registry.dat file, 187, 275, 284
troubleshooting, 275
Virtual Switch Manager, 106
virtualization engine, 160–161
Virtualization node (App-V policies), 273
virtualization technologies
dual booting and, 97
identifying for business needs, 25–29
implementation considerations, 17–25
overview of, 1–12
usage scenarios for, 12–17
virtual machines. See virtual machines
VM-based VDI, 10–12, 252
VM-based virtual desktops. See also personal virtual desktops; pooled virtual desktops
deploying, 404, 522
described, 9–12
licensing considerations, 23
storage considerations, 510
user profile disks, 70, 523–524
virtual desktop collections, 393, 524–533
VMBus (virtual machine bus), 99
VMs (virtual machines)
App-V and, 162
automatic creation, 525
checkpoint limitations, 155
Client Hyper-V and. See Client Hyper-V configuration information, 113–114
controlling, 125–130
copying exported, 134
copying imported, 135
creating, 112–121
creating personal virtual desktops, 484
described, 1, 96
dynamic memory, 137–138
exporting, 132, 134
generation 1, 121–124, 398
generation 2, 124–125
importing, 133–135
integration services, 138–141
Live Migration, 487–488
managing files, 130–135
managing virtual hard disks, 141–151
memory considerations, 101, 137–138
migrating, 100
modifying settings, 121–124
moving files, 130–132
optimizing performance, 156
processing overview, 135–136
replicating, 100
as sequencers, 328–329
states supported, 126
storage considerations, 101, 253, 510
Sysprep tool, 503
testing environments, 111
unique IDs, 133–134
Volume Activation Services server role, 492
Volume Activation Tools, 492
Volume Shadow Copy Service (VSS), 498
VPNs (virtual private networks), 8, 16–17, 388, 542
VSS (Volume Shadow Copy Service), 498
W
WDDM (Windows Display Driver Model), 398
Web Server role, 210
Wi-Fi connections, mobile devices and, 65
wildcard certificates, 279, 473
Windows 7 operating system
App-V client, 213, 225, 229–230
App-V Sequencer, 182, 326
application sequencing, 326–327
Credential Roaming, 68
deleting user profiles, 33–34
integration services, 99
KMS support, 493
multi-monitor support, 396
Offline Files, 60–61
pooled and personal virtual desktops, 490–491
RADC feature, 6, 462
RemoteApp for Hyper-V, 539
roaming user profiles, 46
signing tool, 377
UE-V support, 68, 72
user state virtualization options, 75–76
vGPU support, 398
virtualization features, 490–491
VM-based virtual desktops, 404
Windows XP Mode, 97
Windows 8 operating system
Active Directory-based activation, 493
App-V client, 213, 225, 229–230
application sequencing, 162, 182, 326–327
Client Hyper-V, 6, 100, 113, 125, 150
Group Policy settings, 87
modifying startup processes, 590
multi-monitor support, 396
network bridges, 111
Offline Files, 60–61, 64–66
optimizing configuration, 498
optimizing VM deployment, 503
pooled and personal virtual desktops, 490–491
Primary Computer setting, 66
RemoteApp for Hyper-V, 539
resource bottlenecks, 585
SLAT support, 102
Sysprep tool, 503
UE-V and, 71, 83, 88
user state virtualization options, 75–76
vGPU support, 398
VHDX format, 142
virtualization features, 490–491
Windows 8.1 operating system
Active Directory-based activation, 493
App-V client, 162, 213, 225, 229–230
App-V Sequencer, 182
application sequencing, 327, 335, 344
application virtualization, 5
Client Hyper-V. See Client Hyper-V
evaluating compatibility considerations, 40
Group Policy support, 33, 60
GVLKs, 492
integration services, 140
managing checkpoints, 151, 155
metered networks, 65
Microsoft accounts and, 71, 76
mobile device connections, 65
modifying startup programs, 590
Offline Files, 64
optimizing configuration, 497–499
partitions, 495–496
RDS, 389, 396
RemoteFX, 397–398
shadowing connections, 472
Storage Spaces, 11
UE-V requirements, 71
user profile content, 34, 39
user state information, 31–32
user state virtualization, 44
virtual desktop templates, 491–492
virtualization features, 490–491
VM-based virtual desktops, 9, 404
Windows SIM, 495–496
Windows Defender, 327, 335–337
Windows Display Driver Model (WDDM), 398
Windows Event Log, 255–256
Windows Event Viewer, 256–259, 555, 565–567
Windows Features dialog box, 102–103
Windows Installer Service, 456
Windows Management Instrumentation (WMI), 75, 226
Windows Media Player, 336, 396
Windows Network Load Balancing, 439–440
Windows PowerShell. See also specific cmdlets
adding and publishing packages, 289–290
application sequencing, 351
AppVClient module, 268–269, 294–296
AppVSequencer module, 294, 296, 351
AppVServer module, 294–295
bulk changes and, 68
Client Hyper-V settings, 103
configuring App-V client, 267–269
configuring UE-V settings, 77–78
creating and managing connection groups, 290–294
creating package accelerators, 366–367
creating packages from package accelerators, 377
deploying RDS, 419
deploying UE-V agent, 81
elevated prompts, 297
ESD model and, 191
Hyper-V module, 105
Integrated Scripting Environment, 106–107
managing checkpoints, 329–330
managing connections, 471
managing management servers, 289–297
managing UE-V agent, 83–84
RemoteApp programs, 461
removing applications, 305–306
UE-V requirements, 71
Windows Registry, 274–275
Windows Search, 327, 335–336, 498
Windows Security dialog box, 464
Windows Server
App-V, 188–189, 202, 207, 210
App-V client, 247
App-V Sequencer, 182
application sequencing, 327–328
application virtualization, 6, 162
Best Practices Analyzer, 415
Client Hyper-V, 95, 97, 99–101, 124–125, 329
Credential Roaming, 68
data Deduplication feature, 510
described, 9
desktop virtualization, 7
failover clustering, 487, 489, 506
Folder Redirection, 57
high availability, 443, 486, 488
integration services, 99, 139–141
licensing requirements, 22, 401
load balancing, 439–440
management packs, 581–583
metered networks, 65
monitoring performance, 566, 568–571, 579, 588–590
NIC Teaming feature, 515
Offline Folders, 62
Primary Computer setting, 66, 68
RDS. See RDS (Remote Desktop Services)
Remote Desktop Easy Print, 470
RemoteApp, 5
resource bottlenecks, 585
Server Message Block, 488, 507
session-based desktops, 405
shadowing connections, 472
Storage Spaces, 2, 6, 9, 505
storage technologies, 508–511
storage virtualization, 11
UE-V, 71, 78
use state virtualization, 44, 57, 62, 65
user profile disks, 413
user profiles, 48
vGPU, 398
virtual hard disks, 142, 147
virtual machines, 113, 129, 135
Volume Activation Services server role, 492
Windows Server Update Services (WSUS), 14, 141, 494
Windows Setup Screen, 496–497
Windows SIM (System Image Manager), 495–496
Windows Store apps, 70, 87
Windows Sysinternals tool suite, 571–572, 590
Windows System Configuration, 590
Windows System Image Manager, 495–496
Windows System Resource Manager (WSRM), 589
Windows Update, 327, 335–336
Windows Virtual Desktop Access (VDA), 23, 402
Windows Vista operating system
  integration services, 99
  Offline Folders, 63
  RemoteApp for Hyper-V, 539
  user profiles, 48
Windows XP operating system
  application compatibility, 5
  Client Hyper-V, 96–97
  Folder Redirection, 57
  integration services, 99, 139
  Offline Files, 61
  Remote Desktop Easy Print, 470
  RemoteApp for Hyper-V, 539
  session collections, 430, 432
  SSL support, 430
  user profiles, 33–34, 46, 48
wireless access points, 111
wireless network adapters, 100
WMI (Windows Management Instrumentation), 75, 226
write-back cache, 508–510
WSRM (Windows System Resource Manager), 589
WSUS (Windows Server Update Services), 14, 141, 494

X
xClipboard setting, 467
xDriveRedirection setting, 467
XenApp (Citrix), 253
XenDesktop (Citrix), 253
XML files
  connection groups, 305
described, 284
dynamic configuration and, 310
exporting package configuration to, 287, 307
xPnPRedirection setting, 467
xPortRedirection setting, 467
xPrinterRedirection setting, 467

Z
.ZIP files, 275, 358