EXAM CRAM

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Exam 70-643

MCTS

Windows Server 2008 Applications Infrastructure, Configuring

Patrick Regan

MCTS 70-643 Exam Cram: Windows Server 2008 Applications Infrastructure, Configuring

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Introduction

Welcome to the 70-643 Exam Cram! Whether this book is your first or your 15th *Exam Cram* series book, you'll find information here that will help ensure your success as you pursue knowledge, experience, and certification. This book aims to help you get ready to take and pass the Microsoft certification exam "TS: Windows Server 2008 Applications Infrastructure, Configuring" (Exam 70-643). After you pass this exam, you will earn the Microsoft Certified Technology Specialist: Windows Server 2008 Applications certification.

This introduction explains Microsoft's certification programs in general and talks about how the *Exam Cram* series can help you prepare for Microsoft's latest certification exams. Then Chapters 1 through 9 are designed to remind you of everything you'll need to know to pass the 70-643 certification exam. The two sample tests at the end of the book (Chapters 10 through 13) should give you a reasonably accurate assessment of your knowledge and, yes, we've provided the answers and their explanations for these sample tests. Read the book, understand the material, and you'll stand a very good chance of passing the real test.

Exam Cram books help you understand and appreciate the subjects and materials you need to know to pass Microsoft certification exams. *Exam Cram* books are aimed strictly at test preparation and review. They do not teach you everything you need to know about a subject. Instead, the author streamlines and highlights the pertinent information by presenting and dissecting the questions and problems he's discovered that you're likely to encounter on a Microsoft test.

Nevertheless, to completely prepare yourself for any Microsoft test, we recommend that you begin by taking the "Self Assessment" that is included in this book, immediately following this introduction. The self-assessment tool helps you evaluate your knowledge base against the requirements for becoming a Microsoft Certified Technology Specialist (MCTS) and will be the first step in earning more advanced certifications, including Microsoft's IT Professional and Professional Developer (MCITP and MCPD) and Architect (MCA).

Based on what you learn from the self assessment, you might decide to begin your studies with classroom training or some background reading. On the other hand, you might decide to pick up and read one of the many study guides available from Microsoft or third-party vendors. We also recommend that you supplement your study program with visits to http://www.examcram.com to receive additional practice questions, get advice, and track the Windows certification programs.

This book also offers you an added bonus of access to Exam Cram practice tests online. This software simulates the Microsoft testing environment with similar types of questions to those you're likely to see on the actual Microsoft exam. We also strongly recommend that you install, configure, and play around with the Microsoft Windows Vista and Windows Server 2008 operating systems. Nothing beats hands-on experience and familiarity when it comes to understanding the questions you're likely to encounter on a certification test. Book learning is essential, but without a doubt, hands-on experience is the best teacher of all!

The Microsoft Certification Program

Microsoft currently offers multiple certification titles, each of which boasts its own special abbreviation. (As a certification candidate and computer professional, you need to have a high tolerance for acronyms.)

The certification for end-users is

- **Microsoft Office Specialists:** For professionals recognized for demonstrating advanced skills with Microsoft desktop software (including Microsoft Office).

The older certifications associated with the Windows Server 2003 operating system and related network infrastructure are

- **Microsoft Certified Professional (MCP):** For professionals who have the skills to successfully implement Microsoft products (such as Windows XP or Windows Server 2003) or technology as part of a business solution in an organization.
- **Microsoft Certified Desktop Support Technician (MCDST):** For professionals who have the technical and customer service skills to troubleshoot hardware and software operation issues in Microsoft Windows environments.
- **Microsoft Certified Systems Administrators (MCSA):** For professionals who administer network and systems environments based on the Microsoft Windows operating systems. Specializations include MCSA: Messaging and MCSA: Security.
- **Microsoft Certified Systems Engineer (MCSE):** For professionals who design and implement an infrastructure solution that is based on the Windows operating system and Microsoft Windows Server System software. Specializations include MCSE: Messaging and MCSE: Security.

The newer certifications that are based on Windows Vista, Windows Server 2008, and related server products are

- **Microsoft Certified Technology Specialist (MCTS):** For professionals who target specific technologies and distinguish themselves by demonstrating in-depth knowledge and expertise in the various Microsoft specialized technologies. The MCTS is a replacement for the MCP program.
- **Microsoft Certified IT Professional (MCITP):** For professionals who demonstrate comprehensive skills in planning, deploying, supporting, maintaining, and optimizing IT infrastructures. The MCITP is a replacement for the MCSA and MCSE programs.
- **Microsoft Certified Architect (MCA):** For professionals who are identified as top industry experts in IT architecture and who use multiple technologies to solve business problems and provide business metrics and measurements. Candidates for the MCA program are required to present to a review board—consisting of previously certified architects—to earn the certification.

For those who want to become or who are database professionals, the following certifications are based on the Microsoft SQL Server products:

- **Microsoft Certified Database Administrators (MCDBA):** For professionals who design, implement, and administer Microsoft SQL Server databases.

For developers and programmers, the following certifications are based on the Microsoft .NET Framework and Visual Studio products:

- **Microsoft Certified Professional Developer (MCPD):** For professionals who are recognized as expert Windows Application Developers, Web Application Developers, or Enterprise Applications Developers. They demonstrate that you can build rich applications that target a variety of platforms such as the Microsoft .NET Framework 2.0.
- **Microsoft Certified Application Developers (MCAD):** For professionals who use Microsoft technologies to develop and maintain department-level applications, components, web or desktop clients, or back-end data services.

For trainers and curriculum developers, the following certifications are available:

- **Microsoft Certified Trainer (MCT):** For qualified instructors who are certified by Microsoft to deliver Microsoft training courses to IT professionals and developers.
- **Microsoft Certified Learning Consultant (MCLC):** Recognizes MCTs whose job roles have grown to include frequent consultative engagements with their customers and who are experts in delivering customized learning solutions that positively affect customer return on investment (ROI).

In 2008, Microsoft introduced two advanced certifications. The Master certifications identify individuals with the deepest technical skills available on a particular Microsoft product such as Windows Server 2008, Exchange 2007, and SQL Server 2008. To achieve Master certification, candidates must attend several required sessions, successfully complete all in-class (written and lab) exams, and successfully complete a qualification lab exam.

The highest level certification is the Microsoft Certified Architect (MCA) program focusing on IT architecture. Microsoft Certified Architects have proven experience with delivering solutions and can communicate effectively with business, architecture, and technology professionals. These professionals have three or more years of advanced IT architecture experience and possess strong technical and leadership skills. Candidates are required to pass a rigorous Review Board interview conducted by a panel of experts.

The best place to keep tabs on all Microsoft certifications is the following website:

http://www.microsoft.com/learning/default.mspx

Microsoft changes their website often, so if this URL does not work in the future, you should use the Search tool on Microsoft's site to find more information on a particular certification.

Microsoft Certified Technology Specialist

Technology Specialist certifications enable professionals to target specific technologies and to distinguish themselves by demonstrating in-depth knowledge and expertise in their specialized technologies. Microsoft Technology Specialists are consistently capable of implementing, building, troubleshooting, and debugging a particular Microsoft technology.

At the time of the writing of this book, there are 28 Microsoft Certified Technology Specialist (MCTS) certifications:

Technology Specialist: SQL Server 2008, Business Intelligence Development and Maintenance

Technology Specialist: SQL Server 2008, Database Development

Technology Specialist: SQL Server 2008, Implementation and Maintenance

Technology Specialist: .NET Framework 3.5, Windows Presentation Foundation Applications

Technology Specialist: .NET Framework 3.5, Windows Communication Foundation Applications

Technology Specialist: .NET Framework 3.5, Windows Workflow Foundation Applications

Technology Specialist: .NET Framework 2.0, Web Applications

Technology Specialist: .NET Framework 2.0, Windows Applications

Technology Specialist: .NET Framework 2.0, Distributed Applications

Technology Specialist: SQL Server 2005

Technology Specialist: SQL Server 2005, Business Intelligence

Technology Specialist: BizTalk Server 2006

Technology Specialist: Microsoft Office Project Server 2007, Enterprise Project Management

Technology Specialist: Microsoft Office Project 2007, Project Management

Technology Specialist: Microsoft Office Live Communications Server 2005

Technology Specialist: Microsoft Exchange Server 2007, Configuration

Technology Specialist: Microsoft Office SharePoint Server 2007, Configuration

Technology Specialist: Microsoft Office SharePoint Server 2007, Application Development

Technology Specialist: Windows Mobile 5.0, Applications

Technology Specialist: Windows Mobile 5.0, Implementation and Management

Technology Specialist: Windows Server 2003, Hosted Environments, Configuration, and Management

Technology Specialist: Windows Server 2008, Active Directory Configuration

Technology Specialist: Windows Server 2008, Network Infrastructure Configuration

Technology Specialist: Windows Server 2008, Applications Infrastructure Configuration

Technology Specialist: Windows SharePoint Services 3.0, Application Development

Technology Specialist: Windows SharePoint Services 3.0, Configuration

Technology Specialist: Windows Vista and 2007 Microsoft Office System Desktops, Deployment and Maintenance

Technology Specialist: Windows Vista, Configuration

Microsoft Certified IT Professional

The new Microsoft Certified IT Professional (MCITP) credential lets you highlight your specific area of expertise. Now, you can easily distinguish yourself as an expert in database administration, database development, business intelligence, or support. At the time of this writing, the following Microsoft Certified IT Professional certifications exist:

IT Professional: Database Developer
IT Professional: Database Administrator
IT Professional: Business Intelligence Developer
IT Professional: Enterprise Support Technician
IT Professional: Consumer Support Technician
IT Professional: Database Developer 2008
IT Professional: Database Administrator 2008
IT Professional: Enterprise Messaging Administrator
IT Professional: Enterprise Project Management with Microsoft Office Project Server 2007
IT Professional: Enterprise Administrator
IT Professional: Server Administrator

The MCTS on Windows Server 2008 helps you and your organization take advantage of advanced server technology with the power to increase the flexibility of your server infrastructure, save time, and reduce costs. Transition certifications are available today for Windows Server 2003 certified professionals, while full certification paths will be available soon after the Windows Server 2008 product release. For more details about these certifications, visit the following website:

http://www.microsoft.com/learning/mcp/windowsserver2008/default.mspx

If the URL is no longer available, don't forget to search for MCTS and Windows Server 2008 with the Microsoft search tool found on the Microsoft website.

Microsoft Certified Technology Specialist: Windows Server 2008 Applications Infrastructure

The Microsoft Certified Technology Specialist certifications enable professionals to target specific technologies and distinguish themselves by demonstrating in-depth knowledge and expertise in their specialized technologies. A Microsoft

Certified Technology Specialist in Windows Vista, Configuration possesses the knowledge and skills to configure Windows Vista for optimal performance on the desktop, including installing, managing, and configuring the new security, network, and application features in Windows Vista.

To earn the Microsoft Certified Technology Specialist: Windows Vista, Configuration, you must pass one exam that focuses on supporting end-user issues about network connectivity, security, applications installation and compatibility, and logon problems that include account issues and password resets:

Exam 70-643: TS: Windows Server 2008 Applications Infrastructure, Configuration

If you decide to take Microsoft recognized class, you would take several classes to cover all of the material found on this exam. The preparation guide (including exam objectives) for Exam 70-643 TS: Windows Server 2008 Applications Infrastructure, Configuration can be found at

http://www.microsoft.com/learning/exams/70-643.mspx

Taking a Certification Exam

After you prepare for your exam, you need to register with a testing center. At the time of this writing, the cost to take exam 70-643 is (U.S.) $125, and if you don't pass, you can take each again for an additional (U.S.) $125 for each attempt. In the United States and Canada, tests are administered by Prometric. Here's how you can contact them:

- **Prometric:** You can sign up for a test through the company's website, http://www.2test.com or http://www.prometric.com. Within the United States and Canada, you can register by phone at 800-755-3926. If you live outside this region, you should check the Prometric website for the appropriate phone number.

To sign up for a test, you must possess a valid credit card or contact Prometric for mailing instructions to send a check (in the United States). Only when payment is verified, or a check has cleared, can you actually register for a test.

To schedule an exam, you need to call the appropriate phone number or visit the Prometric websites at least one day in advance. To cancel or reschedule an exam in the United States or Canada, you must call before 3 p.m. Eastern time the day before the scheduled test time (or you might be charged, even if you don't show up to take the test). When you want to schedule a test, you should have the following information ready:

- Your name, organization, and mailing address.
- Your Microsoft test ID. (In the United States, this means your Social Security number; citizens of other countries should call ahead to find out what type of identification number is required to register for a test.)
- The name and number of the exam you want to take.
- A method of payment. (As mentioned previously, a credit card is the most convenient method, but alternate means can be arranged in advance, if necessary.)

After you sign up for a test, you are told when and where the test is scheduled. You should arrive at least 15 minutes early. You must supply two forms of identification—one of which must be a photo ID—to be admitted into the testing room.

Tracking Certification Status

As soon as you pass a qualified Microsoft exam and earn a professional certification, Microsoft generates transcripts that indicate which exams you have passed. You can view a copy of your transcript at any time by going to the MCP secured site (this site may change as the MCP is retired) and selecting the Transcript Tool. This tool enables you to print a copy of your current transcript and confirm your certification status.

After you pass the necessary set of exams, you are certified. Official certification is normally granted after six to eight weeks, so you shouldn't expect to get your credentials overnight. The package for official certification that arrives includes a Welcome Kit that contains a number of elements (see Microsoft's website for other benefits of specific certifications):

- A certificate that is suitable for framing, along with a wallet card and lapel pin.
- A license to use the related certification logo, which means you can use the logo in advertisements, promotions, and documents, and on letterhead, business cards, and so on. Along with the license comes a logo sheet, which includes camera-ready artwork. (Note that before you use any of the artwork, you must sign and return a licensing agreement that indicates you'll abide by its terms and conditions.)
- Access to the *Microsoft Certified Professional Magazine Online* website, which provides ongoing data about testing and certification activities, requirements, changes to the MCP program, and security-related information on Microsoft products.

Many people believe that the benefits of MCP certification go well beyond the perks that Microsoft provides to newly anointed members of this elite group. We're starting to see more job listings that request or require applicants to have Microsoft and other related certifications, and many individuals who complete Microsoft certification programs can qualify for increases in pay and responsibility. As an official recognition of hard work and broad knowledge, a certification credential is a badge of honor in many IT organizations.

About This Book

Each topical *Exam Cram* chapter follows a regular structure and contains graphical cues about important or useful information. Here's the structure of a typical chapter:

- **Opening hotlists:** Each chapter begins with a list of the terms, tools, and techniques that you must learn and understand before you can be fully conversant with that chapter's subject matter. The hotlists are followed with one or two introductory paragraphs to set the stage for the rest of the chapter.
- **Topical coverage:** After the opening hotlists and introductory text, each chapter covers a series of topics related to the chapter's subject. Throughout that section, we highlight topics or concepts that are likely to appear on a test, using a special element called an Exam Alert:

EXAM ALERT

This is what an Exam Alert looks like. Normally, an alert stresses concepts, terms, software, or activities that are likely to relate to one or more certification-test questions. For that reason, we think any information in an Exam Alert is worthy of unusual attentiveness on your part.

You should pay close attention to material flagged in Exam Alerts; although all the information in this book pertains to what you need to know to pass the exam, Exam Alerts contain information that is really important. You'll find what appears in the meat of each chapter to be worth knowing, too, when preparing for the test. Because this book's material is very condensed, we recommend that you use this book along with other resources to achieve the maximum benefit.

In addition to the Exam Alerts, we provide tips that will help you build a better foundation for Windows Server 2008 knowledge. Although the tip information might not be on the exam, it is certainly related and it will help you become a better-informed test taker.

TIP

This is how tips are formatted. Keep your eyes open for these, and you'll become a Windows Server 2008 guru in no time!

NOTE

This is how notes are formatted. Notes direct your attention to important pieces of information that relate to Windows Server 2008 and Microsoft certification.

- **Exam prep questions:** Although we talk about test questions and topics throughout the book, the section at the end of each chapter presents a series of mock test questions and explanations of both correct and incorrect answers.
- **Details and resources:** Every chapter ends with a section titled "Need to Know More?" That section provides direct pointers to Microsoft and third-party resources that offer more details on the chapter's subject. In addition, that section tries to rank or at least rate the quality and thoroughness of the topic's coverage by each resource. If you find a resource you like in that collection, you should use it, but you shouldn't feel compelled to use all the resources. On the other hand, we recommend only resources that we use on a regular basis, so none of our recommendations will be a waste of your time or money (but purchasing them all at once probably represents an expense that many network administrators and Microsoft certification candidates might find hard to justify).

The bulk of the book follows this chapter structure, but we'd like to point out a few other elements. Chapters 10 to 13—two practice exams and their answers (with detailed explanations)—help you assess your understanding of the material presented throughout the book to ensure that you're ready for the exam.

Finally, the tear-out Cram Sheet attached next to the inside front cover of this *Exam Cram* book represents a condensed collection of facts and tips that we think are essential for you to memorize before taking the test. Because you can dump this information out of your head onto a sheet of paper before taking the exam, you can master this information by brute force; you need to remember it only long enough to write it down when you walk into the testing room. You might even want to look at it in the car or in the lobby of the testing center just before you walk in to take the exam.

We've structured the topics in this book to build on one another. Therefore, some topics in later chapters make the most sense after you've read earlier chapters. That's why we suggest that you read this book from front to back for your initial test preparation. If you need to brush up on a topic or if you have to bone up for a second try, you can use the index or table of contents to go straight to

the topics and questions that you need to study. Beyond helping you prepare for the test, we think you'll find this book useful as a tightly focused reference to some of the most important aspects of Windows Vista.

The book uses the following typographical conventions:

- Command-line strings that are meant to be typed into the computer are displayed in monospace text, such as

```
net use lpt1: \\print_server_name\printer_share_name
```

- *New terms* are introduced in italics.

Given all the book's elements and its specialized focus, we've tried to create a tool that will help you prepare for and pass Microsoft Exam 70-643. Please share with us your feedback on the book, especially if you have ideas about how we can improve it for future test takers. Send your questions or comments about this book via email to `feedback@quepublishing.com`. We'll consider everything you say carefully, and we'll respond to all suggestions. For more information on this book and other Que Certification titles, visit our website at http://www.quepublishing.com. You should also check out the new Exam Cram website at http://www.examcram.com, where you'll find information, updates, commentary, and certification information.

Exam Layout and Design

Historically, there have been six types of question formats on Microsoft certification exams. These types of questions continue to appear on current Microsoft tests, and they are discussed in the following sections:

- Multiple-choice, single answer
- Multiple-choice, multiple answers
- Build-list-and-reorder (list prioritization)
- Create-a-tree
- Drag-and-connect
- Select-and-place (drag-and-drop)

The Single-Answer and Multiple-Answer Multiple-Choice Question Formats

Some exam questions require you to select a single answer, whereas others ask you to select multiple correct answers. The following multiple-choice question requires you to select a single correct answer. Following the question is a brief summary of each potential answer and why it is either right or wrong.

1. You have three domains connected to an empty root domain under one contiguous domain name: tutu.com. This organization is formed into a forest arrangement, with a secondary domain called frog.com. How many schema masters exist for this arrangement?

   - ❍ **A.** 1
   - ❍ **B.** 2
   - ❍ **C.** 3
   - ❍ **D.** 4

1. The correct answer is A because only one schema master is necessary for a forest arrangement. The other answers (B, C, and D) are misleading because they try to make you believe that schema masters might be in each domain or perhaps that you should have one for each contiguous namespace domain.

This sample question format corresponds closely to the Microsoft certification exam format. The only difference is that on the exam, the questions are not followed by answers and their explanations. To select an answer, you position the cursor over the option button next to the answer you want to select. Then you click the mouse button to select the answer.

Let's examine a question for which one or more answers are possible. This type of question provides check boxes rather than option buttons for marking all appropriate selections.

2. What can you use to seize FSMO roles? (Choose two.)

   - ❍ **A.** The `ntdsutil.exe` utility
   - ❍ **B.** The Active Directory Users and Computers console
   - ❍ **C.** The `secedit.exe` utility
   - ❍ **D.** The `utilman.exe` utility

2. Answers A and B are correct. You can seize roles from a server that is still running through the Active Directory Users and Computers console, or in the case of a server failure, you can seize roles with the `ntdsutil.exe` utility. You use the `secedit.exe` utility to force group policies into play; therefore, Answer C is incorrect. The `utilman.exe` tool manages accessibility settings in Windows Server 2003; therefore, Answer D is incorrect.

This particular question requires two answers. Microsoft sometimes gives partial credit for partially correct answers. For Question 2, you have to mark the check boxes next to Answers A and B to obtain credit for a correct answer. Notice that to choose the right answers you also need to know why the other answers are wrong.

The Build-List-and-Reorder Question Format

Questions in the build-list-and-reorder format present two lists of items—one on the left and one on the right. To answer the question, you must move items from the list on the right to the list on the left. The final list must then be reordered into a specific sequence.

These questions generally sound like this: "From the following list of choices, pick the choices that answer the question. Arrange the list in a certain order." Question 3 shows an example of how these questions would look.

3. From the following list of famous people, choose those who have been elected president of the United States. Arrange the list in the order in which the presidents served.

- Thomas Jefferson
- Ben Franklin
- Abe Lincoln
- George Washington
- Andrew Jackson
- Paul Revere

3. The correct answer is

1. George Washington
2. Thomas Jefferson
3. Andrew Jackson
4. Abe Lincoln

On an actual exam, the entire list of famous people would initially appear in the list on the right. You would move the four correct answers to the list on the left and then reorder the list on the left. Notice that the answer to Question 3 does not include all the items from the initial list. However, that might not always be the case.

To move an item from the right list to the left list on the exam, you first select the item by clicking it, and then you click the Add button (left arrow). After you move an item from one list to the other, you can move the item back by first selecting the item and then clicking the appropriate button (either the Add button or the Remove button). After you move items to the left list, you can reorder an item by selecting the item and clicking the up or down arrow buttons.

The Create-a-Tree Question Format

Questions in the create-a-tree format also present two lists—one on the left side of the screen and one on the right side of the screen. The list on the right consists of individual items, and the list on the left consists of nodes in a tree. To answer the question, you must move items from the list on the right to the appropriate node in the tree.

These questions can best be characterized as simply a matching exercise. Items from the list on the right are placed under the appropriate category in the list on the left. Question 4 shows an example of how they would look.

4. The calendar year is divided into four seasons:

1. Winter
2. Spring
3. Summer
4. Fall

Identify the season during which each of the following holidays occurs:

- ❍ Christmas
- ❍ Fourth of July
- ❍ Labor Day
- ❍ Flag Day
- ❍ Memorial Day
- ❍ Washington's Birthday
- ❍ Thanksgiving
- ❍ Easter

4. The correct answers are

1. Winter
   - ▶ Christmas
   - ▶ Washington's Birthday
2. Spring
   - ▶ Flag Day
   - ▶ Memorial Day
   - ▶ Easter

3. Summer
    - Fourth of July
    - Labor Day
4. Fall
    - Thanksgiving

In this case, you use all the items in the list. However, that might not always be the case.

To move an item from the right list to its appropriate location in the tree, you must first select the appropriate tree node by clicking it. Then, you select the item to be moved and click the Add button. After you add one or more items to a tree node, the node appears with a **+** icon to the left of the node name. You can click this icon to expand the node and view the items you have added. If you have added any item to the wrong tree node, you can remove it by selecting it and clicking the Remove button.

The Drag-and-Connect Question Format

Questions in the drag-and-connect format present a group of objects and a list of "connections." To answer the question, you must move the appropriate connections between the objects.

This type of question is best described with graphics. For this type of question, it isn't necessary to use every object, and you can use each connection multiple times.

The Select-and-Place Question Format

Questions in the select-and-place (drag-and-drop) format display a diagram with blank boxes and a list of labels that you need to drag to correctly fill in the blank boxes. To answer such a question, you must move the labels to their appropriate positions on the diagram. This type of question is best described with graphics.

Special Exam Question Formats

Starting with the exams released for the Windows Server 2003 MCSE track, Microsoft introduced several new question types in addition to the more traditional types of questions that are still widely used on all Microsoft exams. These innovative question types have been highly researched and tested by Microsoft before they were chosen to be included in many of the "refreshed" exams for the MCSA/MCSE on the Windows 2000 track and for the new exams on the Windows Server 2003 and Windows Server 2008 track. These special question types are as follows:

- Hot area questions
- Active screen questions
- Drag-and-drop–type questions
- Simulation questions

Hot Area Question Types

Hot area questions ask you to indicate the correct answer by selecting one or more elements within a graphic. For example, you might be asked to select multiple objects within a list.

Active Screen Question Types

Active screen questions ask you to configure a dialog box by modifying one or more elements. These types of questions offer a realistic interface in which you must properly configure various settings, just as you would within the actual software product. For example, you might be asked to select the proper option within a drop-down list box.

Drag-and-Drop Question Types

New drag-and-drop questions ask you to drag source elements to their appropriate corresponding targets within a work area. These types of questions test your knowledge of specific concepts and their definitions or descriptions. For example, you might be asked to match a description of a computer program to the actual software application.

Simulation Question Types

Simulation questions ask you to indicate the correct answer by performing specific tasks, such as configuring and installing network adapters or drivers, configuring and controlling access to files, or troubleshooting hardware devices. Many of the tasks that systems administrators and systems engineers perform can be presented more accurately in simulations than in most traditional exam question types.

Microsoft's Testing Formats

Currently, Microsoft uses three different testing formats:

- Fixed length
- Short form
- Case study

Other Microsoft exams employ advanced testing capabilities that might not be immediately apparent. Although the questions that appear are primarily multiple choice, the logic that drives them is more complex than that in older Microsoft tests, which use a fixed sequence of questions, called a *fixed-length test*. Some questions employ a sophisticated user interface, which Microsoft calls a *simulation*, to test your knowledge of the software and systems under consideration in a more-or-less "live" environment that behaves just like the real thing. You should review the Microsoft Learning, Reference, and Certification Web pages at http://www.microsoft.com/learning/default.mspx for more detailed information.

In the future, Microsoft might choose to create exams using a well-known technique called *adaptive testing* to establish a test taker's level of knowledge and product competence. In general, adaptive exams might look the same as fixed-length exams, but they discover the level of difficulty at which an individual test taker can correctly answer questions. Test takers with differing levels of knowledge or ability therefore see different sets of questions; individuals with high levels of knowledge or ability are presented with a smaller set of more difficult questions, whereas individuals with lower levels of knowledge are presented with a larger set of easier questions. Two individuals might answer the same percentage of questions correctly, but the test taker with a higher knowledge or ability level will score higher because his or her questions are worth more. Also, the lower-level test taker will probably answer more questions than his or her more knowledgeable colleague. This explains why adaptive tests use ranges of values to define the number of questions and the amount of time it takes to complete the test.

NOTE

Microsoft does *not* offer adaptive exams at the time of this book's publication.

Most adaptive tests work by evaluating the test taker's most recent answer. A correct answer leads to a more difficult question, and the test software's estimate of the test taker's knowledge and ability level is raised. An incorrect answer leads to a less difficult question, and the test software's estimate of the test taker's knowledge and ability level is lowered. This process continues until the test targets the test taker's true ability level. The exam ends when the test taker's level of accuracy meets a statistically acceptable value (in other words, when his or her performance demonstrates an acceptable level of knowledge and ability) or when the maximum number of items has been presented. (In which case, the test taker is almost certain to fail.)

Microsoft has also introduced a short-form test for its most popular tests. This test delivers 25 to 30 questions to its takers, giving them exactly 60 minutes to complete the exam. This type of exam is similar to a fixed-length test in that it allows readers to jump ahead or return to earlier questions and to cycle through the questions until the test is done. Microsoft does not use adaptive logic in

short-form tests, but it claims that statistical analysis of the question pool is such that the 25 to 30 questions delivered during a short-form exam conclusively measure a test taker's knowledge of the subject matter in much the same way as an adaptive test. You can think of the short-form test as a kind of "greatest hits exam" (that is, it covers the most important questions) version of an adaptive exam on the same topic.

Because you won't know which form the Microsoft exam might take, you should be prepared for either a fixed-length or short-form exam. The layout is the same for both fixed-length and short-form tests—you are not penalized for guessing the correct answer(s) to questions, no matter how many questions you answer incorrectly.

The Fixed-Length and Short-Form Exam Strategy

One tactic that has worked well for many test takers is to answer each question as well as you can before time expires on the exam. Some questions you will undoubtedly feel better equipped to answer correctly than others; however, you should still select an answer to each question as you proceed through the exam. You should click the Mark for Review check box for any question that you are unsure of. In this way, at least you have answered all the questions in case you run out of time. Unanswered questions are automatically scored as incorrect; answers that are guessed at have at least some chance of being scored as correct. If time permits, after you answer all questions you can revisit each question that you have marked for review. This strategy also enables you to possibly gain some insight into questions that you are unsure of by picking up some clues from the other questions on the exam.

TIP

Some people prefer to read over the exam completely before answering the trickier questions; sometimes, information supplied in later questions sheds more light on earlier questions. At other times, information you read in later questions might jog your memory about facts, figures, or behavior that helps you answer earlier questions. Either way, you could come out ahead if you answer only those questions on the first pass that you're absolutely confident about. However, be careful not to run out of time if you choose this strategy!

Fortunately, the Microsoft exam software for fixed-length and short-form tests makes the multiple-visit approach easy to implement. At the top-left corner of each question is a check box that permits you to mark that question for a later visit.

Here are some question-handling strategies that apply to fixed-length and short-form tests. Use them if you have the chance:

- When returning to a question after your initial read-through, read every word again; otherwise, your mind can miss important details. Sometimes, revisiting a question after turning your attention elsewhere lets you see something you missed, but the strong tendency is to see only what you've seen before. Avoid that tendency at all costs.
- If you return to a question more than twice, articulate to yourself what you don't understand about the question, why answers don't appear to make sense, or what appears to be missing. If you chew on the subject awhile, your subconscious might provide the missing details, or you might notice a "trick" that points to the right answer.

As you work your way through the exam, another counter that Microsoft provides will come in handy—the number of questions completed and questions outstanding. For fixed-length and short-form tests, it's wise to budget your time by making sure that you've completed one-quarter of the questions one-quarter of the way through the exam period and three-quarters of the questions three-quarters of the way through.

If you're not finished when only five minutes remain, use that time to guess your way through any remaining questions. Remember, guessing is potentially more valuable than not answering. Blank answers are always wrong, but a guess might turn out to be right. If you don't have a clue about any of the remaining questions, pick answers at random or choose all As, Bs, and so on. (Choosing the same answer for a series of question all but guarantees you'll get most of them wrong, but it also means you're more likely to get a small percentage of them correct.)

EXAM ALERT

At the very end of your exam period, you're better off guessing than leaving questions unanswered.

Question-Handling Strategies

For those questions that have only one right answer, usually two or three of the answers will be obviously incorrect and two of the answers will be plausible. Unless the answer leaps out at you (if it does, reread the question to look for a trick; sometimes those are the ones you're most likely to get wrong), begin the process of answering by eliminating those answers that are most obviously wrong.

You can usually immediately eliminate at least one answer out of the possible choices for a question because it matches one of these conditions:

- The answer does not apply to the situation.
- The answer describes a nonexistent issue, an invalid option, or an imaginary state.

After you eliminate all answers that are obviously wrong, you can apply your retained knowledge to eliminate further answers. You should look for items that sound correct but refer to actions, commands, or features that are not present or not available in the situation that the question describes.

If you're still faced with a blind guess among two or more potentially correct answers, reread the question. Picture how each of the possible remaining answers would alter the situation. Be especially sensitive to terminology; sometimes the choice of words (for example, "remove" instead of "disable") can make the difference between a right answer and a wrong one.

You should guess at an answer only after you've exhausted your ability to eliminate answers and you are still unclear about which of the remaining possibilities is correct. An unanswered question offers you no points, but guessing gives you at least some chance of getting a question right; just don't be too hasty when making a blind guess.

Numerous questions assume that the default behavior of a particular utility is in effect. If you know the defaults and understand what they mean, this knowledge will help you cut through many of the trickier questions. Simple "final" actions might be critical as well. If you must restart a utility before proposed changes take effect, a correct answer might require this step as well.

Mastering the Test-Taking Mindset

In the final analysis, knowledge breeds confidence, and confidence breeds success. If you study the materials in this book carefully and review all the practice questions at the end of each chapter, you should become aware of the areas where you need additional learning and study.

After you've worked your way through the book, take the practice exams in the back of the book. Taking these tests provides a reality check and helps you identify areas to study further. Make sure you follow up and review materials related to the questions you miss on the practice exams before scheduling a real exam. Don't schedule your exam appointment until after you've thoroughly

studied the material and you feel comfortable with the whole scope of the practice exams. You should score 80% or better on the practice exams before proceeding to the real thing. (Otherwise, obtain some additional practice tests so that you can keep trying until you hit this magic number.)

TIP

If you take a practice exam and don't get at least 80% of the questions correct, keep practicing. Microsoft provides links to practice-exam providers and also self-assessment exams at http://www.microsoft.com/learning/mcpexams/prepare/default.asp.

Armed with the information in this book and with the determination to augment your knowledge, you should be able to pass the certification exam. However, you need to work at it, or you'll spend the exam fee more than once before you finally pass. If you prepare seriously, you should do well.

The next section covers other sources that you can use to prepare for Microsoft certification exams.

Additional Resources

A good source of information about Microsoft certification exams comes from Microsoft itself. Because its products and technologies—and the exams that go with them—change frequently, the best place to go for exam-related information is online.

Microsoft offers training, certification, and other learning-related information and links at the http://www.microsoft.com/learning web address. If you haven't already visited the Microsoft Training and Certification website, you should do so right now. Microsoft's Training and Certification home page resides at http://www.microsoft.com/learning/default.mspx.

Coping with Change on the Web

Sooner or later, all the information we've shared with you about the Microsoft Certified Professional pages and the other web-based resources mentioned throughout the rest of this book will go stale or be replaced by newer information. In some cases, the URLs you find here might lead you to their replacements; in other cases, the URLs will go nowhere, leaving you with the dreaded "404 File not found" error message. When that happens, don't give up.

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There's always a way to find what you want on the web if you're willing to invest some time and energy. Most large or complex websites—and Microsoft's qualifies on both counts—offer search engines. All of Microsoft's web pages have a Search button at the top edge of the page. As long as you can get to Microsoft's site (it should stay at http://www.microsoft.com for a long time), you can use the Search button to find what you need.

The more focused (or specific) that you can make a search request, the more likely the results will include information you can use. For example, you can search for the string

```
"training and certification"
```

to produce a lot of data about the subject in general, but if you're looking for the preparation guide for Exam 70-643, *Windows Server 2008 Applications Infrastructure, Configuring*, you'll be more likely to get there quickly if you use a search string similar to the following:

```
"Exam 70-643" AND "preparation guide"
```

Likewise, if you want to find the Training and Certification downloads, you should try a search string such as this:

```
"training and certification" AND "download page"
```

Finally, you should feel free to use general search tools—such as http://www.google.com, http://www.yahoo.com, http://www.excite.com, and http://www.ask.com—to look for related information. Although Microsoft offers great information about its certification exams online, there are plenty of third-party sources of information and assistance that need not follow Microsoft's party line. Therefore, if you can't find something where the book says it lives, you should intensify your search.

Thanks for making this *Exam Cram* book a pivotal part of your certification study plan; best of luck on becoming certified!

CHAPTER 3

Windows Server 2008 Storage

Terms you'll need to understand:

- ✓ Virtual Disk Specification (VDS)
- ✓ IDE Drives
- ✓ SCSI Drives
- ✓ Redundant Arrays of Inexpensive Disks (RAID)
- ✓ network-attached storage (NAS)
- ✓ storage area network (SAN)
- ✓ iSCSI
- ✓ fibre channel
- ✓ Storage Manager
- ✓ iSCSI initiator
- ✓ partition
- ✓ Master Boot Record (MBR)
- ✓ GUID partition table (GPT)
- ✓ basic disks
- ✓ dynamic disks
- ✓ `diskpart.exe` command
- ✓ simple volumes
- ✓ spanned volumes
- ✓ striped volumes
- ✓ mirrored volumes
- ✓ RAID-5 volumes
- ✓ mount points

Techniques/concepts you'll need to master:

- ✓ Connect to a NAS and SAN, using Windows Server 2008.
- ✓ Use Storage Explorer to view and manage Fibre Channel and ISCSI Fabrics.
- ✓ Manage disks using the Disk Management console and `diskpart.exe` command.
- ✓ Enable and configure RAID, using Windows Server 2008.

When working with Windows, you have to work with disks. Although simple servers have you install Windows Server 2008 on a local IDE (parallel and serial) or SCSI hard drive, more complex systems may use an attached remote computer storage device such as a storage area network (SAN) or network-attached storage (NAS). Therefore, you need to know what options are available and how to configure a server's physical and virtual disk drives so that the server can meet the needs of network applications while providing reliability.

The *Virtual Disk Specification (VDS)* protocol provides a mechanism for remote configuration of disks, *partitions*, volumes, and *iSCSI initiators* on a server. Through the VDS protocol, a client can change the configuration of disks into partitions, partitions into volumes, and volumes into file systems. In the VDS protocol, two entities are involved: the server whose storage is configured and the client who needs to change the server storage configuration.

IDE and SCSI Drives

Today's hard drives are either integrated drive electronics (IDE) or small computer system interface (SCSI, pronounced "skuzzy") drives. *IDE drives* are designed as fast, low-cost drives. Traditional IDE drives were based on the parallel AT attachment (ATA) standard that used a parallel 40-pin connector. Today's IDE drives follow the serial ATA standard (SATA), which uses a connector that is attached with only four wires and a smaller power connector. Although the serial ATA uses fewer wires/connectors, it provides faster throughput then parallel ATA IDE drives.

Servers and high-performance workstations typically use *SCSI drives*. SCSI drives typically offer faster performance and throughput than IDE drives and SCSI drives support a larger number of drives to be attached through the same interface.

Redundant Arrays of Inexpensive Disks (RAID)

To help with data protection and system reliability, there are *redundant arrays of inexpensive disks (RAID)* that use two or more drives in combination to create a fault tolerance system to protect against physical hard drive failure and to increase hard drive performance. A RAID can be accomplished with either hardware or software and is usually used in network servers. Hardware RAID offers better performance and is transparent to the operating system. However, it costs

more to implement because you need a RAID controller. Software RAID is inexpensive and easy to configure because it has no special hardware requirements other than multiple disks.

There are several levels of RAID. The first one is RAID 0. RAID 0 stripes data across all drives. With striping, all available hard drives are combined into a single large virtual file system, with the file system's blocks arrayed so they are spread evenly across all the drives. For example, if you have three 500MB hard drives, RAID 0 provides for a 1.5GB virtual hard drive. When you store files, they are written across all three drives. When a large file is written, a part of it may be written to the first drive, the next chunk to the second drive, more to the third drive, and perhaps more wrapping back to the first drive to start the sequence again. Unfortunately, with RAID 0 there is no parity control or fault tolerance, so it really is not a true form of RAID. If one drive fails, you lose all data on the array. However, RAID 0 does have several advantages because it has increased performance through load balancing.

A common RAID used in networked PCs and servers is RAID 1, known as disk-mirroring. Disk-mirroring copies a partition onto a second hard drive. As information is written, it is written to both hard drives simultaneously. If one of the hard drives fails, the PC still functions because it can access the other hard drive. You can then replace the failed drive, and data is copied from the remaining good drive to the replaced drive.

NOTE

This book focuses on RAID 0, 1, and 5 because that is the software RAID that is supported by Windows Server 2008. There are other levels of RAID, but RAID 0, 1, and 5 are the most popular and are the only software RAID supported by Windows Server 2008.

Another common RAID is RAID 5 (sometimes referred to as striped volume with parity), which is similar to striping, except one of the hard drives is used for parity (error-correction) to provide fault tolerance. To increase performance, the error-correction is spread across all hard drives in the array to avoid having one drive do all the work in calculating the parity bits. If one drive fails, you still keep working because the missing data can be filled in by doing parity calculations with the remaining drives. When the failed drive is replaced, the missing information is rebuilt. However, if two drives fail, you do loose all data on the array. RAID-5 has better performance than RAID 1. RAID 5 usually requires at least three drives, with more preferable. If you have 3×500GB drives, you will have 2×500GB=1000GB of disk space because one of the drives must be used for parity. If you have 6×500GB drives, you have 5×500GB=2500GB of disk space.

RAID can be implemented through the use of a hardware RAID controller or through software. Windows Server 2003 and Windows Server 2008 offers software RAID that supports RAID 0, RAID 1, and RAID 5. Typically, for better performance and reliability, it is recommended that you use hardware RAID.

Network-Attached Storage (NAS) and Storage Area Networks (SAN)

Network-attached storage (NAS) is a file-level computer data storage device that is connected to a computer network to provide shared drives or folders. To make NAS fault tolerant, NAS systems usually contain one or more hard disks, often arranged as RAIDs. NAS units also usually have a web interface as opposed to keyboard/video/mouse.

A *storage area network (SAN)* is an architecture that attaches remote computer storage devices (such as disk arrays, tape libraries, and optical jukeboxes) to servers in such a way that, to the operating system, the devices appear as locally attached. They are typically used in larger organizations where the SAN acts as a central disk repository that services multiple servers and network applications. The SAN usually contains multiple hard drives that use RAID or other technology to make the system redundant against drive failure and to offer high performance.

Most SANs use the SCSI protocol for communication between servers and disk drive devices. But instead of using the same SCSI interface used in local hard drives, it uses network interfaces, such as

- Fibre Channel
- iSCSI

A fabric is a network topology where devices are connected to each other through one or more high-efficiency data paths. In the case of a *Fibre Channel* fabric, the network includes one or more Fibre Channel switches that enable servers and storage devices to connect to each other through virtual point-to-point connections. For *iSCSI* fabrics, the network includes one or more Internet Storage Name Service (iSNS) servers that provide discoverability and partitioning of resources.

Fibre Channel

Fibre Channel is a gigabit-speed network technology primarily used for storage networking. Fibre Channel is standardized in the T11 Technical Committee of

the InterNational Committee for Information Technology Standards (INCITS), an American National Standards Institute (ANSI)–accredited standards committee. Despite its name, Fibre Channel signaling can run on both twisted pair copper wire and fiber-optic cables. Fibre Channel Protocol (FCP) is the interface protocol of SCSI on the Fibre Channel.

In a Fibre Channel switched fabric (FC-SW), Fibre Channel switches connect devices together. When a host or device communicates with another host or device, the source and target create a point-to-point connection between themselves and communicate directly with each other. The fabric itself routes data from the source to the target. In an FC-SW, the media is not shared. Therefore, any device can communicate with any other device, assuming it is not busy, and communication occurs at full bus speed regardless of whether other devices and hosts are communicating at the same time.

A port in Fibre Channel is any entity that actively communicates over the network. Port is usually implemented in a device such as disk storage, an HBA on a server, or a Fibre Channel switch. There are three major Fibre Channel topologies, describing how a number of ports are connected together:

- **Point-to-Point (FC-P2P):** Two devices are connected back to back. This is the simplest topology, with limited connectivity.
- **Arbitrated loop (FC-AL):** In this design, all devices are in a loop or ring, similar to token ring networking. Adding or removing a device from the loop causes all activity on the loop to be interrupted. The failure of one device causes a break in the ring. Fibre Channel hubs exist to connect multiple devices together and may bypass failed ports. A loop may also be made by cabling each port to the next in a ring. A minimal loop containing only two ports, while appearing to be similar to FC-P2P, differs considerably in terms of the protocol.
- **Switched fabric (FC-SW):** All devices or loops of devices are connected to Fibre Channel switches, similar conceptually to modern Ethernet implementations. The switches manage the state of the fabric, providing optimized interconnections.

When a host or device is powered on, it must first log in to the fabric. This enables the device to determine the type of fabric (a fabric supports a specific set of characteristics) and provides a fabric address to a host or device. A given host or device continues to use the same fabric address while it is logged on to the fabric; the fabric address is guaranteed to be unique for that fabric. For a host or device to communicate with another device, it must establish a connection to that device before transmitting data. The switches route the packets in the fabric.

In a fabric topology, each device (including the HBA) is called a node. Each node has a fixed 64-bit worldwide name (WWN) assigned by the manufacturer and registered with the IEEE to ensure it is globally unique. A node can have multiple ports, each with a unique 64-bit port name and 24-bit port ID. For example, a dual-port HBA has a single worldwide name (WWN) and two worldwide port IDs used for frame routing. When a port logs in to the fabric, it registers various attributes that are stored in the fabric (usually within a switch). Zoning is a method of restricting which ports or WWN can communicate with each other.

LUNs allow SANs to break the SAN storage down into manageable pieces. The SAN then assigns each LUN to one or more servers in the SAN. If a LUN is not mapped to a given server, that server cannot see or access the LUN. LUN masking is a method of restricting which devices can view, send, and receive commands to specific LUNs on a storage controller. You need to identify only the server or cluster that is to access the LUN, and then select which HBA ports on that server or cluster will be used for LUN traffic.

When a server or cluster is identified, Storage Explorer automatically discovers the available Fibre Channel HBA ports on that server or cluster. You can also add ports manually by entering their World Wide Name (WWN).

iSCSI

iSCSI is a protocol that enables clients to send SCSI commands over a TCP/IP network using TCP port 3260. Because it uses Ethernet switches and cabling, typically Gigabit Ethernet or Fibre, it can connect a SAN to multiple servers and provide long-distance connections.

A LUN is a logical reference to a portion of a storage subsystem. A LUN can comprise a disk, a section of a disk, a whole disk array, or a section of a disk array in the subsystem. Using LUNs simplifies the management of storage resources in your SAN because LUNs serve as logical identifiers through which you can assign access and control privileges.

Because you connect to the SAN over a network, the network adapter must be dedicated to either network communication (traffic other than iSCSI) or iSCSI, not both. Therefore, if you are using iSCSI, you need two sets of network cards, one for iSCSI and one for network connections.

For a server to connect to a SAN, the server connects to a target using an iSCSI initiator. A target defines the portals/servers (IP addresses) that can be used to connect to the iSCSI device, as well as the security settings (if any) that the iSCSI device requires to authenticate the servers requesting access to its resources.

For a server to connect to an iSCSI SAN, the server uses an iSCSI initiator software to log on and connect to the SAN. After access is granted by the SAN, the server can start reading and writing to all LUNs assigned to that server. After the software initiator connects to a LUN, the iSCSI session emulates a SCSI hard disk so that the server treats the LUN just like any other hard drive.

Each iSCSI initiator can have one or more network adapters through which communication is established. Additional network adapters provide increased bandwidth and redundancy.

The iSCSI software can be built into the iSCSI host adapter (more commonly known as a Host Bus Adapter (HBA). A typical HBA is packaged as a combination of a Gigabit Ethernet NIC and a SCSI bus adapter, which is what it appears as to the operating system. The HBA contains special firmware that contains the iSCSI initiator software. Because a hardware initiator processes iSCSI and TCP processing and the Ethernet interrupts, performance can be increased over iSCSI initiator software running on the server.

For iSCSI initiators to find a storage device to connect to, the iSCSI initiator uses Internet Storage Name Service (iSNS) protocol to provide both naming and resource discovery services for storage devices on the IP network. The iSCSI initiator then uses the following to connect to the SAN:

- Hostname or IP address (for example, "iscsi.example.com")
- Port number (for example, 3260)
- iSCSI name (for example, the IQN "iqn.2003-01.com.ibm:00.fcd0ab21.shark128")
- An optional CHAP secret password

The iSCSI Name follows one of the following formats:

- **iSCSI Qualified Name (IQN):** IQN follows the format

  iqn.yyyy-mm.{reversed domain name}

  For example:

  iqn.2001-04.com.acme:storage.tape.sys1.xyz

  IQN addresses are the most common format.

- **Extended Unique Identifier (EUI):** EUI follows the format

  eui.{EUI-64 bit address}

For example:

eui.02004567A425678D

EUI is provided by the IEEE Registration authority in accordance with EUI-64 standard.

- **T11 Network Address Authority (NAA):** NAA follows the format

  naa.{NAA 64 or 128 bit identifier}

  For example:

  naa.52004567BA64678D

  NAA is part OUI, which is provided by the IEEE Registration Authority. NAA name formats were added to iSCSI in RFC 3980, to provide compatibility with naming conventions used in Fibre Channel and SAS storage technologies.

Configuring the iSCSI Initiators

Microsoft Windows Server 2008 includes two iSCSI Initiator software interfaces. They are

- iSCSI Initiator applet (located in the Administrative Tools and Control Panel)
- `iscsicli` command interface

EXAM ALERT

For the exam, be sure you know how to connect to and configure an iSCSI volume using an iSCSI initiator.

iSCSI Initiator Applet

By using an iSCSI Initiator (located in the Administrative Tools and the Control Panel), you connect a storage array or volume of a storage array to a server and mount the array or volume as a local volume. An iSCSI initiator is the software component residing on a server or other computer that is installed and configured to connect to an iSCSI target. An iSCSI target is the actual storage array or volume.

When you open the iSCSI Initiator program, you see the following six tabs:

- **General:** Enables you to rename the initiator and configure the CHAP authentication and IPSec tunnel.

- **Discovery:** Specifies the location of the SAN and Internet Storage Name Service (iSNS) servers.
- **Targets:** Specifies to which storage devices the server has access and allows you to log on to those devices.
- **Favorite Targets:** Specifies which targets reconnect each time you start your computer.
- **Volumes and Devices:** Shows volumes and devices that are connected to the server.
- **RADIUS:** Specifies the RADIUS server to use for authentication.

Figure 3.1 shows the Discovery tab.

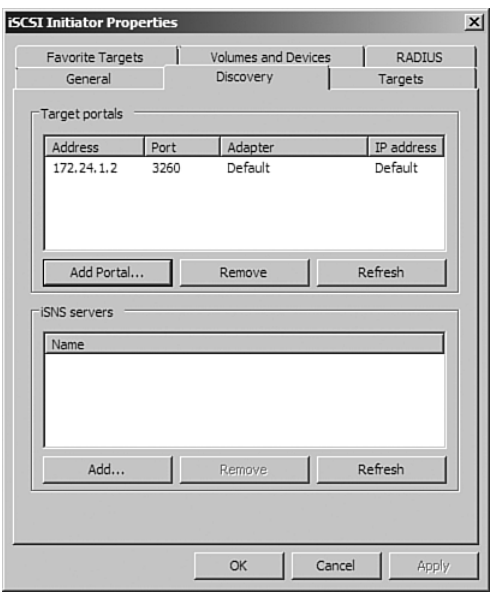

FIGURE 3.1 The iSCSI Initiator Properties dialog.

1. To connect to the iSCSI array, select the Discovery tab and click Add Portal.
2. In the Add Target Portal dialog box, provide the name or IP address of your iSCSI array. The default communication port for iSCSI traffic is 3260. If you have configured CHAP security or are using IPSec for communication between your client and the array, click Advanced and make necessary configuration changes.
3. Back in the Add Target Portal dialog box, click OK to make the initial connection to the iSCSI array.

4. To see the list of available targets (volumes to connect to and mount on the server), select the Targets tab.
5. To connect to an available target, choose the target and click Log On.
   - If you want your server to connect to this volume automatically when your system boots, make sure you select Automatically Restore This Connection When The System Boots. If you do not, you need to reconnect it manually.
   - To enable high availability and to boost performance, choose Enable Multi-Path. Of course, you would need to have multiple network adapters dedicated to the iSCSI connection to use multi-pathing (MPIO).
   - If you are using CHAP or IPSec for communication with a target, click Advanced. After you are finished configuring the Log On options, click OK. The target status should change to Connected (see Figure 3.2).

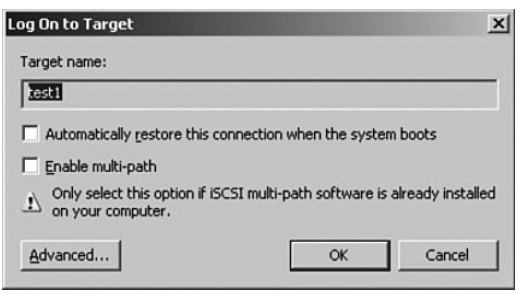

FIGURE 3.2 Log On to Target dialog box for iSCSI.

6. To bind the available iSCSI targets to the iSCSI startup process and assign them to a drive letter or mount point, select the Volumes and Devices tab. Click Add and specify the drive letter or mount point. Then Click OK.

If the iSCSI volume is a new volume that has not been mounted before, when you open the Disk Management console, it is treated as a new hard drive. At this point, you have to initialize the new drive, create a partition, and format the new volume.

iSCSICLI

`iSCSICLI` is a command-line tool suitable for scripting the Microsoft iSCSI initiator service. Although some of these commands may become lengthy and complex, this enables you to access all features of iSCSI. Some of the functions include:

- `iscsicli AddTarget`: Creates a connection to a volume or device
- `iscsicli AddPersistentDevices`: To make an iSCSI device persistent

- `iscsicli RemovePersistentDevices`: Prevents the reconnection to a specified volume
- `iscsicli ClearPersistentDevices`: Removes all volumes and devices from the list of persistent devices.

For more information, access the Microsoft iSCSI Software Initiator User's Guide from Microsoft:

http://www.microsoft.com/downloads/details.aspx?familyid=12CB3C1A-15D6-4585-B385-BEFD1319F825&displaylang=en

Storage Explorer

With Storage Explorer, you can view and manage the Fibre Channel and iSCSI fabrics that are available in your SAN. Storage Explorer can display detailed information about servers connected to the SAN, as well as components in the fabrics such as host bus adapters (HBA), Fibre Channel switches, and iSCSI initiators and targets (see Figure 3.3).

In addition, you can also perform many administrative tasks on an iSCSI fabric including logging onto the iSCSI targets, configuring iSCSI security, adding iSCSI target portals, adding iSNS servers, and managing Discovery Domains and Discovery Domain Sets.

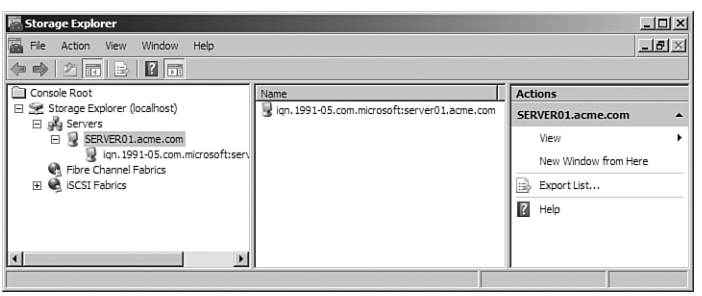

FIGURE 3.3 The Storage Explorer dialog.

Storage Manager for SANs

The *Storage Manager* for SANs, a Windows Server 2008 feature, can be used to create and manage logical unit numbers (LUN) on both Fibre Channel and iSCSI disk storage subsystems that support Virtual Disk Service (VDS).

For Fibre Channel SANs, when a server or cluster is identified, Storage Manager for SANs automatically discovers the available Fibre Channel HBA ports on that server or cluster. You can also add ports manually by typing their World Wide Name (WWN).

For iSCSI SANs, you only need to identify the server or cluster that will access the LUN, and Storage Manager for SANs automatically discovers the iSCSI initiators on that server or cluster and lists all the available adapters for those initiators. After the iSCSI initiator adapters have been discovered, you can select which adapters will be used for LUN traffic.

To add and configure a server with Fibre Channel connections, follow these steps:

1. In the console tree for Storage Manager for SANs, click LUN Management.
2. In the Actions pane, click Manage Server Connections.
3. In the Manage Server Connections dialog box, click Add.
4. In the Add Server dialog box, type the name or browse to the server that you want to add, and optionally, type a description for it.
5. Click OK. The server will now be listed in the Manage Server Connections dialog box, with all the ports that were automatically discovered on it listed on the Fibre Channel Ports tab.
6. If necessary, you can add a Fibre Channel manually by clicking Add on the Fibre Channel Ports tab and entering the WWN of the new port. Then click OK.
7. To enable Fibre Channel ports for LUN access, select a server from the server list. Then on the Fibre Channel Ports tab, select all the ports that you want to enable on the selected server.

NOTE

If you enable more than one Fibre Channel port and the server is not configured to use Multipath I/O, data corruption may occur.

8. Click OK when you have finished configuring the Fibre Channel connections.

Storage Manager for SANs includes the Provision Storage Wizard, which you can use to create a logical unit number (LUN) on a Fibre Channel or iSCSI disk storage subsystem. Before you create a LUN on a storage subsystem, verify that all the following requirements are fulfilled:

- The storage subsystem supports Virtual Disk Service (VDS).
- The VDS hardware provider for the storage subsystem is installed on your server.
- Storage space is available on the storage subsystem.
- If the server to which you will be assigning the LUN will access the LUN through more than one Fibre Channel port or iSCSI initiator, Multipath I/O has been installed and is running on that server.

To create a LUN, select LUN Management. In the Actions pane, click Create LUN. Then follow the steps in the Provision Storage Wizard pages.

If you create a LUN and do not choose to create a volume for it immediately by using the Provision Storage Wizard, the disk associated with that LUN is visible to the server to which you assign it, but it is offline. Before you can create a partition or volume on that disk, you must first use Disk Management or DiskPart to bring the disk online.

You can also use Storage Manager for SANs to assign a LUN to a server or cluster with the Assign LUN wizard. To start the Assign LUN wizard, click LUN Management in Storage Manager, and then select the LUN you want to assign in the Results pane. Then click Assign LUN in the Actions pane.

Disk Partitioning

When you prepare any drive or volume to be used by Windows Server 2008, you must first partition the disk and then format the disk. Partitioning is defining and dividing the physical or virtual disk into logical volumes called partitions. Each partition functions as if it were a separate disk drive.

Windows Server 2008 supports two types of disk partitioning styles:

- *Master Boot Record (MBR)*
- *GUID partition table (GPT)*

MBR disks have been used as standard equipment on IBM-compatible personal computers since the days of MS-DOS. MBR disks support volume sizes of up to two terabytes (TB) and allow up to four primary partitions per disk. Alternatively, MBR disks support three primary partitions, one extended partition, and an unlimited number of logical drive letters.

Windows Server 2008 includes support for global unique identifier—or GUID—Partition Table (GPT) disks in cluster storage. GPT disks were introduced with computers equipped with Intel Itanium-based processors and the Extensible Firmware Interface (EFI) as an alternative to a Basic Input/Output System (BIOS) as the interface between the computer's hardware devices, its firmware, and the operating system. GPT provides a more flexible mechanism for partitioning disks than the older MBR partitioning scheme that has been common to PCs. GPT disks support volume sizes up to 18 exabytes (EB) and can store up to 128 partitions on each disk. Eighteen exabytes are roughly equivalent to 18 billion gigabytes. Critical system files are stored on GPT partitions, and GPT disks store a duplicate set of partition tables to ensure that partitioning information is retained.

Disk Storage Management

Windows Server 2008 supports two types of hard disk storage: basic and dynamic. All disks begin as *basic disks* until a server administrator converts them to dynamic status, one physical disk at a time. The biggest advantage that *dynamic disks* offer when compared to basic disks is that you can create software-based fault-tolerant volumes via the operating system from the volumes stored on dynamic disks (*mirrored volumes*/RAID 1 and Striping with Parity/RAID-5) volumes. Of course, you can always implement a hardware RAID solution by using a RAID controller and the disks can retain their basic status, or they can be converted to dynamic status under Windows Server 2008.

Basic Disks

A basic disk under Windows Server 2008 is essentially the same as the disk configuration under earlier versions of Windows: It is a physical disk with primary and extended partitions. Prior to Windows 2000, Microsoft did not call disks *basic* because that was the only type of disk available. There were no dynamic disks. As long as you use the File Allocation Table (FAT or FAT32) file system, Windows Vista, Windows XP, Windows 2000, Windows NT, Windows 9x, and the MS-DOS operating systems can access basic disks. You can create up to three primary partitions and one extended partition on a basic disk of four primary partitions.

You can create a single extended partition with logical drives on a basic disk. Basic disks store their configuration information in the Partition Table, which is stored on the first sector of each hard disk. The configuration of a basic disk consists of the partition information on the disk.

Dynamic Disks

A Windows Server 2008 dynamic disk is a physical disk configuration that does not use partitions or logical drives, and the MBR is not used. Instead, the basic partition table is modified and any partition table entries from the MBR are added as part of the Logical Disk Manager (LDR) database that stores dynamic disk information at the end of each dynamic disk. Dynamic disks can be divided into as many as 2,000 separate volumes, but you should limit the number of volumes to 32 for each dynamic disk to avoid slow boot time performance.

Dynamic disks do not have the same limitations as basic disks. For example, you can extend a dynamic disk "on the fly" without requiring a reboot. Dynamic disks are associated with disk groups, which are disks that are managed as a collection. This managed collection of disks helps organize dynamic disks. All dynamic disks in a computer are members of the same disk group. Each disk in a disk group stores replicas of the same configuration data. This configuration data is stored in the 1MB LDR region at the end of each dynamic disk.

Dynamic disks support five types of volumes: simple, spanned, mirrored, striped, and RAID-5. You can extend a volume on a dynamic disk. Dynamic disks can contain a virtually unlimited number of volumes, so you are not restricted to four volumes per disk as you are with basic disks. Regardless of the type of file system, only computers running Windows Vista (Ultimate and Business Editions), Windows XP Professional, Windows 2000 Professional or Server, Windows Server 2003, or Windows Server 2008 can directly access dynamic volumes on hard drives that are physically connected to the computer. However, computers running other operating systems can access dynamic volumes remotely when they connect to shared folders over the network.

Managing Basic Disks and Dynamic Disks

When you install Windows Server 2008, the system automatically configures the existing hard disks as basic NTFS disks, unless they have been configured as dynamic from a previous installation. Windows Server 2008 does not support dynamic disks on mobile PCs (laptops or notebooks). If you're using an older desktop machine that is not Advanced Configuration and Power Interface (ACPI) compliant, the Convert to Dynamic Disk option is not available.

Dynamic disks have some additional limitations. You can install Windows Server 2008 on a dynamic volume that you converted from a basic disk, but you cannot extend either the system or the boot volume on a dynamic disk. Any troubleshooting tools that cannot read the dynamic disk management database work only on basic disks.

EXAM ALERT

Dynamic disks are supported only on computers that use the Small Computer System Interface (SCSI), Fibre Channel, Serial Storage Architecture (SSA), or Integrated Drive Electronics (IDE). Portable computers, removable disks, and disks connected via Universal Serial Bus (USB) or FireWire (IEEE 1394) interfaces are not supported for dynamic storage. Dynamic disks are also not supported on hard drives with a sector size of less than 512 bytes.

You can format partitions with the FAT16, FAT32, or NTFS on a basic or a dynamic disk. However, you can format a dynamic volume as NTFS only from the Disk Management console. You must use Windows Server 2008 Explorer to format a dynamic volume as FAT or FAT32.

EXAM ALERT

Windows Server does not support formatting partitions or volumes larger than 32GB as FAT32. Partitions or volumes larger than 32GB that have been upgraded from previous operating systems can be mounted and used under Windows Server 2008. Partitions or volumes larger than 32GB that have been created by third-party utilities can also be mounted and used under Windows Server 2008.

When you install a fresh copy of Windows Server 2008 or when you perform an upgrade installation from Windows NT 4.0 Server with SP5, Windows 2000, or Windows Server 2003, the computer system defaults to basic disk storage. One or more of the disk drives could already be configured as dynamic if you upgraded from Windows 2000 Server, Windows Server 2003, or Windows Server 2008 (or if you import a "foreign disk" from a Windows 2000 Server or from another Windows Server 2003 computer). A disk is considered foreign when you move it from one computer to another computer, until you select the Import option for it in the Disk Management console.

Converting Basic Disks to Dynamic Disks

From the graphical user interface (GUI), you use the Windows Server 2008 Disk Management console (an MMC snap-in) to upgrade a basic disk to a dynamic disk. The Disk Management snap-in is located in the Computer

Management console and the Server Management console. You must be a member of the local Administrators group or the backup operators group, or else the proper authority must be delegated to you if you are working within an Active Directory environment to make any changes to the computer's disk management configuration.

For the conversion to succeed, any disks to be converted must contain at least 1MB of unallocated space. Disk Management automatically reserves this space when creating partitions or volumes on a disk, but disks with partitions or volumes created by other operating systems might not have this space available. (This space can exist even if it is not visible in Disk Management.) Windows Server 2008 requires this minimal amount of disk space to store the dynamic database, which the operating system that created it maintains. Before you convert any disks, close any programs that are running on those disks. After you convert a disk to dynamic, remember that you can have only one operating system that is bootable on each dynamic disk!

To convert a basic disk to a dynamic disk from the Disk Management console, follow these steps:

1. Open the Disk Management console.
2. Right-click the basic disk that you want to convert to a dynamic disk and click Convert to Dynamic Disk.

When you upgrade an empty basic disk to a dynamic disk, you do not need to reboot. However, if you convert a basic disk that already has partitions on it, or if the basic disk contains the system or boot partitions, you must restart your computer for the change to take effect.

NOTE

You can mount and dismount volumes from the command line with the `mountvol.exe` command. On basic disks, if you type **`mountvol x: /p`**, where *`x:`* represents the volume's drive letter, you can dismount a volume and take it offline. Unfortunately, the `/p` parameter is not supported on dynamic disks. The command `mountvol x: /l` displays the specified drive letter's volume ID. By using the syntax `mountvol x: volume_ID`, you can assign a drive letter to the volume and remount it to bring it back online. For example, the command `mountvol S: \\?\Volume{55e769f0-40d5-11d4-b223-806d6172696f}\` would assign drive letter S: to the volume ID specified. You can also use Disk Management to mount and dismount volumes from the GUI. You can mount and dismount volumes by right-clicking a volume and selecting Change Drive Letter and Paths. By removing the drive letter and any other paths (*mount points*) for the volume, you take the volume offline.

To convert a basic disk to a dynamic disk from the Windows Server 2008 command line:

1. Open a command prompt window, type **`diskpart`**, and press Enter.
2. Type **`commands`** or **`help`** to view a list of available commands.
3. Type **`select disk 0`** to select the first hard disk (**`select disk 1`** to select the second hard disk, and so on) and press Enter.
4. Type **`convert dynamic`** and press Enter.
5. Type **`exit`** to quit the `diskpart.exe` tool and then restart the computer to have the new configuration take effect.

When you convert a basic disk to a dynamic disk, any existing partitions on the basic disk become *simple volumes* on the dynamic disk. Any existing mirror sets, stripe sets, stripe sets with parity, or volume sets become mirrored volumes, *striped volumes*, dynamic *RAID-5 volumes*, or *spanned volumes*, respectively. After you convert a basic disk to a dynamic disk, you cannot change the volumes back to partitions. Instead, you must first delete all dynamic volumes on the disk, right-click the disk in Disk Management, and then select the Convert to Basic Disk option.

NOTE

Converting to a dynamic disk is a one-way process. Yes, you can convert a dynamic disk back to a basic disk, but you'll lose all your data. Obviously, this loss is a major consideration! If you find yourself needing to do it, first back up your data and then you can delete all the volumes on the disk, convert the disk to basic, and restore your data.

Because the conversion process from basic to dynamic is per physical disk, a disk has all dynamic volumes or all basic partitions; you won't see both on the same physical disk. Remember, you do not need to restart your computer when you upgrade from an empty basic to a dynamic disk from the Disk Management console. However, you do have to restart your computer if you use the *`diskpart.exe`* command-line tool for the conversion; if you convert a disk containing the system volume, boot volume, or a volume with an active paging file; or if the disk contains any existing volumes or partitions.

NOTE

When you upgrade or convert a basic disk to a dynamic disk, at least 1MB of free space must be available for the dynamic disk database. Under normal circumstances, this requirement should not be a problem.

Converting Dynamic Disks Back to Basic Disks

You must remove all volumes (and therefore all data) from a dynamic disk before you can change it back to a basic disk. After you convert a dynamic disk back to a basic disk, you can create only partitions and logical drives on that disk. After being converted from a basic disk, a dynamic disk can no longer contain partitions or logical drives, nor can older versions of Windows before Windows 2000 access the dynamic disk. To revert a dynamic disk to a basic disk, follow these steps:

1. Back up the data on the dynamic disk.
2. Open Disk Management.
3. Delete all the volumes on the disk.
4. Right-click the dynamic disk that you want to change back to a basic disk and then click Convert to Basic Disk.
5. Restore the data to the newly converted basic disk.

Converting Basic Disks to GPT Disks

You can change a disk from MBR to GPT partition style as long as the disk does not contain any partitions or volumes. You cannot use the GPT partition style on removable media, or on cluster disks that are connected to shared SCSI or Fibre Channel buses that are used by the Cluster service.

Take these steps to change a master boot record disk into a GUID partition table disk within the Windows interface:

1. Back up or move the data on the basic MBR disk you want to convert into a GPT disk.
2. If the disk contains any partitions or volumes, right-click any volumes on the disk and then click Delete Partition or Delete Volume.
3. Right-click the MBR disk that you want to change into a GPT disk and then click Convert to GPT Disk.

Take these steps to change a master boot record disk into a GUID partition table disk from a command line:

1. Back up or move the data on the basic MBR disk you want to convert into a GPT disk.
2. Open a command prompt and type **`diskpart`**. If the disk does not contain any partitions or volumes, skip to step 6.

3. At the `diskpart` prompt, type **`list volume`**. Make note of the volume number you want to delete.
4. At the `diskpart` prompt, type **`select volume <volumenumber>`**.
5. At the `diskpart` prompt, type **`delete volume`**.
6. At the `diskpart` prompt, type **`list disk`**. Make note of the disk number of the disk that you want to convert to a GPT disk.
7. At the `diskpart` prompt, type **`select disk <disknumber>`**.
8. At the `diskpart` prompt, type **`convert gpt`**.

Converting GPT Disks to Basic Disks

You can change a disk from GPT to MBR partition system as long as the disk is empty and contains no volumes. If it has data, you must back up your data and then delete all partitions or volumes before converting the disk.

To change a GUID partition table disk into a master boot record disk within the Windows interface, follow these steps:

1. Back up or move all volumes on the basic GPT disk you want to convert into a MBR disk.
2. If the disk contains any partitions or volumes, right-click any volumes on the disk and then click Delete Volume.
3. Right-click the GPT disk that you want to change into an MBR disk and then click Convert to MBR disk.

To change a GUID partition table disk into a master boot record disk using the command line, follow these steps:

1. Back up or move all volumes on the basic GPT disk you want to convert into a MBR disk.
2. Open a command prompt and type **`diskpart`**. If the disk does not contain any partitions or volumes, skip steps 3-5.
3. At the `diskpart` prompt, type **`list volume`**. Make note of the volume number you want to delete.
4. At the `diskpart` prompt, type **`select volume <volumenumber>`**.
5. At the `diskpart` prompt, type **`delete volume`**.
6. At the `diskpart` prompt, type **`list disk`**. Make note of the disk number of the disk that you want to convert to a GPT disk.

7. At the `diskpart` prompt, type **`select disk <disknumber>`**.
8. At the `diskpart` prompt, type **`convert mbr`**.

Moving Disks to Another Computer

To move disks to another computer, follow these steps:

1. Before you disconnect the disks, use Disk Management on the source computer and make sure that the status of all volumes on each of the disks is healthy. For any volumes that are not healthy, repair the volumes before you move the disks.
2. If the disks are dynamic, right-click each disk and select Remove Disk.
3. Power off the computer, remove the physical disks, and then install the physical disks on the target computer.
4. When you restart the target computer, the Found New Hardware dialog box should appear. If not, click Start, Control Panel, Add Hardware to launch the Add Hardware Wizard. Use the wizard to properly install the disks on the computer.
5. Open Disk Management on the target computer.
6. Click Action, Rescan Disks from the menu bar.
7. For any disks that are labeled Foreign, right-click them, click Import Foreign Disks, and then follow the instructions provided by the Disk Management console.

CAUTION

You can move dynamic disks only to Windows Server 2008, Windows Server 2003, Windows 2000, or Windows XP Professional computers.

Reactivating a Missing or Offline Disk

A dynamic disk can become "missing" or "offline" when it is somehow damaged, it suddenly loses power, or it has its data cable disconnected while still powered on. Unfortunately, you can reactivate only dynamic disks—not basic disks.

Follow these steps to reactivate a missing or offline dynamic disk:

1. Launch the Disk Management console.
2. Right-click the disk marked Missing or Offline and then select the Reactivate Disk option.

3. After the disk is reactivated, the disk should be labeled as "online."
4. Exit from the Disk Management MMC.

Basic Partitions

You can create primary partitions, extended partitions, and logical drives only on basic disks. Partitions and logical drives can reside only on basic disks. You can create up to four primary partitions on a basic disk or up to three primary partitions and one extended partition. You can use the free space in an extended partition to create multiple logical drives. You must be a member of the local Administrators group or the backup operators group, or else the proper authority must be delegated to you (if you are working within an Active Directory environment) to create, modify, or delete basic volumes.

NOTE

You can extend a basic partition with the `diskpart.exe` command-line utility, but it must be formatted as NTFS, it must be adjacent to contiguous unallocated space on the same physical disk, and it can be extended onto only unallocated space that resides on the same physical disk.

To create or delete a partition or logical drive, you can use the `diskpart.exe` command-line tool or the GUI and perform the following steps:

1. Open the Disk Management console.
2. Perform one of the following options:
   - Right-click an unallocated region of a basic disk and click New Partition.
   - Right-click an area of free space within an extended partition and click New Logical Drive.
   - Right-click a partition or logical drive and select Delete Partition to remove that partition or logical drive. Click Yes to confirm the deletion.
3. When you choose to create a new partition or logical drive, the New Partition Wizard appears. Click Next to continue.
4. Click Primary Partition, Extended Partition, or Logical Drive and answer the prompts regarding disk space allocation and so on as requested by the wizard to finish the process.

You must first create an extended partition before you can create a new logical drive, if no extended partition exists already. If you choose to delete a partition, all data on the deleted partition or logical drive is lost. You cannot recover deleted partitions or logical drives. You cannot delete the system partition, boot partition, or any partition that contains an active paging file. The operating system uses one or more paging files on disk as virtual memory that can be swapped into and out of the computer's physical random access memory (RAM) as the system's load and volume of data dictate.

CAUTION

Windows Server 2008 requires that you delete all logical drives and any other partitions that have not been assigned a drive letter within an extended partition before you delete the extended partition itself.

Dynamic Volumes

With dynamic disks, you are no longer limited to four volumes per disk (as you are with basic disks). You can install Windows Server 2008 onto a dynamic volume; however, these volumes must contain the partition table (which means that these volumes must have been converted from basic to dynamic under Windows Server 2008, Windows Server 2003, Windows XP Professional, or Windows 2000). You cannot install Windows Server 2008 onto dynamic volumes that you created directly from unallocated space. Only computers running Windows XP Professional, the Windows 2000 family of operating systems, the Windows Server 2003 family of products, or the Windows Server 2008 can access dynamic volumes. The five types of dynamic volumes are

- Simple
- Spanned
- Mirrored
- Striped
- RAID-5

Windows Server 2008 supports all five dynamic volume types. You must be a member of the local Administrators group or the backup operators group, or you must have the proper permissions delegated to you (if you are working within an Active Directory environment) to create, modify, or delete dynamic volumes.

CAUTION

When you create dynamic volumes on dynamic disks using the Disk Management console, you only have the option of formatting new dynamic volumes with the NTFS file system. However, you can use the `format.exe` command at a command prompt window to format a dynamic volume using the FAT or FAT32 file system. For example, you can create a new dynamic volume using Disk Management; do not format the drive, and be sure to assign a drive letter to it. Then, at a command prompt, type **`format x: /fs:fat32`**, where *`x:`* represents the drive letter and `fat32` represents the file system that you want to format on the volume. You can alternatively specify `fat` or `ntfs` as the file system when you use the `format` command.

Simple Volumes

A simple volume consists of disk space on a single physical disk. It can consist of a single area on a disk or multiple areas on the same disk that are linked together. To create a simple volume, follow these steps:

1. Open Disk Management.
2. Right-click the unallocated space on the dynamic disk where you want to create the simple volume and then click New Volume.
3. Using the New Volume Wizard, click Next, click Simple, and then follow the instructions and answer the questions asked by the wizard.

Here are some guidelines about simple volumes:

- You can create simple volumes on dynamic disks only.
- Simple volumes are not fault tolerant.
- Simple volumes cannot contain partitions or logical drives.
- Neither MS-DOS nor Windows operating systems other than Windows Server 2008, Windows Server 2003, Windows XP Professional, and Windows 2000 can access simple volumes.

Spanned Volumes

A spanned volume consists of disk space from more than one physical disk. You can add more space to a spanned volume by extending it at any time. To create a spanned volume, follow these steps:

1. Open Disk Management.

2. Right-click the unallocated space on one of the dynamic disks where you want to create the spanned volume and then click New Volume.
3. Using the New Volume Wizard, click Next, click Spanned, and then follow the instructions and answer the questions asked by the wizard.

Here are some guidelines about spanned volumes:

- You can create spanned volumes on dynamic disks only.
- You need at least two dynamic disks to create a spanned volume.
- You can extend a spanned volume onto a maximum of 32 dynamic disks.
- Spanned volumes cannot be mirrored or striped.
- Spanned volumes are not fault tolerant.

Extending Simple or Spanned Volumes

Simple volumes are the most basic volumes on dynamic disks. If you extend a simple volume to another dynamic disk, it automatically becomes a spanned volume. You can extend a simple volume to make it a spanned volume, and you can also further extend a spanned volume to add disk storage capacity to the volume. You cannot extend a mirrored volume. Take these steps to extend a simple or a spanned volume:

1. Open Disk Management.
2. Right-click the simple or spanned volume you want to extend, click Extend Volume, and then follow the instructions and answer the questions asked by the Extend Volume Wizard.

You should be aware of the many rules about extending a simple or a spanned volume:

- You can extend a volume only if it contains no file system or if it is formatted using NTFS. You cannot extend volumes formatted using FAT or FAT32.
- After a volume is extended onto multiple disks (spanned), you cannot mirror the volume, nor can you make it into a striped volume or a RAID-5 volume.
- You cannot extend boot volumes, system volumes, striped volumes, mirrored volumes, or RAID-5 volumes.

- After a spanned volume is extended, no portion of it can be deleted without the entire spanned volume being deleted.
- You can extend a simple or a spanned volume only if the volume was created as a dynamic volume under Windows Server 2003 or Windows Server 2008. You cannot extend a simple or spanned volume that was originally converted from basic to dynamic under Windows 2000 or Windows XP Professional.
- You can extend simple and spanned volumes on dynamic disks onto a maximum of 32 dynamic disks.
- Spanned volumes write data to subsequent disks only as each disk volume fills up. Therefore, a spanned volume writes data to physical disk 0 until it fills up, then it writes to physical disk 1 until its available space is full, then it writes to physical disk 2, and so on. However, if just one disk fails as part of the spanned volume—all the data contained on that spanned volume is lost.

Striped Volumes

A striped volume stores data in stripes on two or more physical disks. Data in a striped volume is allocated alternately and evenly (in stripes) to the disks contained within the striped volume. Striped volumes can substantially improve the speed of access to the data on disk. Striped volumes are often referred to as RAID-0; this configuration tends to enhance performance, but it is not fault tolerant. To create a striped volume, follow these steps:

1. Open Disk Management.
2. Right-click unallocated space on one of the dynamic disks where you want to create the striped volume and select New Volume from the menu that appears.
3. Using the New Volume Wizard, click Next, select Striped, and follow the instructions and answer the questions asked by the wizard.

Here are some guidelines about striped volumes:

- You need at least two physical dynamic disks to create a striped volume.
- You can create a striped volume onto a maximum of 32 disks.
- Striped volumes are not fault tolerant.

- For increased volume capacity, select disks that contain similar amounts of available disk space. A striped volume's capacity is limited to the space available on the disk with the smallest amount of available space.
- Whenever possible, use disks that are the same model and from the same manufacturer.
- Striped volumes cannot be extended or mirrored. If you need to make a striped volume larger by adding another disk, you first have to delete the volume and then re-create it.

Mirrored Volumes and RAID-5 Volumes

You can create mirrored volumes and RAID-5 volumes only on dynamic disks running on Windows Server 2008, Windows Server 2003, or Windows 2000 Server computers. Both mirrored volumes and RAID-5 volumes are considered fault tolerant because these configurations can handle a single disk failure and still function normally. Mirrored volumes and RAID-5 volumes both require that an equal amount of disk space be available on each disk that will be a part of these volumes. A mirrored volume must use two physical disks—no more and no fewer than two physical hard disk drives. A RAID-5 volume must use at least three physical hard disks up to a maximum of 32 physical disks.

Many network administrators and consultants agree that hardware-based fault-tolerant solutions are more robust and reliable than software-based fault-tolerant configurations. By installing one or more RAID controller adapter cards into a server, you can set up several different types of hardware fault tolerance, such as mirroring, RAID-5, RAID 10 (mirrored volumes that are part of a striped array set), and RAID 0+1 (striped volumes that are part of a mirrored set). When you use hardware RAID, you can retain basic disks or you can convert disks to dynamic; hardware RAID is hidden to Windows Server 2008. Of course, it's less expensive to implement a software solution, such as setting up mirrored volumes or RAID-5 volumes using the Disk Management console in Windows Server 2008, but often the improved performance, reliability, and flexibility of hardware-based RAID far outweighs its extra cost.

Working with Mirrored Volumes

A mirrored volume uses volumes stored on two separate physical disks to "mirror" (write) the data onto both disks simultaneously and redundantly. This configuration is also referred to as RAID-1. If one of the disks in the mirrored configuration fails, Windows Server 2008 writes an event into the system log of the Event Viewer. The system functions normally (unless the second disk fails) until the

failed disk is replaced and then the volume can be mirrored again. Mirrored volumes cost you 50% of your available storage space because of the built-in redundancy. If you mirror two 70GB disks, you are left with just 70GB of space rather than 140GB.

You can make mirrored volumes more robust by installing a separate hard disk controller for each disk; technically, this is known as disk duplexing. Disk duplexing is better than disk mirroring because you alleviate the single point of failure by having one controller for each disk. Under Windows Server 2008, disk duplexing is still referred to as disk mirroring. You can create mirrored volumes only by using dynamic disks. To create a new empty mirrored volume from unallocated space, follow these steps:

1. Open Disk Management.
2. Right-click an area of unallocated space on a dynamic disk and select New Volume.
3. Click Next for the New Volume Wizard welcome window.
4. Click Mirrored as the volume type option and click Next.
5. Select one of the available dynamic disks and click Add.
6. Enter the amount of storage space to be used (in MB) for this mirrored volume, up to the maximum available space on the first disk that you selected, and then click Next.
7. Assign the new volume a drive letter, mount the volume in an empty NTFS folder, or choose not to assign the volume a drive letter or path and click Next.
8. Choose whether to format the new mirrored volume. If you choose to format the new volume, specify the following settings:
   - File system (NTFS is the only option for dynamic volumes under the Disk Management console)
   - Allocation unit size
   - Volume label
   - Mark the check box to Perform a Quick Format (if desired)
   - Mark the check box to Enable File and Folder Compression (if desired)
9. Click Next to continue.
10. Click Finish to complete the New Volume Wizard.

To create a mirrored volume from a boot or system volume, or to create a mirrored volume from an existing volume that already contains data, follow these steps:

1. Open Disk Management.
2. Right-click an existing dynamic volume and select Add Mirror.
3. Select one of the available dynamic disks on which to create the redundant volume and click Add Mirror.

You should be aware of some important issues and guidelines before you attempt to mirror system or boot volumes:

- When you mirror volumes stored on ATA disks, you must change the jumper switch on the nonfailed drive to the master position (on restart) if the master disk on the primary IDE channel fails, until you replace the failed disk.
- Microsoft does not recommend mirroring the system volume using one ATA disk and one SCSI disk because the system can encounter startup problems if one of the drives fails.
- If you plan to use separate SCSI controllers for each SCSI disk that you will mirror, you should use identical controllers from the same manufacturer.
- For a mirrored system volume, be sure to run a test to simulate a disk failure and attempt to start the system from the remaining mirrored volume. Perform this test regularly as part of your backup routine before a real failure occurs.

You can stop mirroring a volume by either breaking or removing the mirror. When you break a mirrored volume, each volume that makes up the mirror becomes an independent simple volume, and they are no longer fault tolerant. When you remove a mirrored volume, the removed mirrored volume becomes unallocated space on its disk, whereas the remaining mirrored volume becomes a simple volume that is no longer fault tolerant. All data that was stored on the removed mirrored volume is erased. To break a mirrored volume, take these steps:

1. Open Disk Management.
2. Right-click one of the mirrored volumes that you want to break and select Break Mirrored Volume.
3. Click Yes in the Break Mirrored Volume message box.

If you want to completely destroy one of the mirrored volumes and leave just one of the volumes intact, you need to perform a removal procedure instead of simply breaking the mirrored volumes. Take these steps to remove a mirrored volume:

1. Open Disk Management.
2. Right-click a mirrored volume and then select Remove Mirror.
3. At the Remove Mirror dialog box, select the disk from which you want to completely erase the mirrored volume and turn the volume into unallocated space. The remaining volume stays with all its data intact as a simple volume.
4. Click the Remove Mirror button.
5. Click Yes to confirm the removal action at the Disk Management message box that appears.

Working with RAID-5 Volumes

Windows Server 2008 supports disk striping with parity (RAID-5) volumes with the Disk Management console and through the `diskpart.exe` command-line utility. You need a minimum of three physical disks to create a RAID-5 volume. You are limited to a maximum of 32 physical disks in creating a RAID-5 volume under Windows Server 2008. In creating a fault-tolerant volume using a RAID-5 configuration, you effectively lose an amount of storage equivalent to the capacity of one of the disks because parity information gets stored across all the disks (disk striping with parity). For example, if you use three 70GB disks, your RAID-5 volume can store up to approximately 140GB of data. The remaining 70GB is used for storing the important parity data across all three disks in case of a failure—a 33% loss of available storage capacity. However, as you add disks to a RAID-5 volume, the percentage of lost storage space diminishes. For example, if you use five 70GB disks, you would again lose 70GB of available storage capacity, but that accounts only for a 20% overall loss in capacity (70GB divided by 350GB total available disk space equals .20, or 20%). In the event that one disk within the RAID-5 volume fails, the remaining disks can re-create the data stored on the failed disk as soon as a new disk is installed to replace the failed disk. To create a RAID-5 volume using Disk Management, follow these steps:

1. Open Disk Management. Be sure that the computer has three or more dynamic disks—each with unallocated space.
2. Right-click an area of unallocated space on one of the dynamic disks that you want to use for the RAID-5 volume and select New Volume.

3. Click Next for the Welcome to the New Volume Wizard window.
4. Select the RAID-5 option button and click Next.
5. Select each available disk that you want to use as part of the RAID-5 volume from within the Available list box and click Add for each one. You must select at least 3 disks and no more than 32 disks.
6. Select any disks that you do not want to use as part of the RAID-5 volume within the Selected list box, and click Remove to remove any disks that you do not want to include as a part of the RAID-5 volume.
7. Enter the storage capacity that you want for the RAID-5 volume in the Select the Amount of Space in MB spin box and click Next to continue.
8. Choose to assign the volume a drive letter, mount the volume in an empty NTFS folder, or choose to not assign a drive letter or path to the new RAID-5 volume and click Next.
9. Choose whether to format the new RAID-5 volume. If you choose to format the new volume, specify the following settings:
   - File system (NTFS is the only option for dynamic volumes under the Disk Management console).
   - Allocation unit size.
   - Volume label.
   - Mark the check box to Perform a Quick Format (if desired).
   - Mark the check box to Enable File and Folder Compression (if desired).
10. Click Next to continue.
11. Click Finish to complete the New Volume Wizard.

If one disk within a RAID-5 volume is intermittently failing, you can attempt to reactivate it by right-clicking the disk and selecting Reactivate Disk. If one disk within a RAID-5 volume appears to be permanently failed, you can replace that failed disk with another dynamic disk attached to the computer or you can install a new disk. To regenerate the RAID-5 volume, right-click the RAID-5 volume on the failed disk and select Repair Volume. The replacement disk must contain at least as much unallocated space as that used by the failed disk for the RAID-5 volume.

Mount Points

When you prepare a volume in Windows Server 2008, you can assign a drive letter to the new volume or you can create a mount point with the new volume as an empty NTFS folder. By using volume mount points, you can graft, or mount, a target partition into a folder on another drive. The mounting is handled transparently to the user and applications. With the NTFS volume mount points feature, you can surpass the 26-drive-letter limitation.

To assign a mount-point folder path to a drive by using the Windows interface, follow these steps:

1. In Disk Manager, right-click the partition or volume where you want to assign the mount-point folder path, and then click Change Drive Letter and Paths.
2. To assign a mount-point folder path, click Add. Click Mount in the following empty NTFS folder, type the path to an empty folder on an NTFS volume, or click Browse to locate it (see Figure 3.4).

To remove the mount-point folder path, click it and then click Remove.

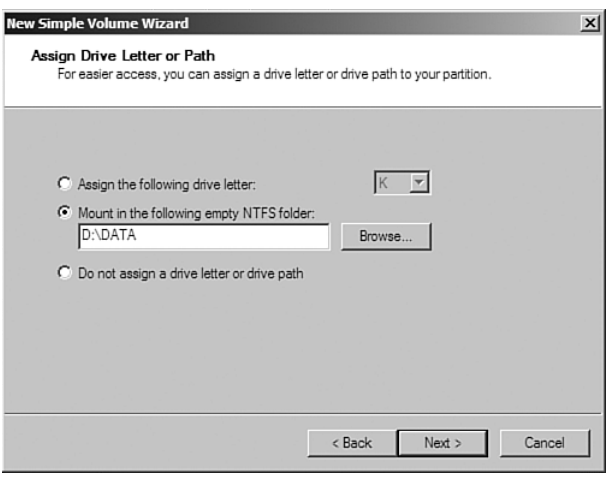

FIGURE 3.4 Mounting a volume to an NTFS folder.

Exam Prep Questions

1. You have a new Windows Server 2008 computer with multiple hard drives. You want to implement RAID1 on the server. What do you need to first?

   - ❍ **A.** Enable write catching on the first disk.
   - ❍ **B.** Enable write catching on the second disk.
   - ❍ **C.** Convert the basic disk to dynamic disks.
   - ❍ **D.** Convert the dynamic disk to basic disks.

2. You have a Windows Server 2008 computer with two hard drives. What type of RAID can you implement to provide fault tolerance?

   - ❍ **A.** RAID 0
   - ❍ **B.** RAID 1
   - ❍ **C.** RAID 5
   - ❍ **D.** RAID 1 and 5

3. Which of the following types of fault-tolerant (RAID) configurations (without using a RAID controller or third-party software) can you set up, using either Disk Management or the `diskpart.exe` command-line tool under Windows Server 2008? (Choose three.)

   - ❍ **A.** RAID 0
   - ❍ **B.** RAID 2
   - ❍ **C.** RAID 5
   - ❍ **D.** RAID 1
   - ❍ **E.** RAID 0+1
   - ❍ **F.** RAID 10

4. On which of the following hard-disk configurations can you install a fresh copy of Windows Server 2008? (Choose two.)

   - ❍ **A.** On a basic partition
   - ❍ **B.** On a dynamic volume that was created from unallocated space
   - ❍ **C.** On a dynamic volume that was upgraded from a basic volume
   - ❍ **D.** On a basic volume that is part of a removable disk
   - ❍ **E.** On a dynamic disk that already has Windows XP Professional installed on it

5. You have a Windows Server 2008 computer with three hard drives installed. After Windows has been installed, each disk has at least 12GB of available disk space. What can you do to provide fault tolerance data system while maximizing disk space?

- ❍ **A.** Create a striped volume on the second and third disk.
- ❍ **B.** Create a striped volume on all three disks.
- ❍ **C.** Create a striped volume using the second and third disk.
- ❍ **D.** Create a striped volume with parity using all three hard drives.

6. You have a Windows Server 2008 computer. You want to provide fault tolerance for the volume containing the operating system. Each disk is configured as a basic disk. The operating system is installed on the first disk. What should you do?

- ❍ **A.** Configure a new mirrored volume using disk 0 and 1.
- ❍ **B.** Convert disk 0 to a dynamic disk. Configure a new mirrored volume using disk 0 and 1.
- ❍ **C.** Convert disk 1 to a dynamic disk. Configure a new mirrored volume using disk 0 and 1.
- ❍ **D.** Convert disk 0 and disk 1 to dynamic disks. Configure the two disks as a striped set using disk 0 and 1.
- ❍ **E.** Convert disk 0 and disk 1 to dynamic disks. Configure the two disks as a mirrored volume.

7. How many primary partitions without an extended partition can reside on a basic MBR disk under Windows Server 2003?

- ❍ **A.** 3
- ❍ **B.** 4
- ❍ **C.** 1
- ❍ **D.** 128

8. Which of the following statements are true about basic disks under Windows Server 2008? (Choose two.)

- ❍ **A.** Basic disks are not supported under Windows Server 2008.
- ❍ **B.** Basic disks that were configured as one disk striping with parity set under Windows NT Server 4.0 are mounted automatically after the server is upgraded to Windows Server 2003.
- ❍ **C.** Basic disks can be formatted only as FAT or FAT32.
- ❍ **D.** You cannot convert dynamic disks back to basic disks without deleting all data and volumes on the disks first.
- ❍ **E.** IEEE 1394 disks can only be basic disks.

9. You have a Windows Server 2008 computer. What command do you use to convert a basic disk to a dynamic disk?

- ❍ **A.** `diskpart basic to dynamic`
- ❍ **B.** `diskpart convert dynamic`
- ❍ **C.** `format c: /fs:dynamic`
- ❍ **D.** `convert c: /fs:dynamic`

10. What command would you use to make an iSCSI volume connect every time you boot your system?

- ❍ **A.** `iscsicli AddTarget`
- ❍ **B.** `iscsicli AddPersistentDevices`
- ❍ **C.** `iscsicli RemovePersistentDevices`
- ❍ **D.** `iscsicli ClearPersistentDevices`

11. What command would you use to remove all iSCSI volumes so that they do not connect when you boot your system?

- ❍ **A.** `iscsicli AddTarget`
- ❍ **B.** `iscsicli AddPersistentDevices`
- ❍ **C.** `iscsicli RemovePersistentDevices`
- ❍ **D.** `iscsicli ClearPersistentDevices`

12. What command would you use to change a master boot record disk into a GUID partition table disk?

- ❍ **A.** `fdisk`
- ❍ **B.** `format`
- ❍ **C.** `diskpart`
- ❍ **D.** `convert`

13. What is the default port used by iSCSI?

- ❍ **A.** TCP port 389
- ❍ **B.** TCP port 443
- ❍ **C.** TCP port 1433
- ❍ **D.** TCP port 3260

14. You have the following address:

iqn.2534-05.com.microsoft:storage.tape.sys2.123

What type of address is this?

- ❍ **A.** MAC Address
- ❍ **B.** IP Address
- ❍ **C.** iSCSI Qualified Name
- ❍ **D.** Extended Unique Identifier

Answers to Exam Prep Questions

1. Answer C is correct. RAID 1 (disk mirroring) needs two disks to be implemented. Before you can enable RAID 1 using Windows Server 2008, you need to convert basic disks to dynamic disks, which converts the partitions into volumes. Answers A and B are incorrect because write catching improves disk performance but does not help implement RAID 1. Answer D is incorrect because to implement RAID 1 using Windows Server 2008, you must use dynamic disks.

2. Answer B is correct. RAID 1, disk mirroring, uses two disks to provide fault tolerance. In RAID 1, whatever is written to one disk is written to the other. Answer A is incorrect because RAID 0, disk striping, does enhance performance, but does not provide fault tolerance. Answers C and D are incorrect because RAID 5 (disk striping with parity) needs three disks to be implemented.

3. Answers A, C, and D are correct. Windows Server 2003 supports disk striping (RAID 0), disk striping with parity (RAID 5), and disk mirroring (RAID 1). Answer B is incorrect because Windows Server 2008 does not natively support hammering code error-correcting code (ECC) disk configurations (RAID 2). Answer E is incorrect because Windows Server 2008 does not natively support striped volumes that are part of a mirrored set (RAID 0+1). Answer F is incorrect because Windows Server 2008 does not natively support mirrored volumes that are part of a striped array set (RAID 10).

4. Answers A and C are correct. You can install a fresh copy of Windows Server 2008 onto a basic partition and onto a dynamic volume if the volume was originally a basic partition that was upgraded to dynamic because Windows Server 2008 can be installed only on a disk that contains a partition table. Answer B is incorrect because a dynamic volume that was created from unallocated space does not contain a partition table. Answer D is incorrect because Windows Server 2008 Setup does not support installation onto removable media such as USB disks or IEEE 1394 (FireWire) disks. Answer E is incorrect because you can install only one operating system per dynamic disk.

5. Answer D is correct. Of these four options, only striped volume with parity is fault tolerant. If one hard drive fails, the data will still be accessible. Answers A, B, and C are incorrect because although striped volumes do provide better performance, they do not provide fault tolerance. If one disk fails, you loose all data.

6. Answer E is correct. To use RAID provided by Windows Server 2008, you must use dynamic disks. To provide fault tolerance, you create a mirrored set using disk 0 and 1. Answers A, B, and C are incorrect because a basic disk cannot be used for mirror or RAID 5 disks. Answer D is incorrect because the striped set is not fault tolerant.

7. Answer B is correct. You can create up to four primary partitions on a basic disk without an extended partition. Answer A is incorrect because you are limited to three primary partitions only if there is an extended partition on the disk. Answer C is incorrect because you can have more than one primary partition on a basic disk. Answer D is incorrect because you are limited to a maximum of four primary partitions on a basic MBR disk; a basic GPT disk can host up to 128 partitions.

8. Answers D and E are correct. To convert dynamic disks back to basic disks, you must remove all volumes on the disk, which means that all data must be removed as well. IEEE 1394 (or FireWire) disks cannot be converted to dynamic; therefore, they can only be basic disks. Answer A is incorrect because basic disks are supported under Windows Server 2008. Answer B is incorrect because basic disk sets that were created under previous versions of Microsoft server products are not mounted by the operating system; you must use the `ftonline.exe` tool on the setup CD-ROM. Answer C is incorrect because basic disks (and dynamic disks) can be formatted as FAT, FAT32, or NTFS.

9. Answer B is correct. The command to use to convert a basic disk to a dynamic disk is `diskpart convert dynamic`. Answer A is incorrect because the command is `diskpart convert dynamic`. Answers C and D are incorrect because the `format` and `convert` commands cannot be used to convert basic to dynamic disks.

10. Answer B is correct. The `iscsicli AddPersistentDevices` command makes an iSCSI device persistent so that it connects every time the system boots. Answer A is incorrect because `iscsicli AddTarget` only creates a connection to a volume or device. If you reboot your system, it does not automatically connect. Answers C and D are incorrect because the `iscsicli RemovePersistentDevices` command prevents the reconnection to a specified volume, and the `iscsicli ClearPersistentDevices` command removes all volumes and devices from the list of persistent devices.

11. Answer D is correct. The `iscsicli RemovePersistentDevices` command prevents reconnection to a specified volume. Answer A is incorrect because `iscsicli AddTarget` only creates a connection to a volume or device. If you reboot your system, it does not automatically connect. Answer B is incorrect because the `iscsicli AddPersistentDevices` command makes an iSCSI device persistent so that it connects every time the system boots. Answer C is incorrect because the `iscsicli RemovePersistentDevices` command prevents the reconnection to a specified volume, not all volumes.

12. Answer C is correct. The `diskpart` command is a powerful disk management tool that can convert an MBR disk to a GUID partition table disk. Answer A is incorrect because `fdisk` is a partitioning tool used in older operating systems. Answer B is incorrect because the `format` command is used to format a disk, which would define FAT32 or NTFS. Answer D is incorrect because the `convert` command could be used to convert a FAT32 volume to a NTFS volume.

13. Answer D is correct. The default port for iSCSI is 3260. Answer A is incorrect because TCP port 389 is used by Lightweight Directory Access Protocol (LDAP). Answer B is incorrect because TCP port 443 is used by SSL. Answer C is incorrect because TCP port 1433 is used by SQL servers.

14. Answer C is correct. The address is an example of the iSCSI Qualified Name, which is the most commonly used iSCSI address. Answer A is incorrect because the MAC addresses used to identify network cards are 48-bits/12 hexadecimal numbers. Answer B is incorrect because an IPv4 address is a 32-bit address consisting of four 8-bit octets, each octet ranging from 0-255. Answer D is incorrect because the Extended Unique Identifier is another addressing scheme used by iSCSI, which is provided by the IEEE Registration authority in accordance with EUI-64 standard (EUI is short for extended unique identifier).

Need to Know More?

For more information about storage technologies, including NTFS and FAT file systems and Basic and Dynamic Disks, visit the following website:

http://technet2.microsoft.com/windowsserver/en/library/57282c22-30e9-4d52-9c6d-2d2db8c56adc1033.mspx?mfr=true

For more information about the `diskpart.exe` command, visit the following websites:

http://support.microsoft.com/kb/300415

http://technet2.microsoft.com/WindowsServer/en/Library/ca099518-dde5-4eac-a1f1-38eff6e3e5091033.mspx?mfr=true

For more information about iSCSI, including links to the iSCSI Software Initiator, visit the following website:

http://www.microsoft.com/windowsserver2003/technologies/storage/iscsi/default.mspx

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