Microsoft

MCTS EXAM
70-432

Microsoft® SQL Server® 2008– Implementation and Maintenance

Mike Hotek

SELF-PACED

Training Kit

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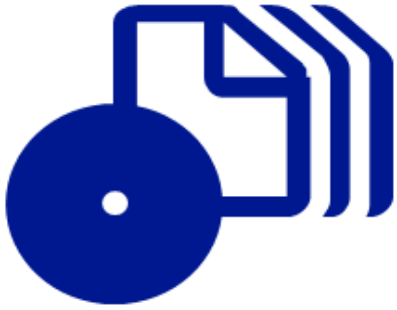

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Exam 70-432: Microsoft SQL Server 2008—Implementation and Maintenance

0BJECTIVE	LOCATION IN BOOK
INSTALLING AND CONFIGURING SQL SERVER 2008	
Configure additional SQL Server components.	Chapter 1, Lessons 3 and 4 Chapter 5, Lessons 1, 2 and 3
Configure SQL Server instances.	Chapter 1, Lesson 3
Configure SQL Server services.	Chapter 1, Lesson 3
Install SQL Server 2008 and related services.	Chapter 1, Lesson 3 Chapter 5, Lessons 1, 2 and 3
Implement database mail.	Chapter 1, Lesson 4
Configure full-text indexing.	Chapter 5, Lessons 1, 2 and 3
MAINTAINING SQL SERVER INSTANCES	
Manage SQL Server Agent jobs.	Chapter 10, Lesson 2
Manage SQL Server Agent alerts.	Chapter 10, Lesson 4
Manage SQL Server Agent operators.	Chapter 10, Lesson 3
Implement the declarative management framework (DMF).	Chapter 8, Lessons 1 and 2
Back up a SQL Server environment.	Chapter 9, Lessons 1, 2 and 3
MANAGING SQL SERVER SECURITY	
Manage logins and server roles.	Chapter 11, Lesson 3
Manage users and database roles.	Chapter 11, Lesson 3
Manage SQL Server instance permissions.	Chapter 11, Lesson 4
Manage database permissions.	Chapter 11, Lesson 4
Manage schema permissions and object permissions.	Chapter 11, Lesson 4
Audit SQL Server instances.	Chapter 11, Lesson 5
Manage transparent data encryption.	Chapter 11, Lesson 6
Configure surface area.	Chapter 8, Lessons 1, 2 and 3 Chapter 11, Lesson 2

0BJECTIVE	LOCATION IN BOOK
MAINTAINING A SQL SERVER DATABASE	
Back up databases.	Chapter 2, Lesson 1 Chapter 9, Lesson 1
Restore databases.	Chapter 9, Lessons 2 and 3
Manage and configure databases.	Chapter 2, Lessons 2, 3 and 4
Manage database snapshots.	Chapter 9, Lesson 3
Maintain database integrity.	Chapter 2, Lesson 4
Maintain a database by using maintenance plans.	Chapter 9, Lesson 1
PERFORMING DATA MANAGEMENT TASKS	
Import and export data.	Chapter 7, Lessons 1, 2, 3 and 4
Manage data partitions.	Chapter 6, Lessons 1, 2, 3 and 4
Implement data compression.	Chapter 3, Lesson 1
Maintain indexes.	Chapter 4, Lesson 3 Chapter 5, Lessons 1, 2 and 3
Manage collations.	Chapter 2, Lesson 3
MONITORING AND TROUBLESHOOTING SQL SERVER	
Identify SQL Server service problems.	Chapter 12, Lesson 4
Identify concurrency problems.	Chapter 12, Lesson 2
Identify SQL Agent job execution problems.	Chapter 10, Lesson 1
Locate error information.	Chapter 12, Lesson 1
OPTIMIZING SQL SERVER PERFORMANCE	
Implement Resource Governor.	Chapter 13, Lesson 6
Use the Database Engine Tuning Advisor.	Chapter 13, Lesson 4
Collect trace data by using SQL Server Profiler.	Chapter 12, Lesson 2
Collect performance data by using Dynamic Management Views (DMVs).	Chapter 13, Lesson 5
Collect performance data by using System Monitor.	Chapter 12, Lesson 1
Use Performance Studio.	Chapter 13, Lesson 7
IMPLEMENTING HIGH AVAILABILITY	
Implement database mirroring.	Chapter 15, Lessons 1, 2 and 3
Implement a SQL Server clustered instance.	Chapter 14, Lessons 1 and 2
Implement log shipping.	Chapter 16, Lessons 1, 2 and 3
Implement replication.	Chapter 17, Lessons 1, 2 and 3

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MCTS Self-Paced Training Kit (Exam 70-432): Microsoft® SQL Server® 2008—Implementation and Maintenance

Training Kit

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To Genilyn,
My compass in a storm and the light to show me the way home

Contents at a Glance

Contents

Acknowledgements

Thank you to all my readers over the past decade or so; it's hard to believe that this will be the seventh SQL Server book I've written and it would not be possible without you. I'd like to thank my editorial team at Microsoft Press, Denise Bankaitis and Laura Sackerman. I would especially like to thank Ken Jones, who has gone through five books with me and has proved to be an invaluable asset to Microsoft Press. Thank you to Rozanne Whalen, who has now tech-edited three books for me. I don't know how she does it, but Susan McClung's word wizardry has transformed my writing into the volume you hold in your hands. That all of this content is coherent is a testament to the many hours of hard work put in by Rozanne, Susan, and the rest of the editing team.

Introduction

This training kit is designed for information technology (IT) professionals who plan to take the Microsoft Certified Technology Specialist (MCTS) Exam 70-432, as well as database administrators (DBAs) who need to know how to implement, manage, and troubleshoot Microsoft SQL Server 2008 instances. It's assumed that before using this training kit, you already have a working knowledge of Microsoft Windows and SQL Server 2008, and you have experience with SQL Server or another database platform.

By using this training kit, you learn how to do the following:

- Install and configure SQL Server 2008
- Create and implement database objects
- Implement high availability and disaster recovery
- Secure instances, databases, and database objects
- Monitor and troubleshoot SQL Server instances

Using the CD and DVD

A companion CD and an evaluation software DVD are included with this training kit. The companion CD contains the following:

- **Practice tests** You can reinforce your understanding of how to implement and maintain SQL Server 2008 databases by using electronic practice tests that you can customize to meet your needs from the pool of Lesson Review questions in this book. Alternatively, you can practice for the 70-432 certification exam by using tests created from a pool of about 200 realistic exam questions, which will give you enough different practice tests to ensure that you're prepared.
- **Practice files** Not all exercises incorporate code, but for each exercise that has code, you can find one or more files in a folder for the corresponding chapter on the companion CD. You can either type the code from the book or open the corresponding code file in a query window.
- **eBook** An electronic version (eBook) of this training kit is included for use at times when you don't want to carry the printed book with you. The eBook is in Portable Document Format (PDF), and you can view it by using Adobe Acrobat or Adobe Reader. You can use the eBook to cut and paste code as you work through the exercises.
- **Sample chapters** Sample chapters from other Microsoft Press titles on SQL Server 2008. These chapters are in PDF format.

- **Evaluation software** The evaluation software DVD contains a 180-day evaluation edition of SQL Server 2008 in case you want to use it instead of a full version of SQL Server 2008 to complete the exercises in this book.

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How to Install the Practice Tests

To install the practice test software from the companion CD to your hard disk, perform the following steps:

1. Insert the companion CD into your CD-ROM drive and accept the license agreement that appears onscreen. A CD menu appears.

NOTE **ALTERNATIVE INSTALLATION INSTRUCTIONS IF AUTORUN IS DISABLED**

If the CD menu or the license agreement doesn't appear, AutoRun might be disabled on your computer. Refer to the Readme.txt file on the companion CD for alternative installation instructions.

2. Click Practice Tests and follow the instructions on the screen.

How to Use the Practice Tests

To start the practice test software, follow these steps:

1. Click Start and select All Programs, Microsoft Press Training Kit Exam Prep. A window appears that shows all the Microsoft Press training kit exam prep suites that are installed on your computer.
2. Double-click the lesson review or practice test that you want to use.

Lesson Review Options

When you start a lesson review, the Custom Mode dialog box appears, enabling you to configure your test. You can click OK to accept the defaults, or you can customize the number of questions you want, the way the practice test software works, which exam objectives you want the questions to relate to, and whether you want your lesson review to be timed. If you are retaking a test, you can select whether you want to see all the questions again or only those questions you previously skipped or answered incorrectly.

After you click OK, your lesson review starts. You can take the test by performing the following steps:

1. Answer the questions and use the Next, Previous, and Go To buttons to move from question to question.
2. After you answer an individual question, if you want to see which answers are correct, along with an explanation of each correct answer, click Explanation.
3. If you would rather wait until the end of the test to see how you did, answer all the questions and then click Score Test. You see a summary of the exam objectives that you chose and the percentage of questions you got right overall and per objective. You can print a copy of your test, review your answers, or retake the test.

Practice Test Options

When you start a practice test, you can choose whether to take the test in Certification Mode, Study Mode, or Custom Mode.

- **Certification Mode** Closely resembles the experience of taking a certification exam. The test has a set number of questions, it is timed, and you cannot pause and restart the timer.
- **Study Mode** Creates an untimed test in which you can review the correct answers and the explanations after you answer each question.
- **Custom Mode** Gives you full control over the test options so that you can customize them as you like.

In all modes, the user interface that you see when taking the test is basically the same, but different options are enabled or disabled, depending on the mode. The main options are discussed in the previous section, "Lesson Review Options."

When you review your answer to an individual practice test question, a "References" section is provided. This section lists the location in the training kit where you can find the information that relates to that question, and it provides links to other sources of information. After you click Test Results to score your entire practice test, you can click the Learning Plan tab to see a list of references for every objective.

How to Uninstall the Practice Tests

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CHAPTER 2

Database Configuration and Maintenance

The configuration choices that you make for a database affect its performance, scalability, and management. In this chapter, you learn how to design the file and filegroup storage structures underneath a database. You learn how to configure database options and recovery models. You will also learn how to check and manage the integrity of a database.

Exam objectives in this chapter:

- Back up databases.
- Manage and configure databases.
- Maintain database integrity.
- Manage collations.

Lessons in this chapter:

Before You Begin

To complete the lessons in this chapter, you must have:

- Microsoft SQL Server 2008 installed
- The *AdventureWorks* database installed within the instance

REAL WORLD

Michael Hotek

I have worked on millions of databases across thousands of customers during the portion of my career where I have worked with SQL Server. In all that time, I have come up with many best practices while at the same time creating many arguments among the "purists." All my recommendations and approaches to architecting and managing SQL Servers come from a pragmatic, real-world perspective that, although rooted in a deep knowledge of SQL Server, hardware, networking, and many other components, rarely matches up with the perfect world theory.

Designing the disk structures that underlie a database is one of the cases where I deviate from a lot of the theoretical processes and computations that you will find published. Although you can find entire white papers and even sections of training classes devoted to teaching you how to calculate disk transfer and random vs. sequential writes, I have never encountered an environment where I had the time or luxury to run those calculations prior to implementing a system.

It is really nice that there are formulas to calculate the disk transfer of a given disk configuration, and you can also apply statistical methods to further refine those calculations based on the random vs. sequential I/O of a system. However, all the time spent doing the calculations is worthless unless you also know the required read and write capacity of the databases you are going to place on that disk subsystem. Additionally, unless you are buying a new storage system, dedicated to a specific application, you will have a very difficult time architecting the disk storage underneath a database according to all the theories.

The challenge in achieving optimal performance is to separate the transaction logs from data files so that you can isolate disk I/O. The transaction log is the key to high-performance write operations, because the maximum transaction rate is bound by the write capacity to the transaction log file. After taking care of the transaction log, you need to add enough files and filegroups to achieve enough disk throughput to handle the read/write activity. However, the most important component of performance is to write applications with efficient code that accesses only the minimum amount of data necessary to accomplish the business task.

Lesson 1: Configuring Files and Filegroups

Data within a database is stored on disk in one or more data files. Prior to being written to the data file(s), every transaction is written to a transaction log file. In this lesson, you learn how to design the data files underneath a database, group the files into filegroups to link physical storage into a database, and manage the transaction log. You also learn how to configure the *tempdb* database for optimal performance.

After this lesson, you will be able to:

- Create filegroups
- Add files to filegroups
- Work with *FILESTREAM* data
- Configure the transaction log

Estimated lesson time: 20 minutes

Files and Filegroups

Although storing all your data in memory would provide extremely fast access, you would lose everything after the machine was shut down. To protect your data, it has to be persisted to disk. Underneath each database is one or more files for persisting your data.

SQL Server uses two different types of files—data and transaction log files. Data files are responsible for the long-term storage of all the data within a database. Transaction log files, discussed in more detail later in this lesson, are responsible for storing all the transactions that are executed against a database.

Instead of defining the storage of objects directly to a data file, SQL Server provides an abstraction layer for more flexibility called a *filegroup*. Filegroups are a logical structure, defined within a database, that map a database and the objects contained within a database, to the data files on disk. Filegroups can contain more than one data file.

All objects that contain data, tables, indexes, and indexed views have an ON clause that you can use to specify when you create an object that allows you to specify the filegroup where SQL Server stores the object. As data is written to the objects, SQL Server uses the filegroup definition to determine on which file(s) it should store the data.

At the time that a file is added to a database, you specify the initial size of the file. You can also specify a maximum size for the file, as well as whether SQL Server automatically increases the size of the file when it is full of data. If you specify automatic growth, you can specify whether the file size increases based on a percentage of the current size or whether the file size increases at a fixed amount that you define.

Unless a filegroup has only a single file, you do not know in which file a specific row of data is stored. When writing to files, SQL Server uses a proportional fill algorithm. The proportional fill algorithm is designed to ensure that all files within a filegroup reach the maximum defined capacity at the same time. For example, if you had a data file that was 10 gigabytes (GB) and a data file that was 1 GB, SQL Server writes ten rows to the 10 GB file for every one row that is written to the 1 GB file.

The proportional fill algorithm is designed to allow a resize operation to occur at a filegroup level. In other words, all files within a filegroup expand at the same time.

File Extensions

SQL Server uses three file extensions: .mdf, .ndf, and .ldf. Unfortunately, many people have placed a lot of emphasis and meaning on these three extensions, where no meaning was ever intended. Just like Microsoft Office Word documents have a .doc or .docx extension, and Microsoft Office Excel files have an .xls or .xlsx extension, the extension is nothing more than a naming convention. I could just as easily create a Word document with an extension of .bob, or even no extension, without changing the fact that it is still a Word document or preventing the ability of Word to open and manipulate the file.

A file with an .mdf extension is usually the first data file that is created within a database, generally is associated with the primary filegroup, and usually is considered the primary data file which contains all the system objects necessary to a database. The .ndf extension is generally used for all other data files underneath a database, regardless of the filegroup to which the file is associated. The .ldf extension generally is used for transaction logs.

The file extensions that you see for SQL Server are nothing more than naming conventions. SQL Server does not care what the file extensions are or even if the files have extensions. If you really wanted to, you could use an .ldf extension for the primary data file, just as you could use an .mdf extension for a transaction log file. Although the use of file extensions in this way does not affect SQL Server, it generally could cause confusion among the other database administrators (DBAs) in your organization. To avoid this confusion, it is recommended that you use the .mdf, .ndf, and .ldf naming conventions commonly used across the SQL Server industry, but do not forget that this is just a naming convention and has absolutely no effect on SQL Server itself.

All data manipulation within SQL Server occurs in memory within a set of buffers. If you are adding new data to a database, the new data is first written to a memory buffer, then written to the transaction log, and finally persisted to a data file via a background process called *check pointing*. When you modify or delete an existing row, if the row does not already exist

in memory, SQL Server first reads the data off disk before making the modification. Similarly if you are reading data that has not yet been loaded into a memory buffer, SQL Server must read it out of the data files on disk.

If you could always ensure that the machine hosting your databases had enough memory to hold all the data within your databases, SQL Server could simply read all the data off disk into memory buffers upon startup to improve performance. However, databases are almost always much larger than the memory capacity on any machine, so SQL Server retrieves data from disk only on an as-needed basis. If SQL Server does not have enough room in memory for the data being read in, the least recently used buffer pools are emptied to make room for newly requested data.

Because accessing a disk drive is much slower than accessing memory, the data file design underneath a database can have an impact on performance.

The first layer of design is within the disk subsystem. As the number of disk drives within a volume increases, the read and write throughput for SQL Server increases. However, there is an upper limit on the disk input/output (I/O), which is based upon the capacity of the redundant array of independent disks (RAID) controller, host bus adapter (HBA), and disk bus. So you cannot fix a disk I/O bottleneck by continually adding more disk drives. Although entire 200+ page white papers have been written on random vs. sequential writes, transfer speeds, rotational speeds, calculations of raw disk read/write speeds, and other topics, the process of designing the disk subsystem is reduced to ensuring that you have enough disks along with appropriately sized controllers and disk caches to deliver the read/write throughput required by your database.

If it were simply a matter of the number of disks, there would be far fewer disk I/O bottlenecks in systems. But there is a second layer of data file design: determining how many data files you need and the location of each data file.

SQL Server creates a thread for each file underneath a database. As you increase the number of files underneath a database, SQL Server creates more threads that can be used to read and write data. However, you cannot just create a database with thousands of files to increase its number of threads. This is because each thread consumes memory, taking away space for data to be cached, and even if you could write to all the threads at the same time, you would then saturate the physical disks behind the data files. In addition, managing thousands of data files underneath a database is extremely cumbersome, and if a large percentage of the files need to expand at the same time, you could create enough activity to halt the flow of data within the database.

Due to the competing factors and the simple fact that in the real world, few DBAs have the time to spend running complex byte transfer rate calculations or even to design the disk layer based on a precise knowledge of the data throughput required, designing the data layer is an iterative approach.

Designing the data layer of a database begins with the database creation. When you create a database, it should have three files and two filegroups. You should have a file with an .mdf extension within a filegroup named *PRIMARY*, a file with an .ndf extension in a filegroup with any name that you choose, and the transaction log with an .ldf extension.

NOTE **FILE EXTENSIONS**

As stated in the sidebar "File Extensions," earlier in this chapter, file extensions are nothing more than naming conventions. They do not convey any special capabilities.

Besides being the logical definition for one or more files that defines the storage boundary for an object, filegroups have a property called *DEFAULT*. The purpose of the *DEFAULT* property is to define the filegroup where SQL Server places objects if you do not specify the ON clause during object creation.

When the database is created, the primary filegroup is marked as the default filegroup. After you create the database, you should mark the second filegroup as the default filegroup. By changing the default filegroup, you ensure that any objects you create are not accidentally placed on the primary filegroup and that only the system objects for the database reside on the primary filegroup. You change the default filegroup by using the following command:

```
ALTER DATABASE <database name> MODIFY FILEGROUP <filegroup name> DEFAULT
```

The main reason not to place any of your objects on the primary filegroup is to provide as much isolation in the I/O as possible. The data in the system objects does not change as frequently as data in your objects. By minimizing the write activity to the primary data file, you reduce the possibility of introducing corruption due to hardware failures. In addition, because the state of the primary filegroup also determines the state of the database, you can increase the availability of the database by minimizing the changes made to the primary filegroup.

Following the initial creation of the database, you add filegroups as needed to separate the storage of objects within the database. You also add files to filegroups to increase the disk I/O available to the objects stored on the filegroup, thereby reducing disk bottlenecks.

Transaction Logs

When SQL Server acknowledges that a transaction has been committed, SQL Server must ensure that the change is hardened to persistent storage. Although all writes occur through memory buffers, persistence is guaranteed by requiring that all changes are written to the transaction log prior to a commit being issued. In addition, the writes to the transaction log must occur directly to disk.

Because every change made to a database must be written directly to disk, the disk storage architecture underneath your transaction log is the most important decision affecting the maximum transaction throughput that you can achieve.

SQL Server writes sequentially to the transaction log but does not read from the log except during a restart recovery. Because SQL Server randomly reads and writes to the data files underneath a database, by isolating the transaction log to a dedicated set of disks you ensure that the disk heads do not have to move all over the disk and move in a mostly linear manner.

EXAM TIP

The maximum transaction throughput for any database is bound by the amount of data per second that SQL Server can write to the transaction log.

Benchmarks

Benchmark disclosures are the best source of information when designing the disk storage for optimal performance. Many organizations and the press place great emphasis on various benchmarks. However, a careful study reveals that, by itself, SQL Server doesn't have as large of an impact on the overall numbers as you are led to believe. The transaction processing engine within SQL Server is extremely efficient and has a fixed contribution to transaction throughput, but the real key to maximizing the transaction rate is in the disk storage. Given the same disk configuration, a 7,200 RPM drive delivers about 50 percent of the SQL Server transaction rate of a 15,000 RPM drive. Having 100 disks underneath a transaction log generally doubles the transaction rate of having only 50 disks. In addition, one of the tricks used in benchmarks is to partition a disk such that all the SQL Server data is written to the outside half or less of the disk platter, because based on physics, as the read/write head of a disk moves toward the edge of a circular object, the velocity increases, thereby spinning a larger segment of the disk platter underneath the drive head per unit of time.

FILESTREAM data

Although the volume of data within organizations has been exploding, leading the way in this data explosion is unstructured data. To tackle the problem of storing, managing, and combining the large volumes of unstructured databases with the structured data in your databases, SQL Server 2008 introduced *FILESTREAM*.

The *FILESTREAM* feature allows you to associate files with a database. The files are stored in a folder on the operating system, but are linked directly into a database where the files can be backed up, restored, full-text-indexed, and combined with other structured data.

Although the details of *FILESTREAM* are covered in more detail in Chapter 3, "Tables," and Chapter 5, "Full Text Indexing," to store *FILESTREAM* data within a database, you need to specify where the data will be stored. You define the location for *FILESTREAM* data in a database by designating a filegroup within the database to be used for storage with the *CONTAINS FILESTREAM* property. The *FILENAME* property defined for a *FILESTREAM* filegroup specifies the path to a folder. The initial part of the folder path definition must exist; however, the last folder in the path defined cannot exist and is created automatically. After the *FILESTREAM* folder has been created, a filestream.hdr file is created in the folder, which is a system file used to manage the files subsequently written to the folder.

tempdb Database

Because the *tempdb* database is much more heavily used than in previous versions, special care needs to be taken in how you design the storage underneath *tempdb*.

In addition to temporary objects, SQL Server uses *tempdb* for worktables used in grouping/sorting operations, worktables to support cursors, the version store supporting snapshot isolation level, and overflow for table variables. You can also cause index build operations to use space in *tempdb*.

Due to the potential for heavy write activity, you should move *tempdb* to a set of disks separated from your databases and any backup files. To spread out the disk I/O, you might consider adding additional files to *tempdb*.

NOTE **MULTIPLE *tempdb* FILES**

A common practice for *tempdb* is to create one file per processor. The one file per processor is with respect to what SQL Server would consider a processor and not the physical processor, which could have multiple cores as well as hyperthreading.

Quick Check

1. **What are the types of files that you create for databases and what are the commonly used file extensions?**
2. **What is the purpose of the transaction log?**

Quick Check Answers

1. **You can create data and log files for a database. Data files commonly have either an .mdf or .ndf extension, whereas log files have an .ldf extension.**
2. **The transaction log records every change that occurs within a database to persist all transactions to disk.**

PRACTICE Creating Databases

In this practice, you will create a database with multiple files that is enabled for FILESTREAM storage in the c:\test folder

1. Execute the following code to create a database:

```
CREATE DATABASE TK432 ON  PRIMARY
( NAME = N'TK432_Data', FILENAME = N'c:\test\TK432.mdf' ,
    SIZE = 8MB , MAXSIZE = UNLIMITED, FILEGROWTH = 16MB ),
 FILEGROUP FG1
```

```
( NAME = N'TK432_Data2', FILENAME = N'c:\test\TK432.ndf' ,
    SIZE = 8MB , MAXSIZE = UNLIMITED, FILEGROWTH = 16MB ),
 FILEGROUP Documents CONTAINS FILESTREAM  DEFAULT
( NAME = N'Documents', FILENAME = N'c:\test\TK432Documents' )
 LOG ON
( NAME = N'TK432_Log', FILENAME = N'c:\test\TK432.ldf' ,
    SIZE = 8MB , MAXSIZE = 2048GB , FILEGROWTH = 16MB )
GO
```

2. Execute the following code to change the default filegroup:

```
ALTER DATABASE TK432
MODIFY FILEGROUP FG1
DEFAULT
GO
```

Lesson Summary

- You can define one or more data and log files for the physical storage of a database.
- Data files are associated to a filegroup within a database.
- Filegroups provide the logical storage container for objects within a database.
- Files can be stored using the new *FILESTREAM* capabilities.

Lesson Review

The following question is intended to reinforce key information presented in Lesson 1, "Configuring Files and Filegroups." The question is also available on the companion CD if you prefer to review it in electronic form.

NOTE **ANSWERS**

Answers to this question and an explanation of why each answer choice is correct or incorrect is located in the "Answers" section at the end of the book.

1. You have a reference database named *OrderHistory,* which should not allow any data to be modified. How can you ensure, with the least amount of effort, that users can only read data from the database?
   - **A.** Add all database users to the db_datareader role.
   - **B.** Create views for all the tables and grant select permission only on the views to database users.
   - **C.** Set the database to READ_ONLY.
   - **D.** Grant select permission on the database to all users and revoke insert, update, and delete permissions from all users on the database.

Lesson 2: Configuring Database Options

Data within a database is stored on disk in one or more data files. Prior to being written to the data file(s), every transaction is written to a transaction log file. In this lesson, you learn how to design the data files underneath a database, group the files into filegroups to link physical storage into a database, and manage the transaction log.

After this lesson, you will be able to:

- Set the database recovery model
- Configure database options
- Manage collation sequences
- Check and maintain database consistency

Estimated lesson time: 20 minutes

Database Options

A database has numerous options that control a variety of behaviors. These options are broken down into several categories, including the following:

- Recovery
- Auto options
- Change tracking
- Access
- Parameterization

Recovery Options

The recovery options determine the behavior of the transaction log and how damaged pages are handled.

Recovery Models

Every database within a SQL Server instance has a property setting called the *recovery model*. The recovery model determines the types of backups you can perform against a database. The recovery models available in SQL Server 2008 are:

- Full
- Bulk-logged
- Simple

THE FULL RECOVERY MODEL

When a database is in the Full recovery model, all changes made, using both data manipulation language (DML) and data definition language (DDL), are logged to the transaction log. Because all changes are recorded in the transaction log, it is possible to recover a database in the Full recovery model to a given point in time so that data loss can be minimized or eliminated if you should need to recover from a disaster. Changes are retained in the transaction log indefinitely and are removed only by executing a transaction log backup.

> ***BEST PRACTICES*** **RECOVERY MODELS**
>
> **Every production database that accepts transactions should be set to the Full recovery model. By placing the database in the Full recovery model, you can maximize the restore options that are possible.**

THE BULK-LOGGED RECOVERY MODEL

Certain operations are designed to manipulate large amounts of data. However, the overhead of logging to the transaction log can have a detrimental impact on performance. The Bulk-logged recovery model allows certain operations to be executed with minimal logging. When a minimally logged operation is performed, SQL Server does not log every row changed but instead logs only the extents, thereby reducing the overhead and improving performance. The operations that are performed in a minimally logged manner with the database set in the Bulk-logged recovery model are:

- *BCP*
- *BULK INSERT*
- *SELECT…INTO*
- *CREATE INDEX*
- *ALTER INDEX…REBUILD*

Because the Bulk-logged recovery model does not log every change to the transaction log, you cannot recover a database to a point in time, within the interval that a minimally logged transaction executed, when the Bulk-logged recovery model was enabled.

THE SIMPLE RECOVERY MODEL

The third recovery model is Simple. A database in the Simple recovery model logs operations to the transaction log exactly as the Full recovery model does. However, each time the database checkpoint process executes, the committed portion of the transaction log is discarded. A database in the Simple recovery model cannot be recovered to a point in time because it is not possible to issue a transaction log backup for a database in the simple recovery model.

Because the recovery model is a property of a database, you set the recovery model by using the *ALTER DATABASE* command as follows:

```
ALTER DATABASE database_name
SET RECOVERY { FULL | BULK_LOGGED | SIMPLE }
```

The backup types available for each recovery model are shown in Table 2-1.

TABLE 2-1 Backup Types Available for Each Recovery Model

RECOVERY MODEL	BACKUP TYPE		
	FULL	**DIFFERENTIAL**	**TRAN LOG**
Full	Yes	Yes	Yes
Bulk	Yes	Yes	Yes/no minimally logged
Simple	Yes	Yes	No

EXAM TIP

You need to know which types of backups are possible for each recovery model.

Damaged Pages

It is possible to damage data pages during a write to disk if you have a power failure or failures in disk subsystem components during the write operation. If the write operation fails to complete, you can have an incomplete page in the database that cannot be read. Because the damage happens to a page on disk, the only time that you see a result of the damage is when SQL Server attempts to read the page off disk.

The default configuration of SQL Server does not check for damaged pages and could cause the database to go off-line if a damaged page is encountered. The PAGE_VERIFY CHECKSUM option can be enabled, which allows you to discover and log damaged pages. When pages are written to disk, a checksum for the page is calculated and stored in the page header. When SQL Server reads a page from disk, a checksum is calculated and compared to the checksum stored in the page header. If a damaged page is encountered, an 824 error is returned to the calling application and logged to the SQL Server error log and Windows Application Event log, and the ID of the damaged page is logged to the suspect_pages table in the *msdb* database.

In SQL Server 2005, the only way to fix a damaged page was to execute a page restore, which is discussed in Chapter 9, "Backing Up and Restoring a Database." In addition to a page restore, if the database is participating in a database mirroring session, SQL Server 2008 automatically replaces the page with a copy of the page from the mirror. When Database Mirroring automatically fixes a corrupt page, an entry is logged and can be reviewed with the sys.dm_db_mirroring_auto_page_repair view.

Auto Options

There are five options for a database that enable certain actions to occur automatically:

- AUTO_CLOSE
- AUTO_SHRINK

- AUTO_CREATE_STATISTICS
- AUTO_UPDATE_STATISTICS
- AUTO_UPDATE_STATISTICS_ASYNCH

Each database within an instance requires a variety of resources, the most significant of which is a set of memory buffers. Each open database requires several bytes of memory and any queries against the database populate the data and query caches. If the AUTO_CLOSE option is enabled, when the last connection to a database is closed, SQL Server shuts down the database and releases all resources related to the database. When a new connection is made to the database, SQL Server starts up the database and begins allocating resources.

By default, AUTO_CLOSE is disabled. Unless you have severe memory pressure, you should not enable a database for AUTO_CLOSE. In addition, a database that is frequently accessed should not be set to AUTO_CLOSE because it would cause a severe degradation in performance. This is because you would never be able to use the data and query caches adequately.

Data files can be set to grow automatically when additional space is needed. Although most operations to increase space affect the database on a long-term basis, some space increases are needed only on a temporary basis. If the AUTO_SHRINK option is enabled, SQL Server periodically checks the space utilization of data and transaction log files. If the space checking algorithm finds a data file that has more that 25 percent free space, the file automatically shrinks to reclaim disk space.

Expanding a database file is a very expensive operation. Shrinking a database file is also an expensive operation. If the size of a database file increased during normal operations, it is very likely that if the file shrinks, the operation would recur and increase the database file again. The only operations that cause one-time space utilization changes to database files are administrative processes that create and rebuild indexes, archive data, or load data. Because the growth of database files is so expensive, it is recommended to leave the AUTO_SHRINK option disabled and manually shrink files only when necessary.

Statistics allow the Query Optimizer to build more efficient query plans. If the AUTO_CREATE_STATSTICS option is enabled, SQL Server automatically creates statistics that are missing during the optimization phase of query processing. Although the creation of statistics incurs some overhead, the benefit to query performance is worth the overhead cost for SQL Server to create statistics automatically when necessary.

Statistics capture the relative distribution of values in one or more columns of a table. After the database has been in production for a while, normal database changes do not appreciably change the statistics distribution in general. However, mass changes to the data or dramatic shifts in business processes can suddenly introduce significant skew into the data. If the statistics are not updated to reflect the distribution shift, the Optimizer could select an inefficient query plan.

Databases have two options that allow SQL Server to update out-of-date statistics automatically. The AUTO_UPDATE_STATISTICS option updates out-of-date statistics during query optimization. If you choose to enable AUTO_UPDATE_STATISTICS, a second

option, AUTO_UPDATE_STATISTICS_ASYNC, controls whether statistics are updated during query optimization or if query optimization continues while the statistics are updated asynchronously.

Change Tracking

One of the challenges for any multiuser system is to ensure that the changes of one user do not accidentally overwrite the changes of another. To prevent the changes of multiple users from overriding each other, applications are usually built within mechanisms to determine whether a row has changed between the time it was read and the time it is written back to the database. The tracking mechanisms usually involve columns with either a datetime or timestamp column and also might include an entire versioning system.

SQL Server 2008 introduces a new feature implemented through the CHANGE_TRACKING database option. Change tracking is a lightweight mechanism that associates a version with each row in a table that has been enabled for change tracking. Each time the row is changed, the version number is incremented. Instead of building systems to avoid changes from multiple users overriding each other, applications need only compare the row version to determine if a change has occurred to the row between when the row was read and written.

After change tracking has been enabled for the database, you can choose which tables within a database that change tracking information should be captured for. Over time, change tracking information accumulates in the database, so you can also specify how long tracking information is retained through the CHANGE_RETENTION option and whether tracking information should be automatically cleaned up with the AUTO_CLEANUP option.

Access

Access to a database can be controlled through several options.

The status of a database can be explicitly set to ONLINE, OFFLINE, or EMERGENCY. When a database is in an ONLINE state, you can perform all operations that would otherwise be possible. A database that is in an OFFLINE state is inaccessible. A database in an EMERGENCY state can be accessed only by a member of the db_owner role, and the only command allowed to be executed is *SELECT*.

You can control the ability to modify data for an online database by setting the database to either READ_ONLY or READ_WRITE. A database in READ_ONLY mode cannot be written to. In addition, when a database is placed in READ_ONLY mode, SQL Server removes any transaction log file that is specified for the database. Changing a database from READ_ONLY to READ_WRITE causes SQL Server to re-create the transaction log file.

User access to a database can be controlled through the SINGLE_USER, RESTRICTED_USER, and MULTI_USER options. When a database is in SINGLE_USER mode, only a single user is allowed to access the database. A database set to RESTRICTED_USER only allows access to members of the db_owner, dbcreator, and sysadmin roles.

If multiple users are using the database when you change the mode to SINGLE_USER or users that conflict with the allowed set for RESTRICTED_USER, the *ALTER DATABASE* command is blocked until all the non-allowed users disconnect. Instead of waiting for users to complete operations and disconnect from the database, you can specify a ROLLBACK action to terminate connections forcibly. The ROLLBACK IMMEDIATE option forcibly rolls back any open transactions, along with disconnecting any nonallowed users. You can allow users to complete transactions and exit the database by using the ROLLBACK AFTER <*number of seconds*> option, which waits for the specified number of seconds before rolling back transactions and disconnecting users.

The normal operational mode for most databases is ONLINE, READ_WRITE, and MULTI_USER.

Parameterization

One of the "hot button" topics in application development is whether to parameterize calls to the database. When a database call is parameterized, the values are passed as variables. You can find just as many articles advocating for both sides. Unfortunately, applications gain a significant benefit when database calls are parameterized.

SQL Server caches the query plan for every query that is executed. Unless there is pressure on the query cache that forces a query plan from the cache, every query executed since the instance started is in the query cache. When a query is executed, SQL Server parses and compiles the query. The query is then compared to the query cache using a string-matching algorithm. If a match is found, SQL Server retrieves the plan that has already been generated and executes the query.

A query that is parameterized has a much higher probability of being matched because the query string does not change even when the values being used vary. Therefore, parameterized queries can reuse cached query plans more frequently and avoid the time required to build a query plan.

Because not all applications parameterize calls to the database, you can force SQL Server to parameterize every query for a given database by setting the PARAMETERIZATION FORCED database option.

The default setting for a database is not to force parameterization. The reuse of query plans provides a benefit so long as the query plan being reused is the most efficient path through the data. For tables where there is significant data skew, one value produces an efficient query plan, whereas another value causes a different query plan to be created. In addition, applications see the effect of parameterization only if the majority of database calls have an extremely short duration.

So long as the majority of your database calls have a very short duration and the query plan generated do not change depending upon the parameters passed, you could see a performance boost by forcing parameterization.

Collation Sequences

SQL Server has the capability to store character data that spans every possible written language. However, not every language follows the same rules for sorting or data comparisons. SQL Server allows you to define the rules for comparison, sorting, case sensitivity, and accent sensitivity through the specification of a collation sequence.

When you install SQL Server, you specify a default collation sequence that is used for all databases, tables, and columns. You can override the default collation sequence at each level. The collation sequence for an instance can be overridden at a database level by specifying the COLLATE clause in either the *CREATE DATABASE* or *ALTER DATABASE* command.

Quick Check

1. How do you restrict database access to members of the db_owner role and terminate all active transactions and connection at the same time?
2. What backups can be executed for a database in each of the recovery models?

Quick Check Answers

1. You would execute the following command: ALTER DATABASE <*database name*> SET RESTRICTED_USER WITH ROLLBACK IMMEDIATE.
2. You can create full, differential, and file/filegroup backups in the Simple recovery model. The Bulk-logged recovery model allows you to execute types of backups, but you cannot restore a database to a point in time during an interval when a minimally logged transaction is executing. All types of backups can be executed in the Full recovery model.

PRACTICE Changing the Database Recovery Model

In this practice, you change the recovery model of the *AdventureWorks* database to *FULL* to ensure that you can recover from a failure to a point in time.

1. Execute the following code:

```
ALTER DATABASE AdventureWorks
    SET RECOVERY FULL
GO
```

2. Right-click the *AdventureWorks* database, select Properties, and select the Options tab to view the recovery model and make sure that it is full.

Lesson Summary

- You can set the recovery model for a database to Full, Bulk-logged, or Simple.
- You can back up transaction logs for a database in the Full or Bulk-logged recovery model.
- The AUTO_SHRINK option shrinks a database file when there is more than 25 percent of free space in the file.
- You can track and log damaged pages by enabling the PAGE_VERIFY CHECKSUM option.

Lesson Review

The following question is intended to reinforce key information presented in Lesson 2, "Configuring Database Options." The question is also available on the companion CD if you prefer to review it in electronic form.

NOTE **ANSWERS**

Answers to this question and an explanation of why each answer choice is correct or incorrect is located in the "Answers" section at the end of the book.

1. You are the database administrator at Blue Yonder Airlines and are primarily responsible for the *Reservations* database, which runs on a server running SQL Server 2008. In addition to customers booking flights through the company's Web site, flights can be booked with several partners. Once an hour, the *Reservations* database receives multiple files from partners, which are then loaded into the database using the Bulk Copy Program (BCP) utility. You need to ensure that you can recover the database to any point in time while also maximizing the performance of import routines. How would you configure the database to meet business requirements?
   A. Enable AUTO_SHRINK
   B. Set PARAMETERIZATION FORCED on the database
   C. Configure the database in the Bulk-logged recovery model
   D. Configure the database in the Full recovery model

Lesson 3: Maintaining Database Integrity

In a perfect world, everything that you save to disk storage would always write correctly, read correctly, and never have any problems. Unfortunately, your SQL Server databases live in an imperfect world where things do go wrong. Although this occurs very rarely, data within your database can become corrupted if there is a failure in the disk storage system as SQL Server is writing to a page. Data pages are 8 kilobytes (KB) in size, but SQL Server divides a page into 16 blocks of 512 bytes apiece when performing write operations. If SQL Server begins writing blocks on a page and the disk system fails in the middle of the write process, only a portion of the page is written successfully, producing a problem called a *torn page*. In this lesson, you learn how to detect and correct corruption errors in your database.

After this lesson, you will be able to:

- Check a database for integrity
- Use DMVs to diagnose corruption issues

Estimated lesson time: 20 minutes

Database Integrity Checks

As you learned in Lesson 2, databases have an option called *PAGE_VERIFY*. The page verification can be set to either *TORN_PAGE_DETECTION* or *CHECKSUM*. The *PAGE_VERIFY TORN_PAGE_DETECTION* option exists for backwards compatibility and should not be used. When the *PAGE_VERIFY CHECKSUM* option is enabled, SQL Server calculates a checksum for the page prior to the write. Each time a page is read off disk, a checksum is recalculated and compared to the checksum written to the page. If the checksums do not match, the page has been corrupted.

When SQL Server encounters a corrupt page, an error is thrown, the command attempting to access the corrupt page is aborted, and an entry is written into the suspect_pages table in the *msdb* database.

BEST PRACTICES **PAGE VERIFICATION**

You should enable the *PAGE_VERIFY CHECKSUM* option on every production database.

Although page verification can detect and log corrupted pages, the page must be read off disk to trigger the verification check. Data is normally read off disk when users and applications access data, but instead of having a user receive an error message, it is much better for you to proactively find corruption and fix the problem by using a backup before the user has a process aborted.

You can force SQL Server to read every page from disk and check the integrity by executing the *DBCC CHECKDB* command. The generic syntax of *DBCC CHECKDB* is:

```
DBCC CHECKDB [( 'database_name' | database_id | 0
    [ , NOINDEX | { REPAIR_ALLOW_DATA_LOSS | REPAIR_FAST
    | REPAIR_REBUILD } ] )]
    [ WITH {[ ALL_ERRORMSGS ] [ , [ NO_INFOMSGS ] ] [ , [ TABLOCK ] ]
           [ , [ ESTIMATEONLY ] ] [ , [ PHYSICAL_ONLY ] ] | [ , [ DATA_PURITY ] ] } ]
```

When *DBCC CHECKDB* is executed, SQL Server performs all the following actions:

- Checks page allocation within the database
- Checks the structural integrity of all tables and indexed views
- Calculates a checksum for every data and index page to compare against the stored checksum
- Validates the contents of every indexed view
- Checks the database catalog
- Validates Service Broker data within the database

To accomplish these checks, *DBCC CHECKDB* executes the following commands:

- *DBCC CHECKALLOC*, to check the page allocation of the database
- *DBCC CHECKCATALOG*, to check the database catalog
- *DBCC CHECKTABLE*, for each table and view in the database to check the structural integrity

Any errors encountered are output so that you can fix the problems. If an integrity error is found in an index, you should drop and re-create the index. If an integrity error is found in a table, you need to use your most recent backups to repair the damaged pages.

NOTE **DATABASE MIRRORING**

If the database is participating in Database Mirroring, SQL Server attempts to retrieve a copy of the page from the mirror. If the page can be retrieved from the mirror and has the correct page contents, the page is replaced automatically on the principal without requiring any intervention. When SQL Server replaces a corrupt page from the mirror, an entry is written into the *sys.dm_db_mirroring_auto_page_repair* view.

Quick Check

1. **Which option should be enabled for all production databases?**
2. **What checks does *DBCC CHECKDB* perform?**

Quick Check Answers

1. **You should set the *PAGE_VERIFY CHECKSUM* option for all production databases.**
2. ***DBCC CHECKDB* checks the logical and physical integrity of every table, index, and indexed view within the database, along with the contents of every indexed view, page allocations, Service Broker data, and database catalog.**

PRACTICE Checking Database Integrity

In this practice, you check the integrity of the *AdventureWorks* database.

1. Execute the following code:

```
DBCC CHECKDB ('AdventureWorks') WITH NO_INFOMSGS, ALL_ERRORMSGS
GO
```

2. Review the results.

Lesson Summary

- The *PAGE_VERIFY CHECKSUM* option should be enabled for every production database to detect any structural integrity errors.
- When a corrupt page is encountered, the page is logged to the suspect_pages table in the *msdb* database. If a database is participating in a Database Mirroring session, SQL Server automatically retrieves a copy of the page from the mirror, replaces the page on the principal, and logs an entry in the *sys.dm_db_mirroring_auto_page_repair* view.
- *DBCC CHECKDB* is used to check the logical and physical consistency of a database.

Lesson Review

The following question is intended to reinforce key information presented in Lesson 3, "Maintaining Database Integrity." The question is also available on the companion CD if you prefer to review it in electronic form.

> ***NOTE*** **ANSWERS**
>
> **Answers to this question and an explanation of why each answer choice is correct or incorrect is located in the "Answers" section at the end of the book.**

1. Which commands are executed when you run the *DBCC CHECKDB* command? (Check all that apply.)
   - **A.** *DBCC CHECKTABLE*
   - **B.** *DBCC CHECKIDENT*
   - **C.** *DBCC CHECKCATALOG*
   - **D.** *DBCC FREEPROCCACHE*

Chapter Review

To practice and reinforce the skills you learned in this chapter further, you can perform the following tasks:

- Review the chapter summary.
- Review the list of key terms introduced in this chapter.
- Complete the case scenario. This scenario sets up a real-world situation involving the topics in this chapter and asks you to create a solution.
- Complete the suggested practices.
- Take a practice test.

Chapter Summary

- Databases can be configured with the Full, Bulk-logged, or Simple recovery model.
- The recovery model of the database determines the backups that can be created, as well as limitations on the recovery options that can be performed.
- You can set a collation sequence for a database that overrides the collation sequence defined for the instance.

Key Terms

Do you know what these key terms mean? You can check your answers by looking up the terms in the glossary at the end of the book.

- Corrupt page
- Filegroup
- Recovery model

Case Scenario

In the following case scenario, you apply what you've learned in this chapter. You can find answers to these questions in the "Answers" section at the end of this book.

Case Scenario: Configuring Databases for Coho Vineyard

BACKGROUND

Company Overview

Coho Vineyard was founded in 1947 as a local, family-run winery. Due to the award-winning wines it has produced over the last several decades, Coho Vineyards has experienced significant growth. To continue expanding, several existing wineries were acquired over the years. Today, the company owns 16 wineries; 9 wineries are in Washington, Oregon, and California, and the remaining 7 wineries are located in Wisconsin and Michigan. The wineries

employ 532 people, 162 of whom work in the central office that houses servers critical to the business. The company has 122 salespeople who travel around the world and need access to up-to-date inventory availability.

Planned Changes

Until now, each of the 16 wineries owned by Coho Vineyard has run a separate Web site locally on the premises. Coho Vineyard wants to consolidate the Web presence of these wineries so that Web visitors can purchase products from all 16 wineries from a single online store. All data associated with this Web site be stored in databases in the central office.

When the data is consolidated at the central office, merge replication will be used to deliver data to the salespeople as well as to allow them to enter orders. To meet the needs of the salespeople until the consolidation project is completed, inventory data at each winery is sent to the central office at the end of each day. Merge replication has been implemented to allow salespeople to maintain local copies of customer, inventory, and order data.

EXISTING DATA ENVIRONMENT

Databases

Each winery presently maintains its own database to store all business information. At the end of each month, this information is brought to the central office and transferred into the databases shown in Table 2-2.

TABLE 2-2 Coho Vineyard Databases

DATABASE	SIZE
Customer	180 megabytes (MB)
Accounting	500 MB
HR	100 MB
Inventory	250 MB
Promotions	80 MB

After the database consolidation project is complete, a new database named *Order* will serve as a data store to the new Web store. As part of their daily work, employees also will connect periodically to the *Order* database using a new in-house Web application.

The *HR* database contains sensitive data and is protected using Transparent Data Encryption (TDE). In addition, data in the Salary table is encrypted using a certificate.

Database Servers

A single server named DB1 contains all the databases at the central office. DB1 is running SQL Server 2008 Enterprise on Windows Server 2003 Enterprise.

Business Requirements

You need to design an archiving solution for the *Customer* and *Order* databases. Your archival strategy should allow the Customer data to be saved for six years.

To prepare the *Order* database for archiving procedures, you create a partitioned table named Order.Sales. Order.Sales includes two partitions. Partition 1 includes sales activity for the current month. Partition 2 is used to store sales activity for the previous month. Orders placed before the previous month should be moved to another partitioned table named Order.Archive. Partition 1 of Order.Archive includes all archived data. Partition 2 remains empty.

A process needs to be created to load the inventory data from each of the 16 wineries by 4 A.M. daily.

Four large customers submit orders using Coho Vineyards Extensible Markup Language (XML) schema for Electronic Data Interchange (EDI) transactions. The EDI files arrive by 5 P.M. and need to be parsed and loaded into the *Customer, Accounting,* and *Inventory* databases, which each contain tables relevant to placing an order. The EDI import routine is currently a single-threaded C++ application that takes between three and six hours to process the files. You need to finish the EDI process by 5:30 P.M. to meet your Service Level Agreement (SLA) with the customers. After the consolidation project has finished, the EDI routine loads all data into the new *Order* database.

You need to back up all databases at all locations. You can lose a maximum of five minutes of data under a worst-case scenario. The *Customer, Account, Inventory, Promotions,* and *Order* databases can be off-line for a maximum of 20 minutes in the event of a disaster. Data older than six months in the *Customer* and *Order* databases can be off-line for up to 12 hours in the event of a disaster.

Answer the following questions.

1. How should you configure the databases for maximum performance?
2. How should the databases be configured to meet recovery obligations?

Suggested Practices

To help you master the exam objectives presented in this chapter, complete the following tasks.

Configuring Databases

- **Practice 1** Create a database which can store *FILESTREAM* data.
- **Practice 2** Change the recovery model and observe the effects on backup and restore options.

- **Practice 3** Change the database state to READ_ONLY and observe the effect on the transaction log file.
- **Practice 4** Create multiple connections to a database, change the access to RESTRICTED_USER, and specify the ROLLBACK IMMEDIATE option. Observe the effects.

Take a Practice Test

The practice tests on this book's companion CD offer many options. For example, you can test yourself on just one exam objective, or you can test yourself on all the 70-432 certification exam content. You can set up the test so that it closely simulates the experience of taking a certification exam, or you can set it up in study mode so that you can look at the correct answers and explanations after you answer each question.

MORE INFO **PRACTICE TESTS**

For details about all the practice test options available, see the section entitled "How to Use the Practice Tests," in the Introduction to this book.

CHAPTER 8

Designing Policy Based Management

Prior to Microsoft SQL Server 2008, you performed configuration management of an environment by using a conglomeration of documents, scripts, and manual checking. The configuration options, naming conventions, and allowed feature set were outlined in one or more documents. To enforce your standards, you would have had to connect to each instance and execute scripts that needed to be maintained and updated with new versions and service packs. In this chapter, you learn about the new Policy Based Management framework that allows you to check and enforce policy compliance across your entire SQL Server infrastructure.

Exam objectives in this chapter:

- Implement the declarative management framework (DMF).
- Configure surface area.

Lesson in this chapter:

Before You Begin

To complete the lessons in this chapter, you must have:

- SQL Server 2008 installed
- The *AdventureWorks* database installed within the instance

REAL WORLD

Michael Hotek

Managing a single server running SQL Server or even a small group of them, one at a time, has always been reasonably straightforward. However, when you needed to uniformly manage an entire SQL Server environment or a large group of instances, you had to either write a large amount of custom code or purchase additional products.

One customer I work with has an environment with more than 5,000 SQL Server instances. Prior to the release of SQL Server 2008, two DBAs were required to manage the almost 50,000 lines of code that checked instances for compliance to corporate policies. They devoted more than 70 hours each week to maintaining the code and checking systems.

After deploying SQL Server 2008, they started to convert all their code to policies. After the conversion was completed, they estimate that less than 1,000 lines of custom logic remained. By using the central management features to check and enforce policies across the environment, they should be able to save over 3,000 hours of management and maintenance time per year.

Lesson 1: Designing Policies

SQL Server 2008 has a new feature called Policy Based Management, also known as the declarative management framework (DMF), to tackle the problem of standardizing your SQL Server instances. Although Policy Based Management can be used just to alert an administrator when an object is out of compliance, depending upon the type of policy, you can also enforce compliance by preventing changes that would violate a policy.

Policy Based Management introduces the following new objects that are used to design and check for compliance:

- Facets
- Conditions
- Policies
- Policy targets
- Policy categories

After this lesson, you will be able to:

- Create conditions
- Define policies
- Specify targets for policy checking
- Configure policy categories
- Check for policy compliance
- Import and export policies

Estimated lesson time: 30 minutes

Facets

Facets are the core object upon which your standards are built. Facets define the type of object or option to be checked, such as database, Surface Area, and login. SQL Server ships with 74 facets, implemented as .NET assemblies, each with a unique set of properties.

All the objects for Policy Based Management are stored within the *msdb* database. You can get a list of the facets available by querying the dbo.syspolicy_management_facets table. Unfortunately, unless you want to write code to interact with Server Management Objects (SMOs), the only way to get a list of facet properties is to open each facet in SQL Server Management Studio (SSMS), one at a time, and view the list of properties.

Conditions

When you define a WHERE clause for a data manipulation language (DML) statement, you set a condition for the DML statement that defines the set of rows that meet your specific inclusion criteria. Within the Policy Based Management framework, *conditions* are the equivalent of a *WHERE* clause that defines the criteria needing to be checked.

You define the conditions that you want to check or enforce for a policy by defining criteria for the properties of a facet. Just like a WHERE clause, a condition can be defined by one or more facet properties, and a single facet property can be checked for multiple criteria. The comparison operators that can be used are restricted by the data type of the property. For example, a property of type *string* can be checked with =, <>, *LIKE, NOT LIKE, IN,* or *NOT IN*, whereas a boolean type can only be checked for = and <>.

If a condition that you want to check for a facet does not have a specific property that can be used, you can use the advanced editor to define complex conditions that compare multiple properties and incorporate functions. For example, you can check that every table has a primary key and that a table with a single index must be clustered. Unfortunately, if you define a condition using the advanced editor, a policy that incorporates the condition must be executed manually and cannot be scheduled.

Conditions are checked in a single step. You cannot have a condition pull a list of objects, iterate across the list of objects, and then apply subsequent checks. To work within the Policy-Based Management framework, conditions need to return a True or False value. Therefore, when building complex conditions with the advanced editor, you cannot return a list of objects that do not meet your criteria. You have to define the condition such that if any object does not meet your criteria, a value of False is returned.

Although you can check many properties of a facet within a single condition, a single condition can't be defined for multiple facets. For example, you can check all 10 of the properties for the Surface Area Configuration facet in a single condition, but you have to define a second condition to check a property of the Surface Area Configuration for Analysis Services.

Policy Targets

Conditions are the foundation for policies. However, you don't always want to check policies across every object available, such as every database in an instance or every index within every database. Conditions can also be used to specify the objects to compare the condition against, called *policy targeting* or target sets.

You can target a policy at the server level, such as instances that are SQL Server 2005 or SQL Server 2008. You can also target a policy at the database level, such as all user databases or all system databases.

Policies

Policies are created for a single condition and set to either enforce or check compliance. The execution mode can be set as follows:

- **On demand** Evaluates the policy when directly executed by a user
- **On change, prevent** Creates data definition language (DDL) triggers to prevent a change that violates the policy
- **On change, log only** Checks the policy automatically when a change is made using the event notification infrastructure
- **On schedule** Creates a SQL Server Agent job to check the policy on a defined schedule

If a policy contains a condition that was defined using the advanced editor, the only available execution mode is On Demand.

To use the *On change, prevent* and *On change, log only* execution modes, the policy must target instances running SQL Server 2005 and above. The *On change, log only* execution mode uses the event notification infrastructure that is available only for SQL Server 2005 and later. The *On change, prevent* execution mode depends on DDL triggers to prevent a change that is not in compliance with the policy and are available only for SQL Server 2005 and later. In addition, you can set a policy to *On change, prevent* only if it is possible for a DDL trigger to prevent the change. For example, you could prevent the creation of an object that violated your naming conventions, but you could not enforce a policy that all databases have to be in the Full recovery model because the *ALTER DATABASE* command executes outside the context of a transaction.

Policy Categories

Policy categories can be used to group one or more policies into a single compliance unit. If not specified, all policies belong to the *DEFAULT* category. To check or enforce policies, you create a subscription to one or more policies.

Subscription occurs at two levels—instance and database. A member of the sysadmin role can subscribe an instance to a policy category. Once subscribed, the owner of each database within the instance can subscribe their database to a policy category.

Each policy category has a *Mandate* property that applies to databases. When a policy category is set to *Mandate* and a sysadmin subscribes the instance to a policy category, all databases that meet the target set are controlled by the policies within the policy category. A policy subscription to a policy category set to *Mandate* cannot be overridden by a database owner.

Policy Compliance

Because you cannot set all policies to enforce compliance, you need to check policies manually that cannot be enforced on a regular basis. You view policies that apply to an instance by right-clicking the name of the instance within Object Explorer and selecting Policies, View.

You can check policies that apply to an instance by right-clicking the name of the instance within Object Explorer and selecting Policies, Evaluate.

You can check all policies within an instance, as shown in Figure 8-1, by right-clicking the Policies node and selecting Evaluate.

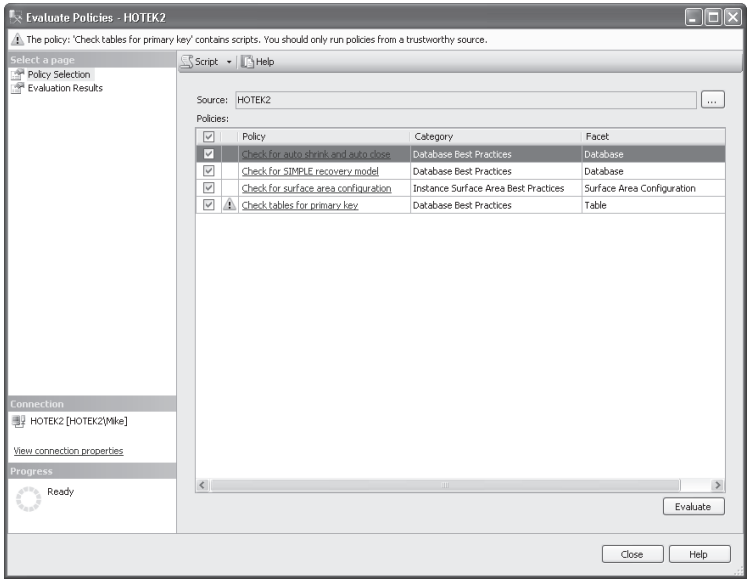


FIGURE 8-1 Evaluate policies

By clicking Evaluate, you execute the policies and review the results, as shown in Figure 8-2.

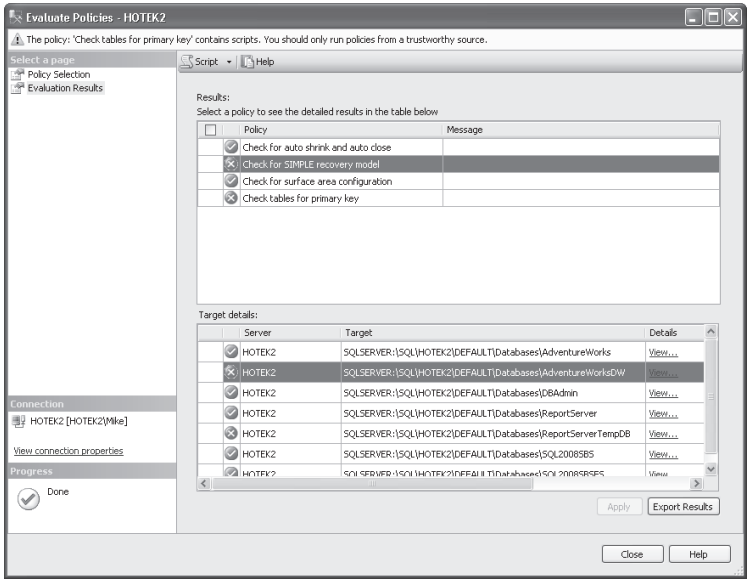


FIGURE 8-2 Policy check results

EXAM TIP

Defining a condition to be used as a policy target is a critical component to well-defined policies. A policy fails during a check if the object does not conform to the criteria and if the property does not exist. For example, attempting to check that the Web Assistant is disabled against a SQL Server 2008 instance fails because the feature does not exist.

Central Management Server

Policy Based Management would be limited to SQL Server 2008 and be very tedious if you had to do any of the following:

- Duplicate policies on every instance
- Create subscriptions to each instance in your environment individually
- Check compliance for each instance individually

Within the Registered Servers pane in SSMS, you can configure a Central Management Server. Underneath the Central Management Server, you can create multiple levels of folders, and register instances into the appropriate folder. After you have the Central Management Server structure set up in SSMS, you can evaluate polices against a specific instance, folder, or all instances underneath the Central Management Server. Figure 8-3 shows an example of a Central Management Server.

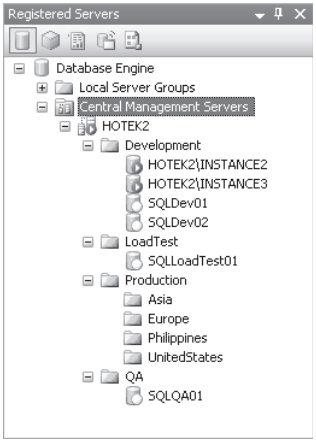


FIGURE 8-3 Central Management Server

Import and Export Policies

Policies and conditions can be exported to files as well as imported from files. SQL Server ships with 53 policies that are located in the Microsoft SQL Server\100\Tools\Policies folder. There are 50 policies for the database engine, 2 policies for Reporting Services, and 1 policy for Analysis Services. The CodePlex site (*http://www.codeplex.com*) has additional policies that you can download and import.

You can import policies within the Registered Servers pane or the Object Explorer. Within Object Explorer, you can right-click the Policies node underneath Policy Management and select Import Policy. Within Registered Servers, you can right-click the Central Management Server or any folder or instance underneath the Central Management Server and select Import Policies. If you import policies from the Central Management Server, the policies are imported to every instance defined underneath the Central Management Server, but not to the Central Management Server itself. Likewise, right-clicking a folder imports the policies to all instances within the folder hierarchy. To import policies to the Central Management Server, you must connect to the instance within Object Explorer and import from the Policies node.

Quick Check

1. What are the five objects that are used within Policy Based Management?
2. What are the allowed execution modes for a policy?
3. Which object has a property that allows you to mandate checking for all databases on an instance?
4. How many facets can be checked within a single condition?
5. How many conditions can be checked within a single policy?

Quick Check Answers

1. The objects that are used with Policy Based Management are facets, conditions, policies, policy targets, and policy categories.
2. The policy execution modes are *On demand*, *On schedule, On change, Log only*, and *On change, prevent*.
3. Policy categories allow you to mandate checking of all databases within an instance.
4. A condition can be defined on only one facet.
5. A policy can check only a single condition.

PRACTICE Defining Policies and Checking for Compliance

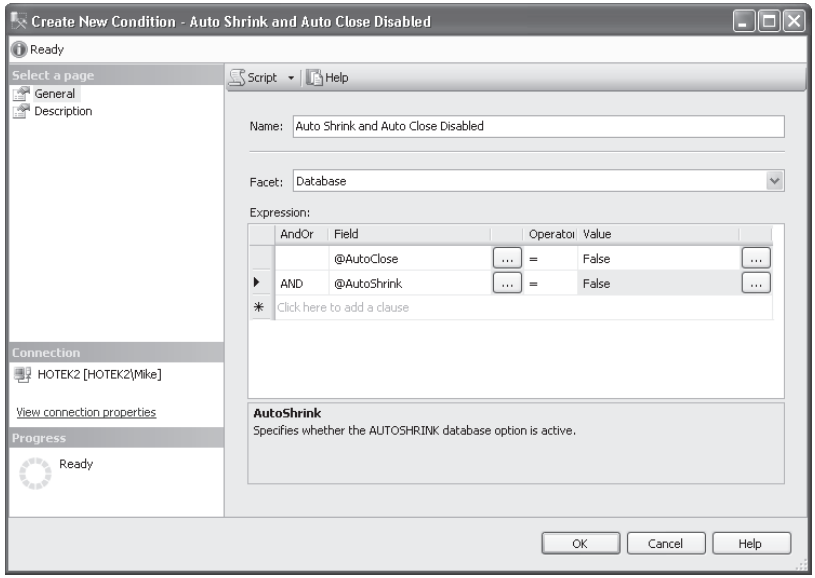
In these practices, you define and check several policies for your environment.

PRACTICE 1 Create a Condition

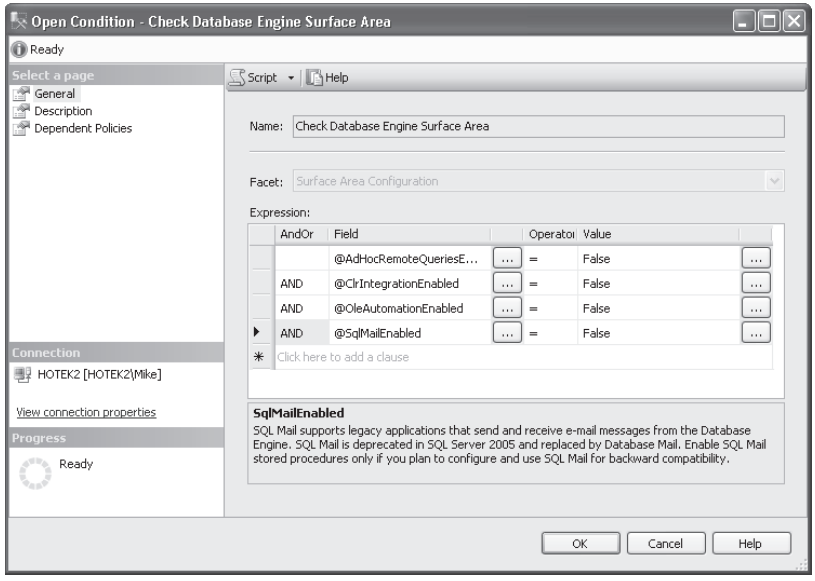
In this practice, you create a condition for the following:

- Check that a database does not have the *auto shrink* or *auto close* properties set.
- Check that CLR, OLE Automation, Ad Hoc Remote Queries, and SQL Mail are all disabled.
- Check that a database is not in the Simple recovery model.
- Check that all tables have a primary key.

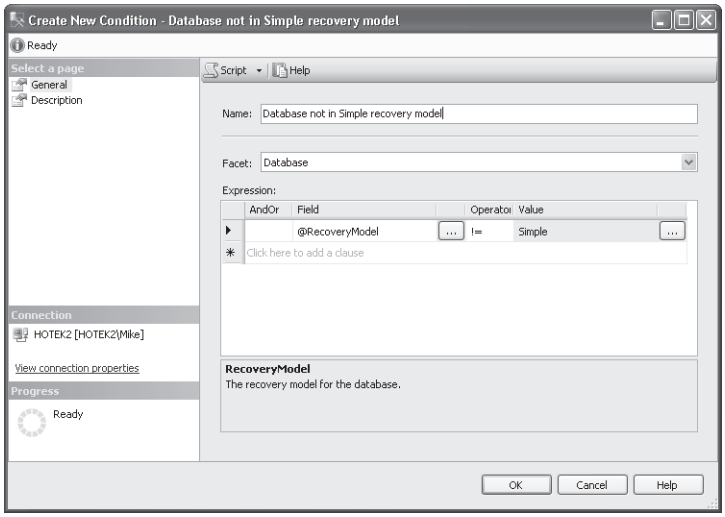
1. In Object Explorer, expand the Policy Management node within the Management node.
2. Right-click the Conditions node and select New Condition.
3. Configure the condition as shown here. Click OK when you are done.



4. Right-click the Conditions node again, select New Condition, and configure the condition as shown here. Click OK.



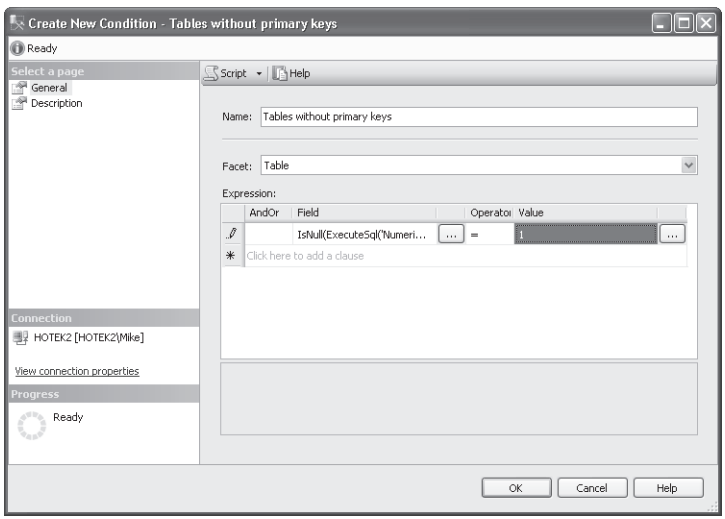
5. Right-click the Conditions node, select New Condition, and configure this third condition as shown here. Click OK when you are finished.



6. Right-click the Conditions node and select New Condition. Select the Table facet, click the ellipsis button next to the Field column to display the Advanced Edit dialog box, enter the following code in the Cell Value text box, and click OK:

```
IsNull(ExecuteSql('Numeric', 'SELECT 1 FROM sys.tables a INNER JOIN sys.indexes b
   ON a.object_id = b.object_id WHERE b.is_primary_key = 1
    AND a.name = @@ObjectName AND a.schema_id = SCHEMA_ID(@@SchemaName)'), 0)
```

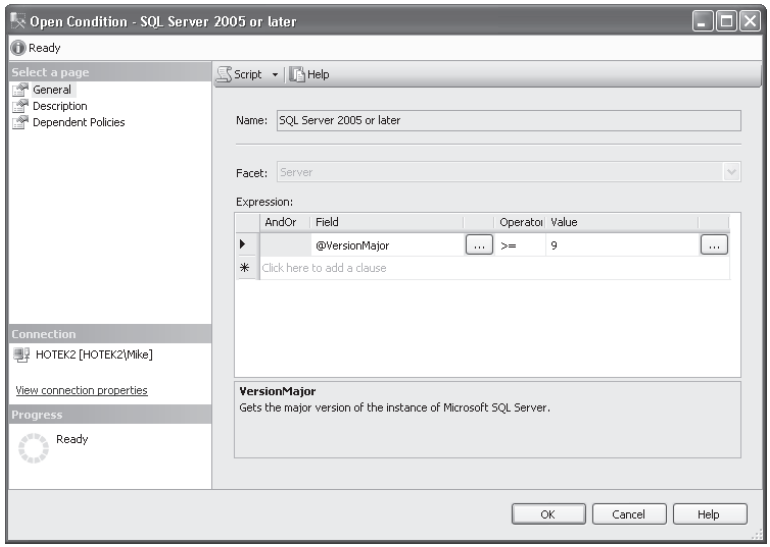
7. Configure the Name, Operator, and Value as shown here, and then click OK.



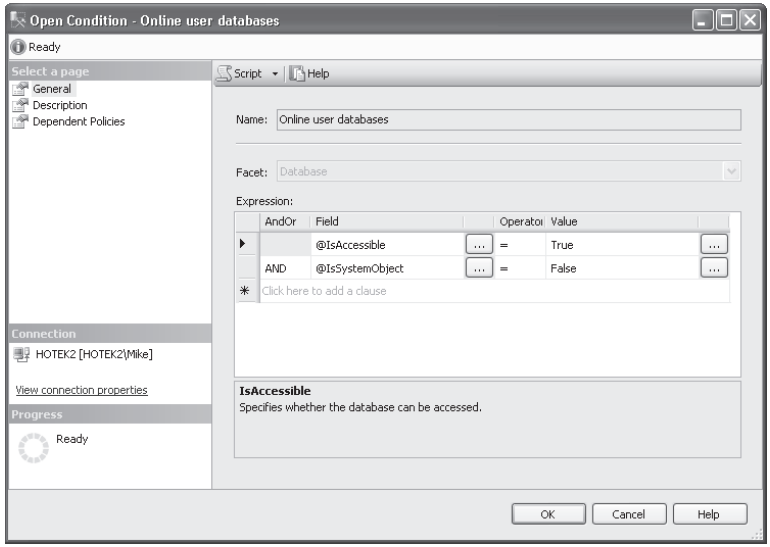
PRACTICE 2 Create a Condition for a Target Set

In this practice, you create a condition to target all SQL Server 2005 and later instances, along with a condition to target all user databases that are online.

1. Right-click the Conditions node, select New Condition, and configure the condition as shown here. Click OK.



2. Right-click the Conditions node, select New Condition, and configure the condition as shown here. Click OK when you are done.



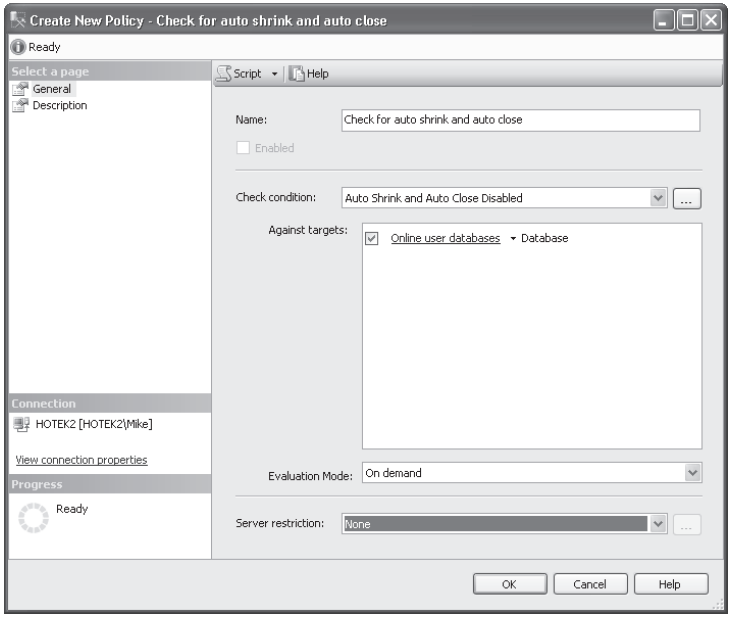
PRACTICE 3 Create a Policy

In this practice, you create policies that use the conditions you just created to do the following:

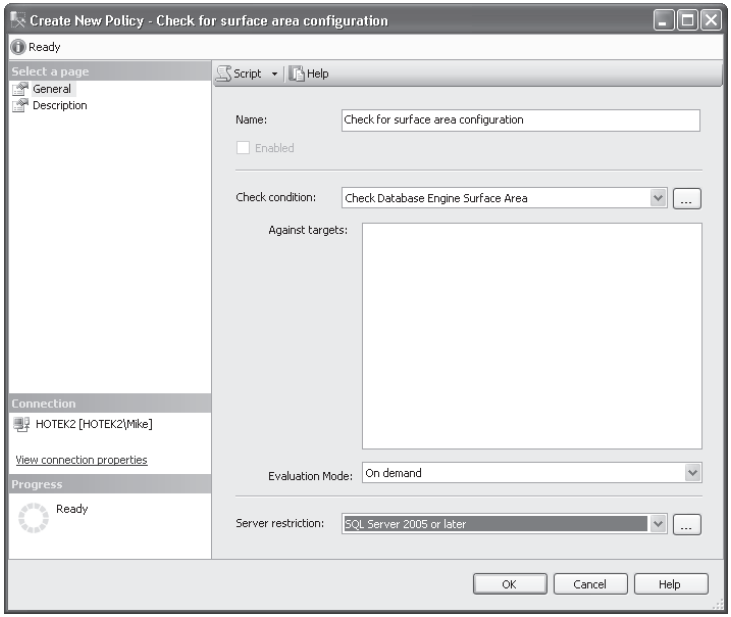
- Check that a database does not have the *auto shrink* or *auto close* properties set.
- Check that CLR, OLE Automation, Ad Hoc Remote Queries, and SQL Mail are all disabled.

- Check that a database is not in the Simple recovery model.
- Check that all tables have a primary key.

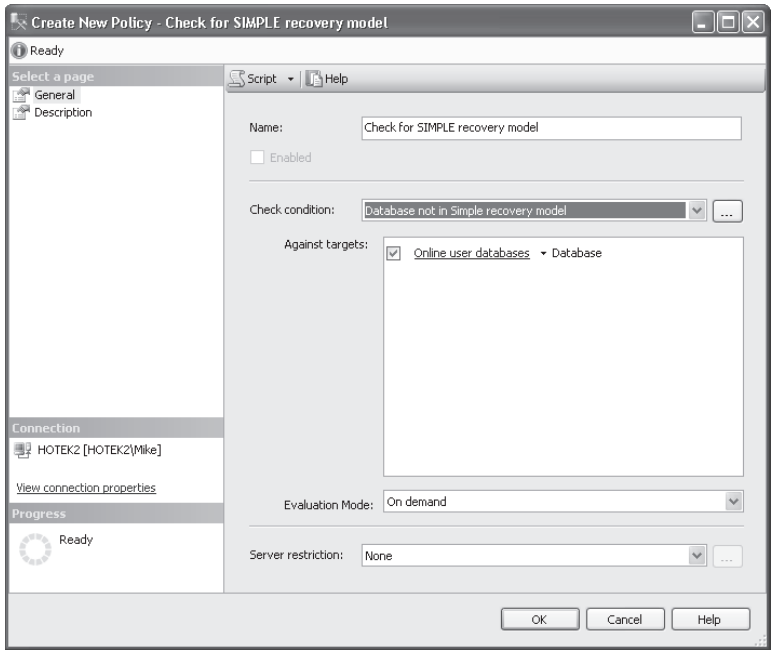
1. Right-click the Policies node, select New Policy, and configure the policy as shown here. Click OK.



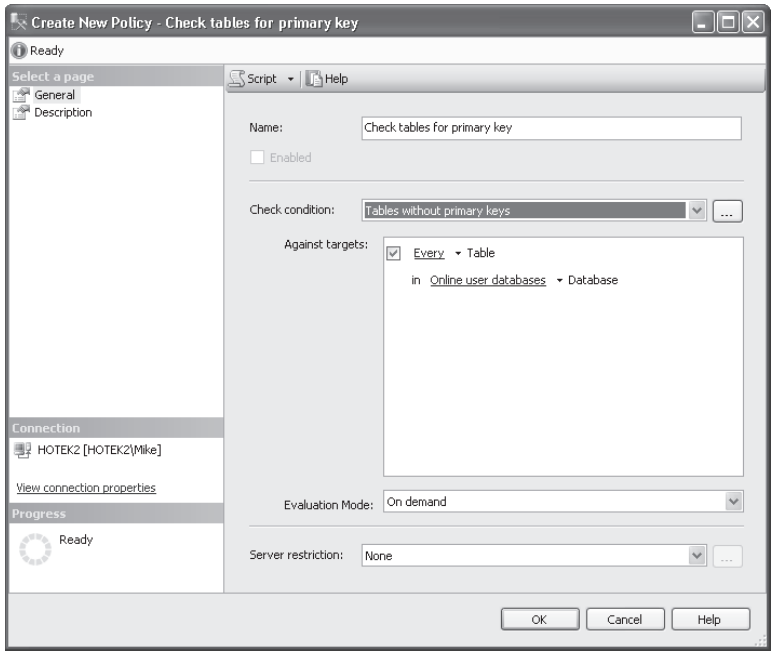
2. Right-click the Policies node, select New Policy, and configure this second policy as shown here. Click OK.



3. Right-click the Policies node, select New Policy, and configure the policy as shown here. Click OK.



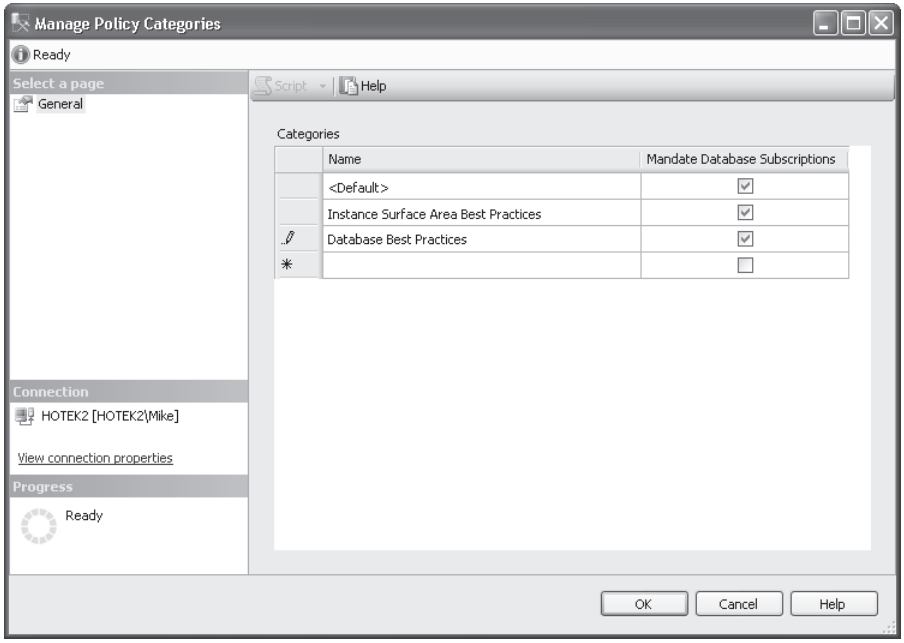
4. Right-click the Policies node, select New Policy, and configure the last policy as shown here. Click OK.



PRACTICE 4 Create a Policy Category

In this practice, you create two policy categories for the policies that you created.

1. Right-click Policy Management, select Manage Categories, and create the categories as shown here. Click OK.

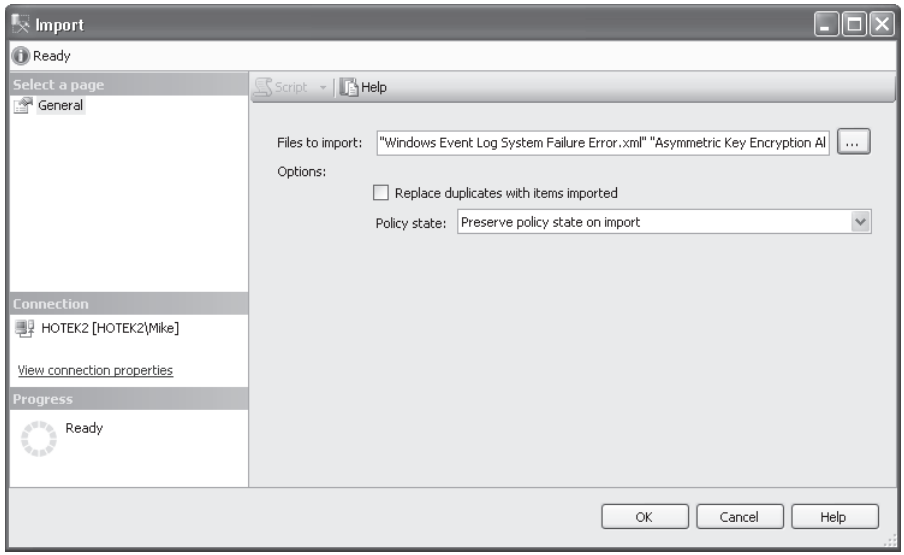


2. In SSMS, in the console tree, expand the Policies folder. Right-click the Check For Auto Shrink And Auto Close Policy, select Properties, click the Description tab, and change the category to Database Best Practices. Click OK.
3. Right-click the Check For Simple Recovery Model Policy, select Properties, select the Description tab, and change the category to Database Best Practices. Click OK.
4. Right-click the Check For Surface Area Configuration Policy, select Properties, click the Description tab, and change the category to Instance Surface Area Best Practices. Click OK.
5. Right-click the Check Tables For Primary Key Policy, select Properties, select the Description tab, and change the category to Database Best Practices. Click OK.

PRACTICE 5 Import Policies

In this practice, you import the policies that ship with SQL Server.

1. Right-click the Policies node underneath Policy Management and select Import Policy.
2. Click the ellipsis button next to the Files To Import text box, navigate to the Microsoft SQL Server\100\Tools\Policies\DatabaseEngine\1033 folder, select all the files in the folder, as shown here, and click Open.



3. Select the Replace Duplicates With Items Imported check box, select Preserve Policy State On Import, and click OK.
4. Take the time to browse the policies and conditions that were created during the import.

Lesson Summary

- You can build policies to enforce conditions across any version of SQL Server.
- Policies can enforce a single condition and each condition can be based on a single facet.
- Policy categories allow you to group policies together for compliance checking.
- A policy category can be set with the *Mandate* property, which requires the policy to be checked against all databases within an instance.

Lesson Review

The following question is intended to reinforce key information presented in this lesson. The question is also available on the companion CD if you prefer to review it in electronic form.

NOTE **ANSWERS**

Answers to this question and an explanation of why each answer choice is correct or incorrect is located in the "Answers" section at the end of the book.

1. You have defined several policies that you want applied to all databases within an instance. How do you ensure that a database owner is not allowed to avoid the policy check with the least amount of administrative effort?
   - **A.** Create a condition that checks all databases.
   - **B.** Add the policy to a user-defined policy category and set the *Mandate* property.
   - **C.** Add the policy to the default policy category.
   - **D.** Check the policies manually against the instance.

Chapter Review

To practice and reinforce the skills you learned in this chapter further, you can perform the following tasks:

- Review the chapter summary.
- Review the list of key terms introduced in this chapter.
- Complete the case scenario. The scenario sets up a real-world situation involving the topics in this chapter and asks you to create a solution.
- Complete the suggested practices.
- Take a practice test.

Chapter Summary

- Facets are the .NET assemblies that define the set of properties for an object upon which conditions are built.
- A condition can be defined for a single facet and a policy can be checked for a single instance.
- Policies can be checked manually or automatically. Automatic policy checking can be performed on a scheduled basis or by using the event notification infrastructure.
- A database owner can subscriber a database to one or more policies; however, a policy that belongs to a policy category set with the *Mandate* property requires checking against all databases.

Key Terms

Do you know what these key terms mean? You can check your answers by looking up the terms in the glossary at the end of the book.

- Condition
- Facet
- Policy category
- Policy target

Case Scenario

In the following case scenario, you apply what you've learned in this chapter. You can find answers to these questions in the "Answers" section at the end of this book.

Case Scenario: Designing a Management Strategy for Coho Vineyard

BACKGROUND

Company Overview

Coho Vineyard was founded in 1947 as a local, family-run winery. Due to the award-winning wines it has produced over the last several decades, Coho Vineyards has experienced significant growth. To continue expanding, several existing wineries were acquired over the years. Today, the company owns 16 wineries; 9 wineries are in Washington, Oregon, and California, and the remaining 7 wineries are located in Wisconsin and Michigan. The wineries employ 532 people, 162 of whom work in the central office that houses servers critical to the business. The company has 122 salespeople who travel around the world and need access to up-to-date inventory availability.

Planned Changes

Until now, each of the 16 wineries owned by Coho Vineyard has run a separate Web site locally on the premises. Coho Vineyard wants to consolidate the Web presence of these wineries so that Web visitors can purchase products from all 16 wineries from a single online store. All data associated with this Web site will be stored in databases in the central office.

When the data is consolidated at the central office, merge replication will be used to deliver data to the salespeople as well as to allow them to enter orders. To meet the needs of the salespeople until the consolidation project is completed, inventory data at each winery is sent to the central office at the end of each day.

Management wants to ensure that you cannot execute stored procedures written in C#.NET or use the *OPENROWSET* or *OPENDATASOURCE* command.

EXISTING DATA ENVIRONMENT

Databases

Each winery presently maintains its own database to store all business information. At the end of each month, this information is brought to the central office and transferred into the databases shown in Table 8-1.

TABLE 8-1 Coho Vineyard Databases

DATABASE	SIZE
Customer	180 megabytes (MB)
Accounting	500 MB
HR	100 MB
Inventory	250 MB
Promotions	80 MB

After the database consolidation project is complete, a new database named *Order* will serve as a data store to the new Web store. As part of their daily work, employees also will connect periodically to the *Order* database using a new in-house Web application.

The *HR* database contains sensitive data and is protected using Transparent Data Encryption (TDE). In addition, data in the Salary table is encrypted using a certificate.

Database Servers

A single server named DB1 contains all the databases at the central office. DB1 is running SQL Server 2008 Enterprise on Windows Server 2003 Enterprise.

Business Requirements

You need to design an archiving solution for the *Customer* and *Order* databases. Your archival strategy should allow the *Customer* data to be saved for six years.

To prepare the *Order* database for archiving procedures, you create a partitioned table named Order.Sales. Order.Sales includes two partitions. Partition 1 includes sales activity for the current month. Partition 2 is used to store sales activity for the previous month. Orders placed before the previous month will be moved to another partitioned table named Order. Archive. Partition 1 of Order.Archive includes all archived data. Partition 2 remains empty.

A process needs to be created to load the inventory data from each of the 16 wineries by 4 A.M. daily.

Four large customers submit orders using Coho Vineyards Extensible Markup Language (XML) schema for Electronic Data Interchange (EDI) transactions. The EDI files arrive by 5 P.M. and need to be parsed and loaded into the *Customer, Accounting,* and *Inventory* databases, which each contain tables relevant to placing an order. The EDI import routine is currently a single threaded C++ application that takes between three and six hours to process the files. You need to finish the EDI process by 5:30 P.M. to meet your Service Level Agreement (SLA) with the customers. After the consolidation project finishes, the EDI routine loads all data into the new *Order* database.

You need to back up all databases at all locations. All production databases are required to be configured with the Full recovery model. You can lose a maximum of five minutes of data under a worst-case scenario. The *Customer, Account, Inventory, Promotions,* and *Order* databases can be off-line for a maximum of 20 minutes in the event of a disaster. Data older than six months in the *Customer* and *Order* databases can be off-line for up to 12 hours in the event of a disaster.

Answer the following question.

- What policies would you implement to check and enforce the business requirements for Coho Vineyard?

Suggested Practices

To help you master the exam objectives presented in this chapter, complete the following tasks.

Implement Policy Based Management

- **Practice 1** Configure a policy to check the surface area configuration for all your SQL Server instances.
- **Practice 2** Configure a policy to check the last time a database was successfully backed up.
- **Practice 3** Configure policies to check the membership of the sysadmin and db_owner roles.
- **Practice 4** Configure a policy to ensure that databases are not set to either *auto shrink* or *auto close*.
- **Practice 5** Based on the policies that ship with SQL Server 2008, decide which policies apply to your environment and implement the policy checks.

Take a Practice Test

The practice tests on this book's companion CD offer many options. For example, you can test yourself on just one exam objective, or you can test yourself on all the 70-432 certification exam content. You can set up the test so that it closely simulates the experience of taking a certification exam, or you can set it up in study mode so that you can look at the correct answers and explanations after you answer each question.

MORE INFO **PRACTICE TESTS**

For details about all the practice test options available, see the section entitled "How to Use the Practice Tests," in the Introduction to this book.

Index

Symbols and Numbers

A

B

C

D

E

F

G

H

I

J

K

L

M

N

O

P

Q

R

S

T

U

V

W

X