



**IBM Informix Storage Manager Administrator's Guide**





**Note:**

Before using this information and the product it supports, read the information in "Notices" on page C-1.

This edition replaces G229-6388-01.

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### In This Introduction

This introduction provides an overview of the information in this manual and describes the conventions it uses.

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### About This Publication

This publication describes IBM Informix Storage Manager (ISM), which manages storage devices and media for your Informix® database server. Use ISM with ON-Bar to back up and restore database server data.

#### Types of Users

This manual is written for the following users:

- Database administrators
- Database server administrators
- Backup operators

This manual is written with the assumption that you have the following background:

- Familiarity with the ON-Bar backup and restore utility  
For more information about ON-Bar, refer to the *IBM Informix Backup and Restore Guide*
- A working knowledge of your computer, your operating system, and the utilities that your operating system provides
- Some experience working with relational databases or exposure to database concepts

If you have limited experience with relational databases, SQL, or your operating system, refer to the *IBM Informix Dynamic Server Getting Started Guide* for your database server for a list of supplementary titles.

## Software Dependencies

ISM supports the following database servers:

- IBM Informix Dynamic Server, Version 7.3x
- IBM Informix Dynamic Server with Advanced Decision Support and Extended Parallel Options, Version 8.2x
- IBM Informix Extended Parallel Server, Version 8.3x
- IBM Informix Extended Parallel Server, Version 8.4
- IBM Informix Extended Parallel Server, Version 8.51
- IBM Informix Dynamic Server (IDS), Version 9.2x
- IBM Informix Dynamic Server (IDS), Version 9.3
- IBM Informix Dynamic Server with J/Foundation, Version 9.3
- IBM Informix Dynamic Server (IDS), Version 9.40
- IBM Informix Dynamic Server (IDS), Version 10.0
- IBM Informix Dynamic Server (IDS), Version 11.10 and later

## Assumptions About Your Locale

IBM Informix products can support many languages, cultures, and code sets. All the information related to character set, collation, and representation of numeric data, currency, date, and time is brought together in a single environment, called a Global Language Support (GLS) locale.

The examples in this manual are written with the assumption that you are using the default locale, **en\_us.8859-1**. This locale supports U.S. English format conventions for date, time, and currency. In addition, this locale supports the ISO 8859-1 code set, which includes the ASCII code set plus many 8-bit characters such as é, è, and ñ.

If you plan to use nondefault characters in your data or your SQL identifiers, or if you want to conform to the nondefault collation rules of character data, you need to specify the appropriate nondefault locale.

For instructions on how to specify a nondefault locale, additional syntax, and other considerations related to GLS locales, see the *IBM Informix GLS User's Guide*.

## Demonstration Database

The DB–Access utility, provided with the database server products, includes one or more of the following demonstration databases:

- The **stores\_demo** database illustrates a relational schema with information about a fictitious wholesale sporting-goods distributor. Many examples in IBM Informix manuals are based on the **stores\_demo** database.

### Extended Parallel Server

- The **sales\_demo** database illustrates a dimensional schema for data-warehousing applications. For conceptual information about dimensional data modeling, see the *IBM Informix Database Design and Implementation Guide*.

### End of Extended Parallel Server

### Dynamic Server

- The **superstores\_demo** database illustrates an object-relational schema. The **superstores\_demo** database contains examples of extended data types, type and table inheritance, and user-defined routines.

End of Dynamic Server

For information about how to create and populate the demonstration databases, see the *IBM Informix DB–Access User’s Guide*. For descriptions of the databases and their contents, see the *IBM Informix Guide to SQL: Reference*.

The scripts that you use to install the demonstration databases reside in the **\$INFORMIXDIR/bin** directory on UNIX® and in the **%INFORMIXDIR%\bin** directory on Windows.

## What’s New in Storage Manager for IBM Informix Dynamic Server, Version 11.50

For a comprehensive list of new features for this release, see the *IBM Informix Dynamic Server Getting Started Guide*. The following changes and enhancements are relevant to this publication.

Table 1. What’s New in IBM Informix Storage Manager Administrator’s Guide for Version 11.50.xC3

Overview	Reference
The ISM Administrator program lets you to manage your ISM server and storage devices from a graphical interface.	Tasks using ISM Administrator are throughout the book, including the following topics: “Labeling a Volume” on page 4-7, “Cloning Save Sets” on page 4-14.

## Documentation Conventions

This section describes the following conventions, which are used in the product documentation for IBM® Informix Dynamic Server:

- Typographical conventions
- Feature, product, and platform conventions
- Syntax diagrams
- Command-line conventions
- Example code conventions

### Typographical Conventions

This publication uses the following conventions to introduce new terms, illustrate screen displays, describe command syntax, and so forth.

Convention	Meaning
KEYWORD	Keywords of SQL, SPL, and some other programming languages appear in uppercase letters in a serif font.
<i>italics</i>	Within text, new terms and emphasized words appear in italics. Within syntax and code examples, variable values that you are to specify appear in italics.
<b>boldface</b>	Names of program entities (such as classes, events, and tables), environment variables, file names, path names, and interface elements (such as icons, menu items, and buttons) appear in boldface.

Convention	Meaning
monospace	Information that the product displays and information that you enter appear in a monospace typeface.
KEYSTROKE	Keys that you are to press appear in uppercase letters in a sans serif font.
>	This symbol indicates a menu item. For example, “Choose <b>Tools</b> > <b>Options</b> ” means choose the <b>Options</b> item from the <b>Tools</b> menu.

Technical changes to the text are indicated by special characters depending on the format of the documentation:

#### HTML documentation

New or changed information is surrounded by blue >> and << characters.

#### PDF documentation

A plus sign (+) is shown to the left of the current changes. A vertical bar (|) is shown to the left of changes made in earlier shipments.

## Feature, Product, and Platform Markup

Feature, product, and platform markup identifies paragraphs that contain feature-specific, product-specific, or platform-specific information. Some examples of this markup follow:

```

_____ Dynamic Server _____
Identifies information that is specific to IBM Informix Dynamic Server
_____ End of Dynamic Server _____

```

```

_____ Windows Only _____
Identifies information that is specific to the Windows operating system
_____ End of Windows Only _____

```

This markup can apply to one or more paragraphs within a section. When an entire section applies to a particular product or platform, this is noted as part of the heading text, for example:

#### **Table Sorting (Windows)**

## Example Code Conventions

Examples of SQL code occur throughout this publication. Except as noted, the code is not specific to any single IBM Informix application development tool.

If only SQL statements are listed in the example, they are not delimited by semicolons. For instance, you might see the code in the following example:

```

CONNECT TO stores_demo
...

DELETE FROM customer
  WHERE customer_num = 121
...

COMMIT WORK
DISCONNECT CURRENT

```

To use this SQL code for a specific product, you must apply the syntax rules for that product. For example, if you are using an SQL API, you must use EXEC SQL at the start of each statement and a semicolon (or other appropriate delimiter) at the end of the statement. If you are using DB–Access, you must delimit multiple statements with semicolons.

**Tip:** Ellipsis points in a code example indicate that more code would be added in a full application, but it is not necessary to show it to describe the concept being discussed.

For detailed directions on using SQL statements for a particular application development tool or SQL API, see the documentation for your product.

---

## Additional Documentation

You can view, search, and print all of the product documentation from the IBM Informix Dynamic Server information center on the Web at <http://publib.boulder.ibm.com/infocenter/idshelp/v115/index.jsp>.

For additional documentation about IBM Informix Dynamic Server and related products, including release notes, machine notes, and documentation notes, go to the online product library page at <http://www.ibm.com/software/data/informix/pubs/library/>. Alternatively, you can access or install the product documentation from the Quick Start CD that is shipped with the product.

---

## Compliance with Industry Standards

The American National Standards Institute (ANSI) and the International Organization of Standardization (ISO) have jointly established a set of industry standards for the Structured Query Language (SQL). IBM Informix SQL-based products are fully compliant with SQL-92 Entry Level (published as ANSI X3.135-1992), which is identical to ISO 9075:1992. In addition, many features of IBM Informix database servers comply with the SQL-92 Intermediate and Full Level and X/Open SQL Common Applications Environment (CAE) standards.

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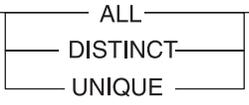
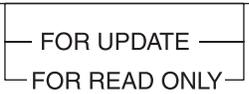
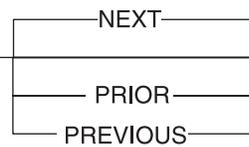
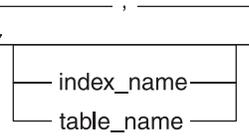
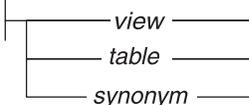
## Syntax Diagrams

This guide uses syntax diagrams built with the following components to describe the syntax for statements and all commands other than system-level commands.

*Table 2. Syntax Diagram Components*

Component represented in PDF	Component represented in HTML	Meaning
	>>-----	Statement begins.
	----->	Statement continues on next line.
	>-----	Statement continues from previous line.
	-----<<	Statement ends.
	-----SELECT-----	Required item.

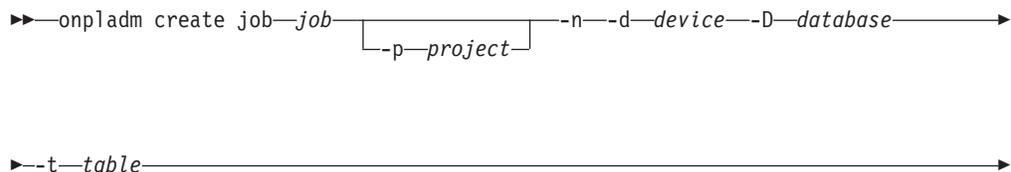
Table 2. Syntax Diagram Components (continued)

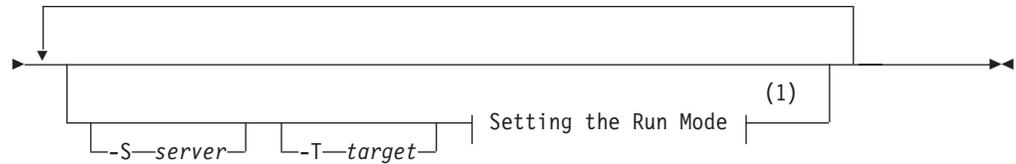
Component represented in PDF	Component represented in HTML	Meaning
	<code>--+-----+-- '-----LOCAL-----'</code>	Optional item.
	<code>---+-----ALL-----+-- +--DISTINCT-----+ '---UNIQUE-----'</code>	Required item with choice. One and only one item must be present.
	<code>---+-----+-- +--FOR UPDATE-----+ '--FOR READ ONLY--'</code>	Optional items with choice are shown below the main line, one of which you might specify.
	<code>.---NEXT-----. ---+-----+-- +---PRIOR-----+ '---PREVIOUS-----'</code>	The values below the main line are optional, one of which you might specify. If you do not specify an item, the value above the line will be used as the default.
	<code>.-----,-----. v ---+-----+-- +---index_name---+ '---table_name---'</code>	Optional items. Several items are allowed; a comma must precede each repetition.
	<code>&gt;&gt;-  Table Reference  -&lt;&lt;</code>	Reference to a syntax segment.
Table Reference 	Table Reference <code> ---+-----view-----+--  +-----table-----+ '-----synonym-----'</code>	Syntax segment.

## How to Read a Command-Line Syntax Diagram

The following command-line syntax diagram uses some of the elements listed in the table in Syntax Diagrams.

### Creating a No-Conversion Job



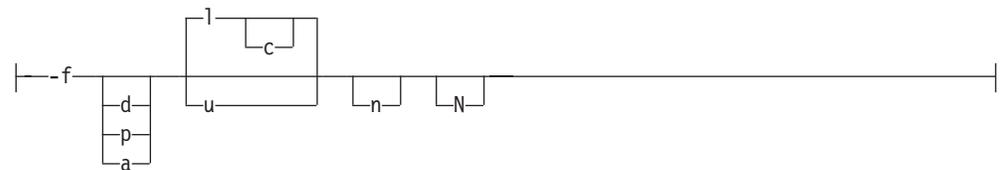


**Notes:**

- 1 See page Z-1

The second line in this diagram has a segment named “Setting the Run Mode,” which according to the diagram footnote, is on page Z-1. If this was an actual cross-reference, you would find this segment in on the first page of Appendix Z. Instead, this segment is shown in the following segment diagram. Notice that the diagram uses segment start and end components.

**Setting the Run Mode:**



To see how to construct a command correctly, start at the top left of the main diagram. Follow the diagram to the right, including the elements that you want. The elements in this diagram are case sensitive because they illustrate utility syntax. Other types of syntax, such as SQL, are not case sensitive.

The Creating a No-Conversion Job diagram illustrates the following steps:

1. Type **onpladm create job** and then the name of the job.
2. Optionally, type **-p** and then the name of the project.
3. Type the following required elements:
  - **-n**
  - **-d** and the name of the device
  - **-D** and the name of the database
  - **-t** and the name of the table
4. Optionally, you can choose one or more of the following elements and repeat them an arbitrary number of times:
  - **-S** and the server name
  - **-T** and the target server name
  - The run mode. To set the run mode, follow the Setting the Run Mode segment diagram to type **-f**, optionally type **d**, **p**, or **a**, and then optionally type **l** or **u**.
5. Follow the diagram to the terminator.

**Keywords and Punctuation**

Keywords are words reserved for statements and all commands except system-level commands. When a keyword appears in a syntax diagram, it is

shown in uppercase letters. When you use a keyword in a command, you can write it in uppercase or lowercase letters, but you must spell the keyword exactly as it appears in the syntax diagram.

You must also use any punctuation in your statements and commands exactly as shown in the syntax diagrams.

## Identifiers and Names

Variables serve as placeholders for identifiers and names in the syntax diagrams and examples. You can replace a variable with an arbitrary name, identifier, or literal, depending on the context. Variables are also used to represent complex syntax elements that are expanded in additional syntax diagrams. When a variable appears in a syntax diagram, an example, or text, it is shown in *lowercase italic*.

The following syntax diagram uses variables to illustrate the general form of a simple SELECT statement.

►►—SELECT—*column\_name*—FROM—*table\_name*—◄◄

When you write a SELECT statement of this form, you replace the variables *column\_name* and *table\_name* with the name of a specific column and table.

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## How to Provide Documentation Feedback

You are encouraged to send your comments about IBM Informix user documentation by using one of the following methods:

- Send e-mail to [docinf@us.ibm.com](mailto:docinf@us.ibm.com).
- Go to the Information Center at <http://publib.boulder.ibm.com/infocenter/idshelp/v115/index.jsp> and open the topic that you want to comment on. Click the feedback link at the bottom of the page, fill out the form, and submit your feedback.

Feedback from both methods is monitored by those who maintain the user documentation of Dynamic Server. The feedback methods are reserved for reporting errors and omissions in our documentation. For immediate help with a technical problem, contact IBM Technical Support. For instructions, see the IBM Informix Technical Support Web site at <http://www.ibm.com/planetwide/>.

We appreciate your suggestions.

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## In This Chapter

This chapter provides an overview of how IBM Informix Storage Manager (ISM) works with the ON-Bar utility, which you can use to perform backups and restores. For more information, see the *IBM Informix Backup and Restore Guide*.

ISM provides data-storage management services for your Informix database server. ISM receives backup and restore requests from ON-Bar and directs your data to and from storage volumes that are mounted on storage devices. ISM tracks backed-up data through a data life cycle that the database administrator or system administrator determines and can automatically manage your storage devices and storage volumes.

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## What Is ISM?

ISM includes the following components:

- The ISM server for exchanging backup and recovery information between storage devices and ON-Bar
- The ISM catalog, which maintains up-to-date records of the backup operations that have been performed and the media on which the backed-up data is stored
- The ISM Administrator program lets you to manage your ISM server and storage devices from a graphical interface. You can use ISM Administrator to monitor the progress of your backup and restore operations, manage backed-up data, and control your storage media and storage devices.

+  
+  
+  
+

The ISM server resides on the same computer as ON-Bar and the Informix database server; your storage devices must be attached to this computer as well. The ISM server runs on UNIX or Windows. ISM supports both 32-bit and 64-bit operating systems.

## Networker

EMC NetWorker® (formerly Legato NetWorker) is a network storage management solution that protects and helps to manage data across an entire network of computers. It manages your data and creates a database of saved data to make it easy to locate data for recovery. EMC NetWorker is not an IBM Informix utility. For information on using NetWorker nsr commands with ISM, see your EMC NetWorker documentation.

## ISM Server Tasks

Figure 1-1 shows the interaction between ON-Bar, ISM server, and ISM commands. ISM must be running before you can use the ISM commands.

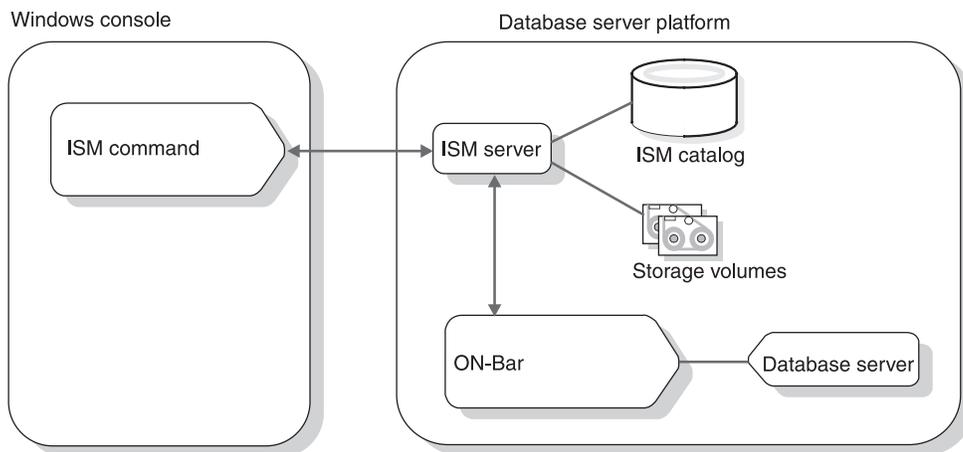


Figure 1-1. ON-Bar and ISM Interaction

The ISM server performs the following tasks:

- Receives backup and restore requests from ON-Bar
- Manages the data life cycle of your data
- Maintains the ISM catalog

The ISM catalog allows you to store related save sets in volumes and to track related volumes by means of volume pools. A volume is a specific backup medium, such as a disk or reel of magnetic tape. A volume pool is a named set of volumes.

- Creates and saves information that is needed to restore the state of the ISM server after a disk failure.

The ISM command-line utilities allow you to perform the following tasks:

- Add, change, and delete administrative users
- Connect to and administer multiple ISM servers on your network
- Configure up to four storage devices for each ISM server
- Configure up to four active data streams
- Label and mount storage volumes on your storage devices
- Determine how long the ISM server should track backed-up data

- Manage the storage volumes
- Create exact copies of data

For a complete description, see Appendix A, “ISM Command-Line Utilities,” on page A-1.

---

## Y2K Compliance

ISM is Y2K compliant. ISM supports dates in the year 2000 and beyond. All internal dates are stored in an internal format that allows representation of dates from January 1, 1970 through December 31, 2037. ISM correctly interprets the year 2000 as a leap year. When a year is entered as a two-digit specification, ISM interprets it as follows:

- A year entered in the range of 70 - 99 is interpreted as 1970 - 1999
- A year entered in the range of 00 - 37 is interpreted as 2000 - 2037
- A year entered in the range of 38 - 69 is invalid

---

## How Do ON-Bar and ISM Fit Together?

ON-Bar and ISM communicate through an X/Open Backup Services Application (XBSA) Programming Interface, which enables ISM to provide media-management services for the database server. Figure 1-1 on page 1-2 illustrates how ON-Bar and ISM interact on a network to back up the database server.

You can initiate ON-Bar backup and restore operations with the **onbar** command line, the **onbar** script, or the ON-Bar option in IBM Informix Server Administrator (ISA). For information on how to run ON-Bar commands from ISA, see the ISA online help.

## What Happens During a Backup Operation?

The database server administrator or operator uses ON-Bar to request a backup operation. When the ISM server receives a backup request from ON-Bar, it creates one or more save sets on the storage media as the data is backed up. The ISM server writes the backup data to storage volumes mounted on storage devices that are attached to the ISM server. ISM uses volume pools to sort specific data onto preselected storage volumes in order to help manage your data. For example, by default ISM writes data from dbspaces to a collection of volumes in the ISMData volume pool and the logical-log files to volumes in the ISMLogs volume pool.

During a backup or restore operation, ISM requests that you mount a labeled storage volume from the appropriate volume pool on one of the storage devices attached to the ISM server. You can label and mount a storage volume when you receive the request from the ISM server, or you can prelabel several volumes and mount them as you need them.

To further automate the labeling and mounting process, you can designate that a specific storage device should handle all storage media that is loaded in it exclusively as ISM media. This arrangement means that you can load a blank tape in a storage device, and the ISM server labels and mounts it when it needs a new storage volume for an ON-Bar backup. For more information, see Chapter 4, “Managing Storage Volumes,” on page 4-1.

Figure 1-2 on page 1-4 illustrates how data and requests move between ON-Bar, the ISM server, and the database server during a backup operation. Backup requests are processed in the following sequence:

1. The user uses ON-Bar to start a backup operation.
  2. ON-Bar determines what data needs to be backed up.
  3. ON-Bar connects to the ISM server.
  4. ON-Bar retrieves the data from the appropriate storage spaces or logical logs on the Informix database server, builds a list of backup objects, and passes it to the ISM server.
  5. The ISM server creates a save set from the data and writes that save set to the proper storage volumes.
  6. The ISM server enters a record of the save sets and the storage volumes in the ISM catalog.
- The ISM server uses the ISM catalog to track the save sets and the volumes to which they are backed up.
7. After the backup operation finishes, ON-Bar disconnects from ISM.
  8. ON-Bar creates a save set called the ISM server bootstrap, which contains configuration information about the ISM server for disaster recovery purposes. The ISM server writes the ISM server bootstrap to a volume from the ISMData volume pool. You can send the ISM server bootstrap information to the printer that you designated during installation.
  9. ON-Bar writes information about the backup to the database server message log and ON-Bar activity log. ISM writes information about the backup to the `ISM\2.20\logs\messages` log.

Use the `ism_watch` command to track ISM server activity.

**Warning:** Because ISM server bootstrap information is vital for disaster recovery, keep the most recent bootstrap printout in a safe place.

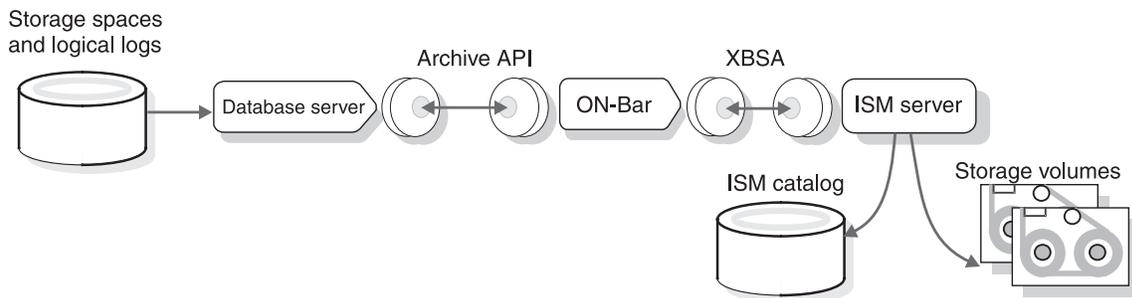


Figure 1-2. Data Movement During an ON-Bar Backup

## What Happens During a Restore Operation?

The database server administrator or operator uses ON-Bar to request a restore operation. When the ISM server receives a restore request from ON-Bar, ISM searches the ISM catalog to identify the required storage volumes. When ISM recovers data, ISM requests a specific storage volume by name. To fulfill this request, mount the appropriate storage volume on one of the storage devices that is attached to the ISM server.

Figure 1-3 illustrates how data and requests move between ON-Bar, the ISM server, and the database server through XBSA during a restore operation. Restore requests are processed in the following sequence:

1. The user uses ON-Bar to start a restore operation.
2. ON-Bar determines what data needs to be restored.
3. ON-Bar connects to the ISM server.
4. The ISM server searches the ISM catalog for specific restore objects that ON-Bar requests. ISM maps each restore object to its offset in a save set.
5. ON-Bar retrieves the data from the ISM server and passes it to the Informix database server, object by object.
6. The database server writes the data to the proper storage spaces or logical logs.
7. After the restore operation finishes, ON-Bar disconnects from ISM.

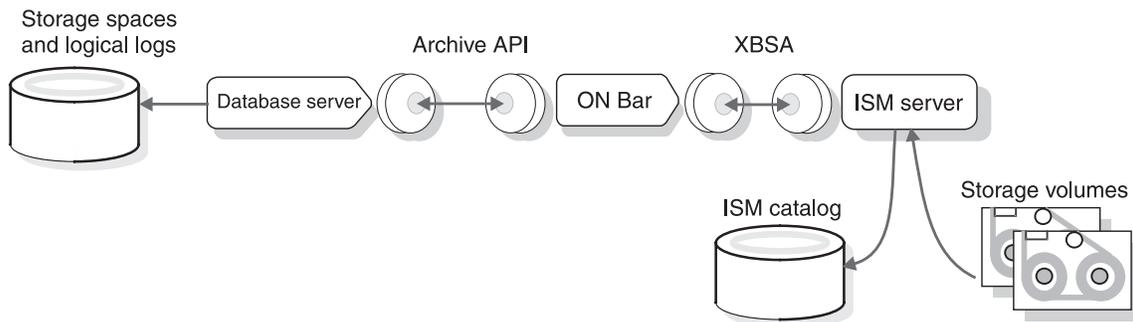


Figure 1-3. Data Movement During an ON-Bar Restore

## Configuring ISM

This section contains ISM configuration information. Before you can use ISM with ON-Bar to back up and restore data, you must configure it.

The ISM server files are installed but not started when you install the database server.

### To configure ISM:

1. Copy the **sm\_versions.std** file to **sm\_versions** and verify that the latest ISM information is in the file.
2. Verify that the **BAR\_BSALIB\_PATH** configuration parameter points to the correct XBSA shared library for ISM. For details, see the *IBM Informix Backup and Restore Guide*.

3. Set ISM environment variables.

To set up ISM, see “Setting Up ISM on UNIX” on page 1-6 or “Setting Up ISM on Windows” on page 1-7.

4. Add administrative users. Ensure that your administrative users have privileges on both the computer that runs the ISM server software (either UNIX or Windows) and the computer that runs the ISM commands (Windows).

For details, see “Adding the First Administrative User to the ISM Server” on page 2-3.

5. Determine whether you want to back up data to disk (also called *file-type devices*), tape, or optical drives.

If you want to back up data to file-type devices, see “Using File Systems as Storage Devices” on page 3-5.

If you want to back up data to tape or optical drives, see “Adding and Deleting Storage Devices” on page 3-2.

6. Configure a storage device for storage-space backups and another one for logical-log backups. The devices must be attached to the computer where ISM is installed.

For details, see “Using Storage Devices for Logical-Log Backups” on page 3-6.

7. Label your storage volumes.

- ISMData is the default volume pool name for storage spaces. ISMLogs is the default volume pool name for logical-log files.
- Use the ISMDiskData and ISMDiskLogs volume pools if you are using file-type storage devices.

For more information, see “Using Volume Pools and Volume Labels” on page 4-5. For information on how to change which volume pool is used for which data, see “Using ISM Configuration Parameters to Change the Volume Pool Name” on page 2-6.

8. Mount the storage volumes on the storage devices.
9. Establish a retention period for the backed-up data that the ISM server tracks. The default value is six months.

For details, see “Setting the Retention Period for All Data” on page 2-2.

10. Determine if you want the ISM server to automatically manage the storage volumes loaded in a storage device.

See “Automating Media Management for Tape and Optical Devices” on page 3-8.

11. Designate a safe place to keep the ISM server bootstrap printouts. You need the information in the bootstrap printout for disaster recovery purposes.

For details, see “If You Have the ISM Server Bootstrap Printout” on page 5-3.

After you configure the ISM server and storage devices and label volumes for your database and logical-log backups, you are ready to initiate a backup operation with ON-Bar.

**Warning:** Install only one storage manager per computer to prevent possible conflicts with the XBSA shared library. Do not run ISM and NetWorker on the same computer because they write files to the `/nsr` directory.

#### Extended Parallel Server

Extended Parallel Server allows multiple ISM instances but only one instance per coserver node.

#### End of Extended Parallel Server

**Tip:** If the database server is installed on UNIX, the ISM utilities are stored in the `bin` directory with the other binaries. If the database server is installed on Windows, the ISM utilities are stored in the ISM directory.

## Setting Up ISM on UNIX

To start ISM on UNIX for the first time, issue the `ism_startup -init` command. The following C shell script is an example of a simple setup for making ON-Bar storage-space and logical-log backups to disk files:

```
#!/bin/csh
# setup for ISM storage manager

echo "ISM setup begins"

# the user must edit these two lines to select
# appropriate disk locations for storage manager use.
setenv SM_DISKDEV1 /backups/dbspaces
setenv SM_DISKDEV2 /backups/logfiles

# start ISM server
echo "initialize ISM server, must be done as root"
ism_startup -init
```

**Important:** To make **informix** the ISM user and thereby ensure **informix** has access to conduct ISM operations during daily routines, you must run the following command after any **ism\_startup -init** or ISM installation:

```
ism_add -admin informix@server

# create some devices and media
# the ISM user, defined in ism_add -admin, can do these tasks
echo "create and mount ISM devices and pools"
ism_add -device $SM_DISKDEV1 -type file
ism_add -device $SM_DISKDEV2 -type file
ism_op -label $SM_DISKDEV1 -pool ISMDiskData -volume ISMData
ism_op -label $SM_DISKDEV2 -pool ISMDiskLogs -volume ISMLogs
ism_op -mount $SM_DISKDEV1
ism_op -mount $SM_DISKDEV2
echo "end of ISM setup"
```

**To configure ISM to start up automatically:**

1. Add **\$INFORMIXDIR/bin/ism\_startup** to one of the **rc** scripts in **/etc/rc2.d** (on Solaris) to start the ISM server when UNIX boots. Make sure the **PRINTER** environment variable is set correctly.
2. Add **\$INFORMIXDIR/bin/ism\_shutdown -q** to one of the **rc** scripts in **/etc/rc0.d** to shut down the ISM server when UNIX shuts down.

After you configure ISM, you can set the **LOG\_BACKUP\_MODE** configuration parameter to **CONT** or **MANUAL** to back up the logical logs. Until ISM is configured and available to back up the logical logs, **LOG\_BACKUP\_MODE** should be set to **NONE**.

**To stop and start ISM manually:**

- After you shut down the database server, to shut down ISM, use the **ism\_shutdown** command.
- Before you restart the database server, issue the **ism\_startup** command to start ISM.

## Setting Up ISM on Windows

The database server installation program creates the following ISM services:

- ISM Local Execution
- ISM Portmapper
- ISM Server

You can use a batch file called **ism\_startup.bat** to set up ISM operations with ON-Bar on Windows and start the ISM services. This batch file configures two file-type devices to back up logical logs and storage spaces. This configuration

allows you to back up logical logs and storage spaces to disk. You must edit the locations for the **SM\_DISKDEV1** and **SM\_DISKDEV2** environment variables as needed.

**Important:** Install and enable the Netware IPX and SPX networking protocols on the computer where the Informix database server is installed only if you encounter network flooding.

You must be a member of the **Informix-Admin** group to perform these operations. To open a command window for running ISM commands, select **Start > Programs > Informix > ol\_servername**.

```
REM setup for IBM Informix Storage Manager
echo "ISM setup begins"
```

```
REM this step should be done only once
ism_startup -init
```

**Important:** To make **informix** the ISM user and thereby ensure **informix** has access to conduct ISM operations during daily routines, you must run the following command after any **ism\_startup -init** or ISM installation:

```
ism_add-admin informix@server
```

```
REM user must edit these two lines to select appropriate disk
REM locations for storage manager use.
set SM_DISKDEV1=\backups\dbspaces
set SM_DISKDEV2=\backups\logfiles
```

```
REM we need to create some devices and media
echo "create and mount ISM devices and pools"
ism_add -device %SM_DISKDEV1% -type file
ism_add -device %SM_DISKDEV2% -type file
ism_op -label %SM_DISKDEV1% -pool ISMDiskData -volume ISMData
ism_op -label %SM_DISKDEV2% -pool ISMDiskLogs -volume ISMLogs
ism_op -mount %SM_DISKDEV1%
ism_op -mount %SM_DISKDEV2%
echo "end of ISM setup"
```

## Setting Up ISM Volume Pool Names

If you use ISM, you can specify the volume pool names for storage spaces and logical logs in the **ISM\_DATA\_POOL** and **ISM\_LOG\_POOL** configuration parameters in the **ONCONFIG** file. If you do not set these parameters, **ISMData** is the default volume pool name for storage spaces and **ISMLogs** is the default volume pool name for logical logs.

If you are using **ISMDiskData** and **ISMDiskLogs** for the volume pool names, update the **ISM\_DATA\_POOL** and **ISM\_LOG\_POOL** entries in the **ONCONFIG** file with those names.

To back up storage spaces and logical logs to the same storage device, set the **ISM\_DATA\_POOL** and **ISM\_LOG\_POOL** parameters in the **ONCONFIG** file to the same volume pool name. However, for best restore performance, we recommend that you back up storage spaces and logical logs to different volume pools on different storage devices.

## Setting Up ISM and ON-Bar on UNIX

### Setting ISM Environment Variables and ONCONFIG Parameters

When you use ISM, you must set certain environment variables that affect the way in which the ISM server handles requests. For information, see “Using ON-Bar Environment Variables with ISM” on page 2-8.

#### Dynamic Server

You set these environment variables in the **onbar** script or in your environment.

#### End of Dynamic Server

#### Extended Parallel Server

You can set these environment variables in your environment if you enter **onbar -w** at the command prompt, or before you start the database server set them in **start\_worker.sh** or **start\_worker.bat**.

#### End of Extended Parallel Server

### Updating the onbar Script

If you configure ISM and ON-Bar to use a storage pool other than ISMData, you need to edit the **onbar** or **onbar.bat** script to direct **ism\_catalog** to the storage pool that you are using. For example, if you use the ISMDiskData pool, make the following changes in the **ism\_catalog** line of the **onbar** script:

#### UNIX Only

On UNIX, the command in the **onbar** script is:

```
\${INFORMIXDIR}/bin/ism_catalog -create_bootstrap -pool  
ISMDiskData
```

#### End of UNIX Only

#### Windows Only

On Windows, the command in the **onbar.bat** script is:

```
%ISMDIR%\bin\ism_catalog -create_bootstrap -pool ISMDiskData
```

#### End of Windows Only

**Warning:** If the **onbar** script selects a nonexistent storage pool, ON-Bar seems to hang and a message appears in the ISM log that an operation is waiting for the ISMData pool to be mounted.

For more information on the **onbar** script, see the *IBM Informix Backup and Restore Guide*.

---

## Uninstalling ISM

The following two sections provide procedures for uninstalling ISM on UNIX and Windows. You must uninstall your currently running ISM in these situations:

- Before you reinstall ISM on UNIX or on Windows
- Before you install NetWorker or another storage manager

You must not install ISM on a computer in which a NetWorker server or a NetWorker client is already installed. If you attempt such an installation, it fails with the following message:

```
The ISM setup script detected that another storage manager is
installed in /nsr, which conflicts with ISM. If you want to setup
ISM, you need to de-install the other storage manager and then
run $INFORMIXDIR/bin/ism_startup -init.
```

For ISM to be installed on a computer that has a NetWorker server or client on it, the NetWorker server or client has to be completely uninstalled first.

### To uninstall your currently running ISM on UNIX:

1. Log in as user **informix**.
2. Change to the ISM binaries directory:  

```
cd $INFORMIXDIR/bin
```
3. Become user **root**.
4. Shut down the ISM daemons:  

```
./ism_shutdown -q
```
5. Verify that the daemons are shut down:  

```
ps -ef | grep nsr
```
6. Move the ISM executables to a temporary directory:  

```
mkdir ./ism.tmp
mv ism* ism.tmp
mv nsr* ism.tmp
mv mm* ism.tmp
mv save* ism.tmp
mv scanner ism.tmp
mv usam ism.tmp
mv recover ism.tmp
```
7. Move the ISM catalogs to a temporary directory:  

```
cd $INFORMIXDIR
mv ism ism.bak
```
8. Remove the symbolic link to the ISM catalogs:  

```
rm /nsr
```
9. Remove the call to **ism\_catalog** from the **\$INFORMIXDIR/onbar** script.

Now you are ready to install your new storage manager on UNIX.

**Tip:** The **ism\_shutdown** command shuts down the ISM daemons **nsrd**, **nsrexecd**, **nsrmmdbd**, and **nsrindexd**. It does not uninstall ISM, that is, it does not remove the ISM executables in **\$INFORMIXDIR/bin**, the symbolic link **/nsr**, or the various ISM files in **\$INFORMIXDIR/ism**.

### To uninstall your currently running ISM on Windows®:

1. Shut down ISM. On a command line enter:  

```
ism_shutdown -deinstall
```

2. Shut down the Informix database server:  

```
onmode -yuk
```
3. Check **Settings > Control Panel > Services** to see if the database server is down. If it is not down, wait until it is.
4. Change the user environment variable **PATH** so that **%ISMDIR%\bin** is no longer in the environment variable **PATH**. You might find:  

```
PATH=c:\WINDOWS\system32;d:\ISM\1.00\bin;c:\msdev;
```

 Change it to:  

```
PATH=c:\WINDOWS\system32;c:\msdev;
```
5. Rename the directory that contains the ISM executables:  

```
rename %ISMDIR% ism.bak
```
6. Delete the user environment variable ISMDIR.
7. Start the Windows registry. On the command line enter:  

```
regedt32
```
8. Go to **HKEY\_LOCAL\_MACHINE > SOFTWARE > Informix > ISM**.  
 With the cursor on **ISM**, click to select and then choose **Edit > Delete** from the registry menu.
 

**Warning:** Make sure that ISM is selected. You must have the correct entry. Be careful when you edit the registry because mistakes can corrupt Windows.
9. Go to **HKEY\_LOCAL\_MACHINE > SOFTWARE > XBSA**.  
 With the cursor on **XBSA**, click to select and then choose **Edit > Delete** from the registry menu.

---

## Using ISM with DNS Disabled

### Windows Only

The domain name service (DNS) translates the host names into internet protocol (IP) addresses. This means that when your computer is not on the network, DNS is disabled and you need to provide the IP address and hostname in the hosts file.

### End of Windows Only

### Dynamic Server

For nonnetwork ISM installations with Dynamic Server, create a Windows hosts file with the default local loopback entry as follows:

```
127.0.0.1    localhost
```

The hosts file is located in **C:\WINNT\system32\drivers\etc\hosts**. If this entry is not present in the hosts file, you might get the following error when you use ISM:

```
nsrmmmd #1: unauthorized READ_LABEL call to mmd 1: Access violation -  

[] unknown host: 127.0.0.1
```

### End of Dynamic Server

---

## Migrating ISM 1.0 to ISM 2.2

You can either upgrade ISM 1.0 to ISM 2.2 alone or upgrade ISM with the database server version.

Migration reinstalls the ISM binaries but maintains the ISM data (the catalogs and tape volumes that contain the save sets).

The following section explains how to migrate ISM 1.0 to ISM 2.2. ISM 2.2 includes changes to the format of data in the ISM catalogs and volumes. Begin the following procedure with ISM 1.0 running on your old database server version.

**Important:** Do not use ISM 1.0 storage media for future backups after you migrate from ISM 1.0 to ISM 2.2.

### To migrate ISM:

1. Complete a full backup of your system with one of the following commands:

```
onbar -b -w  
onbar -b -L 0
```

2. Create a bootstrap of your ISM 1.0 server with the following command:

```
ism_catalog -create_bootstrap -pool ISMData
```

The bootstrap is a copy of the files and directories in **\$INFORMIXDIR/ism/mm, index, and res** (UNIX) or **%ISMDIR%\mm, index, and res** (Windows). These directories are backed up into a single save set, called the bootstrap.

3. Shut down the ISM 1.0 server.

#### UNIX Only

On UNIX:

```
ism_shutdown
```

#### End of UNIX Only

#### Windows Only

On Windows:

```
ism_shutdown -deinstall
```

#### End of Windows Only

4. Remove the ISM 1.0 catalogs.

**Warning:** Do not remove the **res** directory.

#### UNIX Only

On UNIX:

```
rm -rf $INFORMIXDIR/ism/index  
rm -rf $INFORMIXDIR/ism/mm
```

End of UNIX Only

Windows Only

On Windows:

```
del %ISMDIR%/index
```

```
del %ISMDIR%/mm
```

End of Windows Only

If you have file-type devices configured in ISM, you cannot move, copy, or rename the directories that contain those devices.

5. Remove ISM 1.0. (This step is optional.)

Follow the instructions on how to remove ISM 1.0 in “Uninstalling ISM” on page 1-10. Use **regedt32** to check the registry keys.

6. On Windows, you must rename or remove the ISM 1.0 **bin** directory because the ISM 2.2 installer installs the ISM files in a different directory. Then move the ISM 2.2 **bin** directory to the ISM 1.0 **bin** directory location.
7. Install the new ISM 2.2 files, either separately or with the new database server version.

**Warning:** You must install the new ISM 2.2 files in the same directory as the ISM 1.0 files.

8. If you are upgrading ISM on Windows, follow these steps to ensure that ISM is properly configured.
  - a. The installer might have made a Windows command window script for the Informix environment. The filename of this script is *servername.CMD*.
  - b. Edit this file to be sure that **ISMDIR** and **PATH** are correct for the location of the ISM 2.2 directory.
  - c. Change the **%INFORMIXDIR%\bin\onbar.bat** file for any user-customized references to the ISM directory.
  - d. If necessary, edit the **%INFORMIXDIR%\bin\SETISM.BAT** file to ensure that it refers to the ISM 2.2 directory.
  - e. Check your database server configuration file (usually **%INFORMIXDIR%\etc\ONCONFIG.servername**). Be sure that the **BAR\_BSALIB\_PATH** parameter points to the **libbsa.dll** in the **bin** subdirectory of the ISM 2.2 directory.
  - f. Check Windows system environment variable settings that affect the **PATH** environment variable or that set the **ISMDIR** environment variable.
  - g. Copy the **sm\_versions.std** file to create a new **sm\_versions** file.
  - h. If you changed the configuration files, you might need to reboot Windows.

**Warning:** An error message that an entry point cannot be found in **libnsr.dll** means part of the Windows configuration still references the old ISM installation.

9. Start the ISM server with the following command. Do not initialize the server.

```
ism_startup
```
10. Place the tape that contains the bootstrap in a device and mount it, if it is not already mounted.
11. Create an index for your host with the following command:

```
nsrck -c
```

12. Locate the bootstrap on the tape and note the save-set ID: **ism\_catalog** **-find\_bootstrap** *device\_name*.

13. Recover your bootstrap with the following command:

```
ism_catalog -recover
```

**Important:** Do not replace the **res** directory with the **res.R** directory. Wait for the preceding command to issue a message that the index was fully recovered.

14. Remove all the defined devices with the following command. You must unmount each device individually.

```
ism_op -unmount device_name
```

15. Segregate all ISM 1.0 volumes. Make backups of file-type devices.

**Important:** For future use, you must store the tape with the bootstrap that you created in step 2. Without the bootstrap, you cannot revert to ISM 1.0 if you need to.

16. Label new volumes.

ISM 2.2 must not write to any ISM 1.0 volumes because they would be unreadable by ISM 1.0 if you chose to revert.

```
ism_op -label device_name -volume volume_name -pool  
ISMData
```

17. Mount the new volumes with the following command for each device:

```
ism_op -mount device_name
```

18. Create a new bootstrap to back up the converted indexes.

```
ism_catalog -create_bootstrap -pool ISMData
```

19. Upgrade the database server to the new version if necessary, and then start the database server.

20. Immediately perform a level-0 backup.

```
onbar -b -L 0
```

---

## Reverting from ISM 2.2 to ISM 1.0

When you revert the database server to an earlier version, do *not* revert to ISM 1.0. All versions of the database server, up through Version 9.3, support ISM 2.2. Also, ISM 2.2 is year-2000 compliant, but ISM 1.0 is not. Versions of the database server without ON-Bar are not compatible with ISM.

- Because the database server installers install ISM, be sure to preserve the ISM 2.2 directory by renaming it.
- To install the earlier database server version, follow the instructions in the *IBM Informix Installation Guide*.
- To revert to the earlier database server version, follow the instructions in the *IBM Informix Migration Guide*.
- To restore the ISM directory, copy the new ISM files to the directory that you renamed earlier and rename the directory to its original name.

If you need to revert the database server and perform a point-in-time restore of the earlier database server version, ISM 2.2 might have the original backups in its catalog (if you followed the procedure in this manual for upgrading ISM). If the backups are no longer in the ISM catalog, recover the catalogs from the backup media after you revert the database server.

---

## Using ISM

To have access to and be able to run ISM, you must correctly configure certain privileges and system requirements.

### Using ISM Administrative Privileges

By default, ISM grants administrative user privileges to **root** or **informix** for ISM servers on UNIX and to **Administrator** for ISM servers on Windows. Only users included in the ISM server administrator list can make configuration changes to the ISM server. For more details, see “Adding the First Administrative User to the ISM Server” on page 2-3.

**Important:** If the ISM server software is running on UNIX, you must have **root** or user **informix** privileges to recover data. For more information, see Chapter 5, “Recovering Save Sets with ISM,” on page 5-1.

### Starting and Stopping ISM

To start ISM, issue the following command:

```
ism_startup
```

To stop ISM, issue the following command:

```
ism_shutdown
```

### Preventing Corruption of ISM’s Internal Database

Always shut down the server properly with the **ism\_shutdown** command to prevent corruption of the database accessed by the **nsrmmdbd** daemon. In the event that the database becomes corrupted due to improper shutdown or because of hardware failure, follow these steps to re-create the client index and the **/nsr/mm/mmvolume** database:

1. Shut down the ISM server with the **ism\_shutdown** command.
2. Rename the client index and the volume database using the following commands:

```
mv nsr_home_directory/index/server_name/db nsr_home_directory/index/server_name/db.old
```

```
mv nsr_home_directory/mm/mmvolume nsr_home_directory/mm/mmvolume.old
```

where

*nsr\_home\_directory* is the directory where **nsr** is installed. In most cases it will be **nsr**.

*server\_name* is the backup server.

The following example uses **/nsr** as *nsr\_home\_directory* and client as *server\_name*:

```
mv /nsr/index/client/db /nsr/index/client/db.old
```

```
mv /nsr/mm/mmvolume /nsr/mm/mmvolume.old
```

3. Restart the ISM server using the **ism\_startup** command.
4. Check the consistency of the index files by running the command **nsrck -F**.
5. If necessary, to create new indexes, run the command **nsrck -c** as user **root**. This command will create new indexes in a newly created db subdirectory.

### Reviewing ISM Logs

The ISM server maintains two log files in which it records its activities. The first log records the requests received and operations that the ISM server performs. The second log records the XBSA messages that the ISM server sends or receives.

To review either of the log files directly, make a copy and open the copy with a text editor. The log files reside in the following locations:

**UNIX Only**

- On UNIX, the activity log is located in a file named **\$INFORMIXDIR/ism/logs/daemon.log**. The XBSA messages log is located in **\$INFORMIXDIR/ism/applogs/xbsa.messages**.

If you have different Informix database servers installed in different directories on the same computer, you can find the location of the activity log for the active ISM server with the following command:

```
ls -ls /nsr
```

**End of UNIX Only**

**Windows Only**

- On Windows, the activity log is located in a file named **%ISMDIR%\logs\daemon.log**. The XBSA messages log is located in **c:\nsr\applogs\xbsa.messages**.

**End of Windows Only**

For more information on the activity log and XBSA messages log, see “Using ISM Environment Variables” on page 2-7.

---

## Chapter 2. Configuring ISM Server Properties

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---

### In This Chapter

This chapter describes how to customize the ISM server properties to suit your environment.

The ISM server connects your Informix database server to your storage devices and enables you to monitor the progress of your backup and restore operations, manage backed-up data, and control your storage media and storage devices.

Use the `ism_config` command to change the ISM server properties. For more information, see “`ism_config`” on page A-6.

---

### Setting the Number of Parallel Data Streams

ISM supports up to four parallel data streams. You can adjust the number of data streams that can be active at one time. When you set this value, it allows you to specify the number of save sets that are backed up to the ISM server simultaneously. Backing up save sets in parallel allows your storage devices to operate at their most efficient levels because they receive a steady stream of data, which is written onto your storage volumes. For example, suppose that you have four storage devices and set the number of parallel data streams to four. During a backup to all four devices, each device receives one data stream.

**To set or adjust the number of data streams that can be backed up in parallel:**

1. To display the ISM server properties, use the following command:

```
ism_show -config
```

The `parallelism` field in the `ism_show -config` output indicates the number of parallel data streams.

2. To change the number of parallel data streams, use the following command:

```
ism_config -streams #datastreams
```

To back up only one data stream at a time, set the value to 1.

```
ism_config -streams 1
```

- + Alternatively, you can perform the following steps in Windows using ISM
- + Administrator:
- + 1. Click **Device** -> **Server Properties**.
- + 2. Select the **General** tab.

- + 3. Specify a number in the **Maximum Number of Simultaneous Data Streams** field. To back up only one data stream at a time, set the value to 1.
- + 4. Click **OK**.

In the following situations, adjust the number of data streams that you back up in parallel:

- The ISM server is taking too long to back up all the data streams.  
Increase the number of data streams.
- The ISM server is so busy backing up data streams that it is not available for any other tasks.  
Decrease the number of data streams.
- The ISM server runs out of swap space or memory.  
Decrease the number of data streams.

---

## Setting Target Sessions for a New Device

When you define and mount multiple devices for the ISMData pool, all storage-space backups still go to the first device. You can send storage-space backups or logical-log backups to multiple devices at the same time.

### To use multiple devices:

1. Start ISM in the usual way (**ism\_startup**).
2. Define and label all devices (up to 4).
3. Shut down ISM in the usual way (**ism\_shutdown**).
4. Enter the following command at the prompt:  
nsradmin
5. At the **nsradmin** prompt, enter the following command:  
print NSR device
6. To update the target sessions variable for your configured devices, enter the following command. You need to enter this command only once to apply it to all configured devices.  
update target sessions: 1
7. The following information is displayed for each device:  
update resource id: *resource\_id*  
target sessions: 1;  
Update?  
Enter **y**.
8. Restart ISM in the usual way (**ism\_startup**).

---

## Setting the Retention Period for All Data

You can specify how long the ISM server tracks the data on your storage volumes before it designates that a volume is eligible for reuse.

The ISM server maintains an entry for each backed-up save set in the ISM catalog for the length of time that you set as the retention period. You can use ON-Bar to recover a save set at any time during the retention period for a save set.

When the retention period for a save set expires, the ISM server no longer maintains the save-set entry in the ISM catalog.

**To obtain information about the expiration date and retention period:**

1. To display the expiration date for a save set, issue the `ism_show -volumes` command (see the **expires** field).
2. To display the retention period for the ISM server, issue the `ism_show -config` command (see the **retention policy** field).

To recover an expired save set, use the `ism_catalog -recreate_from` command at any point until the storage volume that contains the save set is relabeled. For details on how to recover expired save sets, see “Re-Creating the ISM Catalog Before You Use ON-Bar” on page 5-1.

**To set the retention period for the ISM server:**

1. To set the length of time before the data is marked Expired, issue the following command:

```
ism_config -retention #days
```

2. Specify the retention period in days. The default is six months.

+  
+  
+  
+  
+  
+  
+

Alternatively, you can perform the following steps in Windows using ISM Administrator:

1. Choose **Device** → **Server Properties** to open the Server Properties window and click the **General** tab.
2. Specify a number and calendar unit in the **Retention Period** to set the length of time before the data is marked expired. You can enter a value in days, weeks, months, or years. The default value is six months.
3. Click **OK**.

**Important:** Because changing the retention period for the ISM server applies the new retention period to all the data that the ISM server tracks, some data might become eligible for automatic recycling either sooner or later than you expected. Be careful about changing the retention period for the ISM server because you could potentially overwrite recent backups.

For more information on how ISM manages the life cycle of data, see “Managing the Data Life Cycle” on page 4-1. For details on how to issue ISM commands at the command line, see Appendix A.

---

## Adding, Changing, or Deleting Administrative Users

To make configuration changes to the ISM server, label and mount storage volumes, and initiate cloning operations, you must have administrative user privileges on the ISM server.

### Adding the First Administrative User to the ISM Server

To administer your ISM server, you need administrative user privileges for that ISM server based on the system on which you run your administrative programs. Administrative user privileges can be granted to individual user accounts, UNIX groups, or Windows groups. They are typically restricted to an individual system.

When you installed ISM, the local `root@server_name` for UNIX ISM servers or the local Windows Administrators group, `Administrators@server_name`, for Windows, ISM servers was added as an administrative user by default. To add additional

administrative users, you must log in as either user **root** or **informix** on UNIX or as **Administrators@server\_name** on Windows.

For each administrator entry in the list of administrators, the ISM server compares the hostname of the administrator with the hostname of the account. If the host names match, the ISM server compares the administrator name with both the user and group name of the account. If the administrator name and the user name or group name match, the ISM server grants administrative privileges to that administrator.

For example, if your ISM server is running on a computer called **nova**, but you use ISM commands on a computer called **jupiter**, you must log on to **nova** and add the user name or group name that you use on **jupiter** to the **nova** list of ISM administrative users. The following numbered steps illustrate:

- How to add a user or user group on **jupiter** as an administrative user to the ISM server on **nova**
- How to add a user or user group on **nova** (other than **root**, **informix**, or **Administrator**) as an administrative user to the ISM server on **nova**

#### To add a user or user group:

1. Log on to **nova** as user **root**, **informix**, or **Administrator**.
2. To add a user or group on **jupiter** as an administrative user for the ISM server, run one of the following commands at the command line:

- To add a user named **karen** on **jupiter**, run the following command:

```
ism_add -admin karen@jupiter
```

You might need to qualify the hostname as follows:

```
jupiter.informix.com
```

- To add a group on **jupiter**, run the following command:

```
ism_add -admin group_name@jupiter
```

This user or group can now use any of the ISM command-line utilities on the computer **jupiter** to administer the ISM server on **nova**.

3. To add other users or groups on **nova** (the computer that is running the ISM server) as administrative users for the ISM server, run one of the following commands at the command line:

- To add a user on **nova**, run the following command:

```
ism_add -admin user_name@nova
```

- To add a group on **nova**, run the following command:

```
ism_add -admin group_name@nova
```

This user or group can now use the ISM command-line utilities on **nova** to administer the ISM server on **nova**.

If you are not on the administrative users list and try to make configuration changes to the ISM server, you receive the following message:

```
user user_name needs to be on administrator's list
```

## Choosing Acceptable ISM User and Group Names

If you need to restrict the administrative users list so that it does not include **root**, **informix**, or **Administrators**, make sure that the administrative users list includes access to the user who started the ISM server. Typically this user is the system account.

The following list shows acceptable ISM user and group names.

Acceptable Usage	Example
<i>local_group@hostname</i>	root@jupiter; Administrators@jupiter
<i>global_group@hostname</i>	Domain_Admins@jupiter
<i>account_name@hostname</i>	jsmith@jupiter@informix.com
<i>wildcard@hostname</i>	*@jupiter
<i>account_name@wildcard</i>	jsmith@*

**Important:** Be careful about using wildcards to grant users or groups administrative user privileges. If you use a wildcard before the @ sign, you grant ISM administrative user privileges to any user logged onto that system. If you use a wildcard after the @ sign, you grant ISM administrative user privileges to any group or account that is named before the @ sign, regardless of location. It is recommended that you avoid using wildcards when you grant administrative user privileges.

ISM does not recognize the following names:

*@Domain name*  
*@unresolved TCP/IP name*

ISM displays the following error message:

Cannot establish a connection with server '*hostname*':  
Server *hostname*: Unknown host.

## Deleting an Administrative User

Every user or group in the Administrator list has permission to modify the ISM server configuration.

**To delete an administrative user from the ISM server:**

1. Log on as user **root**, **informix**, or **Administrator**.
2. Specify the user name or group and hostname in the following command:

```
ism_rm -admin name@hostname
```

If you remove yourself as an administrative user, you can no longer administer the ISM server.

---

## Connecting to a Different ISM Server

If you have more than one ISM server on your network, you can open a connection to a different ISM server from your current session. The following commands allow you to specify an ISM server on a different computer:

- **ism\_add**
- **ism\_catalog**
- **ism\_clone**
- **ism\_config**
- **ism\_op**
- **ism\_rm**
- **ism\_show**
- **ism\_watch**

- + Alternatively, you can perform the following steps in Windows using ISM Administrator:
- + 1. In the Devices window, click **View -> New Window**.
- + 2. Specify the name of the ISM server to which you want to connect. ISM lists the last ten ISM servers to which you connected.
- + 3. Click **OK**.

---

## Using ISM Configuration Parameters to Change the Volume Pool Name

The following parameters, when listed in the ONCONFIG configuration file for the database server, affect how the ISM server handles backup and restore requests.

ONCONFIG Parameter	Effect on ISM Server
ISM_DATA_POOL	If present in the ONCONFIG file, this parameter specifies the volume pool to be used for backing up dbspaces and other storage spaces. The value for this parameter can be any volume pool that ISM recognizes. If this parameter is not present, ISM uses the ISMData volume pool.
ISM_LOG_POOL	If present in the ONCONFIG file, this parameter specifies the volume pool to be used for backing up logical logs. The value for this parameter can be any volume pool that ISM recognizes. If this parameter is not present, ISM uses the ISMLogs volume pool.

The following volume pool names are recommended:

- ISMData for storing storage spaces on nonfile-type devices
- ISMDiskData for storing storage spaces on file-type devices
- ISMLogs for storing logical logs on nonfile-type devices
- ISMDiskLogs for storing logical logs on file-type devices

You can direct storage-space and logical-log backups to the same device. In the following example, ISMDiskData is the volume pool name for both storage-space and logical-log backups. However, you can specify any volume pool name in the ONCONFIG file as follows:

```
ISM_DATA_POOL ISMDiskData
ISM_LOG_POOL ISMDiskData
```

If you change the name of either ISMData or ISMLogs, you must also complete the following steps:

- Update ISM\_DATA\_POOL and ISM\_LOG\_POOL in the ONCONFIG file with the new names.
- Change the create-bootstrap command in the **onbar** script (**\$INFORMIXDIR/bin/onbar** or **onbar.bat**).

For example, change **ism\_catalog -create\_bootstrap -pool ISMData** to **ism\_catalog -create\_bootstrap -pool new\_pool\_name**.

If you choose not to use ISM, remove the **create\_bootstrap** command from the **onbar** script or **onbar.bat** script.

UNIX Only

On Solaris, if you are a member of the **bargroup**, it should be your primary group.

End of UNIX Only

For information on the **onbar** script, see the *IBM Informix Backup and Restore Guide*.

---

## Using ISM Environment Variables

The following environment variables control the size and number of log files that ISM maintains.

Environment Variable	Description
<b>ISM_MAXLOGSIZE</b>	If this variable is not set in the environment of the ISM server, its value is 0, which is interpreted as no limit. That is, the system resource is the limit. If this variable is set, the value set is the maximum log size. When the size of the log reaches this <b>ISM_MAXLOGSIZE</b> value, the log is truncated and it starts over with the next log message.
<b>ISM_MAXLOGVERS</b>	If this variable is set in the environment of the ISM server, the variable specifies the maximum number of activity-log files to be preserved by the ISM server. If this environment variable is not set, the default number of files to be preserved is four. If the variable is set to a null value, the ISM server preserves no activity log files.
<b>ISM_DEBUG_FILE</b>	If this variable is set in the environment of the ISM server, the variable specifies where the XBSA messages should be written. If you do not set this variable, the XBSA messages log is in <b>\$INFORMIXDIR/ism/applogs/xbsa.messages</b> on UNIX or <b>c:\nsr\applogs\xbsa.messages</b> on Windows.

When ISM starts up, it checks the length of the activity log. On UNIX, this log resides in the **\$INFORMIXDIR/ism/logs/daemon.log** file. On Windows, the file is **%ISMDIR%\logs\daemon.log**. If the log file exceeds the threshold that the **ISM\_MAXLOGSIZE** environment variable specifies, the ISM server renames it to **daemon.001**. If a file named **daemon.001** is already present, the ISM server renames that file to **daemon.002**, and so on, for all other existing log files up to the maximum number that **ISM\_MAXLOGVERS** specifies.

The ISM server does not monitor the size of the XBSA messages log, which resides in a file named **\$INFORMIXDIR/ism/applogs/xbsa.messages** on UNIX. This log resides in a file named **c:\nsr\applogs\xbsa.messages** on Windows. Use the **ISM\_DEBUG\_FILE** environment variable to change the location of the XBSA messages log.

To manage the growth of this file, set the **ISM\_DEBUG\_LEVEL** environment variable to 1 (the default) or 0, thereby minimizing or eliminating updates. If you

use a higher level of detail, or you want complete assurance that the XBSA messages log can never fill up the disk, you can use the **cron** utility on UNIX or the **Winat** facility on Windows to save a periodic snapshot of the file and then truncate it.

For more information about ISM logs, refer to “Reviewing ISM Logs” on page 1-15. For information about **ISM\_DEBUG\_LEVEL**, see “Using ON-Bar Environment Variables with ISM” below.

---

## Using ON-Bar Environment Variables with ISM

The following environment variables, when set in the ON-Bar environment, determine whether ISM uses compression or encryption when backing up data.

---

### Dynamic Server

You can set these environment variables in the **onbar** script file. For example:  
`ISM_COMPRESSION=TRUE; export ISM_COMPRESSION`

---

### End of Dynamic Server

---

### Extended Parallel Server

You can set these environment variables in the **start\_worker** script file. Insert the lines that contain the environment variables before the line that starts the **onbar\_w** utility.

---

### End of Extended Parallel Server

Environment Variable in Effect When ON-Bar Issues a Request	Effect on ISM Server Processing for That Request
<b>ISM_COMPRESSION</b>	If this variable is set to TRUE in the environment of the <b>onbar</b> process making a request, the ISM server uses a data-compression algorithm to store or retrieve the data specified in that request. If it is set to FALSE or is not present, the ISM server does not use compression.
<b>ISM_ENCRYPTION</b>	If this variable is set to TRUE or XOR in the environment of the <b>onbar</b> process making a request, the ISM server uses encryption to store or retrieve the data specified in that request. If it is set to NONE or is not present, the ISM server does not use encryption.
<b>ISM_DEBUG_LEVEL</b>	If this variable is set in the ON-Bar environment, it controls the level of reporting detail recorded in the XBSA messages log. The XBSA shared library writes to this log. You can specify a value between 0 and 9. If this environment variable is not set, has a null value, or has a value outside of this range, the detail level equals 1 by default. A detail level of 0 suppresses all XBSA debugging records. A level of 1 reports only XBSA failures.

---

## Chapter 3. Managing Storage Devices

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---

### In This Chapter

This chapter discusses the commands that you use to configure storage devices to use ISM.

---

### Choosing and Configuring Storage Devices

Table 3-1 shows the types of storage devices that ISM supports.

*Table 3-1. Types of Storage Devices*

Device Type	Media Type
Half-inch magnetic tape drives	himt
Quarter-inch cartridge tape drives	qic
Four-millimeter (DAT) tape drives	4mm
Eight-millimeter tape drives	8mm
Eight-millimeter five-gigabyte tape drives	8mm 5GB
3480 tape drives	3480
3570 tape drives	3570
4890 tape drives	4890
9490 Timberline tape drives	9490
Digital linear tape drives	dlt
File system	File
Optical disk drives	Optical
VHS tape drives	VHS

**Important:** ISM does not support autochangers or high-speed devices. Autochangers are storage devices such as jukeboxes, carousels, libraries, near-line storage, datawheels, silos, and autoloaders.

Keep the following issues in mind when you configure your storage devices:

- ISM supports up to four storage devices.
- It is recommended that you reserve a storage device for your logical-log backups.
- You cannot use automatic rewind tape devices.

The combination of tape drives, optical disk drives, and file systems that you use depends on your environment needs. When you use a file system (file-type) as a storage device, some limitations are imposed on your configuration. For more information, see “Using File Systems as Storage Devices” on page 3-5.

---

## Adding and Deleting Storage Devices

After you install ISM, you can add up to four storage devices. When you first install the ISM software, you must add the devices that you want to use as storage devices.

### To add a new tape drive or optical disk drive to the ISM server:

1. Create a new device as follows:

```
ism_add -device device_path -type type
```

- a. Specify the complete pathname of the storage device that is connected to the ISM server.

**UNIX Only**

For ISM servers on UNIX computers, the format is as follows:

```
/dev/rmt/0mbn
```

**End of UNIX Only**

**Windows Only**

For ISM servers on Windows, the format is as follows:

```
\\.\Tape0
```

**End of Windows Only**

- b. Specify the device type.

The **Media Types** column in Table 3-1 on page 3-1 shows the valid device types for tape and optical drives.

2. To verify that you created the new device, issue the command:

```
ism_show -devices
```

By default, the new storage device is enabled for use in backup and restore operations.

+ Alternatively, you can perform the following steps in Windows using ISM Administrator:

1. Click **Device -> New**.
2. Specify the complete pathname of the storage device that is connected to the ISM server in the **Storage Device** field. The format depends on your operating system:
  - UNIX: /dev/rmt/0mbn
  - Windows: \\.\Tape0

- + 3. Select the storage-device type from the **Type** field.
- + 4. Click **OK**.

For more information, see “Using Tape Drives and Optical Disk Drives as Storage Devices” on page 3-5.

**Important:** A no-rewind backup device is required when you use tape devices.

**To add a file system as a storage device to the ISM server:**

1. On the ISM server, create a new directory or folder where you want to store the data.

Be sure to create it on media with free space that is larger than the size of your backup. It is recommended that you create the file-type device on a different drive from the one that contains your operating system so that you do not run out of disk space.

2. Create a new device as follows:

```
ism_add -device device_path -type file
```

- a. Specify the pathname of the directory or folder that you just created.
- b. Specify a device type of **file**.

3. To verify that you created the new device, issue the command:

```
ism_show -devices
```

By default, the new storage device is enabled for use in backup and restore operations.

+ Alternatively, you can perform the following steps in Windows using ISM  
+ Administrator:

- + 1. On the ISM server, create a new directory or folder where you want to store the  
+ data. Be sure to create it on media with free space that is larger than the size of  
+ your backup.
- + 2. Return to the ISM Administrator program. Click **Device -> New**.
- + 3. In the **Storage Device** field, enter the complete path name of the directory or  
+ folder that you created.
- + 4. Select **File** from the **Type** field.
- + 5. Click **OK**.

For more information, see “Using File Systems as Storage Devices” on page 3-5.

**Important:** You cannot include file-type volumes used with a file-type device in a pool that includes other types of volumes. ISM does not allow volumes of other types to be recycled or added to a pool of file-type volumes. For details on how ISM uses volume pools, see “How ISM Uses Volume Pools” on page 4-4.

**To delete a storage device:**

1. Remove the storage device as follows:

```
ism_rm -device device_path
```

2. To verify that the device was deleted, issue the command:

```
ism_show -devices
```

+ Alternatively, you can perform the following steps in Windows using ISM  
+ Administrator:

- + 1. Select the appropriate device in the Device window.
- + 2. Click **Device** -> **Delete**.

You cannot remove a storage device that has a storage volume mounted on it.

## Enabling and Disabling a Storage Device

Before the ISM server can use a storage device for backup or restore operations, you must enable it. To determine if a storage device is enabled or disabled, use the **ism\_show -devices** command or the **nsradmin -c** command. You can use the **nsradmin -c** command in full-screen mode to enable or disable a storage device as shown in the following steps.

### Using the nsradmin command to enable or disable a storage device:

1. Log in as user **root**.
2. Enter the following command:  
`nsradmin -c`
3. Choose the command **Select**.
4. Under **type**, choose **NSR device**.
5. Choose the command **Next** until you locate the storage device you want to modify.
6. Choose the command **Edit**, and then press **RETURN**.
7. Under **enabled**, select **Yes** or **No**.
8. Press **ESC** to leave the menu.
9. Press **RETURN** to save your changes.

+ Alternatively, you can perform the following steps in Windows using ISM  
+ Administrator:

- + 1. Select the appropriate device in the Device window.
- + 2. Select or clear the **Disable** option in the **Device** menu. The **Disable** option is  
+ available only when the selected device does not have a storage volume  
+ mounted on it.

You cannot enable or disable a storage device that has an ISM storage volume mounted on it.

## Changing Storage-Device Properties

If a storage device already has a storage volume mounted on it, you cannot change any of the device properties.

Use the **ism\_config** command to change the storage device properties. For details, see “**ism\_config**” on page A-6.

+ Alternatively, you can start Storage Manager Administrator and click **Device** ->  
+ **Properties**. You can change the pathname, the device type, or disable the device. If  
+ a storage device already has a storage volume mounted on it, you cannot change  
+ any of the device properties. However, you can enable the **Automatic Media**  
+ **Management** option from the Device Properties window at any time. This feature  
+ does not apply to file-type storage devices.

## Designating a Storage Device as Read-only

If you want to designate a storage device associated with a volume as read-only, follow these steps:

### Designating a storage device as read-only:

1. Unmount the storage volume on the device that you want to designate as read-only:

```
ism_op -umount device_path
```

2. To designate the storage device as read-only, use the command:

```
ism_config -volume name -only_restore yes
```

You can use this volume only for restores, not for backups.

3. To redesignate the storage device as writable, use the command:

```
ism_config -volume name -only_restore no
```

4. Remount the storage volume on the device.

You can now use this storage volume for backups.

---

## Using Tape Drives and Optical Disk Drives as Storage Devices

Using tape drives or optical disk drives as storage devices provides a long-term, inexpensive way to store your data. You can store tapes and optical disks offsite or in a protected vault. They provide virtually unlimited storage capacity because you can always purchase new media. Tape and optical disk drives access data sequentially, which slows down backup and recovery.

If you are using tape drives or optical disk drives as storage devices for backups of your storage spaces, It is recommended that you reserve one device for your continuous logical-log file storage volumes. The other devices are available to receive data from storage-space backups.

**Important:** When the currently mounted tape becomes full, ISM requires operator intervention to change tapes. The request to change tapes appears in the ISM log. You use the **ism\_watch** command to monitor ISM for tape-change requests. To automate tape changes during unattended backups, you can use NetWorker or other storage managers that support advanced devices.

**Warning:** You must use no-rewind tape devices because ISM writes a file mark on the storage volume at the end of each backup and then appends data onto the storage volume based on the position of the file mark. (A backup operation might contain several save sets.) If you use a rewind tape device, your backups will appear to have completed successfully but your tapes will contain only the last save set. The current save set overwrites the previous save set and data is lost.

---

## Using File Systems as Storage Devices

Backup and restore speed are important considerations when you plan your backup strategy. File-type storage devices such as file systems or the hard drive back up data more quickly than some tape devices. This feature is especially important if you have a limited time for backup. You can also access your data more quickly during restore operations because file systems allow random access to your data.

The maximum size of a file-type device on many systems is 2 gigabytes.

Disadvantages of file-type storage devices include expense (disk drives are more expensive than tapes) and the inability to store the data on the file-type storage device offsite.

You must mount and label storage volumes for file-type devices, even though there is no physical volume to mount. When ISM writes data to this file-type volume, the volume is treated as one or more open files. If you enter a value for the file-type volume, ISM writes data to the file-type volume until that value is reached. For specific instructions on how to label storage volumes, see “Labeling a Volume” on page 4-7.

Although you can specify up to four file-type devices, we recommend a maximum of two file-type devices so that you can reserve two tapes for copying the data. The copying process is called *cloning*. Once a file-type device is full, you must clone the data to tape before you can overwrite the file-type device with new data. Alternately, you could clone your backups to tape after your backups complete. You must recover the data to the cloned copy on tape. For more information, see “Reserving a Storage Device for Cloning” on page 3-6 and “Cloning Storage Volumes” on page 4-13.

**Important:** You cannot include file-type devices in a volume pool that includes other types of storage volumes. ISM does not allow volumes of other types to be recycled or added to a pool of file-type volumes. You cannot clone bootstrap records. Bootstrap records are always backed up to the ISMData volume pool, even when all other data is backed up to ISMDiskData or ISMDiskLogs.

---

## Using Storage Devices for Logical-Log Backups

During a backup, the ISM server automatically routes storage spaces to volumes in the ISMData volume pool and logical-log files to volumes in the ISMLogs volume pool. (For more information, see “Using ISM Configuration Parameters to Change the Volume Pool Name” on page 2-6.) You can configure ON-Bar to back up each logical-log file as soon as it becomes full. Thus the timing of logical-log file backups is not always predictable.

When you keep a storage volume from the ISMLogs volume pool mounted on one of the storage devices, you ensure that a storage device is always available to accept logical-log data that the ISM server routes. It is recommended that you keep an ISMLogs labeled storage volume mounted on one of the storage devices at all times. For more information on volume pools, see “How ISM Uses Volume Pools” on page 4-4.

---

## Reserving a Storage Device for Cloning

Cloning data to tape ensures that you can successfully recover your data after the file-type volumes are relabeled. This procedure requires a second tape device, in addition to the one tape device used for logical-log file backups, as Figure 3-1 shows. For more information, see “Using File Systems as Storage Devices” on page 3-5.

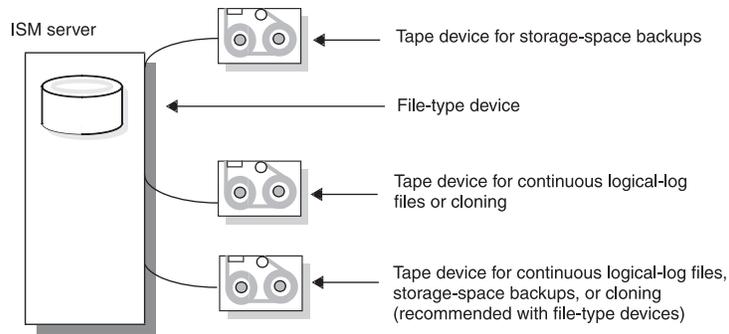


Figure 3-1. ISM Storage-Device Allocation with One File-Type Device

If you are using two file-type devices, reserve two tape devices so you can clone your file-type volumes to tape, as Figure 3-2 shows.

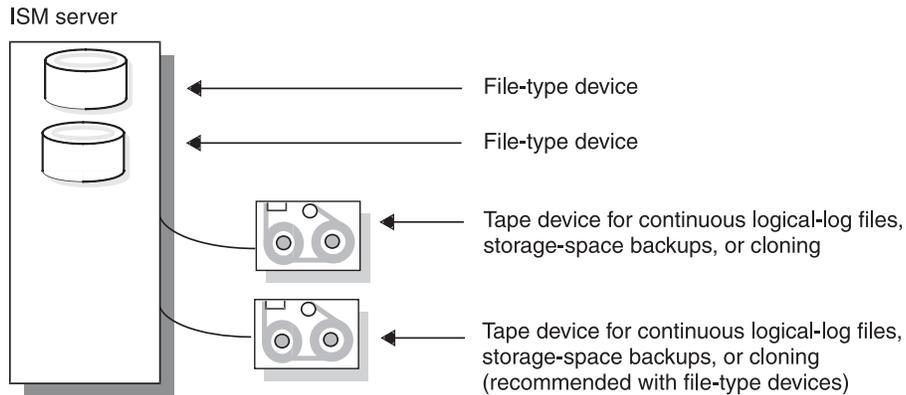


Figure 3-2. ISM Storage-Device Allocation with Two File-Type Devices

**To recover data when the file-type volume mounted on the file-type device fills:**

1. Make sure that the storage device is not active.
2. Protect the storage volume from backup operations. If the storage volume is not mounted, change it to Backup Disabled:
  - a. Unmount it and note the volume name:
 

```
ism_op -unmount device_path
```
  - b. Change the backup status of the specified storage volume to Backup Disabled:
 

```
ism_config -volume name -only_restore yes
```
  - c. Mount the storage volume once again:
 

```
ism_op -mount device_path
```
3. Label and mount a tape volume in the ISMData Clone pool:
  - a. Create a new device as follows:
 

```
ism_add -device device_path -type tape
```
  - b. Label the device:
 

```
ism_op -label device_path -pool pool -volume name
```
  - c. Mount the volume:

```
ism_op -mount device_path
```

4. Clone the file-type volume (or save set) to tape:

```
ism_clone -volume name -pool pool
```

Depending on the type of media that you use, you might need more than one clone volume to hold all the data from the file-type device.

5. Relabel the file-type volume so that it can be used for new backups.

When you relabel the file-type volume, you can no longer access the original data. If you need to recover data, ISM directs you to mount the cloned volume.

---

## Automating Media Management for Tape and Optical Devices

To simplify the backup procedure and avoid the task of prelabeling and mounting a storage volume before backup, use the **Automatic Media Management** option.

If the ISM server detects a writable storage volume from the appropriate volume pool loaded in a storage device, the ISM server automatically mounts the volume and uses it for the backup operation. If the ISM server detects a volume without an ISM label, it considers the volume to be blank and automatically labels, mounts, and overwrites the volume with new data. ISM labels the storage volumes with the next sequential label that is associated with the appropriate pool of volumes.

### Enabling Automatic Media Management

To enable Automatic Media Management from the command line, issue the **ism\_config -volume *volume\_name* -recycle auto** command. This feature does not apply to file-type storage devices.

### Selecting a Storage Volume

When you enable the **Automatic Media Management** option, ISM uses the following hierarchy to choose a storage volume to write data to:

- A writable storage volume from the appropriate volume pool
- A storage volume from the appropriate pool that is eligible for recycling
- An unlabeled storage volume

### Relabeling Volumes Automatically

If ISM detects a storage volume from the appropriate pool with the Recycle status of Eligible, ISM mounts, relabels, and overwrites the storage volume with new data. However, the new label uses the same name and sequence number as the original label. Therefore, newer data might be on a storage volume with a lower label number. ISM labels recycled storage volumes in this way to provide you with an easy way to determine the age of your storage volumes. Lower-numbered storage volumes typically are older than higher-numbered storage volumes, even though the data on the older storage volume might be more recent.

For example, suppose that over time you add ten storage volumes, ISMData.0001 through ISMData.0010, to the ISMData volume pool. When the retention periods for all the save sets on ISMData.0001 expire, ISMData.0001 becomes eligible for automatic recycling. During a backup operation, the ISM server searches for a writable storage volume from the ISMData volume pool. If ISMData.0001 is the only volume from the ISMData pool loaded in a storage device, or if the ISM server needs more than one volume to complete the backup operation and no other writable volumes from the ISMData pool are detected, the ISM server automatically relabels and mounts ISMData.0001 and continues the backup

operation. ISM relabels ISMData.0001 with the same name and sequence number. However, the original data on ISMData.0001 can no longer be recovered.

Although the data on ISMData.0001 might be more recent than the data on ISMData.0010, you can tell at a glance that the physical media on ISMData.0001 is older than ISMData.0010. Because storage media can wear out over time, this labeling scheme enables you to monitor the age of your media.

ISM gives each physical volume a default expiration date of two years after it is labeled. If you relabel a volume, it gets a new two-year expiration date. The expiration date of a storage volume refers to the physical media, not the data on the volume. When a volume reaches its expiration date, ISM automatically changes the Backup status of the volume to Disabled. This status means that no new data can be written to the volume. However, the data on the volume can still be recovered until the volume is relabeled.

To determine the expiration date of your physical media, execute the **ism\_show -volumes** command at the command line. If you relabel volumes within the same volume pool, however, you can easily determine the relative age of a volume by the volume sequence number.

## Using Unrecognizable Volumes

ISM does not recognize storage volumes without a label.

ISM does not recognize the following volume labels and considers these storage volumes as unlabeled:

- Storage volumes that are labeled with something other than an ISM label
- Storage volumes with ISM labels that were written in a density different from that of the device in which they are currently loaded

For example, if you performed ISM backups on a new 8-millimeter tape drive, an older 8-millimeter tape drive might not be able to read the volumes from the newer device because the device uses a different density to write the data.

If ISM does not recognize a storage volume, relabel the storage volume. For details, see “Relabeling a Volume” on page 4-9.

**Warning:** Be careful about sharing non-ISM storage volumes or ISM volumes written in different densities among different backup devices if you use the **Automatic Media Management** option. Otherwise, you might potentially relabel and overwrite valuable data.

Adjusting the number of active data streams on the ISM server can also affect how ISM writes data to the storage volumes. For more information, see “Setting the Number of Parallel Data Streams” on page 2-1.



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## Chapter 4. Managing Storage Volumes

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### In This Chapter

This chapter discusses how ISM manages the life cycle of your data and describes how to manage your storage volumes.

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### Managing the Data Life Cycle

ISM manages your data in the following two ways:

- Uses a data-management policy called a retention period to control the life cycle of your data in the ISM catalog
- Uses volume pools and volume labels to sort and track data in the ISM catalog

#### How ISM Uses the Retention Period

The retention status of a save set and the recycling status of a storage volume indicate how ISM manages your data. A save set can consist of storage-space backups or logical-log backups. To see the status of a save set, use the **ism\_show -volume *name*** command. For more information, see “ism\_show” on page A-9.

The ISM server tracks your data based on the retention period that an administrative user sets. For details, see “Setting the Retention Period for All Data” on page 2-2. Every time that a backup is completed, the ISM server creates entries

for each backed-up save set in the ISM catalog. The ISM catalog allows ON-Bar to reconstruct the data to look exactly as it did at a specific time.

### **What Is the Save-Set Retention Status?**

Retention, expiration, recycling, and labeling are volume-level operations.

The retention policy applies to both volumes and save sets. ISM retains the volume until all the save sets on that volume expire. A volume expires when the newest save set stored on the volume expires. If a volume is empty, it expires when its expiration date is reached.

For example, if you set the retention period to one month, an empty volume expires in one month. Suppose you save a save set to this volume each week until it holds six save sets. This volume expires after 10 weeks, one month after the last save set is saved during the sixth week.

ON-Bar can restore a save set any time during the retention period. To determine if ON-Bar can restore a specific save set, use **ism\_show -volume name** to check the save-set status. If the retention status of the save set is blank, the retention period for the save set has not yet expired, and ON-Bar can restore it. For information on using ON-Bar, refer to the *IBM Informix Backup and Restore Guide*.

If the retention status of a save set is marked Expired, ON-Bar can no longer restore the save set. You need to re-create the save-set entry before you can restore it with ON-Bar. To re-create the save-set entry in the ISM catalog, execute **ism\_catalog -recreate\_from** from the command line. For details on how to recover expired save sets, see “Re-Creating the ISM Catalog Before You Use ON-Bar” on page 5-1 and “ism\_catalog” on page A-2.

When a volume expires, ON-Bar can no longer restore any of the save sets. To recover an expired volume, execute **ism\_catalog -recover\_from** from the command line. After you recover the volume, you can restore the save sets on this volume with ON-Bar.

The status of a save-set entry does not necessarily change to Expired on the same day that its retention period is exceeded. ISM changes the retention status for a save set when *all* the save sets that are dependent on it also exceed their retention periods. Save sets that contain level-1 and level-2 backups are dependent on the save set for the level-0 backup. This extra time ensures that an administrator can reconstruct a save set to a specific time in the retention period.

In Figure 4-1, the retention period is set for one week on the ISM server. The retention period for the save set for the level-0 backup that was performed on September 1 expires on September 8. The level-1 or level-2 backups that were performed during the rest of the week depend on this level-0 backup, so the entry for the level-0 backup does not expire until the entries for the level-1 and level-2 backups have also expired. During this time, you can use ON-Bar to restore the save sets.

On September 15, all the save sets from the backup cycle for the first week change status to Expired.

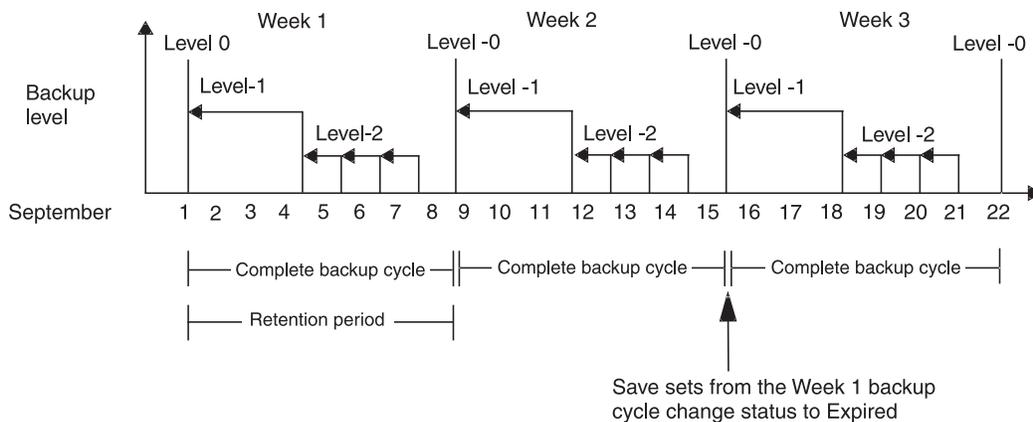


Figure 4-1. One-Week Retention Period

### What Is a Recycling Status of Eligible?

When the retention status of *every* save set on a volume has changed to Expired, ISM changes the recycling status of the volume to Eligible. Because a volume might contain many save sets, the recycling status of a volume might not change to Eligible for some time. All entries for Expired save sets remain listed in the **ism\_show -volume** command until the volume is relabeled (either automatically or manually) or deleted from the ISM catalog. All the data on the volume remains available for recovery with the **ism\_catalog -recreate\_from** command until the volume is relabeled.

Therefore, the change in the recycling status of a volume to Eligible is a reminder to the administrator that the volume can be relabeled if conditions are right. If the administrator mounts the volume on a storage device with the **Automatic Media Management** option enabled, relabeling can occur automatically, and the existing data on the volume is no longer accessible to ISM. At this point, you can no longer recover the data on the storage volume.

When an administrator manually deletes a volume, the ISM server removes the entry for the volume from the ISM catalog. This action effectively releases the volume from the control of ISM. However, the data on a deleted volume is still available for recovery with the **ism\_catalog -recreate\_from** command. This command retrieves the information that is needed to re-create entries in the ISM catalog. Once entries are re-created in the ISM catalog, an administrator can use ON-Bar to recover the data. For details on recovering volumes that have been deleted from the ISM catalog, see “Re-Creating the ISM Catalog Before You Use ON-Bar” on page 5-1.

When a volume is automatically relabeled for reuse within the same pool, the volume name remains unchanged on the volume label. At this point, the volume is ready for new data. All original data is inaccessible and cannot be recovered. For more information on how ISM can automatically recycle storage volumes, see “Relabeling Volumes Automatically” on page 3-8.

### What Is a Recycling Status of Manual?

Occasionally, you might want to keep data on a storage volume longer than the retention period that is specified for the ISM server. Changing the recycling status of a storage volume to Manual allows you to protect the volume from becoming eligible for automatic recycling. As long as the storage volume has a recycling

status of Manual, ISM does not automatically recycle this volume, nor does it set the recycling status to Eligible. ISM continues to track the volume in the ISM catalog, and you can recover the data on the volume with the `ism_catalog -recreate_from` command. The storage volume is protected from automatic recycling until you remove the Manual recycling status or relabel the volume manually.

You can also use the Manual recycling status to create your own volume recycling policy. For example, suppose that you have a limited number of storage volumes and want to reuse them in a specific order, regardless of the age of the data on the volumes. You can apply the Manual recycling status to each volume and then relabel each volume as needed. The ISM server tracks these volumes in the ISM catalog until you relabel or delete them from the ISM catalog. For storage devices that have the **Automatic Media Management** option enabled, the volumes are protected from automatic recycling.

## How ISM Uses Volume Pools

ISM uses pools of volumes to sort and organize your storage space and logical-log backups. A volume pool is a collection of storage volumes. Any tape and optical disk storage volume can belong to the same volume pool. When you initiate an ON-Bar backup, ISM directs the data to a specific volume pool rather than to a specific volume. If ISM detects that a volume from the correct pool is mounted on a storage device, ISM writes data to that volume, regardless of media type.

Every storage volume belongs to a specific pool of volumes. ISM uses two types of volume pools, Backup and Backup Clone. Data cannot be mixed between pools of differing type. This situation enables ISM to keep original and cloned data separate. ISM ships with the following pools for use in backup and cloning operations:

- **ISMData pool.** Storage volumes in this pool accept backups of your storage spaces.
- **ISMLogs pool.** Storage volumes in this pool accept backups of your logical-log files.
- **ISMDiskData pool.** Storage volumes in this pool accept backups of your storage spaces when you use a file-type storage device. Volumes in this pool are of media type *file* and cannot be mixed with volumes of other media type.
- **ISMDiskLogs pool.** Storage volumes in this pool accept backups of your logical-log files when you use a file-type storage device. Volumes in this pool are of media type *file* and cannot be mixed with volumes of other media type.
- **ISMData Clone pool.** Storage volumes in this pool accept clones of your storage-space backups.
- **ISMLogs Clone pool.** Storage volumes in this pool accept clones of your logical-log backups.

We recommend that you use the ISMData and ISMData Clone pools for storage spaces and the ISMLogs and ISMLogs Clone pools for logical logs. If you use file-type storage devices, use the ISMDiskData and ISMDiskLogs pools for the file-type volumes.

ISM also ships with several other preconfigured pools that are included for forward compatibility, as follows:

- Default
- Default Clone

- Full
- NonFull
- Offsite

## Writing to Volumes of Different Media Types

Figure 4-2 illustrates how ISM writes data to volumes of different media type that both belong to the same pool.

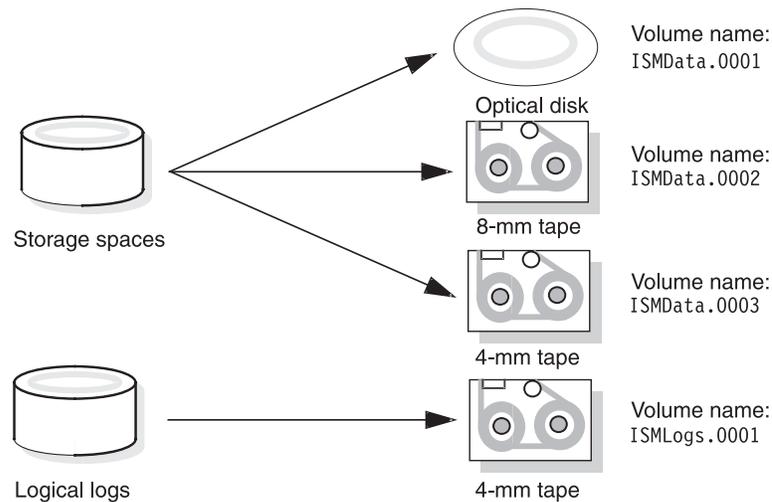


Figure 4-2. Volume Pools That Contain Varying Media Types

You cannot include storage volumes for file-type devices in a volume pool that includes other types of volumes. ISM does not allow volumes of other types to be recycled or added to a pool of file-type volumes. If you use file-type devices, it is recommended that you use the ISMDiskData and ISMDiskLogs pools with file-type volumes. You can then clone the data from your ISMDiskData backups to tape volumes.

For details on the recommended storage-device configuration when you use file-type devices, see “Using File Systems as Storage Devices” on page 3-5. For details on the cloning feature, see “Cloning Storage Volumes” on page 4-13. For information on how to choose which volume pool is used for backups, see the “Using ISM Environment Variables” on page 2-7.

## Using Volume Pools and Volume Labels

The volume label determines the volume pool to which a storage volume belongs. ISM maintains a record of each volume in the ISM catalog. ISM uses the ISM catalog to identify volumes that it needs for backing up and recovering data.

Each volume pool has a matching label format associated with it. ISM automatically uses the label format associated with the pool that you choose. These label formats provide a method for consistently naming and labeling volumes.

ISM automatically labels a volume with the next sequential label available for that volume pool. The label names are recorded internally on the media, creating an electronic volume label.

**Important:** Attach an adhesive label to each volume that matches the internal volume label so that you can easily identify your storage volumes.

The preconfigured ISMData and ISMLogs label formats automatically use the ISM server hostname, the appropriate pool name, and a numbering scheme that labels the volumes from 0001 to 9999, as the following table shows.

Label	Use
nova.ISMData.0024	This volume is from the ISMData pool and contains storage spaces from a host named <b>nova</b> .
nova.ISMLogs.0012	This volume is from the ISMLogs pool and contains logical logs from a host named <b>nova</b> .

The following table lists the pools that you should use for your storage spaces and logical logs and the format of the resulting volume label.

Data for Backup	Pool Name	Numbering Sequence	Volume Label Format
Storage spaces	ISMData	0001-9999	<i>hostname.ISMData.0001</i>
	ISMDiskData	0001-9999	<i>hostname.ISMDiskData.0001</i>
	ISMData Clone	0001-9999	<i>hostname.ISMDataClone.0001</i>
Logical logs	ISMLogs	0001-9999	<i>hostname.ISMLogs.0001</i>
	ISMDiskLogs	0001-9999	<i>hostname.ISMDiskLogs.0001</i>
	ISMLogs Clone	0001-9999	<i>hostname.ISMLogsClone.0001</i>

Use the **ism\_op -label** *device* command to label a volume. After a volume is labeled and mounted, it is available for backups. You can label several volumes at once without dismissing the dialog box, if you prefer. For details, see “ism\_op” on page A-8.

### Using Expiration Dates for Volume Labels

Whenever you label or relabel a storage volume, ISM automatically assigns a two-year expiration date to the volume. This expiration date applies to the physical media and is different from the retention period that you assign to your data. When a volume reaches its two-year expiration date, ISM marks the Backup status for the volume as Disabled. To minimize the failure rate of older media, ISM cannot write new data to the volume. The ISM server still tracks the data on the volume and applies the retention period to the save sets on the volume. Until the volume is relabeled, you can recover the data. When you relabel a storage volume, it receives a new two-year expiration date.

## Managing Storage Volumes

ISM requires that you label and mount a volume before you can use it to back up data. Labeling a volume associates the volume with a specific volume pool and provides ISM with a unique name for tracking and recognizing the media. ISM uses the volume labels to maintain a record of each volume in the ISM catalog. ISM uses the ISM catalog to identify volumes that it needs to back up and recover data.

If you have the **Automatic Media Management** option enabled for a storage device, you can have ISM automatically label and mount volumes on that storage device. For more information, see “Automating Media Management for Tape and Optical Devices” on page 3-8. You can also prelabel a volume without mounting it.

**Tip:** You can put several save sets on one volume if they are intended for the same pool and space exists on the volume.

## Labeling a Volume

When you label a volume, you associate the volume with a specific volume pool, which means that the volume is eligible to receive data when ISM needs a volume from that pool.

### To label a blank volume:

1. Load the volume in a storage device.
2. To label a blank volume, use the following command:  

```
ism_op -label device -pool pool -volume name
```

  - a. Specify the pathname of the device.
  - b. Use the ISMData and ISMData Clone pools for storage spaces and the ISMLogs and ISMLogs Clone pools for logical logs.  
If you use a file-type device, use the ISMDiskData and ISMDiskLogs pools to create file-type storage volumes.
  - c. Specify the volume name.
  - d. Optionally, use the **-set\_capacity** option to set the estimated capacity for the volume:

For *tape volumes*, if you do not set the capacity explicitly, the ISM server uses a default setting based on the media type. ISM writes data to the tape volume, however, until the volume is full, regardless of the estimated capacity that is set.

For *file-type* and *optical disk volumes*, if you do not set a value, ISM writes data to the file-type device or optical device until the device is full. If you enter a value, however, ISM writes data to the file-type or optical disk device until that value is reached.

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Alternatively, you can perform the following steps in Windows using ISM Administrator:

1. Load the volume in a storage device.
2. Open the **Devices** window and select the storage device.
3. Click **Volume -> Label**.
4. Select a volume pool from the **Pool** field. Use the ISMData and ISMData Clone pools for storage spaces and the ISMLogs and ISMLogs Clone pools for logical logs. If you use a file-type device, use the ISMDiskData and ISMDiskLogs pools to create file-type storage volumes.
5. Enter a volume label in the **Volume Label** field. If you do not enter a label, ISM uses the next sequential label according to the rules of the label format that is associated with the volume pool. The next sequential label appears in the Volume Label field.
6. Optionally, set the estimated capacity for the volume:
  - For tape volumes, if you do not set the capacity explicitly, the ISM server uses a default setting based on the media type. ISM writes data to the tape volume until the volume is full, regardless of the estimated capacity that is set.
  - For file-type and optical disk volumes, if you do not set a value, ISM writes data to the file-type device or optical device until the device is full. If you enter a value ISM writes data to the file-type or optical disk device until that value is reached.

- + 7. Click OK.

## Mounting a Volume

Before you can back up or recover data from a volume, you must mount the volume on a storage device that the ISM server recognizes.

If you use a file-type storage device, you must still mount a labeled volume on the file-type device before ISM can write backups to the file-type device. The labeling and mounting processes work the same way for file-type volumes as for tape volumes and optical disks.

### To mount a volume in a specific device:

1. Load the storage volume in the device.
2. Label the storage volume (see “Labeling a Volume” on page 4-7).
3. To mount the storage volume, use the following command:

```
ism_op -mount device
```

+ Alternatively, you can perform the following steps in Windows using ISM  
+ Administrator:

- + 1. Load the volume in the device.
- + 2. Open the **Devices** window and select the storage device.
- + 3. Click **Volume -> Mount**.

The Mount status of the storage volume changes to Mounted, and the volume name and pool name appear in their respective columns.

If you try to initiate an ON-Bar backup when a volume is not mounted, ISM requests a writable volume with the following message:

```
media waiting: backup to pool 'ISMDData' waiting for 1 writable  
backup tape or disk
```

You receive one of three messages to request that you mount a volume, relabel a volume, or label a new volume.

If you are recovering data, ISM requests the volume that you need to mount in the device by its volume name, as the following example shows:

```
media waiting: recover waiting for 8mm 5GB ISMDData.0034
```

**Important:** To perform an unattended backup with a stand-alone device, you must premount the volume if the storage device does not have the **Automatic Media Management** option enabled. The storage device must also be enabled.

## Choosing Volumes for Mounting

When ISM requires a volume for backup, it uses the following hierarchy to select volumes that are not currently in use from the appropriate volume pool:

1. Already mounted storage volume available for backups
2. Already mounted storage volume that is eligible for recycling on a device with the **Automatic Media Management** option enabled
3. Unmounted, unlabeled storage volume in a device with the **Automatic Media Management** option enabled
4. Unmounted storage volume that is available for backups

5. Unmounted storage volume that is eligible for recycling in a device with the **Automatic Media Management** option enabled

## Unmounting Volumes

You can only unmount a storage volume when the storage device is not active.

### To unmount a volume from a specific storage device:

1. To unmount the storage volume, use the following command:

```
ism_op -unmount device
```

The Mount status of the storage volume changes to Unmounted.

2. Unload the volume from the backup device.

+ Alternatively, you can perform the following steps in Windows using ISM  
+ Administrator:

- + 1. Select the storage device in **Devices** window.
- + 2. Click **Volume** -> **Unmount**. The mount status of the storage device changes to  
+ Unmounted.
- + 3. Unload the volume from the backup device.

## Finding a Volume Name

ISM can detect whether a selected storage device has a volume already loaded and whether the volume already has an ISM label. If the physical label on the volume is missing or illegible, perform the following steps to determine its name.

### To detect a storage volume:

1. Load the volume in a storage device.
2. To detect the storage volume, use the following command:

```
ism_op -detect device
```

ISM displays the volume name and pool name.

+ Alternatively, you can perform the following steps in Windows using ISM  
+ Administrator:

- + 1. Load the volume in a storage device.
- + 2. Select the storage device in Storage Manager Administrator.
- + 3. Click **Volume** -> **Detect**. The volume name and pool name are shown.

## Relabeling a Volume

ISM uses volume labels to track your data. Relabeling a volume means that you can no longer recover the original data on the volume. To relabel a volume, use the **ism\_op -label** command. You can relabel a volume only if it is unmounted. If you delete a volume from the ISM catalog, It is recommended that you do not use the deleted volume name for a new volume unless you are sure that you will never need to recover the data on the original volume.

You can relabel a volume whenever you want to. But to ensure that your data is protected, we recommend that you relabel a volume only under the following conditions:

- When a volume is eligible for recycling
- Before a volume is eligible for recycling
- When the volume is a file-type volume

- When you add more volumes to a pool

### **Relabeling a Volume Eligible for Recycling**

When the retention periods for all the save sets on a volume expire and their retention status is marked Expired, the recycling status of the storage volume changes to Eligible. At this point, you know that the retention period set for the ISM server for all the data on the volume has expired. If you use the **Automatic Media Management** option, ISM automatically relabels the volume and overwrites it with new data. However, the new label uses the same name and sequence number as the original label. Therefore, newer data might be on a volume with a lower label number. ISM labels recycled volumes in this way so that you can easily determine the age of your volumes. Each time that a volume is relabeled, it receives a new two-year expiration date. Lower-numbered volumes typically are older than higher-numbered volumes, even though the data on the older volume might be more recent.

Eligible volumes are recycled within the same pool. For example, an eligible volume from the ISMData pool remains in the ISMData pool when it is relabeled. If you want to recycle a volume to a different pool, you must manually label the volume and change the volume pool selection. For more information, see “Recycling a Volume or Adding More Volumes to a Pool” on page 4-10.

### **Relabeling a Volume Before It Is Eligible for Recycling**

You can manually relabel a storage volume at any time. If you relabel a storage volume before it is eligible for recycling, the retention period for some of the save sets on the volume have not yet expired, and you risk losing valuable data. Once a storage volume is relabeled, you can no longer recover the original data.

**Warning:** If you want to relabel a storage volume before its recycling status changes to Eligible, be sure that you do not need any of the save sets on the volume for a restore operation. Relabeling a storage volume overwrites the data on the volume, and you cannot recover the original data.

### **Relabeling a File-Type Volume**

If you use a file-type device, you need to relabel the file-type volume mounted on the file-type device when the volume fills with data. ISM tracks file-type volumes in the same way that it tracks other volumes. If you relabel the file-type volume, you can no longer recover the original data. To ensure that the data is protected, we recommend that you clone the data on your file-type volume to tape *before* you relabel the volume. ISM tracks cloned volumes in the same way that it tracks source volumes. When you clone your data to tape before you relabel a file-type volume, you ensure that you can recover the data.

After the file-type volume is relabeled, it appears to the ISM server that a new file-type volume is available to be mounted.

For more information on cloning volumes, see “Cloning Storage Volumes” on page 4-13.

### **Recycling a Volume or Adding More Volumes to a Pool**

Both recycling eligible volumes and adding more volumes to a pool have advantages. When you recycle, you reuse the same volumes and do not add new volumes to the pool. However, the media might wear out over time and have a higher failure rate. ISM uses the original volume sequence number to relabel volumes within the same volume pool. This number enables you to easily track

which volumes are older. When you relabel a volume to a different volume pool, the volume receives the next available sequence number for the new pool. Because each volume receives a new two-year expiration date when it is relabeled, you cannot determine how old a specific volume is when it is relabeled to a different volume pool.

On the other hand, if your site requires you to maintain the backups in storage for a certain period of time, you might have to add more media to the volume pool instead of recycling it. For example, if your volumes fill up in 90 days but your retention period is set for 180 days, you need to add new media to the pool until you can recycle the backup volumes that contain expired or old backups.

---

## Overriding Automatic Media Management

ISM allows you the flexibility to change how ISM manages a storage volume, if necessary.

### Disabling a Storage Volume

Typically, a storage volume can be used for both backup and restore operations. Occasionally, you might decide that a particular storage volume should not receive any more new data. In this case, you can change the Backup status to Disabled, which prevents ISM from using the storage volume during a backup operation. ISM uses this storage volume only for restore operations until you change the volume status.

If a storage volume fills with data during a backup operation, the ISM server automatically changes the Backup status to Disabled. This action ensures that the ISM server does not try to use the volume for subsequent backup operations. Whenever a storage volume gets full, ISM sets the Backup status to Disabled until that volume is recycled. For the procedure, see “Enabling and Disabling a Storage Device” on page 3-4.

**Important:** The data on the volume with a Backup status of Disabled is still subject to the retention period that is set for the ISM server. The recycling status of the volume changes to Eligible after all the save sets on the volume have expired, and the volume is then eligible for automatic recycling.

### Protecting a Storage Volume from Automatic Recycling

Occasionally, you might decide that you want to keep the data on a particular volume longer than the retention period for the ISM server specifies or because you created a different volume recycling plan. To override the retention period for the data on a volume, change the recycling status of a volume to Manual. The volume is not a candidate for automatic recycling until you *manually* relabel the volume or use the `ism_config -recycle manual` command. ISM continues to track the storage volume in its ISM catalog, and you can always recover the data on the volume with the `ism_catalog -recreate_from` command.

### Deleting Volumes from the ISM Catalog

Removing a volume means that ISM no longer tracks the volume in the ISM catalog and effectively releases the volume from the control of ISM. Remove a volume from the ISM catalog only if you will never need the data on the volume again or if the volume has been physically damaged and is unusable.

You rarely need to remove a volume from the ISM catalog. ISM catalog entries take up a small amount of disk space. Leave the volume in the ISM catalog so that you do not accidentally label another volume with the same name.

If a volume is lost or destroyed, remove its entry from the ISM catalog. Otherwise, ISM might request the volume to recover data.

**To delete a storage volume from the ISM catalog:**

1. Remove the storage device as follows:

```
ism_rm -volume name
```

2. To verify that the storage volume was deleted, issue the command:

```
ism_show -volumes
```

The ISM server no longer tracks the storage volume and its associated save sets.

+ Alternatively, you can perform the following steps in Windows using ISM  
+ Administrator:

- + 1. Open the **Volume Inventory** window and select the volume.
- + 2. Click **Volume -> Delete**.

**Important:** If you accidentally delete a volume from the ISM catalog, you can still recover the data with the **ism\_catalog -recreate\_from** command as long as you have not overwritten the volume with new data.

---

## Cloning Storage Volumes and Save Sets

Cloning volumes or save sets is beneficial for the following purposes:

- Sending data off-site
- Replacing old volumes
- Testing the integrity of your data

If you use a file system as a storage device, clone your data to tape when the file-type volume fills with data. This action ensures that your data is available for recovery if your file-type volume fills quickly.

Create clones of your media to store identical copies of your data off site, or share or transfer important data to other company facilities easily.

Most media has a limited life span. Consequently, routinely replace your volumes. The expiration date of a storage volume indicates how old the physical media is, not the data on the volume. A volume has a default expiration date of two years after it is labeled. If you relabel a volume, it receives a new two-year expiration date. When a volume reaches its expiration date, ISM automatically changes the Backup status of the volume to Disabled. This status means that no new data can be written to the volume. However, the data on the volume can still be recovered until the volume is relabeled. If you have old volumes that contain important data, clone them before they expire to ensure the safety of the data. If you clone a volume to newer media, you can prevent media failures during recover operations. You can determine the expiration date of your physical media with the **ism\_show -volumes** command at the command line.

When you clone a volume, you can determine the integrity of backed-up data. ISM displays an error message if it has difficulty reading the data from the original volume during the cloning process.

You can clone entire volumes from the command line. Because save sets can span multiple volumes, ISM might request more than one source volume to complete the cloning operation. Furthermore, because media varies in size and capacity, you might need more destination volumes to hold the cloned data than the source volumes require. Conversely, depending on the type of media that you use, you might be able to fit multiple source volumes on one destination volume.

**Important:** You cannot perform disaster recovery operations from cloned volumes. For instructions on how to recover the ISM catalog after a disaster, see “Recovering Data After a Disaster” on page 5-3.

## Tracking Cloned Data

Cloned data on a volume is indistinguishable from the original, although the different capacities of storage media can mean that more or fewer volumes are required. Data-tracking information about each cloned save set is added to the existing entries that describe the source save sets. If administrators go outside of the ISM application and duplicate their volumes with a copy utility that the operating system or hardware provides, ISM has no knowledge of these volumes and cannot recover data stored on such volumes.

Both original and cloned volumes share the same ISM catalog entries, so the cloned data is subject to the same retention period as the original data. ISM automatically manages both original and cloned data based on the retention periods for the volumes. If you clone data a week before the retention period for the source data expires, the retention status for the cloned data changes to Expired at the same time that the original data does. If you want to keep data on a cloned volume beyond the retention period of the original data, you can change the recycling status of the cloned volume to Manual. ISM can keep and track the data on the cloned volume indefinitely.

To distinguish between cloned and original volumes, you must assign the cloned volume to a clone pool and include *clone* in the volume name. ISM provides preconfigured ISMData Clone and ISMLogs Clone pools for you to use when you clone your storage spaces and logical logs.

## Cloning Storage Volumes

Cloning with ISM provides an additional layer of protection because it allows you to make identical copies of the data on your volumes as you need them.

The original volume is the *source* volume, and the volume that receives the cloned data is the *destination* volume. The destination volume must be a different volume from the source volume. Cloned data belongs to a clone pool. Use the ISMData Clone pool and the ISMLogs Clone pool for your cloned volumes.

The requirements for cloning storage volumes with ISM follow:

- Two backup devices
- Source and destination volumes

**To clone a file-type storage volume before it is full:**

1. If the volume is already mounted, you must unmount it to change the Backup status. This action ensures that no new data is written to the file-type volume during the cloning operation.

If the volume is already unmounted, change the Backup status for the volume to Disabled.

2. To clone a volume, use the following command:
 

```
ism_clone -volume name
```

  - a. Specify the name of the volume to clone.
  - b. Specify the name of the clone pool (Default Clone, ISMData Clone, or ISMLog Clone).
3. Mount the selected storage volume and cloned volume.

+ Alternatively, you can perform the following steps in Windows using ISM Administrator:

1. In the **Volume Inventory** window, select the storage volume that you want to clone. If you are cloning a file-type storage volume before the volume is full, change the Backup status for the volume to **Disabled**. If the volume is already mounted, you must unmount it in order to change the Backup status. This action ensures that no new data is written to the file-type volume during the cloning operation.
2. Click **Volume -> Clone**.
3. Select a clone pool from the **Clone Pool** field.
4. Click **OK**.
5. Mount the selected storage volume and cloned volume.

## Cloning Save Sets

In addition to cloning all the save sets on a storage volume, you can clone individual save sets. ISM tracks these individual cloned save sets in the same way that it tracks the originals. The cloned save sets are subject to the same retention period as the original save sets and must be written to a volume that belongs to a clone pool. When the original save sets expire, so do the cloned save sets.

### To clone a save set:

1. Mount a storage volume from the appropriate clone pool on a storage device.
2. To display the save set IDs for a volume, use the following command:
 

```
ism_show -volume name
```
3. To clone a save set, use the following command:
 

```
ism_clone -saveset ssid
```

  - a. Specify one or more save set IDs.
  - b. Specify the name of the clone pool.
4. Click the **Clone** button in the toolbar or choose **Save Set > Clone**.
5. Mount the selected storage volume and cloned volume.

+ Alternatively, you can perform the following steps in Windows using ISM Administrator:

1. Mount a storage volume from the appropriate clone pool on a storage device.
2. Select the save set in the **Volume Inventory** window.
3. Click **Save Set -> Clone**.
4. Select the appropriate clone pool from the **Clone Pool** field.
5. Click **OK**.
6. Mount the selected storage volume and cloned volume.

---

## Chapter 5. Recovering Save Sets with ISM

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### In This Chapter

This chapter describes how to recover data at various points during the data life cycle.

---

### Restoring a Save Set with ON-Bar

As long as the retention status for a save set has not changed to Expired to indicate that the retention period for the save set has passed, you can use ON-Bar to initiate a restore operation for that save set. For instructions on how to initiate a restore operation with ON-Bar, refer to the *IBM Informix Backup and Restore Guide*.

---

### Locating Volumes That Contain Partial Save Sets

Depending on the size of your storage spaces, a save set might require more than one storage volume during a backup. The **Partial** column in the **ism\_show -volume** command indicates if a save set spans more than one storage volume. Typically, save sets do not span more than two volumes. If you need to recover a save set, you might want to preload all the volumes before you begin the restore operation.

---

### Re-Creating the ISM Catalog Before You Use ON-Bar

The ISM server tracks the backed-up data in the ISM catalog. You can re-create entries in the ISM catalog for expired save sets and for volumes that have been deleted from the ISM catalog from the command line.

After you re-create entries in the ISM catalog, you can use ON-Bar to recover the data. For details on how to use the ISM command-line utilities, see Appendix A, "ISM Command-Line Utilities."

Before you use ON-Bar to recover data, use the **ism\_catalog -recreate from** command to re-create the entries in the ISM catalog in the following situations:

- Recovering expired save sets

After a save set has expired, you need to re-create its entry in the ISM catalog before you can restore the data with ON-Bar.

- Recovering volumes that are eligible for recycling

When the Recycling status for a storage volume has changed to Eligible, the retention periods for all the save sets on the storage volume have expired. You need to re-create the entries in the ISM catalog before you can restore the data with ON-Bar.

- Recovering volumes that have been deleted from the ISM catalog

If you remove a storage volume from the ISM catalog, but the data on the volume is still intact, you can re-create the entries in the ISM catalog and then use ON-Bar to recover the data on the volume.

If the ISM server is on UNIX, you must have **root** privileges to execute the **ism\_catalog** command. If the ISM server is on Windows, you must be a member of the **Informix-Admin** group.

**To recover entries in the ISM catalog:**

1. Load the volume in a storage device.
2. At the command line, initiate the following command with the full pathname of the storage device on which you loaded the storage volume:

```
ism_catalog -recreate_from device
```

3. Use ON-Bar to restore the data.

When you recover a storage volume in this way, ISM automatically marks the Backup status for the volume as *Disabled* to ensure that no new data is written to the storage volume. To protect the volume from automatic recycling, change the recycling status of the volume to Manual. ISM does not automatically recycle a volume marked Manual.

---

## Recovering Data from a Cloned Volume

Cloned volumes provide added security because they allow you to recover your data in case the original volumes become damaged or destroyed.

During a restore operation, ISM is configured to request the original source volume. However, if you know that the original volume is unavailable (perhaps it is stored off site), you can force ISM to request a cloned volume.

**To force ISM to request a cloned volume:**

1. Use the **ism\_rm -volume** command to delete the original storage volume.

Alternatively, change the Restore status for each save set on the original volume to Disabled:

```
ism_config -volume name -disable_restore ssid
```

To obtain a list of the **ssid** numbers, issue the **ism\_show -volume name** command.

2. Use **ism\_catalog** to recover unexpired save sets.

If the save sets on the cloned volume have expired, follow the instructions in “Re-Creating the ISM Catalog Before You Use ON-Bar” on page 5-1 to re-create the ISM catalog.

3. Use ON-Bar to restore the data.

- + Alternatively, you can perform the following steps in Windows using ISM Administrator:
- + 1. Delete the original volume in the **Volume Inventory** window. Alternatively, you can change the Restore status for each save set on the original volume to **Disabled**.
- + 2. Use `ism_catalog` to recover unexpired save sets. If the save sets on the cloned volume have expired, follow the instructions in “Re-Creating the ISM Catalog Before You Use ON-Bar” on page 5-1 to re-create the ISM catalog.
- + 3. Use ON-Bar to restore the data.

When you delete the original volume from the ISM catalog or change the Restore status for each save set on the original volume to Disabled, ISM knows that the original volume is unavailable for the restore operation and requests the cloned volume instead.

---

## Recovering Data After a Disaster

Hardware malfunctions rarely occur at convenient times, but if you have a disaster recovery plan in place and maintain regular backups of your database server, you are well prepared to recover critical data in a timely manner.

Before you can restore your data with ON-Bar, you must re-create the ISM catalog in the following situations:

- The ISM catalog is corrupted
- You reinstalled the operating system and the Informix database server software, which includes the ISM software

### If You Have the ISM Server Bootstrap Printout

The following steps overwrite all existing information for this ISM server and recover the ISM catalog.

#### To recover the ISM catalog:

1. Locate the most recent bootstrap printout for the ISM server.  
The bootstrap printout lists which volume contains the ISM server bootstrap save set.
2. Mount the volume that contains the most recent bootstrap save set on a storage device and issue the following command:  

```
ism_catalog -recover
```

ISM re-creates the ISM catalog for this ISM server.
3. After you re-create the ISM catalog, use ON-Bar to restore your data.

### If You Do Not Have the ISM Server Bootstrap Printout

If you do not have the most recent ISM server bootstrap printout, you must locate the storage volume that contains the most recent bootstrap save set before you can recover the ISM catalog.

#### To recover the ISM catalog:

1. Mount the storage volume that contains the most recent backup from the ISMData volume pool.  
This volume contains the most recent ISM server bootstrap save set.

If you do not know which volume contains the most recent backup from the ISMData volume pool, you must scan each volume for the most recent bootstrap save set. At the command line, enter the following command with the full pathname of the storage device on which you loaded the storage volume:

```
ism_catalog -find_bootstrap device
```

ISM displays the **ssid** numbers for all bootstrap save sets on the volume. You can use bootstraps to restore the ISM catalog only from volumes of type Backup. You cannot use bootstraps from volumes of type Backup Clone in the restore process.

2. After you locate the volume with the most recent bootstrap save set, issue the following command:

```
ism_catalog -recover
```

ISM re-creates the ISM catalog for this ISM server.

3. After you re-create the ISM catalog, use ON-Bar to restore your data.

**Important:** You cannot perform disaster recovery from a cloned bootstrap save set.

## Creating and Backing Up the ISM Bootstrap

To create the ISM bootstrap, use one of the following methods:

- **onbar** script

If you use the **onbar** script to perform backups, it automatically calls the **ism\_catalog -create\_bootstrap** command, which creates and backs up the ISM bootstrap. For more information, see “Updating the onbar Script” on page 1-9.

- **ism\_catalog -create\_bootstrap** command

The **ism\_catalog -create\_bootstrap** command creates a full backup of the ISM catalog when it is first used, but subsequently performs incremental backups. Therefore, the media or volume containing the first bootstrap creation is always necessary in order to restore the bootstrap successfully. To avoid the need for the first media or volume during bootstrap restore, a full bootstrap backup must be performed every time. To accomplish this, the level must be specified explicitly by using, the underlying **savegrp** command that **ism\_catalog -create\_bootstrap** calls.

To perform a full backup of the ISM catalog every time, run the following command as the user **root**:

```
$INFORMIXDIR/bin/savegrp -O -l full ISMData
```

In this command:

- **-O** is a capital-o (not a zero).
- **ISMData** is the pool name where the bootstrap data is saved.

You can edit the **\$INFORMIXDIR/bin/onbar** shell script to replace the **ism\_catalog -create\_bootstrap** command with the **savegrp** command. Redirect the output (both stdout and stderr) of the **savegrp** command to the ON-Bar activity log file (specified by the **BAR\_ACT\_LOG** configuration parameter in onconfig file).

For more information, see “ism\_catalog” on page A-2.

**Important:** We recommend that you back up the ISM bootstrap after each level-0 backup.

---

## Transferring Data with the Imported Restore

With the imported restore feature, you can transfer all the data from one instance of the database server to the same instance on a foreign host. For example, you can back up data to ISM on one computer and restore it to ISM on a different computer. You can perform imported restores using either whole system (serial) or storage-space (parallel) backups. The parallel backup must include all storage spaces and logical logs. You must also use compatible versions of XBSA libraries and ISM for both operations.

**Important:** You cannot use a backup from one database server version to restore on a different version. You can, however, change the database server name in an imported restore.

### The `ISM_CLIENT` and `ISM_SERVER` Environment Variables

The `ISM_CLIENT` environment variable only needs to be set when you do an imported restore. `ISM_CLIENT` is set on the target server as part of the restore procedure. `ISM_CLIENT` is the hostname of the source.

When you back up the source database server to ISM, set `ISM_SERVER` to the hostname of the source. For the restore procedure, set `ISM_SERVER` to the hostname of the target. In both the backup and the restore procedures, `ISM_SERVER` is the local machine. Remote connections are not supported with ISM.

You obtain the values of these environment variables with the `hostname` command.

### Imported Restore Procedure with Files Larger than 2 GB

If ISM is configured to write storage objects to a device of type file, then it will split objects larger than 2 GB into several files each with a maximum size of 2 GB. These files (known as save sets) have unique names that reflect the order in which the files were created and written. This is also true for the multiple files that comprise a storage object larger than 2 GB. Therefore the order in which the files of such a storage object are written can be determined by their unique file names.

If the ISM catalog needs to be re-created (because the catalog is lost or in an imported restore situation), the command `ism_catalog -recreate_from <device>` is to be used. This command scans the files (save sets) on the device to rebuild the catalog. However, internally it does not use the unique filename to scan the files in the correct order. Instead it relies implicitly on the file creation time or inode number for the correct order. If the files have been copied in the wrong order, then these criteria will not establish the correct order and the command will fail to correctly rebuild the catalog entries for the storage objects. This is only the case for storage objects larger than 2 GB that have been split into several files.

Always use a system utility such as `tar` or `cpio` to copy or archive all the save sets on a device of type file. Do not copy single files. Even though the device is of type file, it is to be treated as a tape device.

If the save sets have already been copied as single files, move the files of storage objects larger than 2 GB to give them different names. The files can remain in the same directory. You can use the command `mv <original_name> <new_name>`. Using the move command `mv` avoids actual move of large data and instead only manipulates the existing inode. For each file create a symbolic link using a

command `ln -s <original name> <new_name>`. Be sure to create these symbolic links in the correct order (as designated by the filenames). These symbolic links will then have new inodes and creation times in the correct order. After this run the command `ism_catalog -recreate_from <device>`, which will correctly scan the device based on the symbolic link names.

The imported restore is a subset of the following three processes:

- Disaster recovery
- Database server upgrade
- Initialization of High-Availability Data Replication (HDR)

As its name implies, you can also use the imported restore solely to complete an imported restore.

An imported restore consists of these three steps:

1. Backing up the source database server to ISM
2. Porting ISM to a target computer that is a different physical host
3. Restoring the data from ISM to the target database server with the same instance on the target computer

These procedures are discussed in detail in the following sections.

**Important:** The imported restore procedure is the same for both UNIX and Windows. However, when you set the environment variables, you must use the appropriate UNIX or Windows syntax.

## Step 1: Backing Up the Source Database Server to ISM

**Important:** If the `hostname` command outputs a fully-qualified hostname, use fully qualified hostnames in the imported restore procedure. An example of a qualified hostname is `mycomputer@informix.com`. If the command outputs the short hostname (`mycomputer`, for example), use the short form.

**To back up the source database server to ISM:**

1. Execute the `hostname` command on your source and target computers.
2. Bring the database server to quiescent mode with the following command:  
`onmode -s`
3. Set the following ISM environment variables:

### UNIX Only

On UNIX:

```
ISM_SERVER = source_hostname
ISM_DATA_VOLUME_POOL = ISMData
ISM_LOG_VOLUME_POOL = ISMLogs
export ISM_SERVER
export ISM_DATA_VOLUME_POOL
export ISM_LOG_VOLUME_POOL
```

End of UNIX Only

Windows Only

On Windows:

```
set ISM_SERVER = source_hostname
set ISM_DATA_VOLUME_POOL = ISMData
set ISM_LOG_VOLUME_POOL = ISMLogs
```

End of Windows Only

4. Perform a full backup of the source database server:  
onbar -b -L 0
5. Back up copies of the following critical files located in the **\$INFORMIXDIR/etc** (UNIX) or **%INFORMIXDIR%\etc** (Windows) directory. When you perform an imported restore to another computer system, you will need to restore these files.

Dynamic Server

On Dynamic Server, copy the following files:

```
ixbar.servernum
# for UNIX users only
$ONCONFIG
sqlhosts
# for Windows users only
%ONCONFIG%
```

End of Dynamic Server

Windows Only

On Windows, use **regedit** to copy the **sqlhosts** information from the source computer to the target computer. Use the following registry entry:

```
HKEY_LOCAL_MACHINE/SOFTWARE/Informix/SQLHOSTS/...
```

End of Windows Only

Extended Parallel Server

On Extended Parallel Server, copy the following files:

```
onconfig.sourcecomputer
Bixbar.hostname.servernum
# for all coserver numbers, copy the oncfg files
oncfg_source_dbservername.servernumber.coservernumber
sqlhosts
xcfg_sourcecomputer.servernumber
```

End of Extended Parallel Server

6. Complete the following steps to make your security portable to the new computer:

UNIX Only

On UNIX:

```
ism_add -admin root@target_hostname  
ism_add -admin informix@target_hostname
```

End of UNIX Only

Windows Only

On Windows:

```
ism_add -admin Administrators@target_hostname  
ism_add -admin informix@target_hostname
```

End of Windows Only

7. Save the bootstrap of your source ISM server:

UNIX Only

On UNIX:

```
$INFORMIXDIR/bin/ism_catalog -create_bootstrap \  
-pool $ISM_DATA_VOLUME_POOL
```

End of UNIX Only

Windows Only

On Windows:

```
cd %INFORMIXDIR%\bin  
ism_catalog -create_bootstrap -pool %ISM_DATA_VOLUME_POOL%
```

End of Windows Only

## Step 2: Porting ISM to Your Target Database Server

You need to port and replicate ISM on the target database server.

**To port ISM to your target database server:**

1. Log in as user **root** (UNIX) or **Administrator** (Windows) on the target database server.
2. Shut down the Informix database server and ISM.

Dynamic Server

On Dynamic Server:

```
onmode -ky  
ism_shutdown
```

End of Dynamic Server

Extended Parallel Server

On Extended Parallel Server:

```
xctl onmode -ky  
ism_shutdown
```

End of Extended Parallel Server

- Unset the **ISM\_CLIENT** environment variable as follows:

```
unset ISM_CLIENT
```

- Edit the **ism\_startup** script or **ism\_startup.bat** script:

UNIX Only

On UNIX:

- Locate the following line in the **\$INFORMIXDIR/bin/ism\_startup** script and type **hostname** verbatim:

```
hostname=$(hostname)
```

- Add the following line immediately after that line:

```
hostname=source_hostname
```

End of UNIX Only

Windows Only

On Windows:

- Locate the following line in the **%INFORMIXDIR%\bin\ism\_startup.bat** script:

```
Set nextLabel = ask_init
```

- Add the following line immediately before that line:

```
set hostname = source_hostname
```

End of Windows Only

- Reinitialize ISM:

```
ism_startup -init
```

- Using a text editor, create a temporary file and enter the following information:

UNIX Only

On UNIX:

```
create type: NSR client; name: source_hostname;  
remote access: root@target_hostname, informix@target_hostname
```

End of UNIX Only

Windows Only

On Windows:

```
create type: NSR client; name: source_hostname;  
update remote access: Administrator@target_hostname,  
informix@target_hostname
```

End of Windows Only

7. Run the following command against the temporary file:

```
nsradmin -s target_hostname -i temporary_file
```

**Important:** After you run this command, you might receive an error message similar to the following message. Ignore this message and complete the procedure as outlined.

```
create failed: save set of All for client source_hostname in group  
Default excludes any clients with the same name from the group.
```

**To replicate ISM with the same resources that you have on the source host, you must recover your bootstrap:**

1. If your source **INFORMIXDIR** does not match your target **INFORMIXDIR**, you need to create a symbolic link to recover the bootstrap from the source computer.

For example, if **INFORMIXDIR** on your source computer is **/usr2/informix** and **INFORMIXDIR** on your target computer is **/usr/local/informix**, create the **/usr2** directory on the target computer and symbolic link as follows:

UNIX Only

On UNIX:

```
mkdir /usr2  
ln -s /usr/local/informix /usr2/informix
```

End of UNIX Only

Windows Only

On Windows:

Create a shortcut from your source **INFORMIXDIR** to your target **INFORMIXDIR**. For information on how to create a shortcut, see your operating-system documentation.

End of Windows Only

2. Add the device that contains the volume pool that contains the bootstrap file:

```
ism_add -device device_name -type device_type
```

3. Add the remaining devices for the other volume pools.

4. Mount the storage volume that contains the most recent backup from the ISMData volume pool.

5. Mount the remaining storage volumes.

6. Scan the volume for the most recent bootstrap save set:

```
ism_catalog -find_bootstrap device_name
```

ISM displays the **ssid** numbers for all bootstrap save sets on the volume.

Record the most recent **ssid** number because you will need to use this number again in step 8.

7. Recover the most recent bootstrap save set:

```
ism_catalog -recover
```

8. Enter the most recent bootstrap save set number you recorded earlier in step 6.

Wait until the following message appears. Ignore the warning and proceed to the next step:

```
nsrindexasm: Didn't find earlier versions to recover!  
WARNING: The online index for hostname was NOT fully  
recovered...
```

9. Shut down ISM:

```
ism_shutdown
```

10. Recover the **res.R** file from the source database server.

The **res.R** file contains the resource configuration information for the source database server.

#### UNIX Only

On UNIX:

```
cd $INFORMIXDIR/ism  
rm -rf res  
mv res.R res
```

End of UNIX Only

#### Windows Only

On Windows:

```
cd %ISMDIR%  
del res  
rmdir res  
move res.R res
```

End of Windows Only

**Important:** Perform step 11 for disaster recovery only if you did not issue the **ism\_add -admin** command on the source computer because it was unavailable.

11. Create the following temporary file and then run the **nsradmin** command against that file.

#### UNIX Only

On UNIX:

```
print type:NSR;  
  
update administrator:informix@source_host,  
root@source_host,informix@target_host,  
root@target_host  
  
nsradmin -f $INFORMIXDIR/ism/res/nsr.res -i temporary_file
```

End of UNIX Only

Windows Only

```
On Windows:
print type:NSR;

update administrator:informix@source_host,
Administrator@source_host,informix@target_host,
Administrator@target_host

nsradmin -f %ISMDIR%\res\nsr.res -i temporary_file
```

End of Windows Only

12. Start ISM:  
ism\_startup
13. Remove the device entries from the source computer that do not exist on the target computer:  
ism\_show -devices  
ism\_rm -device *device\_name*
14. Create any additional media device entries that do not appear in ISM to match those that exist on your target host:  
ism\_show -devices  
ism\_add -device *device\_name* -type *device\_type*
15. Grant permission for local users to access the indexes for the source client.  
Using a text editor, create a temporary file and enter the following information:

**Important:** You must enter the command exactly as it appears, including the space between the two lines.

UNIX Only

```
On UNIX:
print type: NSR client; name: source_hostname

update remote access: informix@target_hostname,
root@target_hostname
```

End of UNIX Only

Windows Only

```
On Windows:
print type: NSR client; name: source_hostname

update remote access: informix@target_hostname,
Administrator@target_hostname
```

End of Windows Only

16. Run the following command against the temporary file:  
nsradmin -s *target\_hostname* -i *temporary\_file*

## Step 3: Restoring Data from ISM to the Target Database

**Important:** Set up the target database server with exactly the same disk layout and device allocations as the source database from which you are transferring the data. Make sure that you assign the same database server number that was used on the source computer.

**To restore the data from ISM to the target database server:**

1. Log in as user **informix**.
2. If the Informix database server is online, shut it down.

```
Dynamic Server
On Dynamic Server:
onmode -ky

End of Dynamic Server
```

```
Extended Parallel Server
On Extended Parallel Server:
xctl onmode -ky

End of Extended Parallel Server
```

3. Configure the following ISM environment variables for this session. For example:

```
UNIX Only
On UNIX:
ISM_CLIENT = source_hostname
ISM_SERVER = target_hostname
ISM_DATA_VOLUME_POOL = same_value_on_source_host
ISM_LOG_VOLUME_POOL = same_value_on_source_host
export ISM_CLIENT ISM_SERVER
export ISM_DATA_VOLUME_POOL
export ISM_LOG_VOLUME_POOL

End of UNIX Only
```

```
Windows Only
On Windows:
set ISM_CLIENT = source_hostname
set ISM_SERVER = target_hostname
set ISM_DATA_VOLUME_POOL = same_value_on_source_host
set ISM_LOG_VOLUME_POOL = same_value_on_source_host

End of Windows Only
```

4. Recover your media database for each of your data volume pools (ISMData, ISMLogs):  
`ism_catalog -recreate_from device_name`
5. Synchronize the media index database:

```
nsrim -v
```

6. To mark your media as appendable for each of your volume pools (ISMData, ISMLogs), complete the following steps:

```
ism_show -devices
ism_op -unmount device_name
ism_show -volumes
ism_config -volume volume_name -only_restore no
ism_op -mount device_name
```

#### Dynamic Server

7. On Dynamic Server, restore copies of the following critical files located in the **\$INFORMIXDIR/etc** (UNIX) or **%INFORMIXDIR%\etc** (Windows) directory:

```
ixbar.servername
# for UNIX users only
$ONCONFIG
sqlhosts
# for Windows users only
%ONCONFIG%
```

#### Windows Only

Use **regedit** to copy the **sqlhosts** information from the source computer to the target computer. Use the following registry entry:

```
HKEY_LOCAL_MACHINE/SOFTWARE/Informix/SQLHOSTS/...
```

Rename the **oncfg\*** file and replace the host database server name with the target database server name. For example:

```
oncfg_target_dbservername.servernum
```

#### End of Windows Only

#### End of Dynamic Server

#### Extended Parallel Server

8. On Extended Parallel Server, restore copies of the following critical files located in the **\$INFORMIXDIR/etc** directory from each coserver on the target computer:

```
onconfig.sourcecomputer
Bixbar.hostname.servernum
oncfg_source_dbservername.servernumber.coservernumber
sqlhosts
xcfg_sourcecomputer.servernumber
```

For the following files, replace the host database server name with the target database server name:

```
oncfg_source_dbservername.servernumber.coservernumber
xcfg_hostname.servernumber
Bixbar.hostname.servernum
```

Edit the **xcfg\_*hostname.servernumber*** file to change the source database server name to the target database server name.

#### End of Extended Parallel Server

9. Update the **sqlhosts** file or registry entry and include the proper shared memory settings for the target database server.

**UNIX Only**

In the **sqlhosts** file, change the database server name in the first and fourth entries on each line, if necessary. Change the hostname in the third entry to the target hostname.

**End of UNIX Only**

10. Update the ONCONFIG file and replace the source database server name with the target database server name. For example:

```
DBSERVERNAME target_dbservername
```

**Extended Parallel Server**

For Extended Parallel Server only, change the host names in the NODE lines. Delete the SADDR, LADDR, and HADDR lines that follow each NODE line in the ONCONFIG file.

**End of Extended Parallel Server**

11. Create new dbspaces if you have not already done so.  
Make sure they reside at the same path locations as they do on the source database server. User **informix** and group **informix** also should own these dbspaces.
12. Perform the imported restore on the target database server:  

```
onbar -r
```
13. Reconfigure your ISM settings for daily backup and restore operations.  
Do not change the settings of the **ISM\_CLIENT** and **ISM\_SERVER** environment variables.

**Important:** If the imported restore fails with an error about the source hostname not having access, grant permission for local users to access the indexes for the source client. For details, see steps 15 and 16 on page 5-12.



---

## Appendix A. ISM Command-Line Utilities

The ISM server supports several command-line utilities for managing administrative users, the ISM catalog, storage devices, and media volumes. If an option contains multiple letters, you can abbreviate it to the shortest unique string. For example, you can specify the **ism\_catalog -recreate\_from** option as **-recr**.

The table below lists all available commands and gives a brief explanation of their function. The following sections contain a more detailed explanation of the commands.

Command	Used to
<b>ism_add</b>	Add administrative users and storage devices.
<b>ism_catalog</b>	Re-create entries in, or recover, the ISM catalog, create a new bootstrap, or find the ISM server bootstrap.
<b>ism_chk.pl</b>	Collect information about ISM, ON-Bar, and the database server.
<b>ism_clone</b>	Initiate a clone operation on a storage volume or save set.
<b>ism_config</b>	Configure the ISM server properties and change storage-volume parameters.
<b>ism_op</b>	Label, mount, and unmount storage volumes.
<b>ism_rm</b>	Remove an administrative user or storage device from the ISM server or remove a storage volume from the ISM catalog.
<b>ism_show</b>	View information about the ISM administrators, media volumes, and storage devices.
<b>ism_shutdown</b>	Shut down the ISM server.
<b>ism_startup</b>	Start an ISM server.
<b>ism_watch</b>	Display a terminal-based screen utility to monitor the ISM server.

---

### ism\_add

The **ism\_add** command enables you to add administrative users and storage devices to the ISM server.

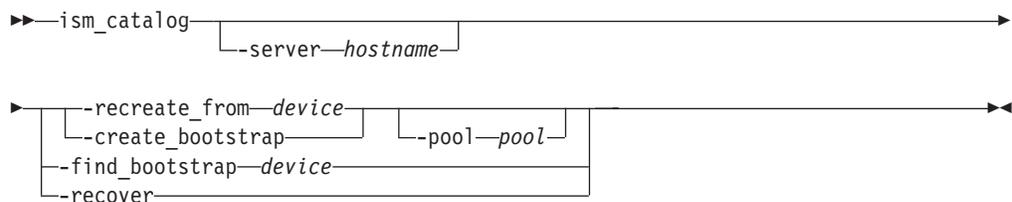
```
▶▶ ism_add [ -server-hostname ] [ -admin-name@ host ] [ -device-name-type-type ] ▶▶
```

Element	Purpose	Key Considerations
<b>-server</b> <i>hostname</i>	Specifies the name of the computer on which the ISM server is running	If you omit this option, this command looks first for an ISM server on the local computer and then for the first ISM server to respond over the network.
<b>-admin</b> <i>name@host</i>	Adds an administrative user to the ISM server	This user can make configuration changes to the ISM server.
<b>-device</b> <i>name</i>	Adds a storage device to the ISM server	ISM supports up to four active devices.
<b>-type</b> <i>type</i>	Designates the type of storage device	You must choose a device type that ISM supports. For more information, see “Adding and Deleting Storage Devices” on page 3-2.

## ism\_catalog

The **ism\_catalog** command enables you to re-create entries in the ISM catalog for a volume that has been removed from the ISM catalog, find the ISM server bootstrap, create a new ISM bootstrap, and recover the entire ISM catalog.

**Important:** To run the **ism\_catalog** command, you must have **root** privileges.



Element	Purpose	Key Considerations
<b>-server</b> <i>hostname</i>	Specifies the name of the computer on which the ISM server is running	If you omit this option, this command looks first for an ISM server on the local computer and then for the first ISM server to respond over the network.
<b>-recreate_from</b> <i>device</i>	Re-creates the ISM catalog directly from the storage media	Use to recover expired save sets or storage volumes that are eligible for recycling. To add the volume to a different volume pool from the one to which it originally belonged, you can use the <b>-pool</b> option.
<b>-create_bootstrap</b>	Creates a new bootstrap for this ISM server	This command writes a new bootstrap for the ISM server.
<b>-pool</b> <i>pool</i>	Designates a volume pool to which to write recovered data or a new bootstrap	None.
<b>-find_bootstrap</b> <i>device</i>	Scans the media looking for the start of the ISM server bootstrap save set  After the media has been scanned, prints the save-set ID ( <i>ssid</i> ) and tape file location of the most recent bootstrap save set.	You need the bootstrap save set for disaster recovery. You use the bootstrap information to recover the ISM catalog directly from storage media with the <b>ism_catalog -recover</b> command. You then use Volume Inventory or the <b>ism_show -volumes</b> command to determine which volumes you want ON-Bar to restore.

Element	Purpose	Key Considerations
<b>-recover</b>	Recovers the ISM catalog from storage media when the catalog has been lost or damaged	This command overwrites the existing ISM catalog. Before you execute this command, you need the bootstrap save-set ID that you obtained from the most recent bootstrap printout or from the <b>ism_catalog -find_bootstrap</b> command.

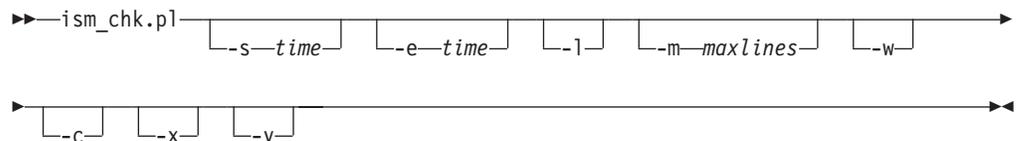
## ism\_chk.pl

The **ism\_chk.pl** command collects information about the current state of ISM, ON-Bar processes, and the database server from various log files and utility programs. The **ism\_chk.pl** report is useful when you are investigating backup or restore problems. For more information, see “Contents of the **ism\_chk.pl** Report” on page A-4.

Although the **ism\_chk.pl** command displays the report on the screen, you can redirect the report to a file. The **ism\_chk.pl** command is a **perl** program that runs on both UNIX and Windows.

To display the usage message, enter the following:

```
perl ism_chk.pl --
```



Element	Purpose	Key Considerations
<b>-s starttime</b>	Allows you to supply a date and time range for scanning the logs  Enter the date and time to begin scanning the logs.	If omitted, the default start date and time is "1980-01-01 00:00:00". Use double quotes only if you include the time in the range.
<b>-e endtime</b>	Allows you to supply a date and time range for scanning the logs  Enter the date and time to stop scanning the logs.	If omitted, the default end date and time is "2999-12-31 23:59:59". Use double quotes only if you include the time in the range.
<b>-l</b>	Prints separate reports for the database server, ON-Bar, and ISM logs.	If omitted, the database server message, ON-Bar activity log, and ISM message logs are combined into a single report, ordered by the time stamp.
<b>-m maxlines</b>	Specifies the maximum number of lines for the log report	Choose this feature when the logs are large or you need only certain parts of the report. The default is 999999 lines.

Element	Purpose	Key Considerations
-w	<p>Prints a report with a table of contents formatted in HTML for display with a web browser</p> <p>If you print the basic report with the <b>-w</b> option, the following table of contents is displayed with links to various sections of the report:</p> <ul style="list-style-type: none"> <li>• Environment variables</li> <li>• Log file list</li> <li>• Informix database server log</li> <li>• ON-Bar activity log</li> <li>• ON-Bar debug log</li> <li>• ISM daemon log</li> <li>• ISM message log</li> <li>• ISM savegrp log</li> <li>• ISM XBSA log</li> <li>• Combined logs</li> </ul>	<p>Set <b>on</b> to use HTML format. The default is HTML <b>off</b>.</p> <p>If you print the report with the <b>-w</b>, <b>-x</b>, and <b>-c</b> options, the following table of contents displays:</p> <ul style="list-style-type: none"> <li>• Environment variables</li> <li>• Log file list</li> <li>• Informix database server log</li> <li>• ON-Bar activity log</li> <li>• ON-Bar debug log</li> <li>• ISM daemon log</li> <li>• ISM message log</li> <li>• ISM savegrp log</li> <li>• ISM XBSA log</li> <li>• Combined logs</li> <li>• ISM save set report</li> <li>• Bootstrap verification report</li> <li>• <b>sysutils</b> generated bootstrap</li> <li>• <b>onstat</b> output</li> <li>• Network status report</li> <li>• ISM resource report</li> <li>• Directory of executables</li> </ul>
-c	Includes information on the ISM catalog, volume, and <b>ixbar</b> in the report	The default is off.
-x	Includes information on the network status and <b>onstat</b> output in the report	The default is off.
-v	Displays progress messages while the report is being constructed and sends the report to the screen	Set <b>on</b> to use verbose mode. The default is quiet mode that sends the report to the screen.

## Specifying the Start and End Times for the Log Report

If you select a narrow time interval for the **ism\_chk.pl** report, you can more easily find the information that you need in the various logs. For example, to produce a report on the logs for a time period from 8:00 A.M., June 1, 1999 to 9:00 P.M., June 2, 1999, specify:

```
ism_chk.pl -s "1999-06-01 08:00:00" -e "1999-06-02 21:00:00"
```

A shorthand way to specify the start and end times is:

```
ism_chk.pl -s "1999-06-01 08" -e "1999-06-02 21"
```

For example, to produce a report on the logs for all day June 3, 1999, specify:

```
ism_chk.pl -s 1999-06-03 -e 1999-06-04
```

## Contents of the **ism\_chk.pl** Report

Table A-1 describes the contents of each section of the **ism\_chk.pl** report. To specify the date and time range for the log information, use the **-s** and **-e** options.

Table A-1. Contents of the `ism_chk.pl` Report

Report Section	Description
Environment variables	Lists the important environment variables that affect <b>oninit</b> , ISM, and ON-Bar.
Log file list	Lists the full path names of the various logs that contain information about ISM and ON-Bar operations.
Database server log ON-Bar activity log ON-Bar debug log ISM daemon log ISM message log ISM savegrp log ISM XBSA log	Lists the text from these logs.
ISM save set report	Lists all the save sets currently in the ISM catalogs. Use the <b>-c</b> option to print this report.
Bootstrap verification report	Verifies that the dbspaces and logical logs that are in the ON-Bar bootstrap file are also in the ISM catalog.  Use the <b>-c</b> option to print this report.
<b>sysutils</b> generated bootstrap	Re-creates the ON-Bar bootstrap file that is generated from the ON-Bar catalogs.  Use the <b>-c</b> option to print this report.
<b>onstat -a</b> output	Displays the output of <b>onstat -a</b> that shows the state of the database server.  Use the <b>-x</b> option to print this report.  For more information, see the <b>onstat</b> section of the utilities chapter in the <i>IBM Informix Administrator's Guide</i> .
network status report	Displays the output of the <b>netstat</b> utility that reports on network load and resources.  Use the <b>-x</b> option to print this report.
ISM resource report	Lists the ISM resource file that contains definitions for storage devices and volumes, and the retention policies for stored objects.  Use the <b>-x</b> option to print this report.
directory of executables	Lists the contents of the Informix executables directory.  Use this output to verify the software version. Use the <b>-x</b> option to print this report.

## Sample `ism_chk.pl` Verbose Output

The following sample output is from the `ism_chk.pl` command with the **-v** verbose flag set. The **-m** option limits the report to the last 10 lines of the logs. The report is written to an ASCII file, **my\_ism\_report**.

```
$ perl ism_chk.pl -v -m 10 > my_ism_report
```

```
ism_chk: checking ISM/Onbar/Online logs
-s 1980-01-01 00:00:00
-e 2999-12-31 23:59:59
-m 10 lines will be displayed
-v report output selected
```

```
checking ISM resources...
checking ONCONFIG ONCONFIG.ol_mazama28...
checking Online log...
```

```

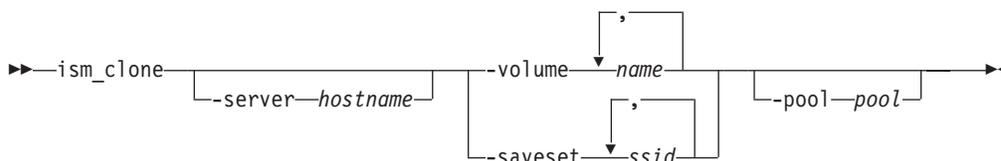
checking Bar Activity Log...
checking Bar Debug Log...
checking ISM daemon log...
checking Message log...
checking Savegrp log...
checking ISM catalog for ssid's...
checking Onbar catalog for ISM ssid's...
checking Onstat...
checking Network status...

ism_chk: all done now.

```

## ism\_clone

The **ism\_clone** command allows you to initiate a clone operation on a storage volume or specific save set from the command line.

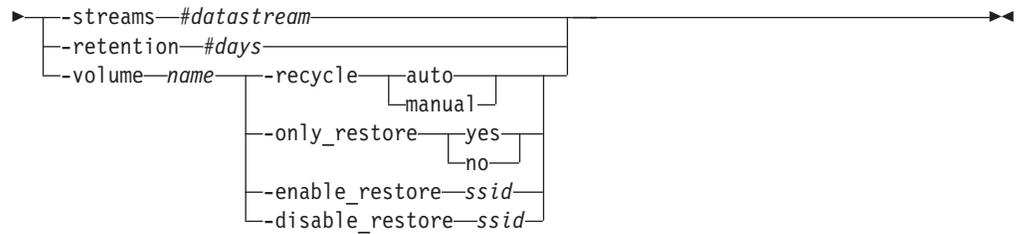


Element	Purpose	Key Considerations
<b>-server</b> <i>hostname</i>	Specifies the name of the computer on which the ISM server is running	If you omit this option, this command looks first for an ISM server on the local computer and then for the first ISM server to respond over the network.
<b>-volume</b> <i>name</i>	Clones one or more storage volumes	You need two storage devices to clone a volume, one for the source volume and one for the clone volume.
<b>-save set</b> <i>ssid</i>	Clones one or more storage-specific save sets	When you clone save sets, you need the save-set ID ( <i>ssid</i> ). To obtain a save-set ID, execute the <b>ism_show -volume name</b> command.
<b>-pool</b> <i>pool</i>	Designates a volume pool	Clone volumes must belong to a clone pool.

## ism\_config

The **ism\_config** command allows you to configure the ISM server properties, such as the number of active data streams and the retention period for the ISM server. You can also change storage-volume parameters such as overriding the retention period of the data on the volume, and enabling or disabling a save set for use in a restore operation.

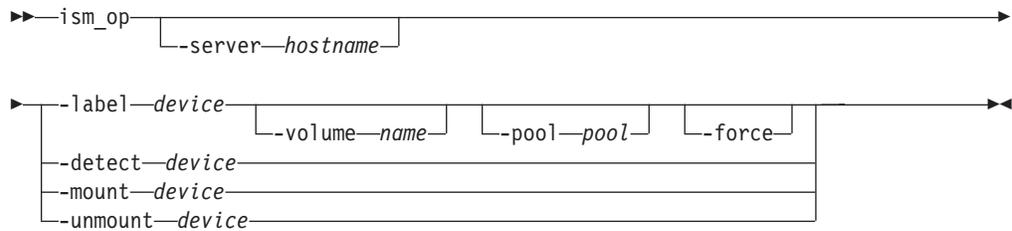




Element	Purpose	Key Considerations
<b>-server</b> <i>hostname</i>	Specifies the name of the computer on which the ISM server is running	If you omit this option, this command looks first for an ISM server on the local computer and then for the first ISM server to respond over the network.
<b>-streams</b> <i>#datastreams</i>	Changes the number of simultaneous data streams for this ISM server	You can configure up to four active data streams for your ISM server.
<b>-retention</b> <i>#days</i>	Changes the retention period for all data that this ISM server tracks	Resetting the retention period applies the new retention period to all the data that this ISM server tracks. Changing the retention period could make some data eligible for automatic recycling sooner or later than you expected.
<b>-volume</b> <i>name</i>	Changes the parameters for a storage volume or save set	The <b>-recycle</b> and <b>-backup</b> parameters are valid only for storage volumes.  The <b>-enable_restore</b> and <b>-disable_restore</b> parameters apply only to save sets and must be applied to save-set IDs.
<b>-recycle</b> <i>auto   manual</i>	Changes the recycle status for a storage volume	The <b>-recycle</b> parameter is valid only for storage volumes.  A volume with a recycle status of <i>auto</i> is eligible for automatic recycling.  A volume with a recycle status of <i>manual</i> is protected from automatic recycling.
<b>-only_restore</b> <i>yes   no</i>	Specify <i>yes</i> to change the mode of a volume to nonappendable. You can use this volume only for restores, not for backups.  Specify <i>no</i> to change the volume to appendable. You can use this volume for backups.	The <b>-only_restore</b> parameter is valid only for storage volumes. It applies to all save sets in the volume.  You can write save sets to an appendable volume but not to a nonappendable volume.
<b>-enable_restore</b> <i>ssid</i>	Enables the restore status for a save set	The <b>-enable_restore</b> parameter is valid only for save sets.  To obtain a save-set ID, run the <b>ism_show -volume name</b> command.
<b>-disable_restore</b> <i>ssid</i>	Disables the restore status for a save set	The <b>-disable_restore</b> parameter is valid only for save sets.  To obtain a save-set ID, run the <b>ism_show -volume name</b> command.

## ism\_op

The **ism\_op** command enables you to perform operations such as labeling, mounting, and unmounting storage volumes.



Element	Purpose	Key Considerations
<b>-server</b> <i>hostname</i>	Specifies the name of the computer on which the ISM server is running	If you omit this option, this command looks first for an ISM server on the local computer and then for the first ISM server to respond over the network.
<b>-label</b> <i>device</i>	Labels or relabels a storage volume	Storage media must be loaded in a storage device. When you relabel a volume, you can no longer recover the original data.
<b>-volume</b> <i>name</i>	Designates a volume name	When you relabel a volume within the same volume pool, ISM uses the same label and sequence number unless you designate a new volume name.
<b>-pool</b> <i>pool</i>	Designates the pool to which the storage volume should belong	When you relabel a volume, it still belongs to the same volume pool, unless you specify a different pool with the <b>-pool</b> option.
<b>-force</b>	Forces a relabel operation on a volume that has a recycle status of <i>manual</i> or contains save sets whose retention periods have not yet expired	Once a volume is relabeled, the original data can no longer be recovered.
<b>-detect</b> <i>device</i>	Displays the volume name and pool name for a volume that is loaded in a storage device	The volume cannot be mounted on the storage device.
<b>-mount</b> <i>device</i>	Mounts a storage volume on the specified storage device	Storage media must be labeled.
<b>-unmount</b> <i>device</i>	Unmounts a storage volume from the specified storage device	None.

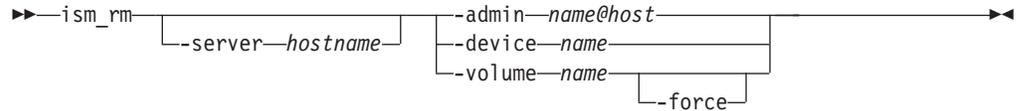
**Note:** The **-volume** and the **-pool** options are required when specifying a device that is being used for the first time.

For example:

```
ism_op -label /ismtape -volume testing1 -pool default
```

## ism\_rm

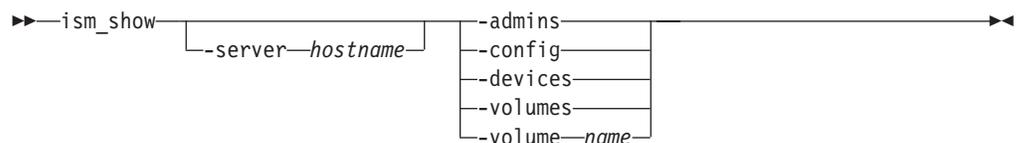
The **ism\_rm** command enables you to remove an administrative user or storage device from the ISM server. You can also remove a storage volume from the ISM catalog.



Element	Purpose	Key Considerations
<b>-server</b> <i>hostname</i>	Specifies the name of the computer on which the ISM server is running	If you omit this option, this command looks first for an ISM server on the local computer and then for the first ISM server to respond over the network.
<b>-admin</b> <i>name@host</i>	Removes an administrative user from the ISM server	If you remove yourself as an administrative user, you can no longer administer this ISM server.
<b>-device</b> <i>name</i>	Removes a storage device from the ISM server	You cannot remove a storage device that is currently in use.
<b>-volume</b> <i>name</i>	Removes a storage volume from the ISM catalog	ISM no longer tracks the data on this storage volume. You can still recover data on the volume with the <b>ism_catalog -recreate_from</b> command.
<b>-force</b>	Forces a storage volume to be removed from the ISM catalog that is marked Manual recycle or a volume that contains save sets whose retention periods have not yet expired	ISM no longer tracks the data on this storage volume.

## ism\_show

The **ism\_show** command enables you to view information about the ISM administrators, media volumes, and storage devices.

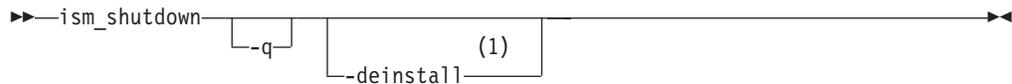


Element	Purpose	Key Considerations
<b>-server</b> <i>hostname</i>	Specifies the name of the computer on which the ISM server is running	If you omit this option, this command looks first for an ISM server on the local computer and then for the first ISM server to respond over the network.
<b>-admins</b>	Shows all administrators for this ISM server	None.
<b>-config</b>	Shows all server parameters for this ISM server	None.
<b>-devices</b>	Displays all storage devices that this ISM server recognizes and the volumes that are currently mounted on the devices	None.

Element	Purpose	Key Considerations
<b>-volumes</b>	Displays the name of each volume in the ISM catalog, the volume pool to which each volume belongs, whether the volume can be used only in restore operations, the number of bytes written to each volume, the percent of space used (or the word full to indicate that the volume is filled to capacity), and the volume expiration date	<p>Volume recycling status is reported in the first column of the report:</p> <ul style="list-style-type: none"> <li>• E indicates that the volume is eligible for recycling.</li> <li>• M indicates that a volume has a Manual recycle status.</li> <li>• X indicates that a volume is eligible for recycling and has a Manual recycle status.</li> </ul> <p>If a volume cannot be used in a backup operation, an <b>-R</b> flag appears in the fourth column of the display.</p>
<b>-volume <i>name</i></b>	Displays the save-set IDs for complete save sets, the save-set name, whether a save set has been marked suspect, the total bytes in the save set, and the save-set creation date for all save sets on a volume	If a save set has been marked suspect, an <b>-S</b> flag appears in the third column of the display.

## ism\_shutdown

The **ism\_shutdown** command shuts down an ISM server.



### Notes:

- 1 Windows Only

Element	Purpose	Key Considerations
<b>-q</b>	Quietly shuts down the ISM server without asking for confirmation	In the absence of the <b>-q</b> option, <b>ism_shutdown</b> prompts for confirmation before it shuts down the ISM server.
<b>-deinstall</b>	Removes Windows services also	

## Usage

You can run this command only from the computer on which the ISM server is running.

### UNIX Only

On UNIX, you must log in as user **root** to use this command. Include this command in the UNIX shut-down script to exit the ISM server automatically whenever the operating system shuts down.

\_\_\_\_\_

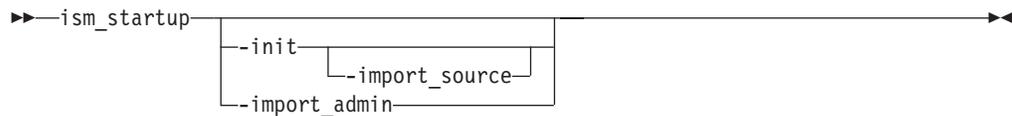
**Windows Only**

On Windows, the Service Control Manager automatically starts the ISM server when the computer reboots and stops it when the computer shuts down. You must be the **Administrator** to run this command.

**End of Windows Only**

## ism\_startup

The **ism\_startup** command starts an ISM server.



Element	Purpose	Key Considerations
-init	Initializes the ISM server	Use this option only once after installation. If you use this option thereafter, it produces a harmless error message and takes no other action. The <b>-init</b> option resets the retention period of the save sets on the volume and other values.

## Usage

You can run this command only from the computer on which the ISM server is installed.

**UNIX Only**

On UNIX, you must log in as user **root** to use this command. Include this command in one of the UNIX startup scripts to start the ISM server automatically whenever the operating system is rebooted.

**End of UNIX Only**

**Windows Only**

On Windows, the Service Control Manager automatically starts the ISM server when the computer reboots and stops it when the computer shuts down. You must be the administrator to run this command.

**End of Windows Only**

## ism\_watch

The **ism\_watch** command brings up a terminal-based screen utility for monitoring the activity of the ISM server.



Element	Purpose	Key Considerations
<code>-p polltime</code>	Specifies the interval in seconds between updates of displayed activities that the ISM server performs	None.
<code>-s hostname</code>	Specifies the name of the computer on which the ISM server is running	If you omit this option, this command looks first for an ISM server on the local computer and then for the first ISM server to respond over the network.

Figure A-1 illustrates a typical screen that the **ism\_watch** command displays.

```
Server: dbservername.pdx.informix.com
Version: IBM Informix Storage Manager 2.2 09/16 Network Edition/1

Saves: 0 session(s) Recovers: 0 session(s)
Device      type      volume
/dev/dsk1   file     Pebblebeach.ISMData.0003 mounted file disk Pebblebe
/dev/rmt/0mbn 8mm      Pebblebeach.ISMData.0003 mounted 8mm tape Default.002

Sessions:

Messages:
Mon 18:04:56 /dev/dsk1 label without mount operation in progress
Mon 18:04:58 /dev/dsk1 labeled file disk Pebblebeach.ISMData.0003
Mon 18:05:03 /dev/dsk1 mount operation in progress
Mon 18:05:04 /dev/dsk1 mounted file disk Pebblebeach.ISMData.0003
Mon 18:05:18 /dev/rmt/0mbn mount operation in progress
Mon 18:06:00 /dev/rmt/0mbn mounted 8mm tape Default.002
Pending:
```

Figure A-1. Monitoring the ISM Server

## NSR Commands

For information on using **nsr** commands with ISM, see your NetWorker documentation.

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## Appendix B. Accessibility

IBM strives to provide products with usable access for everyone, regardless of age or ability.

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### Accessibility features for IBM Informix Dynamic Server

Accessibility features help a user who has a physical disability, such as restricted mobility or limited vision, to use information technology products successfully.

#### Accessibility Features

The following list includes the major accessibility features in IBM Informix Dynamic Server. These features support:

- Keyboard-only operation.
- Interfaces that are commonly used by screen readers.
- The attachment of alternative input and output devices.

**Tip:** The IBM Informix Dynamic Server Information Center and its related publications are accessibility-enabled for the IBM Home Page Reader. You can operate all features using the keyboard instead of the mouse.

#### Keyboard Navigation

This product uses standard Microsoft® Windows navigation keys.

#### Related Accessibility Information

IBM is committed to making our documentation accessible to persons with disabilities. Our publications are available in HTML format so that they can be accessed with assistive technology such as screen reader software. The syntax diagrams in our publications are available in dotted decimal format. For more information about the dotted decimal format, go to “Dotted Decimal Syntax Diagrams.”

You can view the publications for IBM Informix Dynamic Server in Adobe Portable Document Format (PDF) using the Adobe Acrobat Reader.

#### IBM and Accessibility

See the *IBM Accessibility Center* at <http://www.ibm.com/able> for more information about the commitment that IBM has to accessibility.

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### Dotted Decimal Syntax Diagrams

The syntax diagrams in our publications are available in dotted decimal format, which is an accessible format that is available only if you are using a screen reader.

In dotted decimal format, each syntax element is written on a separate line. If two or more syntax elements are always present together (or always absent together), the elements can appear on the same line, because they can be considered as a single compound syntax element.

Each line starts with a dotted decimal number; for example, 3 or 3.1 or 3.1.1. To hear these numbers correctly, make sure that your screen reader is set to read punctuation. All syntax elements that have the same dotted decimal number (for example, all syntax elements that have the number 3.1) are mutually exclusive alternatives. If you hear the lines 3.1 USERID and 3.1 SYSTEMID, your syntax can include either USERID or SYSTEMID, but not both.

The dotted decimal numbering level denotes the level of nesting. For example, if a syntax element with dotted decimal number 3 is followed by a series of syntax elements with dotted decimal number 3.1, all the syntax elements numbered 3.1 are subordinate to the syntax element numbered 3.

Certain words and symbols are used next to the dotted decimal numbers to add information about the syntax elements. Occasionally, these words and symbols might occur at the beginning of the element itself. For ease of identification, if the word or symbol is a part of the syntax element, the word or symbol is preceded by the backslash (\) character. The \* symbol can be used next to a dotted decimal number to indicate that the syntax element repeats. For example, syntax element \*FILE with dotted decimal number 3 is read as 3 \\* FILE. Format 3\* FILE indicates that syntax element FILE repeats. Format 3\* \\* FILE indicates that syntax element \* FILE repeats.

Characters such as commas, which are used to separate a string of syntax elements, are shown in the syntax just before the items they separate. These characters can appear on the same line as each item, or on a separate line with the same dotted decimal number as the relevant items. The line can also show another symbol that provides information about the syntax elements. For example, the lines 5.1\*, 5.1 LASTRUN, and 5.1 DELETE mean that if you use more than one of the LASTRUN and DELETE syntax elements, the elements must be separated by a comma. If no separator is given, assume that you use a blank to separate each syntax element.

If a syntax element is preceded by the % symbol, this identifies a reference that is defined elsewhere. The string following the % symbol is the name of a syntax fragment rather than a literal. For example, the line 2.1 %OP1 means that you should refer to a separate syntax fragment OP1.

The following words and symbols are used next to the dotted decimal numbers:

- ? Specifies an optional syntax element. A dotted decimal number followed by the ? symbol indicates that all the syntax elements with a corresponding dotted decimal number, and any subordinate syntax elements, are optional. If there is only one syntax element with a dotted decimal number, the ? symbol is displayed on the same line as the syntax element (for example, 5? NOTIFY). If there is more than one syntax element with a dotted decimal number, the ? symbol is displayed on a line by itself, followed by the syntax elements that are optional. For example, if you hear the lines 5 ?, 5 NOTIFY, and 5 UPDATE, you know that syntax elements NOTIFY and UPDATE are optional; that is, you can choose one or none of them. The ? symbol is equivalent to a bypass line in a railroad diagram.
- ! Specifies a default syntax element. A dotted decimal number followed by the ! symbol and a syntax element indicates that the syntax element is the default option for all syntax elements that share the same dotted decimal number. Only one of the syntax elements that share the same dotted decimal number can specify a ! symbol. For example, if you hear the lines

2? FILE, 2.1! (KEEP), and 2.1 (DELETE), you know that (KEEP) is the default option for the FILE keyword. In this example, if you include the FILE keyword but do not specify an option, default option KEEP is applied. A default option also applies to the next higher dotted decimal number. In this example, if the FILE keyword is omitted, default FILE(KEEP) is used. However, if you hear the lines 2? FILE, 2.1, 2.1.1! (KEEP), and 2.1.1 (DELETE), the default option KEEP only applies to the next higher dotted decimal number, 2.1 (which does not have an associated keyword), and does not apply to 2? FILE. Nothing is used if the keyword FILE is omitted.

- \* Specifies a syntax element that can be repeated zero or more times. A dotted decimal number followed by the \* symbol indicates that this syntax element can be used zero or more times; that is, it is optional and can be repeated. For example, if you hear the line 5.1\* data-area, you know that you can include more than one data area or you can include none. If you hear the lines 3\*, 3 HOST, and 3 STATE, you know that you can include HOST, STATE, both together, or nothing.

**Notes:**

1. If a dotted decimal number has an asterisk (\*) next to it and there is only one item with that dotted decimal number, you can repeat that same item more than once.
2. If a dotted decimal number has an asterisk next to it and several items have that dotted decimal number, you can use more than one item from the list, but you cannot use the items more than once each. In the previous example, you could write HOST STATE, but you could not write HOST HOST.
3. The \* symbol is equivalent to a loop-back line in a railroad syntax diagram.

- + Specifies a syntax element that must be included one or more times. A dotted decimal number followed by the + symbol indicates that this syntax element must be included one or more times. For example, if you hear the line 6.1+ data-area, you must include at least one data area. If you hear the lines 2+, 2 HOST, and 2 STATE, you know that you must include HOST, STATE, or both. As for the \* symbol, you can only repeat a particular item if it is the only item with that dotted decimal number. The + symbol, like the \* symbol, is equivalent to a loop-back line in a railroad syntax diagram.



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Printed in USA

G229-6388-02

