Pervasive PSQL v11

Advanced Operations Guide

Procedures and References for Advanced Users

Pervasive Software Inc.
12365 Riata Trace Parkway
Building B
Austin, TX 78727 USA

Telephone: 512 231 6000 or 800 287 4383
Fax: 512 231 6010
Email: database@pervasive.com
Web: http://www.pervasivedb.com

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Contents

Figures

Tables

About This Manual

This manual describes advanced procedures and provides technical information of use to the advanced user.

Some of the information in this manual may not apply to you. For example, the chapter on Gateway engine configuration does not apply to Server engines. Such information is clearly marked throughout the manual.

Pervasive Software would appreciate your comments and suggestions about this manual. As a user of our documentation, you are in a unique position to provide ideas that can have a direct impact on future releases of this and other manuals. If you have comments or suggestions for the product documentation, post your request at the Community Forum on the Pervasive Software Web site.

Who Should Read This Manual

This manual is provided for advanced users. Advanced users are considered to have a strong understanding of the underlying operating systems on which you run your Pervasive PSQL-based applications. Advanced users should be comfortable configuring their operating system, and in many cases, must have administrative permissions to configure the database engine. Advanced users may include the following:

- network administrators of networks where one or more Pervasive PSQL-based applications are installed
- value-added resellers of Pervasive PSQL-based applications
- developers of Pervasive PSQL-based applications

Manual Organization

The following list briefly describes each chapter in the manual:

- Chapter 1—Pervasive PSQL Databases

  This chapter explains conceptual information about databases, how to create a database, and how to set properties on one.

- Chapter 2—Concepts of Database Maintenance

  This chapter provides a brief introduction to the basic concepts and procedures involved with the job of maintaining a database.

- Chapter 3—Understanding the Pervasive Component Architecture

  This chapter explains in some detail the major components that make up Pervasive PSQL and some of their unique features.

- Chapter 4—Configuration Reference

  This chapter explains how to use access the configuration properties and provides detailed information about all of the available configuration options for engines and clients.

- Chapter 5—Performance

  This chapter explains how to increase database performance through a variety of means such as tuning and the use of Xtreme I/O driver.

- Chapter 6—Setting Up Referential Integrity

  This chapter explains how to setup referential integrity rules to enforce the internal consistency of related data.

- Chapter 7—Pervasive PSQL Security

  This chapter explains Btrieve security and SQL security.

- Chapter 8—Logging, Backup, and Restore

  This chapter describes how to develop a regular backup procedure to ensure your data is protected, and how to restore from backup if necessary.

- Chapter 9—High Availability Support

  This chapter describes how Pervasive PSQL supports failover clustering.

- Chapter 10—Workgroup Engine in Depth

  This chapter provides technical details and advanced procedures regarding the Workgroup engine.

- Chapter 11—Monitoring Database Resources

  This chapter explains how to use the graphical utility named Monitor to view users connected to a database, file usage information, and resource usage information.

- Chapter 12—Testing Btrieve Operations

  This chapter explains how to use the Function Executor utility to perform individual operations for the transactional interface.

- Chapter 13—Manipulating Btrieve Data Files with Maintenance

  This chapter explains how to use the Maintenance utility.

- Chapter 14—Converting Data Files

  This chapter explains how to use the Rebuild utility.

- Appendix A—Description Files

  This appendix covers how to use description files to archive information about Btrieve data files you have created.

This manual also includes an index.

Conventions

Unless otherwise noted, command syntax, code, and examples use the following conventions:

CASE	Commands and reserved words typically appear in uppercase letters. Unless the manual states otherwise, you can enter these items using uppercase, lowercase, or both. For example, you can type `MYPROG`, `myprog`, or `MYprog`.
Bold	Words appearing in bold include the following: menu names, dialog box names, commands, options, buttons, statements, and so forth.
`Monospaced font`	Monospaced font is reserved for words you enter, such as command syntax.
[ ]	Square brackets enclose optional information, as in [*log_name*]. If information is not enclosed in square brackets, it is required.
|	A vertical bar indicates a choice of information to enter, as in [*file name* | @*file name*].
< >	Angle brackets enclose multiple choices for a required item, as in `/D=<5|6|7>`.
variable	Words appearing in italics are variables that you must replace with appropriate values, as in *file name*.
...	An ellipsis following information indicates you can repeat the information more than one time, as in [*parameter...*].
::=	The symbol ::= means one item is defined in terms of another. For example, a::=b means the item *a* is defined in terms of *b*.

chapter 1

Pervasive PSQL Databases

An Exploration of Object Names, Named Databases, and DSNs

This chapter is divided into the following sections:

Pervasive PSQL Database Concepts

- Named Database
- Metadata
- Identifiers and Object Names
- The Default Database and the Current Database
- File Structure
- Access Methods
- Client/Server Communications
- Database Code Page
- ODBC DSN Creation Options
- Using the idshosts File

Named Database

A named database (also referred to as a DBname) is a database that has a logical name that allows users to identify it without knowing its actual location. Pervasive PSQL requires that all databases be named. When you name a database, you associate that name with a particular dictionary directory path and one or more data file paths.

A named database is connected to through various access methods. For ODBC access, for example, you must set up a Data Source Name (DSN) to refer to the named database. Multiple DSNs may point to the same named database. See ODBC Database Access in *SQL Engine Reference*. For other access methods, application developers can connect to a named database using the API for that access method. Refer to the developer reference guides in the Pervasive PSQL documentation.

Note To work with named databases, you must log into the computer where the database engine is located, using an operating system user name that has administrator-level privileges or is a member of the Pervasive_Admin security group.

The easiest way to create a named database is by using Pervasive PSQL Control Center. See To create a new database in *Pervasive PSQL User's Guide*. Application developers can also create a named database through different access methods APIs. For example, see

CREATE DATABASE for SQL, PvCreateDatabase() for DTI, and Data Access Application Blocks for ADO.NET.

Metadata

The relational interface supports two versions of metadata, referred to as version 1 (V1) and version 2 (V2). V2 metadata allows for identifier names up to 128 bytes long for many identifiers, permissions on views and stored procedures, and data dictionary files (DDFs) specific for V2 metadata.

See Versions of Metadata in *SQL Engine Reference*.

Identifiers and Object Names

An *identifier* is the name of a database or of a column, table, procedure, or other named object within the database. Identifiers are designated as either regular or delimited.

Regular Identifiers

A *regular identifier* is an identifier that is not surrounded by double quotes. Regular identifier must begin with a letter, either upper or lower case. The remainder of the identifier can consist of any combination of upper or lower case letters, digits, and valid characters.

You cannot use a reserved word as a regular identifier.

Regular identifiers are case-insensitive.

Delimited Identifiers

A *delimited identifier* is an identifier surrounded by double quotes. Delimited identifier can consist of any string of valid characters enclosed in double quotes.

While it is not recommended, reserved words can be used as delimited identifiers. For example, INSERT is not permitted as a regular identifier, but "INSERT" is permitted as a delimited identifier. If an identifier is also a keyword, it must be delimited by double quotes. (For example, SELECT “password” FROM my_pword_tbl. “Password” is a keyword in the SET PASSWORD statement so it must be delimited.)

Identifier Restrictions

In addition to the general restrictions listed above, the following table lists restrictions specific to each type of identifier.

Table 1 Identifier Restrictions by Identifier Type

Identifier	Length Limit (bytes)		Invalid Characters[1]	Notes
	V1[2]	V2[3]		
Column	20	128	\ / : * ? " < > |	Must begin with a letter Cannot be null
Database	20	20	` ~ ! @ # $ % ^ & * ( ) _ - + = }] { [| \ : ; " < , ' > . ? /	Must begin with a letter
Function (user-defined)	30	128	For regular identifiers: ` ~ ! @ # $ % ^ & * ( ) - + = }] { [| \ : ; " < , ' > . ? /	Valid characters are letters, digits, and the underscore (“_”) Must begin with a letter
			For delimited identifiers: none	Name must be enclosed in double quotes
Group	30	128	\ / : * ? " < > | (and space character)	Cannot be MASTER
Index	20	128	\ / : * ? " < > | (and space character)	Cannot start with UK_ if you create the index with Pervasive PSQL Control Center (PCC) If you create an index outside of PCC that starts with UK_, you cannot edit the index with PCC
Key (foreign or primary)	20	128	\ / : * ? " < > | (and space character)	Must begin with a letter A foreign key and an index cannot be named the same within the same table
Password	8	128	; ? “ '	Cannot start with a blank (space character) Cannot be null Any displayable character is permissible except for those listed in the “Invalid Characters” column

Table 1 Identifier Restrictions by Identifier Type continued

Identifier	Length Limit (bytes)		Invalid Characters[1]	Notes
	V1[2]	V2[3]		
Procedure (stored)	30	128	For regular identifiers: ` ~ ! @ # $ % ^ & * ( ) - + = }] { [| \ : ; " < , ' > . ? /	Valid characters are letters, digits, and the underscore (“_”) Must begin with a letter
			For delimited identifiers: none	Name must be enclosed in double quotes
Table	20	128	\ / : * ? " < > | (and space character) # ##[4]	Invalid characters apply to both regular and delimited identifiers
Trigger	30	128	For regular identifiers: ` ~ ! @ # $ % ^ & * ( ) - + = }] { [| \ : ; " < , ' > . ? /	Valid characters are letters, digits, and the underscore (“_”) Must begin with a letter
			For delimited identifiers: none	Name must be enclosed in double quotes
User	30	128	\ / : * ? " < > | (and space character)	Cannot be MASTER or PUBLIC
View	20	128	For regular identifiers: ` ~ ! @ # $ % ^ & * ( ) - + = }] { [| \ : ; " < , ' > . ? /	Valid characters are letters, digits, and the underscore (“_”). Must begin with a letter
			For delimited identifiers: none	Name must be enclosed in double quotes.

[1]Unless otherwise noted, invalid characters apply both to regular and to delimited identifiers.

[2]Applies to version 1 (V1) metadata. See Versions of Metadata in *SQL Engine Reference*.

[3]Applies to version 2 (V2) metadata. See Versions of Metadata in *SQL Engine Reference*.

[4]The names of temporary tables begin with # or ##. Therefore, # and ## are invalid characters with which to begin the name of permanent tables. See CREATE (temporary) TABLE in *SQL Engine Reference*.

Unique Scope

Identifiers generally must be unique within a certain *scope*. That is, instances of the same type of object using the same name cannot be used within the same arena. Table 2 shows the arena, or the *scope*, within which a given object name must be unique.

Table 2 Unique Scope for Common Identifiers

A name for this type of object...	... must be unique within this scope:			
	Database	**Table**	**Stored Procedure**	**Other**
Database				All databases hosted by a given database engine
Table	✓			
Trigger, stored procedure, user-defined functions	✓			
User or group	✓			
View	✓			
Constraint	✓			
Column		✓		
Index		✓		Cannot have the same name as a foreign key
Key (foreign)		✓		Cannot have the same name as an index
Cursor			✓	

The Default Database and the Current Database

To support existing applications that do not specify a database name when creating or opening Btrieve files, Pervasive PSQL maintains the concept of a default database for each transactional database engine. The *default database* is a pre-defined database named “DefaultDB.” To make use of the new security models without having to modify your application code, you can associate your Btrieve data directories with the default database, then set up users and privileges in the default database to control access to the data files in those directories.

The database engine also understands the concept of the *current database* for each client connection. If no database name is specified in a Btrieve Login (78), Create (14), or Open (0) operation, the transactional engine assumes the operation is associated with the current database. For each client, the current database is the database to which the most recent Login (78) operation occurred (explicit login). If the client computer has requested no explicit login operations, the current database is the database to which the most recent Create (14) or Open (0) operation occurred (implicit login). If no explicit or implicit logins have occurred, then the current database is the default database, described in the preceding paragraph. Note that the current database may change at any time when the given client performs an implicit or explicit login, or closes the last file handle, making "DefaultDB" the current database. The current database for each client is independent of other clients' activities.

The simplest way to configure the new security model for existing applications is to associate all Btrieve data directories with the default database, and set up rights for the group PUBLIC within this database. The group PUBLIC is automatically created along with the Master user when you enable security for a database. See Transactional Interface Security Quick Start.

File Structure

All Pervasive PSQL databases use a common data format. This commonality allows different access methods, such as transactional and relational, to access the same data. The database management system through which all access methods operate is called the MicroKernel Database Engine (MKDE).

Each Pervasive PSQL database table is a separate file with a default file extension of MKD. Developers, however, can specify any file name extension desired. A MicroKernel file may contain both data and indexes, and is organized into various types of pages. A MicroKernel file contains data in the common data format.

Each Pervasive PSQL database also contains a set of data dictionary files, with a file extension of DDF. The DDF files contain the schema of the database. The DDFs for V1 metadata and V2 metadata use different file names. See System Tables in *SQL Engine Reference*.

(The MKDE is completely unconcerned with the schema of the data apart from the key fields. However, the provision for referential integrity or access via SQL requires knowledge of the schema.)

The names and locations of Pervasive PSQL databases are contained in a binary file named dbnames.cfg. For default locations of Pervasive PSQL files, see Where are the Pervasive PSQL files installed? in *Getting Started With Pervasive PSQL*.

All of the files associated with a Pervasive PSQL database can be viewed from the operating system. Table 3 summarizes the associated files.

Table 3 Files Associated With a Pervasive PSQL Database

Type	Description
Database Names Configuration	The dbnames.cfg file. A binary file that contains the names and locations of the Pervasive PSQL databases.
Data (common data format)	Files named, by default, *tablename*.MKD for relational databases. Each database table has a corresponding MicroKernel file. For transactional data files, the name of each file is specified by the application.
Data Dictionary	Files with an extension of DDF. See System Tables in *SQL Engine Reference*.

File Size

The size limit depends on the file version, the page size, and the number of records per page, as the following tables summarize.

File Versions 9.5 or Newer

The maximum size of a data file is 256 GB. You must use a file format of 9.5 or newer to have a single file size larger than 128 GB.

Note that the following table assumes no record compression on the file. If you use record compression, take into account that additional records are stored per page. See Choosing a Page Size and Estimating File Size, both in *Pervasive PSQL Programmer's Guide*.

Table 4 Comparisons of File Size and Page Sizes for File Versions 9.5 or Newer

Records per Page	Maximum Pages (in millions)	File Size (GB) for Various Page Sizes (bytes)				
		1,024	2,048	4,096	8,192	16,384
1 - 15	256	256 GB	256 GB	256 GB	256 GB	256 GB
16 - 31	128	128 GB	256 GB	256 GB	256 GB	256 GB

Table 4 Comparisons of File Size and Page Sizes for File Versions 9.5 or Newer continued

Records per Page	Maximum Pages (in millions)	File Size (GB) for Various Page Sizes (bytes)				
		1,024	2,048	4,096	8,192	16,384
32 - 63	64	64 GB	128 GB	256 GB	256 GB	256 GB
64 - 127	32	32 GB	64 GB	128 GB	256 GB	256 GB
128 - 255	16	16 GB	32 GB	64 GB	128 GB	256 GB
256 - 511	8	n/a[1]	16 GB	32 GB	64 GB	128 GB
512 - 1023	4	n/a[1]	n/a[1]	16 GB	32 GB	64 GB
1024 - 2047	2	n/a[1]	n/a[1]	n/a[1]	16 GB	32 GB
2048 - 4095	1	n/a[1]	n/a[1]	n/a[1]	n/a[1]	16 GB
[1]"n/a" stands for "not applicable"						

File Versions 9.0 or Older

The maximum size of a data file is 128 GB. You must use a file format of 9.0 or newer to have a single file size larger than 64 GB.

Note that the following table assumes no record compression on the file. If you use record compression, take into account that additional records are stored per page. See Choosing a Page Size and Estimating File Size, both in *Pervasive PSQL Programmer's Guide*.

Table 5 Comparisons of File Size and Page Sizes for File Versions 9.0 or Older

File Version	Records per Page	Maximum Pages (in millions)	File Size (GB) for Various Page Sizes (bytes)								
			512	1024	1536	2048	2560	3072	3584	4096	8192
9.0	1 - 15	256	128	128	128	128	128	128	128	128	128
9.0	16 - 31	128	64	128	128	128	128	128	128	128	128
9.0	32 - 63	64	32	64	96	128	128	128	128	128	128
9.0	64 - 127	32	16	32	48	64	80	96	112	128	128
9.0	128 - 255	16	n/a[1]	16	24	32	40	48	56	64	128
8	any	16	8	16	24	32	40	48	56	64	n/a[1]

Table 5 Comparisons of File Size and Page Sizes for File Versions 9.0 or Older continued

File Version	Records per Page	Maximum Pages (in millions)	File Size (GB) for Various Page Sizes (bytes)								
			512	1024	1536	2048	2560	3072	3584	4096	8192
7	any	16	8	16	24	32	40	48	56	64	n/a[1]
6	any	16	4	4	4	4	4	4	4	4	n/a[1]
5	any	16	4	4	4	4	4	4	4	4	n/a[1]

[1]"n/a" stands for "not applicable"

File Segmentation

By default, a data file is automatically broken into 2 GB operating system file segments as its size passes that boundary. The configuration property, "Limit Segment Size to 2 GB," allows you to specify whether you want files divided into 2 GB segments or unified in a single, non-segmented file. The advantage of using a larger non-segmented file is more efficient disk I/O. Therefore, you can expect increased performance.

The configuration option is part of the Performance Tuning properties for a database engine. See To access configuration settings in PCC for an engine, andLimit Segment Size to 2 GB.

The property is set to "on" by default, causing files to segment at 2 GB boundaries as with previous releases. If you set the property to "off," files can increase past the 2 GB boundary. See also Automatic Upgrade of File Version for additional information relating to the configuration property.

Any non-segmented files are subject to the limit on file size specified by your operating system. For example, creating a large file on a FAT32 file system with Limit Segment Size to 2 GB turned "off" creates multiple 4 GB file extensions. If a previously created file is already segmented, that segmentation remains on the file.

Automatic Upgrade of File Version

If the configuration property "Create File Version" is set to 9.0 or higher, version 8.x files are automatically converted to version 9.0

files when they reach the file limits for version 8.x, which is 64 GB. The following table summarizes this behavior.

Configuration Property Setting for "Create File Version"	Configuration Property Setting for "Limit Segment Size to 2 GB"	File Size At Which Automatic Upgrade of File Version Occurs
9 (default)	Yes (default; option check marked)	64 GB (the maximum size of a version 8.x file)
9 (default)	No (option not check marked)	2 GB (size at which a version 8.x file segments)

For example, a version 8.x file that is 5 GB in size has already passed the 2 GB segmentation boundary. Because the file is already segmented, the segmentation remains on the file. Such a file would continue to segment and grow in size until it reaches 64 GB, at which size the automatic upgrade would occur. This is true whether the configuration property is set to "yes" or "no" because the file is already segmented. As the file grows beyond 64 GB, it will continue to segment until it reaches the maximum size allowed for a version 9.0 file, 128 GB.

A version 8.x file that is 1.5 GB in size would continue to grow until it reaches 2 GB in size. At that point, the automatic upgrade occurs if the configuration property is set to "no." The file can continue to grow as a non-segmented file up to the size limit for version 9.0 files, 128 GB. If the configuration setting is set to "yes," the 2 GB file would continue to segment and grow until it reaches 64 GB in size. At that size, the maximum for a version 8.x file, the automatic upgrade to version 9.0 occurs. As the file grows beyond 64 GB, it will continue to segment until it reaches the maximum size allowed for a version 9.0 file, 128 GB.

The "Create File Version" option is part of the Compatibility properties for a database engine. See To access configuration settings in PCC for an engine.

Note Automatic upgrade of file version works only for an 8.x file format to a 9.0 file format. The automatic upgrade does not work for any other combination of file versions. For example, the upgrade *does not occur* for an 8.x file format to a 9.5 file format, or for a 7.x file format to a 9.0 file format.

Access Methods

The two primary methods in which data is accessed from Pervasive PSQL databases are transactional and relational.

With transactional, an application program navigates up and down along either physical or logical pathways through data records. Using a transactional API, an application program provides direct control and allows a developer to optimize data access based on knowledge of the underlying structure of the data. Btrieve is an example of a transactional database engine.

Relational is an access method in which data is represented as collections of tables, rows, and columns. The relational model insulates the developer from the underlying data structure and presents the data in a simple table format. ODBC is an example of a relational access method.

A single application program may include both types of access. For example, an application may use transactional access for adding and changing data, and relational access for querying the data and report writing.

You need to know the access method(s) used by the application programs that rely on your installation of Pervasive PSQL. The access methods may have different configurations. You may need to customize the configuration to optimize a particular access method.

Also, troubleshooting is easier when you are aware of the access method(s) used by a given application program. For example, if an application program uses relational access through ODBC, you may need to troubleshoot a problem at the ODBC level rather than at the database management system.

See Configuration Reference for the tasks and references pertaining to customizing configurations.

Client/Server Communications

The MKDE supports two types of processing modes, local and client/server. An application accessing the database in local mode accesses a local copy of the MKDE. The local MKDE calls upon the operating system of the workstation which performs the I/O on a local or networked hard disk.

Client/server mode uses a server MKDE executing on a shared file server. When an application program accesses the database engine in client/server mode, the requester connects to the remote MKDE. This requester passes transactional-level requests and data records between the application program and the server MKDE using the network protocol supported by the operating system. File I/O functions are completely handled by the server MKDE in client/server mode and the workstation has no operating system handles allocated to shared data files. Database manipulation is performed by the server-based MKDE on behalf of each workstation.

Note that the processing mode is determined by the configuration of the workstation and not the application program itself. This means that an application is capable of accessing both local and client/server database engines. The application program does not have to be recompiled to switch the application to client/server mode from local mode.

Both Workgroup and Server engine can operate in either mode. When an application on the same computer as the database engine accesses the engine, it is operating in local mode. When an application on a different machine access the engine, it is operating in client/server mode.

The client/server configurations may be customized for the Workgroup and Server versions of Pervasive PSQL. Configuration settings exists in the Pervasive PSQL Control Center (PCC) to facilitate the configuration of client/server configurations as well as stand-alone configurations.

See Configuration Reference for the tasks and references pertaining to configuring the client/server communications and database engine.

Database Code Page

Encoding is a standard for representing character sets. Character data must be put in a standard format, that is, encoded, so that a computer can process it digitally. An encoding must be established between the Pervasive PSQL database engine (server) and a Pervasive PSQL client application. A compatible encoding allows the server and client to interpret data correctly.

The encoding support is divided into database code page and client encoding. The two types of encoding are separate but interrelated. For ease of discussion, database code page and client encoding are discussed together. See Configuring Network Communications for Clients in *Getting Started With Pervasive PSQL*.

ODBC DSN Creation Options

Refer to DSNs and ODBC Administrator in *SQL Engine Reference*. That section also discusses ODBC connection strings.

Using the idshosts File

Typically, an application provides its own file location information. As an alternative, you may provide file location mapping based on information in a text file, idshosts.

The idshosts file was one aspect of Pervasive PSQL (IDS). IDS has been removed from the core product but the idshosts file is still configurable.

If your applications do not use the mapping feature through idshosts, set the configuration setting Use IDS to “Off.” If your applications already use idshosts, or if you prefer to use this alternative method to map file locations, set Use IDS to “On.” See Use IDS.

Note that performance is slower when the idshosts file is used because of the time required to access the file and read its contents.

An idshosts file may be used only with a Windows or a Linux client requester. The client may communicate with a Pervasive PSQL server on Windows or Linux.

Note Pervasive PSQL 8.5 or later is required if you set Use IDS to “On.” The requester uses database URIs to represent the IDS information. Database URIs were added with Pervasive PSQL 8.5. See Database URIs in *Pervasive PSQL Programmer's Guide* in the Developer Reference.

If Use IDS is set to “On,” you must also set Use Remote MicroKernel Engine to “On.” Use Remote MicroKernel Engine is on by default.

See Use IDS and Use Remote MicroKernel Engine.

Format of idshosts Entries

Refer to the comments in the idshosts file itself for how to format entries in the file. The comments also provide example mappings. By default, for Windows platforms, the idshosts file is installed to the `\bin` directory under the database client installation directory. For Linux, idshosts is installed to the `\etc` directory under the database client installation directory (for example, `/user/local/psql/etc`).

chapter

2

Concepts of Database Maintenance

An Introduction to Database Maintenance

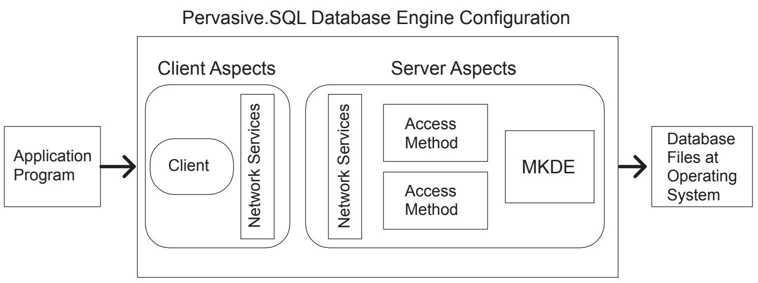
Pervasive PSQL v11 SP3 is a comprehensive database management system built around Pervasive Software's MicroKernel Database Engine. Pervasive PSQL offers easy installation, uncomplicated maintenance, and high levels of performance and reliability. While Pervasive PSQL can run for months or years with practically no maintenance, you can get the most out of it by understanding some of its unique features and learning how to perform useful tasks. This manual describes how to tune, configure, and manage your Pervasive PSQL engine and associated databases.

Configurations

You can configure separate settings for the server and client aspects of the database engine. The settings allow you to optimize the performance of the engine based on your business requirements.

The following figure illustrates the flow from an application program to the database files at the operating system. The database engine resides between the application program and the data files.

Figure 1 Conceptual View of Database Engine Configuration



The types of settings that you can configure for server include the following:

- Access
- Communication protocols
- Compatibility (with previous versions of the MKDE)
- Data integrity
- Debugging
- Directories
- Memory usage
- Performance

The types of settings that you can configure for client include the following:

- Access
- Communication protocols
- Performance
- Security
- Application characteristics

You configure these settings within the PCC. See Configuration Reference for the tasks and references pertaining to configuration.

Database Security

The access to a Pervasive PSQL database can be protected in several ways. Administrative-level security is set through the operating system. You can control who can administer a Pervasive PSQL database with the security mechanisms native to the operating system.

Pervasive PSQL also provides relational security at the user and group levels. You can control who can access the data and at what capability. For example, for each table within a Pervasive PSQL database, you can specify whether a user or group can create, select, update, insert into, delete, or alter the table.

You establish security by setting a password for the entire database. At that point, the only user authorized to access the database is a default user named Master. You can then add additional users and groups.

Security can be set within the PCC. Also supported are two Structured Query Language (SQL) statements pertaining to security: GRANT and REVOKE. GRANT and REVOKE also allow you to set security at the column level if you choose.

The GRANT syntax integrates with transactional Owner Names, allowing owner names to be enforced when using relational access.

See Chapter 7 for information pertaining to security, Owner Names, users, and groups.

Data Archival and Restoration

Backing up data is a routine part of protecting your databases and ensuring disaster recovery. You have several ways in which you can back up and restore your Pervasive PSQL databases.

If your business allows you to stop all applications that access a Pervasive PSQL database, you may use any of the operating system utilities, or third-party software, to backup or restore the database files.

Archival logging is another backup method that you can use to supplement operating system utilities. Archival logging allows you to keep a log of all database operations since your last backup. In case of a system failure, you can restore the data files from backup then roll forward the changes from the log file to return the database to the state it was in prior to the system failure.

Continuous operations allows you to backup database files while the database engine is running and users are connected. After starting Continuous Operations, the database engine closes the active data files and stores all changes in temporary data files (called *delta* files). When the backup is complete, you turn off Continuous Operations. The database engine then reads the delta file and applies all the changes to the original data files.

See Logging, Backup, and Restore for additional information about backing up and restoring databases.

Troubleshooting

The *Pervasive PSQL User's Guide* and *Getting Started With Pervasive PSQL* manuals both contain troubleshooting information. *Getting Started With Pervasive PSQL* contains troubleshooting information pertaining to installing the Pervasive PSQL products. The *User's Guide* contains general troubleshooting information as well as an extensive list of frequently asked questions (FAQs).

Other resources at your disposal for troubleshooting include the Pervasive Software Knowledge Base, which contains information based on actual customer solutions and common problems, and the Support area of the Pervasive Software Web site.

Helpful Utilities

Pervasive PSQL comes with a variety of utilities designed to help you control and manage your databases. For a list of the primary Pervasive PSQL utilities, see *Pervasive PSQL User's Guide*. Note that some utilities can be excluded if you perform a custom installation. See *Getting Started With Pervasive PSQL*.

chapter 3

Understanding the Pervasive Component Architecture

A Discussion of Architecture Features

This chapter covers features designed to offer a trouble-free environment for installing and running critical applications. This chapter is divided into the following sections:

Pervasive PSQL Database Engine

The Pervasive PSQL engine consists of two database sub-engines:

- MicroKernel Database Engine (MKDE), which provides Btrieve/ MicroKernel API support for Pervasive PSQL applications.
- SQL Relational Database Engine (SRDE), which provides ODBC support for Pervasive PSQL applications.

Common Address Space

Pervasive PSQL uses an optimized memory architecture that provides high performance for both transactional and relational data access methods. Both the MKDE and the SRDE load and operate in the same process address space, minimizing the CPU time required to communicate between them.

Row Level Locking

Row level locking improves database engine performance in multi-user environments in which many updates and writes occur at the same time, or in which transactions remain open for an extended period of time.

A transaction locks only the rows that it affects directly, not the entire page. One client can update records on a given page at the same time as another client updates different records on the same page. Waiting is necessary only when a second application attempts to modify the exact same records currently locked by the first application. Thus, row level locking decreases overall wait time and improves performance in a multi-user environment.

This feature is completely transparent within the MicroKernel Database Engine. This feature is always on and is supported across Server and Workgroup products as well as all supported operating system platforms. This feature is supported for data file format v6.x and later.

Row level locking is implemented for data pages and partially implemented for key pages. Row level locking does not apply to variable pages. A small percentage of key page changes may cause key entries to move from one page to another. An example is when a key page is split or combined. These changes retain a full page lock until the transaction completes.

MicroKernel Database Engine

The MicroKernel Database Engine (MKDE) provides Btrieve/MicroKernel API support for Pervasive PSQL applications. Both Pervasive PSQL Server and Pervasive PSQL Workgroup support local applications running on the same computer as the engine. The Server MKDE supports both local applications and remote (client/server) applications. The Workgroup MKDE supports applications running on remote machines as well and can service requests made by another peer Workgroup Engine on a remote machine.

There are two versions of the MicroKernel Engine. The Server Engine runs on Linux and Windows servers. The Workgroup Engine runs on Windows only and is designed for single-user or small workgroup configurations.

The Workgroup Engine is by default configured to start up when you log into Windows. A Workgroup engine can service requests made by another peer engine if the files have already been opened by the engine. It can also serve in a gateway mode by configuring a particular machine and database engine to act as a gateway, thus preventing another Workgroup engine from opening the files.

The Server Engine for Windows is installed to run as a Windows Service. The Workgroup Engine can be installed to run as an application or as a service. If installed as an application, a “tray icon” is displayed to provide a graphical indication when a Workgroup MKDE is running. No tray icon is displayed when the Workgroup MKDE is not running. The tray icon does not display for the Server Engine or if the Workgroup Engine is installed as a service. See also Technical Differences Between Server and Workgroup.

The Btrieve and ODBC APIs in Pervasive PSQL support writing distributed database applications that hide the details of connecting to a local or remote database engine from an application. Using this architecture, an application can access data that is co-located with the application (that is, running on the same computer as the application) while also accessing data on a remote computer. Moreover, a SQL database can be distributed by having DDFs (data dictionary files) serviced by a local MicroKernel Database Engine and data files (tables) serviced by a remote MicroKernel Database Engine. Such a SQL database, which is not serviced exclusively by a local MicroKernel Database Engine, is referred to as a “mixed access database.”

Mixed-access databases are subject to the following constraints:

- The following features are not supported: referential integrity (RI), bound databases, triggers, distributed transaction atomicity (requires two-phase commit).
- The SRDE *and* the MicroKernel Database Engine must be running on the same computer to access DDFs.
- Data files for tables that are involved in an RI relationship, or those that have any triggers defined for them, or are in a bound named database, cannot be opened by a remote MicroKernel Database Engine.
- When opening a file, the SRDE does not verify the version of the MicroKernel Database Engine servicing the request. If an operation that requires v6.30 or higher MicroKernel Database Engine API support (for example, shared locking) is issued to a MicroKernel Database Engine less than v6.30, then an error code is returned. When opening DDFs or when attempting to bind a DDF or data file, the SRDE verifies that the local MicroKernel Database Engine is servicing the request.

Asynchronous I/O

The Server MicroKernel engine for Windows uses asynchronous I/O when writing pages to disk. This feature improves performance. The MicroKernel quickly writes pages to the Windows system cache or its own cache. In turn, Windows signals when the pages are on disk, helping the MicroKernel to perform write operations efficiently.

Read performance is also enhanced when there are many concurrent operations being done in the MicroKernel at the same time, especially if you access your data set on a striped set of disk drives. Each read causes a worker thread to wait until the page is available. With asynchronous I/O, the operating system can pool the work of multiple readers to make the read operations more efficient.

SQL Relational Database Engine

The Pervasive PSQL Relational Database Engine (SRDE) provides ODBC support for Pervasive PSQL applications.

ODBC client platforms include Windows platforms. Remote ODBC application access to the SRDE requires installation of the ODBC Client, which is a specialized ODBC driver that routes client-side ODBC calls to the ODBC communications server over the network.

Some of the features of the SRDE include:

- Atomic statements
- Bidirectional cursors (using the ODBC Cursor Library)
- Outer join support
- Updatable views
- ODBC data type support
- Multiple variable length columns in a table

The ODBC communications server performs the following functions:

- supports network communication for ODBC Clients
- routes ODBC calls to the server-side ODBC Driver Manager (which, in turn, routes ODBC calls to the SRDE)

For additional details on SQL and ODBC, see SQL Overview and DSNs and ODBC Administrator in *SQL Engine Reference*.

Relational Architectural Overview

The following diagram illustrates the architectural components of Pervasive PSQL's relational ODBC interface for the server version. The SQL Connection Manager starts and runs in the same process address space as the MKDE and the SRDE.

Pervasive PSQL Relational Architecture: Server

The SQL Connection Manager supports up to 2000 simultaneous connections and uses the ODBC Driver Manager to make calls to the SQL Relational Database Engine (SRDE), which in turn rests on top of the MicroKernel.

Figure 2 illustrates the client/server relational architecture of Pervasive PSQL. The client talks to the SQL Connection Manager on the server through TCP/IP. This architecture applies to the server engine and to the Workgroup engine (in the case where a client DSN is used to connect from the local Workgroup engine to the remote Workgroup engine).

Figure 2 Client/Server Relational Architecture

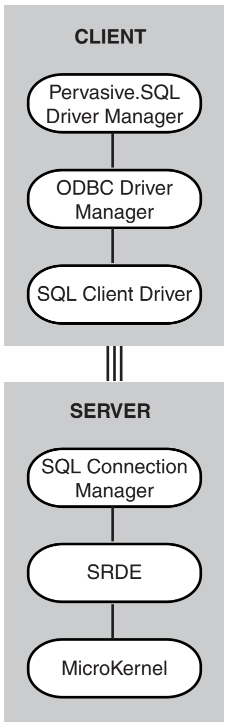
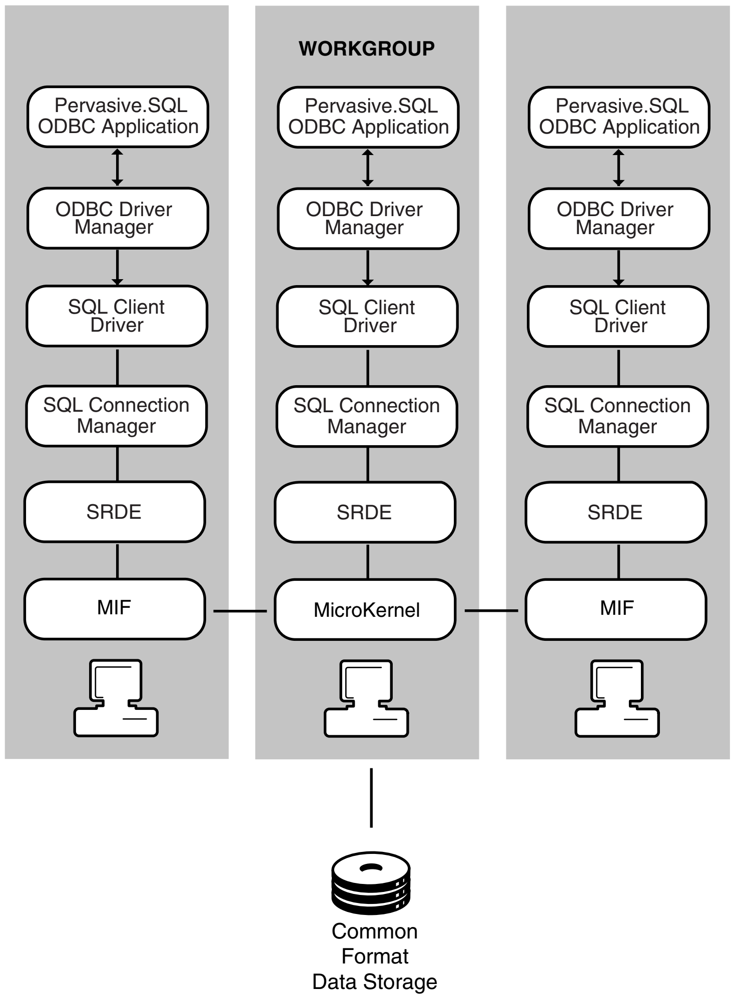


Figure 3 illustrates the Workgroup relational architecture when a DSN is used to connect from the local Workgroup engine to the remote database, assuming that a remote Workgroup engine is acting as a Gateway to the remote data.

Figure 3 Workgroup Relational Architecture



Error Codes

Most Pervasive PSQL top-level components pass through error codes from underlying components so that the actual source of the error is clearly identified to the calling application or in the log file. In situations where an error code may apply to various situations, specific information in the Pervasive PSQL event log should identify the root cause of the error. See Pervasive PSQL Message Logging in *Pervasive PSQL User's Guide*.

Pervasive Auto-Reconnect

Pervasive Auto-Reconnect (PARC) allows client-server or workgroup applications to endure temporary network interruptions without canceling the current database operation. When Pervasive PSQL detects a network interruption, it automatically attempts to reconnect at specific intervals for a configurable amount of time. This feature also preserves the client context so that when communications are re-established, database access continues exactly where it left off when the network interruption occurred.

This feature preserves the application context and attempts to reconnect regardless of whether the client or server was attempting to send data at the moment when the network communications were interrupted.

When a network interruption occurs, the reconnect attempts occur at specific intervals. For all connections, successive attempts are made at 0.5, 1, 2, 4, and 8 seconds, continuing every 8 seconds thereafter until the AutoReconnect Timeout value is reached. If no attempt is successful before the maximum wait time is reached, then the current operation fails and the client connection is reset. The maximum wait time is configurable between 45 seconds and 65,535 seconds.

This feature is disabled by default. For this feature to operate, you must select Enable Auto Reconnect (Windows only) for both client and server configurations. You can specify the time-out value using the server setting Auto Reconnect Timeout.

Remarks

This feature is supported for Btrieve, ODBC, and DTI connections.

The Btrieve communication servers may write out *.PAR or *.SAR files to the Transaction Log Directory. These are temporary files that contain the context for the last item that the server tried to send to the client. When a reconnection occurs, the client may ask for data to be re-sent. The server reads these files to obtain the appropriate data. These files are normally deleted by the server after the data is read or later when the connection is finally terminated.

chapter 4

Configuration Reference

Configuration Methods and Settings Available in Pervasive PSQL

This chapter discusses the following topics:

Configuration Overview

Configuration is the process by which you provide settings for database engines and clients. You can specify configuration settings in Pervasive PSQL Control Center (PCC) or with a command line interface (CLI) utility.

In PCC, the configuration settings are properties of the engine or client. See To access configuration settings in PCC for an engine and To access configuration settings in PCC for a local client.

Configuring any components is optional. If you do not configure them, each component loads with default configuration settings. For best results, you should use only the version of PCC that is the same version as your client and engine components.

You can use configuration for the following reasons:

- Your system or your Pervasive PSQL application requires you to adjust the settings. Refer to your application documentation for recommended values. If you are running multiple applications concurrently, add the recommended values together. If you are running multiple applications sequentially, use the highest recommended value.
- You want to optimize the settings so that Pervasive PSQL provides the services you need without using more memory than necessary. (The stated memory requirements provide guidelines for optimizing your computer's resources.)

The configuration settings themselves are discussed in Configuration Reference.

Ensuring Configuration Changes Take Effect

Some engine configuration settings require that you restart the database engines after the setting is changed. Restarting the engines ensures that the setting takes effect. Each setting in this chapter lists whether a database engine restart is required. Also, PCC informs you with a popup message if a changed setting requires an engine restart.

The CLI utility also informs you provided that you changed the setting from the command line rather by using an input file. Use of an input file always requires that you restart the engines. See Configuration Through CLI Utility.

To stop and start a server database engine from the command line, see the following topics in *Pervasive PSQL User's Guide*:

- Starting and Stopping the Server Engine on a Windows Server
- Starting and Stopping the Database Engine on Linux

To stop and start a Workgroup engine, see Starting and Stopping the Workgroup Engine on Windows in *Pervasive PSQL User's Guide*.

In addition, changing client parameters often requires the client to be restarted. To re-load the client, simply exit all applications that depend on Pervasive PSQL and restart them.

Connecting to Different Machines

You can configure both local and remote engines as well as local client components; however, each engine must be configured separately. See Configuration Through PCC and Configuration Through CLI Utility.

When you are connected to a remote machine with PCC, you can view and change only engine components. Client components (such as on workgroup and workstation engines and client machines) can only be configured locally on each machine.

Configuration Through PCC

In PCC, the configuration settings are properties of an engine or a client. All registered engines appear as nodes in Pervasive PSQL Explorer and allow you to configure settings through the properties. Only the local client appears in Pervasive PSQL Explorer.

You set configuration settings for clients at each client machine itself. By default, PCC is installed with the client components.

➢ To access configuration settings in PCC for an engine

1. In Pervasive PSQL Explorer, expand the Engines node in the tree (click the expand icon to the left of the node).
2. Right-click on the database engine for which you want to specify configuration settings.
3. Click Properties.
4. Click the desired option category in the tree to display the settings for that category of options.
5. Optionally, press shift+F1 to access help for the settings.

➢ To access configuration settings in PCC for a local client

1. In Pervasive PSQL Explorer, expand the Local Client node in the tree (click the expand icon to the left of the node).
2. Right-click on MicroKernel Router.
3. Click Properties.
4. Click the desired option category in the tree to display the settings for that category of options.
5. Optionally, press shift+F1 to access help for the settings.

Configuration Through CLI Utility

The command line interface (CLI) version of configuration provides the same configuration functionality as the property dialogs in Pervasive PSQL Control Center. The CLI Configuration runs on the Windows and Linux platforms supported by Pervasive PSQL v11 SP3.

On Windows, the executable program is bcfg.bat and is installed, by default, in the Program Files directory.

On Linux, the executable program name is bcfg and is located, by default, in the `/usr/local/psql/bin` directory. The following requirements must be met to run bcfg on Linux.

Table 6 Requirements for Running bcfg on Linux

Requirement	Discussion
Java Runtime Environment (JRE)	The JRE components required to run bcfg are installed as part of Pervasive PSQL. Bcfg uses the "local" version of the JRE installed as part of Pervasive PSQL.
Pervasive PSQL server or client	A compatible Pervasive PSQL server or client must already be installed on the same machine. See Installing Pervasive PSQL Server and Client for Linux in *Getting Started With Pervasive PSQL*.

If you have met the requirements to run bcfg on Linux and still are having difficulty running the utility, refer to the following troubleshooting guide.

Table 7 Troubleshooting Guide for Running bcfg on Linux

Troubleshooting Condition	Discussion
You receive the error "java.lang.UnsatisfiedLinkError."	This error typically occurs if you try to start bcfg by double-clicking on the script file using a file browser application. Start bcfg from a command prompt. This error can result if the LD_LIBRARY_PATH variable is not set. If you run bcfg as user "psql," this variable is set in the profile for psql. You may also explicitly set the variable with the following command: `export LD_LIBRARY_PATH=$LD_LIBRARY_PATH:/usr/local/psql/lib`
You receive the following error message: "Unable to connect to database engine. Make sure the target machine is accessible and an engine is running on the target machine."	The context of this error occurs if you attempt to administer the local server. To administer the local server, you must be a member of the **pvsw** group or be the **root** user. See also Pervasive PSQL Account Management on Linux in *Getting Started With Pervasive PSQL*.

Setting a Configuration

You can configure settings one at a time from the command line or by providing one or more settings in an input file.

Tip A convenient way to create an input file is first to create an output file. You can then edit the output file and use the edited version as an input file. See Editing an Input File for the types of edits permissible.

Restarting the Engines

If you use an input file, `bcfg` prompts you to restart the database engines after the utility processes the file. The restart applies regardless of the settings in the input file. Stopping then starting the engines ensures that the configuration settings take effect.

If you configure a setting from the command line, `bcfg` prompts you to restart the database engines only if the setting requires a restart.

See Ensuring Configuration Changes Take Effect for how to restart the engines.

Example Scenario: Configuring a Single Setting from the Command Line

Suppose that you want to turn on a configuration setting having to do with reconnecting a client to the server in the event of a network outage. You are not certain about the name of the configuration setting. Complete the following steps.

1 At a command prompt, type `bcfg -H reconnect` then press Enter.

The utility reports all settings that contain the string "reconnect":

```
ID                Setting Name
-----------------------------
29                Enable Auto Reconnect
148               Enable Auto Reconnect
149               Auto Reconnect Timeout
```

Two of the settings, 29 and 148, look like what you want, but which is which?

2 Type `bcfg 29` then press Enter.

The utility reports the following for setting ID 29:

```
=====================

ENABLE AUTO RECONNECT

=====================

ID: 29

Value: Off

Options: On     Off

Default Value: Off

Description: <Client setting> Specifies if the Client
will attempt to reconnect to the Server in the event
of a network outage. The reconnected Client will
continue processing as if no errors were encountered.
```

The description tells your that this setting applies to a client and that the setting is currently "off."

3 Type `bcfg 29 on` then press Enter.

The utility informs you that system setting 29 has been updated.

4 If you want to verify that the setting is now “on,” type `bcfg 29` then press Enter.

The utility reports the following for setting ID 29:

```
=====================

ENABLE AUTO RECONNECT

=====================

ID: 29

Value: On

Options: On    Off

Default Value: Off

Description: <Client setting> Specifies if the Client
will attempt to reconnect to the Server in the event
of a network outage. The reconnected Client will
continue processing as if no errors were encountered.
```

Note that the value is now set to “on.”

Editing an Input File

An input file must contain at least one complete record for one setting. If you create an input file from an output file and want to remove configuration settings, ensure that the remaining settings are complete records.

At a minimum, a complete record encompasses and ID and Value pair. However, to ensure clarity, it is recommended that you include the top line of the setting header through the setting’s description. For example, here is a suggested minimal record for Enable Auto Reconnect:

```
=====================

ENABLE AUTO RECONNECT

=====================

ID: 29

Value: On

Options: On    Off

Default Value: Off
```

```
Description: <Client setting> Specifies if the Client
will attempt to reconnect to the Server in the event
of a network outage. The reconnected Client will
continue processing as if no errors were encountered.
```

Other than limiting which setting records are included in the input file, the only other change allowed is to the Value assignments. The assignment can be whatever is specified by Options or by Range.

Command Syntax

```
bcfg -I inputfile [-S server] [-U username]
    [-P password] [-E]
```

or

```
bcfg -O outputfile [-S server] [-U username]
    [-P password] [-E]
```

or

```
bcfg ID [value] [-S server] [-U username]
    [-P password]
```

or

```
bcfg -H <keyword | ''keyword with spaces''> [-S server]
    [-U username] [-P password]
```

Options

`-I`	Required parameter if you provide an input file to the utility.
`inputfile`	A text file that contains one or more configuration setting records for a specified server and the value assigned to each setting. A convenient way to create an input file is first to create an output file. You can then edit the setting values as required and use the edited version as an input file. See Editing an Input File for the types of edits permissible.
`-O`	Required parameter if you want the output results of running the utility sent to a text file.
`outputfile`	A text file that contains the current configuration settings for a specified server as a result of running the utility.
`ID`	A two or three digit integer that uniquely identifies the configuration setting. Some configuration settings require that you restart the database engines for the setting to take effect. Bcfg prompts you if a restart is required. See Restarting the Engines.

`value`	A value assigned to the configuration setting. The valid values are specified in a setting record in Options or Range. If Value is omitted, the utility returns the current setting. If Value is included, the utility changes the setting based on the value assignment. See Example Scenario: Configuring a Single Setting from the Command Line.
-H	The help search option for a *keyword* (that is, help for a *keyword*). The utility searches for configuration settings that contain *keyword* and returns the ID and setting name, or returns “no matches found.” See also next row in this table.
`keyword`	The name of the configuration setting, such as ALLOW CLIENT-STORED CREDENTIALS or SUPPORTED PROTOCOLS. Note that *keyword* is case insensitive. However, if the keyword contains one or more spaces, you must double quote the string. The utility can provide help based on partial keywords. For example, if you specify -H client, the utility returns all setting with the word “client” as part of the setting name. If you specify -H a, the utility returns all settings with an “a” in the name.
`-S`	Required parameter if the configuration settings apply to a remote server (a server other than the local one).
`server`	The name or IP address of the remote server that contains the database engine.
`-U`	Required parameter if a user name is required to access *server*.
`username`	User name with which you will connect to *server*. See also Pervasive PSQL Security. If *server* is a local machine, the *username* and *password* are not required if: • You are logged in to the local machine as an administrator or as a member of the Pervasive_Admin group • The local machine is not running Terminal Services.
`-P`	Required parameter if a password is required to access *server*.
`password`	Password used with *username* to connect to the *server*. See *username*. See also Pervasive PSQL Security.
-E	Ignore errors when reading *inputfile* or writing to *outputfile*.

Configuration Settings Parameters

Each configuration setting lists a number of parameters in a tabular format.

Table 8 Tabular Format for Configuration Settings Parameters

Column in Tabular Format	Explanation
Name	The name of the parameter.
Type	Defines the value type. The different types are: • Numeric • Bool(ean) • String • Multisel(ect) – choose several values from a given list • SelectOne – must choose one value from a given list
Value	Shows the current setting.
Units	If the value is numeric, this field explains any specific units of measure, such as KB or seconds, if required.

Services Configuration Parameters

On Windows server environments, Pervasive PSQL Server runs as services. The services are loaded as part of the installation process and are set to be always available if you followed the Complete installation.

You may configure the startup policy for the services from within PCC.

➢ To set services startup policy by using PCC

1. Access Control Center from the operating system Start menu or Apps screen.
2. In the Pervasive PSQL Explorer, expand the Services node (click the expand icon to the left of the node to display the subordinate nodes).
3. Right-click on the desired service: Pervasive PSQL (relational) or Pervasive PSQL (transactional).
4. Click Properties.
5. Click the desired startup policy:

Policy	Meaning
Manual	The service is not started automatically when the operating system starts. You must manually start the service after the operating system starts or restarts.
Automatic	The service is started automatically when the operating system starts or restarts.
Disabled	The service is rendered inoperative until you re-set the startup policy to Manual or to Automatic.

6. Click OK.

Server Configuration Parameters

Each Pervasive PSQL database engine has its own server configuration options. This section describes the different configuration options available for the engines.

You can configure Pervasive PSQL Servers on Windows and Linux platforms using the graphical utility Pervasive PSQL Control Center. You can also use the command-line interface utility `bcfg`. For PCC, see Using Pervasive PSQL Control Center in *Pervasive PSQL User's Guide*. For `bcfg`, see Configuration Through CLI Utility.

The following table lists the Server configuration options and their settings.

Table 9 Server Configuration Options and Settings

Configuration Option	Setting Name
Access	Accept Remote Request
	Allow Cache Engine Connections
	Allow Client-stored Credentials
	Authentication (Linux engines only)
	Configuration File (Linux engines only)
	Prompt for Client Credentials
	Wire Encryption
	Wire Encryption Level
Communication Protocols	Auto Reconnect Timeout
	Enable Auto Reconnect (Windows only)
	Listen IP Address
	NetBIOS Port (Workgroup engines only)
	Supported Protocols
	TCP/IP Multihomed
	TCP/IP Port

Table 9 Server Configuration Options and Settings

Configuration Option	Setting Name
Compatibility	Create File Version
	System Data
Data Integrity	Archival Logging Selected Files
	Initiation Time Limit
	Operation Bundle Limit
	Transaction Durability
	Transaction Logging
	Wait Lock Timeout
Debugging	Number of Bytes from Data Buffer
	Number of Bytes from Key Buffer
	Select Operations
	Trace File Location
	Trace Operation
Directories	DBNames Configuration Location
	Transaction Log Directory
	Working Directory
Information	Server name (display-only) Engine version (display-only) Engine type (display-only)
Memory Usage	Allocate Resources at Startup
	Back to Minimal State if Inactive
	Minimal State Delay
	Sort Buffer Size
	System Cache

Table 9 Server Configuration Options and Settings

Configuration Option	Setting Name
Performance Tuning	Cache Allocation Size
	Communications Threads
	File Growth Factor
	Index Balancing
	Limit Segment Size to 2 GB
	Log Buffer Size
	Max MicroKernel Memory Usage
	Number of Input/Output Threads
	Transaction Log Size

Access

Access contains the following configuration settings:

- Accept Remote Request
- Allow Cache Engine Connections
- Allow Client-stored Credentials
- Authentication (Linux engines only)
- Configuration File (Linux engines only)
- Prompt for Client Credentials
- Wire Encryption
- Wire Encryption Level

Accept Remote Request

Type	Range	Default	Units	Requires Engine Restart
Boolean	On Off	On	None	Yes

This setting specifies whether the Communications Manager accepts requests from remote servers and client workstations. If you turn this option to On, the Communications Manager advertises its presence on the network.

Allow Cache Engine Connections

Type	Range	Default	Units	Requires Engine Restart
Boolean	On Off	On	None	Yes

Specifies if the server will support clients that will attempt to connect to the server with the Cache Engine. When set to Off, clients will still connect to the Server but will not use the Cache Engine.

Allow Client-stored Credentials

Type	Range	Default	Units	Requires Engine Restart
Boolean	On Off	On	None	No

When this setting is On, the database engine accepts user credentials stored on the client. The method and location of storage depends on the operating system of the client:

- Windows clients: these credentials are stored in the Windows registry. When the Prompt for Client Credentials is set to On, then a pop-up dialog allows you to save the credentials by selecting the Save User name and Password check box. Alternatively, you can use the `pvnetpass` command-line utility to manage stored credentials.
- Linux clients: credentials are stored in the Pervasive registry by the `pvnetpass` utility.

When this setting is Off, the database engine forces the client to omit stored credentials from any database operation that requires credentials. Such credentials must be supplied by the application or through the login dialog. The login dialog still writes client-stored credentials if specified using the login dialog, even if this setting is Off. However, they will not be accepted.

When client-stored credentials are allowed, anyone can sit at that particular client computer and login to the database using the stored credentials without knowing those credentials. This behavior can be convenient for environments in which strict authentication of individual users is not a concern, such as a physically secured work area where all users have the same level of access permissions. On the other hand, in environments where unauthorized personnel are present or authorized users have varying levels of access permissions, this setting must be Off.

See also: Prompt for Client Credentials.

Summary Chart of Login Behavior

Table 10 Summary of Login Configuration Behavior

Prompt for Credentials	Allow Client-Stored Credentials	Behavior
Off	Off	Pervasive PSQL client does not prompt the user or use stored credentials, thus credentials must be supplied by the client application during a Btrieve operation.
Off	On	If credentials are not supplied by the client application during the Btrieve operation, the client uses credentials stored by the login dialog or by pvnetpass, if such credentials are available. If no credentials are supplied by either method, the connection attempt fails. No login dialog is displayed.
On	Off	If credentials are not supplied by the client application during the Btrieve operation, the client displays a login dialog to the user, and the Linux client returns a status code for permissions error. Credentials stored by the login dialog or by pvnetpass are not used.
On	On	If credentials are not supplied by the client application during the Btrieve operation, stored credentials are used. If no stored credentials are available, then the client displays a login dialog to the user, and the Linux client returns a status code for permissions error.

Authentication (Linux engines only)

Type	Range	Default	Units	Requires Engine Restart
SelectOne	Three options. See below	Emulate Workgroup Engine	None	Yes

The following options specify which type of authentication to use for access to the server engine. The available options are:

- Emulate Workgroup Engine. Use this value when Samba is used to authenticate user access on the system. If you want to bypass security provided by the operating system and do not want to store RTSS passwords in the registry, use Emulate Workgroup Engine.
- Proprietary Authentication (using btpasswd). Use this value when not using Samba to authenticate and the user does not have an account on the server. This allows a separate password file to be maintained when connecting to the Linux system.

  If you are using BTPASSWD authentication on your Linux server, user names and passwords must be set from clients connecting to this server. Use Pervasive PSQL Control Center or the pvnetpass utility. See Groups, Users, and Security and pvnetpass, both topics in the *Pervasive PSQL User's Guide*.

  Use Proprietary Authentication if stronger security is needed for the server and you want user names and passwords different from any user authentication scheme employed on the Linux server.
- Standard Linux Authentication. Use this value when not using Samba to authenticate but users have accounts on the Linux system.

  Standard Linux authentication is used with PAM. Use PAM if you want to use existing user names and passwords on the Linux server. You can specify user names and passwords from the client using the `pvnetpass` utility. PAM is also very flexible and offers many custom modules for Linux. Check the PAM home page on the Web for more information.

If the Pervasive PSQL installation detects PAM, the installation completes its configuration so that PAM can be used. If you install PAM after installing Pervasive PSQL and want to use standard authentication with PAM, you must re-install Pervasive PSQL. The reason is that the PAM installation copies files, creates configuration files, sets permissions, and creates links. Pervasive PSQL needs to be re-installed to detect PAM and correctly complete its PAM configuration.

You re-install Pervasive PSQL by uninstalling and then installing again. See the chapter Installing Pervasive PSQL Server and Client for Linux in *Getting Started With Pervasive PSQL* for the steps to uninstall and install.

Samba and Authentication

You may use Samba, if available, in addition to any of the three authentication methods described above. The server creates a well-known FIFO share via Samba. FIFO is created in `$PVSW_ROOT/etc/pipe/mkde.pip`. `$PVSW_ROOT/etc/pipe` should be shared by Samba as PVPIPE$.

Note The trailing $ means this share will be hidden. The Pervasive PSQL client components automatically take care of accessing this pipe as `\\<server>\PVPIPE$\mkde.pip` (case-insensitive); you do not need to perform any explicit actions or modify your application to access this pipe. The only exception to this is if you are troubleshooting your Samba or Pervasive PSQL configurations (see section on Troubleshooting below).

When a client connects to the remote engine and discovers the engine returns UNIX in the version block, it will first look in the registry (RTSS) setting) for authentication information. If the user name and password are not found there, the client connects to the above pipe and receives client authentication information from the server, which will be validated later.

To be authenticated, you must be able to connect to the share and read the pipe. This is one way of specifying who can use the engine and who cannot. The easiest way to do this is to utilize the Samba "valid users" setting in smb.conf (Samba configuration file). If the client is unable to get authentication, status 3119 is returned.

The installation program sets up the Samba share (if Samba is installed on the server). For reference, here is an example of setting up the Pervasive pipe.

```
###################################################
[PVPIPE$]
comment = Pervasive pipes
path = /usr/local/psql/etc/pipe
force group = pvsw
# force group pvsw when accessing pipe - will be
# useful if primary group for this user is not pvsw
valid users = @pvsw
# only members of group pvsw will have access
oplocks = False
# Absolutely necessary - prevents caching on the
   client
###################################################
```

To configure access to files shared through Samba, read the Samba documentation.

Note By allowing a client read access to PVPIPE$, that client is authorized to access the engine remotely.

A simple way to ensure the client gets proper authentication is to enter `\\<yourserver>\pvpipe$\mkde.pip` at the command prompt. You should see a lot of question marks (unprintable symbols), occasional printable characters and hear beeps. If you do not, check your Samba configuration to be sure you have rights to read this pipe. If you do but still get error 94 or 3119, validate your RTSS setting using the engine configuration properties in Pervasive PSQL Control Center or with pvnetpass.

Configuration File (Linux engines only)

Type	Range	Default	Units	Requires Engine Restart
String	not applicable	/etc/smb.conf	None	Yes

This setting specifies the location of the smb.conf file used by Linux to export local file systems to Windows clients. The engine requires this file to translate UNC paths on remote systems into local calls to the correct database file.

The default value is /etc/smb.conf. If you installed the Samba configuration file in a different location, enter the correct path and/ or file name.

Prompt for Client Credentials

Type	Range	Default	Units	Requires Engine Restart
Boolean	On Off	Off	None	No

This setting determines whether the Windows Pervasive PSQL client prompts the user for login credentials if no other credentials are available during a database operation that requires user authentication.

When this setting is On, in the absence of other authentication credentials, the engine requires the Windows client to present a login dialog to the user. This setting only applies when Mixed or Database security is in effect, and does not apply to the Linux client under any circumstances. If valid credentials are supplied via another method (for example, explicit Btrieve Login (78) operation or credentials stored on the client), the login dialog does not appear.

If no database context is specified to the engine within the operation requiring user credentials, the engine assumes the user is attempting to login to the current database.

When this setting is Off and one of the new security models is in use, user credentials must be provided programmatically (credentials stored on the client or provided with a Btrieve Login (78), Open (0), or Create (14) operation), or else the login attempt fails with an authentication error.

See Also

Allow Client-stored Credentials

Wire Encryption

Type	Range	Default	Units	Requires Engine Restart
Single select	Never If Needed Always	If Needed	None	Yes

This parameter specifies whether the given client or server should use encryption for its network communications. The default value of If Needed means that the client or server only uses encryption if the other end of the communication stream requires it. For example, assume that Server A has its Wire Encryption value set to Always. Server B has its value set to Never. Your client has its value set to If Needed. In this case, the client will use encryption when communicating with Server A, but it will not use encryption when communicating with Server B.

The following chart summarizes the behavior given each possible combination of client and server values:

Table 11 Client/Server Results of Wire Encryption Combinations

Client Setting	Server Setting “Never”	Server Setting “Always”	Server Setting “If Needed”
Never	Encryption not used	Status Code 5001	Encryption not used
Always	Status Code 5000	Encryption used; level determined by highest Wire Encryption Level setting between client and server	Encryption used; level determined by client’s Wire Encryption Level setting.
If Needed	Encryption not used	Encryption used; level determined by server’s Wire Encryption Level setting	Encryption not used

Wire Encryption Level

Type	Range	Default	Units	Requires Engine Restart
Single select	Low Medium High	Medium	None	Yes

This setting specifies the strength of the encryption key that should be used for encrypted communications. The following levels are available:

Table 12 Meaning of Encryption Level Values

Value	Meaning
Low	40-bit encryption key used
Medium	56-bit encryption key used
High	128-bit encryption key used

Encryption using a key 128 bits long is generally accepted as “strong” encryption. The other settings provide progressively less protection but higher performance, in the event that you require some level of encryption but are willing to accept a lower level of deterrence to gain better performance.

When a client and a server both require encryption and one specifies a stronger encryption level than the other, the two entities use the stronger level to communicate. When a client and a server both require encryption and one specifies a stronger encryption level than the other, the two entities use the stronger level to communicate.

Communication Protocols

Communication Protocols contains the following configuration settings:

- Auto Reconnect Timeout
- Enable Auto Reconnect (Windows only)
- Listen IP Address
- NetBIOS Port (Workgroup engines only)
- Supported Protocols
- TCP/IP Multihomed
- TCP/IP Port

Auto Reconnect Timeout

Type	Range	Default	Units	Requires Engine Restart
Numeric	45 - 65535	180	seconds	Yes

This setting specifies how long the client will attempt to connect to the server before giving up. When a AutoReconnect-enabled client first connects to a AutoReconnect-enabled server, the server communicates this value to the client so that both components know how long to attempt to reconnect in the event of a network interruption.

Enable Auto Reconnect (Windows only)

Type	Range	Default	Units	Requires Engine Restart
Boolean	On Off	Off	None	Yes

This setting specifies whether you want the server to support clients attempting to auto-reconnect during a network outage. A setting of On means AutoReconnect is enabled.

Auto Reconnect is not in effect for a given client connection unless this setting is also enabled in that client's configuration.

To specify how long a client will attempt to reconnect to the server before giving up, see Auto Reconnect Timeout, above.

Listen IP Address

Type	Range	Default	Units	Requires Engine Restart
String	Valid IP address or multiple addresses separated by a comma between each address	0.0.0.0	None	Yes

This option specifies the IP address or addresses the database engine listens on when TCP/IP Multihomed is Off. This option is ignored when TCP/IP Multihomed is On.

Multiple IP addresses may be specified but must be separated by a comma between each address. The string can be a combination of IPv4 and IPv6 addresses. Any of the IPv6 address formats supported by Pervasive PSQL can be used. See Drive-based Formats in *Getting Started With Pervasive PSQL*.

NetBIOS Port (Workgroup engines only)

Type	Range	Default	Units	Requires Engine Restart
Numeric	33 to 254	66	None	Yes

This option specifies the NetBIOS port the MicroKernel listens on. The Server engine does not support NetBIOS.

Supported Protocols

Type	Range	Default	Units	Requires Engine Restart
Multiple select	See below	TCP/IP	None	Yes

This setting specifies the protocols on which the database engine listens for client connections. If more than one protocol is specified, the database engine listens on all specified protocols. The default is TCP/IP. The available options are:

- TCP/IP
- SPXII
- NetBIOS

You must have at least one protocol enabled at both the client and the server or they cannot communicate.

Pervasive PSQL Workgroup

NetBIOS is valid only for Pervasive PSQL Workgroup, not Pervasive PSQL Server.

Linux

TCP/IP is the only supported protocol for Pervasive PSQL running on a Linux platform. Therefore, the Supported Protocols setting is not available on Linux.

TCP/IP Multihomed

Type	Range	Default	Units	Requires Engine Restart
Boolean	On Off	On	None	Yes

This option specifies whether the database engine should listen for client connections on all network interfaces. If it is set to On, the database engine listens on all network interfaces, and the IP address(es) listed in the Listen IP Address option is ignored. If this setting is Off, you must specify in Listen IP Address which address(es) for the database engine to use for client communications.

TCP/IP Port

Type	Range	Default	Units	Requires Engine Restart
Numeric	256 to 65535	1583	None	Yes

This setting configures the port number used by the relational interface.

This port number must be the same as that defined in any Client DSNs pointing to this server. For information on how to change the port number in a Client DSN, see Advanced Connection Attributes for Client DSN in *SQL Engine Reference*.

For additional information on ports, see Changing the Default Communication Ports in *Getting Started With Pervasive PSQL*.

Compatibility

Compatibility contains the following configuration settings:

- Create File Version
- System Data

Create File Version

Type	Range	Default	Units	Requires Engine Restart
SelectOne	6.x - 9.x	9.x	None	No

This setting specifies the format in which all new files are created. The 10.*x* database engine can write to files using the existing file format. In other words, it writes to 7.*x* files using the 7.*x* file format, writes to 8.*x* files using the 8.*x* file format, and so forth. (The 10.*x* database engine can *read* files created with 5.x, 6.*x*, 7.*x*, 8.*x*, and 9.*x* versions of the database engine.)

Specify 6.*x*, 7.*x*, or 8.*x* only if you need backward compatibility with a previous version of the MicroKernel. Specifying a previous file version does not affect any existing 9.*x* files.

Note Dictionary files (DDFs) must be created with a file format of 6.x or later. The New Database wizard uses the setting for create file version. The data files can be in any of the previous file formats supported. Only the DDFs must use a file format of 6.x or later.

System Data

Type	Range	Default	Units	Requires Engine Restart
Single select	See below	If needed	None	No

System data refers to a hidden unique key in each record. Because the MicroKernel relies on uniquely identifying rows in order to ensure transaction durability, a file must either have a unique key defined or have system data included in the file. The default value is If needed; the available options are:

- None. By default, system data is not included on file creation. Application developers using the Create operation can override this setting.
- If needed. System data is added to the file on file creation if the file does not have a unique key.

- Always. System data is always added on file creation, regardless of whether the file has a unique key.

Note The System Data setting does not affect existing files. This setting only affects how new files are created.

If you want to use transaction durability with a file that was not created with System Data turned on and does not have a unique key, you must re-create the file after setting System Data to Yes or If needed.

The SRDE always creates files with System Data. This information applies to files created through SQL, OLE-DB, JDBC, or any method other than the Btrieve API.

Even if a file has a unique key, you may want to include system data, because users can drop indexes.

Data Integrity

Data Integrity contains the following configuration settings:

- Archival Logging Selected Files
- Initiation Time Limit
- Operation Bundle Limit
- Transaction Durability
- Transaction Logging
- Wait Lock Timeout

Archival Logging Selected Files

Type	Range	Default	Units	Requires Engine Restart
Boolean	On, Off	Off	None	Yes

This setting controls whether the MicroKernel performs archival logging, which can facilitate your file backup activities. If a system failure occurs, you can use the archival log files and the BUTIL -ROLLFWD command to recover changes made to a file between the time of the last backup and a system failure.

To direct the MicroKernel to perform archival logging, you must specify the files for which the MicroKernel is to perform archival logging by adding entries to an archival log configuration file that you create on the volume that contains the files. For more information about archival logging, refer to Understanding Archival Logging and Continuous Operations.

Initiation Time Limit

Type	Range	Default	Units	Requires Engine Restart
Numeric	1 - 1800000	10000	milliseconds	No

This setting specifies the time limit that triggers a system transaction. The MicroKernel initiates a system transaction when it reaches the Operation Bundle Limit or the time limit, whichever comes first, or when it needs to reuse cache.

Operation Bundle Limit

Type	Range	Default	Units	Requires Engine Restart
Numeric	1 to 65535	65535	None	No

This option specifies the maximum number of operations (performed on any one file) required to trigger a system transaction. The MicroKernel initiates a system transaction when it reaches the bundle limit or the Initiation Time Limit, whichever comes first, or when it needs to reuse cache.

The MicroKernel Database Engine treats each user transaction (starting with Begin Transaction until End Transaction or Abort Transaction) as one operation. For example, if there are 100 Btrieve operations between the Begin Transaction and the End Transaction operation, then all the 102 Btrieve operations together are treated as a single operation.

Transaction Durability

Type	Range	Default	Units	Requires Engine Restart
Boolean	On Off	Off	None	Yes

Transaction Durability is the same as Transaction Logging except that Transaction Durability guarantees that all successfully completed transactions are committed to the data files in the event of a system crash.

For a full discussion of transaction logging and durability, see Transaction Logging and Durability.

Note When you turn Transaction Durability on, some files may not be able to support the feature. A file must contain at least one unique key, or when it was created, the configuration setting System Data must have been set to "Yes" or "If Needed." Otherwise, any changes to the file are not written to the transaction log. For more information about transaction durability and system data, refer to *Pervasive PSQL Programmer's Guide* in the Developer Reference.

Because System Data does not affect existing files, you may need to re-create files that do not have a unique key and were not created with System Data turned on. Be sure to turn on System Data before re-creating these files.

Caution Gateway locator files allow different engines to manage files in different directories on the same file server. If your database contains data files in different directories, you must be sure that the same database engine manages all the data files in the database. If you have more than one database engine managing files within the same database, database integrity and transaction atomicity are not guaranteed. For more information on how to avoid this potential problem, see Re-directing Locator Files.

Related Settings

See more information on similar and related settings under Transaction Logging.

Transaction Logging

Type	Range	Default	Units	Requires Engine Restart
Boolean	On Off	On	None	Yes

This setting controls whether the MicroKernel ensures atomicity of transactions by logging all operations that affect the data files.

If the related setting, Transaction Durability, is turned on, then logging takes place automatically, and the Transaction Logging setting is ignored.

For a full discussion of transaction logging and durability, see Transaction Logging and Durability.

Note When you turn Transaction Logging on, some files may not be able to support the feature. A file must contain at least one unique key, or when it was created, the configuration setting System Data must have been set to “Yes” or “If Needed.” Otherwise, any changes to the file are not written to the transaction log. For more information about transaction durability and system data, refer to *Pervasive PSQL Programmer's Guide* available in the Developer Reference.

Because System Data does not affect existing files, you may need to re-create files that do not have a unique key and were not created with System Data turned on. Be sure to turn on System Data before re-creating these files.

Caution Do not turn off Transaction Logging unless your database does not require transaction atomicity among data files. Database integrity for multi-file databases cannot be guaranteed if Transaction Logging is turned off.

Do not turn off Transaction Logging unless doing so is supported by your application vendor.

Related Settings

The server configuration setting Transaction Durability is similar to Transaction Logging, but provides a higher level of data safety along with a lower level of performance. The server configuration settings Log Buffer Size and Transaction Log Size are related to Transaction Logging. Log Buffer Size allows you to configure the balance between transaction recoverability and performance. The larger the log buffer, the fewer times it is written to disk, and thus the greater the performance. However, database changes that are in the log buffer are not durable through a system failure.

Transaction Log Size controls how large each log file segment gets before a new segment is started.

Note that all of these settings are ignored if Btrieve or SQL transactions are not being used.

Wait Lock Timeout

Type	Range	Default	Units	Requires Engine Restart
Numeric	0 - 2147483647	15000	milliseconds	Yes

The database engine and its clients use a coordinated retry mechanism when a record lock conflict occurs. If the engine cannot obtain a lock on every requested record within the duration for wait lock timeout, the engine returns control to the application with an appropriate status code.

Wait lock timeout provides the following benefits if a lock conflict occurs:

- allows the database engine to continue processing other requests while waiting for the lock to release
- improves thread queuing if multiple threads are waiting for the locked resource
- improves network performance by reducing network traffic.

Wait lock timeout applies only to the following situations:

- Applications that use the relational interface.
- Windows applications. Such applications receive a lock error within one second (regardless of the setting for wait lock timeout).

Wait lock timeout does not apply to applications that use the transactional interface through a Pervasive client on Windows or Linux. Such applications either receive a lock conflict error immediately after a lock conflict is detected or the lock conflict waits indefinitely for the lock to be released. The application then determines how to handle the conflict (retry, wait, and so forth).

The transactional interface API provides controls to handle record lock situations. Refer to *Btrieve API Guide* in the Pervasive PSQL software development kit (SKD) documentation for a complete discussion. In brief, here are the control mechanisms:

- Explicit record locks – You can add lock biases (100, 200, 300 and 400) to read operations when reading records to specify whether to wait or not.
- Implicit page locks during a transaction – Most page lock conflicts are avoided because of row level locking, but you can add lock bias 500 to your transactions to avoid waiting when a page lock occurs.
- Exclusive file locks – Use concurrent transactions to avoid explicit file locks. If a file cannot be opened exclusively, the request always returns immediately.

Debugging

Debugging contains the following configuration settings:

- Number of Bytes from Data Buffer
- Number of Bytes from Key Buffer
- Select Operations
- Trace File Location
- Trace Operation

Number of Bytes from Data Buffer

Type	Range	Default	Units	Requires Engine Restart
Numeric	0 - 65535	128	bytes	No

This setting specifies the size of the data buffer that the MicroKernel writes to the trace file. The Trace Operation setting must be set to On to use this setting. The size you specify depends on the nature of your tracing needs (whether you need to see the entire data buffer contents or just enough of the buffer contents to identify a record).

Number of Bytes from Key Buffer

Type	Range	Default	Units	Requires Engine Restart
Numeric	0 - 255	128	bytes	No

This setting specifies the size of the key buffer that the MicroKernel writes to the trace file. The Trace Operation setting must be set to On to use this setting. The size you specify depends on the nature of your tracing needs (whether you need to see the entire key buffer contents or just enough of the buffer contents to identify a key).

Select Operations

Type	Range	Default	Units	Requires Engine Restart
Multiselect	See below	All	None	No

The Selected list displays the available Btrieve Interface operation codes that are traced. Select from the list the desired operations to trace.

- Abort Transaction (21)
- Begin Transaction (19)
- Clear Owner (30)
- Close (1)
- Create (14)
- Get Position (22)
- Get Previous (7)
- Get Previous Extended (37)
- Insert (2)
- Insert Extended (40)

- Abort Transaction (21)
- Create Index (31)
- Delete (4)
- Drop Index (32)
- End Transaction (20)
- Extend(16)
- Find Percent (45)
- Get By Percent (44)
- Get Direct/Chunk (23)
- Get Directory (18)
- Get Equal (5)
- Get First (12)
- Get Greater (8)
- Get Greater or Equal (9)
- Get Last (13)
- Get Less or Equal (11)
- Get Less Than (10)
- Get Next (6)
- Get Next Extended (36)
- Get Position (22)
- Open (0)
- Reset (28)
- Set Directory (17)
- Set Owner (29)
- Stat (15)
- Step First (33)
- Step Last (34)
- Step Next (24)
- Step Next Extended (38)
- Step Previous
- Stop (25)
- Step Previous Extended (39)
- Unlock (27)
- Update (3)
- Update Chunk (53)
- Version (26)

Trace File Location

Type	Range	Default	Units	Requires Engine Restart
String	not applicable	*file_path*\PSQL\bin\mkde.tra	None	No

This setting specifies the trace file to which the MicroKernel writes trace information. The file name must include a drive or volume specification and path or use a UNC path. If you do not want the trace file in the default location, enter a different path and/or file name.

For default locations of Pervasive PSQL files, see Where are the Pervasive PSQL files installed? in *Getting Started With Pervasive PSQL*.

Note Do not use the same trace file name for ODBC tracing and MicroKernel tracing.

Trace Operation

Type	Range	Default	Units	Requires Engine Restart
Boolean	On Off	Off	None	No

This setting enables or disables the trace feature, which allows you to trace each Btrieve Interface call and save the results to a file. Developers can use tracing to debug applications. The MicroKernel writes to the trace file using forced write mode, which ensures that data gets written to the file even if the MicroKernel unloads abnormally. The MicroKernel's performance can be severely impacted, depending on the frequency of incoming requests. If you enable this option, you must specify a Trace File.

Note You do not need to restart the engine in order to start and stop tracing. You can turn tracing on or off during runtime and apply the changes directly to the engine. If you receive a message from Configuration indicating that you must restart the engine for changes to take effect, you may safely ignore the message for this setting.

Directories

Directories contains the following configuration settings:

- DBNames Configuration Location
- Transaction Log Directory
- Working Directory

DBNames Configuration Location

Type	Range	Default	Units	Requires Engine Restart
String	not applicable	Varies	None	Yes

This setting specifies the path to an alternate location for the DBNames configuration file.

For Server engines, this is a local file path, not a directory path. For Workgroup engines this could be a remote path that is accessible to the Workgroup MicroKernel. The defaults vary depending upon your particular engine platform.

- Windows platforms: *application_data_directory*\
- Linux server: /usr/local/psql/etc

If you do not want the configuration file in the default location, enter a valid path.

Transaction Log Directory

Type	Range	Default	Units	Requires Engine Restart
String	not applicable	Varies	None	Yes

This setting specifies the location the MicroKernel uses to store the transaction log. The path must be a valid path and include a drive or volume specification or UNC path. The defaults vary depending upon your operating system.

The engine ignores this setting unless Transaction Durability or Transaction Logging is turned on.

Caution Do not use the same directory for multiple database engines (for example, specifying a remote server directory as the Transaction Log Directory for more than one Workgroup engine). Under these circumstances, the engines cannot determine which transaction log segments are used by each engine in the event a log roll forward is necessary.

If your database engine is highly utilized, you should configure your system to maintain the transaction logs on a separate physical volume from the volume where the data files are located. Under heavy load, performance is typically better when the log writes and data file writes are split across different drives instead of competing for I/O bandwidth on a single drive. For a full discussion of transaction logging, see Transaction Logging and Durability.

Working Directory

Type	Range	Default	Units	Requires Engine Restart
String	not applicable	Same directory as data file	None	Yes

This setting specifies the location of the MicroKernel working directory, which is used to store temporary files in operations such as building large indexes. If disk space is limited on certain volumes, you can use this option to specify a working directory on a volume with adequate space.

There is no default value specified; however, if you do not specify a working directory, the default will be the location of the data file. To specify a fixed working directory, enter a path in the Value text box. The path must include a drive or volume specification or a UNC path.

Information

Information lists the following display-only items:

Display-only Item	Discussion
Server name	The name of the machine on which the database engine is running.
Engine version	The release version of the database engine.
Engine type	The product category of the database engine, such as Server or Workgroup.

Memory Usage

Memory Usage contains the following configuration settings:

- Allocate Resources at Startup
- Back to Minimal State if Inactive
- Minimal State Delay

- Sort Buffer Size
- System Cache

Allocate Resources at Startup

Type	Range	Default	Units	Requires Engine Restart
Boolean	On Off	Off	None	Yes

This setting instructs the MicroKernel to allocate resources, including threads and memory buffers, when the MicroKernel is started. The resources allocated at startup includes the background threads in addition to the L1 cache. Pervasive PSQL components automatically allocate resources as needed. Therefore, in most cases, this setting can be “off” (the default).

With the setting “off,” the MicroKernel does not allocate any resources until the first operation request. If your server system supports a large number of users, you may prefer to have this setting “on.”

When first set to “on,” the setting may not produce any noticeable difference in the memory allocated because of how Windows behaves. When the MicroKernel allocates its L1 cache, the Windows operating system simply reserves pages of memory and does not actually commit them to the MicroKernel. Later, when the MicroKernel actually accesses cache memory, Windows then commits actual physical pages and the memory usage of Pervasive PSQL components (such as ntdbsmgr or w3dbsmgr) increases.

If you look at the "VM Size" column in Windows Task Manager, you can see the memory value changing when the L1 cache gets accessed. You should also be able to see a difference in the number of threads when the background threads are accessed.

Back to Minimal State if Inactive

Type	Range	Default	Units	Requires Engine Restart
Boolean	On Off	Off	None	Yes

This setting causes the MicroKernel to free considerable memory and thread resources to the system and return to a minimal state after a certain amount of time without any active clients. The time interval is specified by the value of Minimal State Delay. The MicroKernel reallocates resources when another client becomes active.

Minimal State Delay

Type	Range	Default	Units	Requires Engine Restart
Numeric	0 - 2147483647	300	milliseconds	Yes

This setting specifies how long the MicroKernel waits during a period of inactivity before returning to a minimal state. (This is the initial state in which the MicroKernel begins.) By returning to a minimal state, the MicroKernel frees considerable memory and thread resources to the system. In some cases, you may not want the MicroKernel to return to a minimal state. For example, you may be running a batch file that uses the MicroKernel repeatedly. The MicroKernel reallocates resources when another client becomes active.

This setting is ignored if the value of Back to Minimal State if Inactive is set to Off (the default).

Sort Buffer Size

Type	Range	Default	Units	Requires Engine Restart
Numeric	0 - limited by memory	0	bytes	Yes

This setting specifies the maximum amount of memory (in kilobytes) that the MicroKernel dynamically allocates and de-allocates for sorting purposes during run-time creation of indexes.

If the memory required for sorting exceeds the size specified or is greater than 60 percent of the available process memory, the MicroKernel creates a temporary file. The amount of available memory for a process is a dynamic value and varies according to system configuration and load. If you specify 0 kilobytes, the MicroKernel allocates as much memory as needed, up to 60 percent of the available memory.

System Cache

Type	Range	Default	Units	Requires Engine Restart
Boolean	On, Off	Off (Server engine) On (Workgroup engine)	None	Yes

This option specifies whether the MicroKernel should use the system cache in addition to the MicroKernel's own database cache, as set using the configuration parameter Cache Allocation Size.

If you are using the L2 cache, you should set System Cache to Off. Check the setting of Max MicroKernel Memory Usage. When Max MicroKernel Memory Usage is set to a value greater than zero, you are using L2 cache.

In you are not using L2 cache, performance can be enhanced by turning on System Cache. The MicroKernel relies on the system cache to organize and group pages to be written. It delays a flush long enough to allow the system cache to write the pages to disk in a more efficient manner. However, if your server has an advanced self-cached disk array, you might achieve better performance by setting System Cache to Off.

For Windows Server only, you can use the Paging File and Process objects in the Windows Performance Monitor utility to determine whether the Windows system cache is being used effectively. For the NTDBSMGR instance, monitor the % Usage and % Usage Peak in the Page File object and the Page Faults/Second and Page File Bytes in the Process object.

Performance Tuning

Performance Tuning contains the following configuration settings:

- Cache Allocation Size
- Communications Threads

- File Growth Factor
- Index Balancing
- Limit Segment Size to 2 GB
- Log Buffer Size
- Max MicroKernel Memory Usage
- Number of Input/Output Threads
- Transaction Log Size

Cache Allocation Size

Type	Range	Default	Units	Requires Engine Restart
Numeric	1 megabyte to the amount limited by memory (see Note below)	Initialized dynamically at first start-up	megabytes (see Note below)	Yes

This setting specifies the size of the Level 1 cache that the MicroKernel allocates; the MicroKernel uses this cache when accessing any data files.

Speaking very generally, overall performance is usually best when the Cache Allocation Size is a value less than 40% of the physical memory on the system, and the Configuration setting Max MicroKernel Memory Usage is set to a value greater than 40%. Your exact optimal settings will depend on the size of your data files, the number of other applications running on the system, and the amount of memory installed in the computer.

Server Engine

On Windows, this setting is initially set to 20% of physical memory by the database engine the first time it starts and it writes that value to the Registry. After that, whenever the engine starts, it reads the value from the Registry. Changing the value using Configuration updates the value in the Registry. If you add or remove memory from the system, you must modify this setting to take best advantage of the new amount of memory available.

To optimize your performance, allocate a cache size no larger than the sum of the sizes of the files you are using. However, be careful not to take all available memory, especially when the server is running other applications. You cannot improve performance—and may waste memory—by specifying a value higher than you need.

Workgroup Engine and Client Cache

The database engine initially sets this value the first time it starts and writes the value to the Registry. The initial value is set to 20% of physical memory. The maximum size of the cache depends on the amount of memory in the system, but the engine sets an initial maximum of 64 MB. After the Registry setting is initialized, whenever the engine starts, it reads the value from the Registry. The engine never re-calculates the setting. Changing the value using Configuration updates the value in the Registry. If you add or remove memory from the system, you must modify this setting manually to take best advantage of the new amount of memory available.

Client Cache

This information also applies to the client software (client cache) if the configuration setting Use Cache Engine is turned on.

Note If you use Pervasive PSQL Clients prior to Pervasive PSQL v10, the value for cache allocation size must be specified in bytes, with a minimum of 64 KB (65,536 bytes). The maximum is limited by the amount of memory.

Communications Threads

Type	Range	Default	Units	Requires Engine Restart
Numeric	*num_cores* to 256	*num_cores*, where *num_cores* is the number of processors in the machine on which the database engine is running	None	Yes

This setting specifies how many threads the MicroKernel initially spawns to handle requests from remote clients. Communication threads are the elements that actually perform Btrieve operations on behalf of the requesting remote client process. In this way they are very similar to worker threads. Communications threads increase dynamically as needed up the maximum range allowed. The maximum is 256.

The Communications Threads setting can help improve scaling under certain conditions. For example, if you have many clients performing operations (typically writes) on one file, a lower setting should improve scalability. The lower number of threads prevents context switching on system resources. Another condition that this setting may improve is a slowdown caused by thrashing among large numbers of worker threads. Worker threads are dynamically created only if all the existing threads are waiting on record or file locks.

File Growth Factor

Type	Range	Default	Units	Requires Engine Restart
Numeric	0-100	15	Percent	Yes

This value specifies the approximate percentage of free pages to maintain in version 8.x and later format data files. The setting does not apply to any previous file format versions. The MicroKernel uses this value to decide whether to extend a file or use free pages first. The database engine uses turbo write accelerator so the performance of disk writes can be expected to improve as the number of free pages within the file increases. This is due to the engine's ability to write multiple contiguous file pages on disk. Thus, disk write performance is a trade-off against file size. However, maintaining too many free pages in a file can actually reduce overall performance.

To maintain a certain amount of contiguous free pages in a data file, the database engine must periodically expand the file. Keep in mind that the file size effects of this setting are exponential. For example, if you start with a file that has no free pages and you specify a File Growth Factor value of 50%, the file will eventually double in size. If you specify a File Growth Factor value of 75%, the file will quadruple in size. A value of 90% will cause the file to grow by as much as 10 times.

Note that only completely unused pages are counted as empty, so 15% empty pages does not mean that 15% of the file is unused, as some pages may not be completely full.

This value is only a hint to the MicroKernel; depending on how heavily a given file is being updated, the actual percentage of empty space may be much less at any given moment.

This setting is not applicable to pre-8.x format files. These older files also have empty pages and the percentage of empty pages varies with the activity on the file.

Index Balancing

Type	Range	Default	Units	Requires Engine Restart
Boolean	On Off	Off	None	Yes

This setting controls whether the MicroKernel performs index balancing. Index balancing increases performance on read operations; however, when you enable this option, the MicroKernel requires extra time and may require more disk I/O during insert, update, and delete operations. For more information about index balancing, refer to *Pervasive PSQL Programmer's Guide* available in the Developer Reference.

Limit Segment Size to 2 GB

Type	Range	Default	Units	Requires Engine Restart
Boolean	On Off	On	None	Yes

This setting specifies that a data file is to be automatically broken into 2 GB operating system file segments as its size passes that boundary. If set to On, this setting specifies that you want data files divided into 2 GB segments. If set to Off, this setting specifies that data files will remain a single, non-segmented file. The advantage of using a larger non-segmented file is more efficient disk I/O. Therefore, you can expect increased performance.

Any non-segmented files are subject to the limit on file size specified by your operating system. If a previously created file is already segmented, that segmentation remains on the file.

See also Automatic Upgrade of File Version for related information.

Log Buffer Size

Type	Range	Default	Units	Requires Engine Restart
Numeric	262144 - limited by memory	The smaller value of the following: (physical memory in MB / 256) or 8 MB	bytes	Yes

This setting specifies the size of both the transaction log buffer and the archival log buffer that the MicroKernel uses. You can enhance performance by increasing the log buffer size, because the MicroKernel writes the log information to disk less frequently.

Note If you set Log Buffer Size to a value greater than that of Transaction Log Size, then the MicroKernel automatically increments Transaction Log Size to the value you specified for Log Buffer Size.

Max MicroKernel Memory Usage

Type	Range	Default	Units	Requires Engine Restart
Numeric	0-100	60	Percent	No

This setting specifies the maximum proportion of total physical memory that the MicroKernel is allowed to consume. L1, L2, and all miscellaneous memory usage by the MicroKernel are included (SRDE is not included). The database engine uses less if the specified proportion is not needed or not available.

If the value zero (0) is specified, then dynamic caching is turned off. In this case, the only cache available is L1, the size of which is specified by Cache Allocation Size. If you have a dedicated database server machine, then you should set Max MicroKernel Memory Usage to the maximum value, or whatever proportion of memory is not occupied by the operating system. If you run other applications on your database server and you need to balance performance between all of these, then you should set this value lower so that the database cache does not compete as much with the other applications when using available memory.

Note If Cache Allocation Size is set to a higher amount of physical memory than Max MicroKernel Memory Usage, then Cache Allocation Size takes precedence. For example, a machine has 1 GB of physical memory and you set Cache Allocation Size to 600 MB and Max MicroKernel Memory Usage to 40%. The L1 cache is allocated 600 MB of memory. Since Cache Allocation Size is higher, it takes precedence and the amount of memory allocated to the L1 cache exceeds the value specified for Max MicroKernel Memory Usage.

Use the following equation to determine the approximate value for Max MicroKernel Memory Usage.

(*L1_cache_size* + *internal_allocations* + *L2_cache_size* / *size_of_physical_memory*) * 100

where:

L1_cache_size is the Cache Allocation Size

internal_allocations is approximately 25% of the size of the L1 cache

L2_cache_size is the amount of memory that expands and contracts based on memory load of the system

size_of_physical_memory is the amount of memory installed in the machine

For more information on tuning performance, see Tuning Performance.

Number of Input/Output Threads

Type	Range	Default	Units	Requires Engine Restart
Numeric	1 to 1024	32	None	Yes

This setting specifies how many background I/O threads the MicroKernel spawns. These threads are responsible for writing all pages from the MicroKernel’s cache to the file on disk in an atomic and consistent manner. They also are responsible for initially opening a file and reading the File Control Record. Most of the other reads are done by local worker threads and communication threads. When the MicroKernel updates or writes to data files, it assigns each file to a particular I/O thread sequentially. When it reaches the last thread, the MicroKernel starts over until all data files have been assigned to a background thread. Because the MicroKernel does not spawn additional I/O threads as needed, specify the maximum number of I/O threads you anticipate needing.

For best performance, set this value based on the average number of open files. Monitor shows the current and peak number of files open. If your database has an average of 256 files open, then the default of 32 I/O threads makes each thread responsible for 8 files. A good rule of thumb is to have about 8 files per I/O thread. For example, if your average number of open files is 400, you should use about 50 I/O threads. Specifying a value higher than 64 may degrade performance, but that depends on the capabilities of the system.

Note No accurate way is available to calculate the appropriate number of I/O threads because this setting depends on the machine's characteristics, OS configuration, and the database engine's planned work load.

Transaction Log Size

Type	Range	Default	Units	Requires Engine Restart
Numeric	65536 - limited by disk space	2 times the Log Buffer Size	bytes	Yes

This setting specifies the maximum size of a transaction log segment. When the log file reaches its size limit, the MicroKernel closes the old log segment file and starts a new one. You might want to limit the size of your transaction log segments, because this reduces the disk space that the MicroKernel uses temporarily. However, limiting the size of the transaction log segments does require more processing by the MicroKernel and can decrease performance, because it has to close and create log segments more frequently.

Note If you set the value for this option less than the value you specified for Log Buffer Size, the Database Engine automatically adjusts Transaction Log Size by setting it to the value of Log Buffer Size.

Windows Client Configuration Parameters

The client configuration options are available in all the different installation setups. These options must be configured separately for each workstation, which includes servers acting as workstations.

You can configure the client using the graphical utility Pervasive PSQL Control Center or the command-line interface utility `bcfg`. For PCC, see Using Pervasive PSQL Control Center in *Pervasive PSQL User's Guide*. For `bcfg`, see Configuration Through CLI Utility.

The following table is a mapping of all the available client configuration options and their settings.

Table 13 Client Configuration Settings

Configuration Option	Parameter Name
Access	Gateway Durability
	Number of Load Retries
	Use IDS
	Use Local MicroKernel Engine
	Use Remote MicroKernel Engine
	Wire Encryption
	Wire Encryption Level
Cache Engine	Allocate Resources at Startup
	Back to Minimal State if Inactive
	Cache Allocation Size
	Max MicroKernel Memory Usage
	Minimal State Delay
Cache Engine Debugging	The settings available under Cache Engine Debugging perform the same functions for the client cache as similar settings under Server. See the related server settings for Debugging.

Table 13 Client Configuration Settings

Configuration Option	Parameter Name
Communication Protocols	Enable Auto Reconnect
	Supported Protocols
	Connection Timeout
Performance Tuning	Use Cache Engine
Security	Runtime Server Support
Application Characteristics	Embedded Spaces
	Verify Key Length
	Splash Screen

Access

Access contains the following configuration settings:

- Gateway Durability
- Number of Load Retries
- Use IDS
- Use Local MicroKernel Engine
- Use Remote MicroKernel Engine

Gateway Durability

Type	Range	Default	Units	Requires Engine Restart
Boolean	On Off	Off	None	Not applicable

This option specifies whether the MicroKernel Router should store in the registry a list of computers that do not have Pervasive PSQL running on them. This decreases the time it takes to find a gateway engine. You must set this option to Off when new engines are added to the workgroup.

Number of Load Retries

Type	Range	Default	Units	Requires Engine Restart
Numeric	0 to 65536	5	None	Not applicable

This setting specifies the number of times the MicroKernel Router attempts to connect to the target engine.

Use IDS

Type	Range	Default	Units	Requires Engine Restart
Boolean	On Off	Off	None	Not applicable

This setting is primarily for use with legacy applications that used Pervasive PSQL (IDS). IDS functionality is now integrated into the core product and IDS is no longer available as separately installed components. The integration of IDS requires that you reconfigure your client/server environment.

Typically, an application provides its own file location information. As an alternative, IDS provided file location mapping based on information in a text file, idshosts.

If your applications do not use the mapping feature through idshosts, set Use IDS to Off to improve performance.

If your applications already use idshosts, or if you prefer to use this alternative method to map file locations, set Use IDS to On. See Using the idshosts File.

Note Pervasive PSQL 8.5 or later is required if you set Use IDS to On or if your legacy applications pass file location information in the format of a PIDS URL. The requester uses database URIs to represent the IDS information. Database URIs were added with Pervasive PSQL 8.5. See Database URIs in *Pervasive PSQL Programmer's Guide* available in the Developer Reference.

Use Local MicroKernel Engine

Type	Range	Default	Units	Requires Engine Restart
Boolean	On Off	On	None	Not applicable

This setting determines whether a local application tries to connect to a local engine. If set to Off, no attempt is made to connect to a local engine.

Use Remote MicroKernel Engine

Type	Range	Default	Units	Requires Engine Restart
Boolean	On, Off	On	None	Not applicable

This setting specifies whether the MicroKernel Router allows access to a Server or Workgroup engine running on a remote server. If this value is set to On, and Use Local MicroKernel Engine is set to On, the remote server is tried first.

Wire Encryption

See Wire Encryption.

Note Client-side wire encryption settings are not used by the Pervasive JDBC and ADO.NET access methods. For them, encryption can be specified using the connection string. See Connection String Overview in *JDBC Driver Guide* and Defining Basic Connection Strings in *Data Provider for .NET Guide*.

Wire Encryption Level

See Wire Encryption Level.

Note Client-side wire encryption settings are not used by the Pervasive JDBC and ADO.NET access methods. For them, encryption can be specified using the connection string. See Connection String Overview in *JDBC Driver Guide* and Defining Basic Connection Strings in *Data Provider for .NET Guide*.

Cache Engine

These settings apply only when the cache engine is running. The Workgroup engine doubles as a cache engine. Note, however, that the cache engine is not used if a database server engine is running.

Cache Engine contains the following configuration settings:

- Allocate Resources at Startup
- Back to Minimal State if Inactive
- Cache Allocation Size
- Max MicroKernel Memory Usage
- Minimal State Delay

Allocate Resources at Startup

Type	Range	Default	Units	Requires Database Engine Restart
Boolean	On Off	Off	None	Not applicable

This setting instructs the cache engine to allocate resources, including threads and memory buffers, when the cache engine is started.

If you turn this option off, the cache engine does not allocate any resources until the first operation request. Pervasive PSQL components automatically allocate resources as needed. Therefore, in most cases you do not need to do so explicitly.

Back to Minimal State if Inactive

This setting displays only if the Workgroup engine is running.

Type	Range	Default	Units	Requires Database Engine Restart
Boolean	On Off	Off	None	Not applicable

This setting causes the cache engine to free considerable memory and thread resources to the system and return to a minimal state after a certain amount of time without any active clients. The time interval is specified by the value of Minimal State Delay. The cache engine reallocates resources when another client becomes active.

Cache Allocation Size

Type	Range	Default	Units	Requires Database Engine Restart
Numeric	1 megabyte to the amount limited by memory (see Note below)	Initialized dynamically at first start-up	megabytes (see Note below)	Not applicable

This setting specifies the size of the Level 1 cache that the MicroKernel allocates; the MicroKernel uses this cache when accessing any data files.

Speaking very generally, overall performance is usually best when the Cache Allocation Size is a value less than 40% of the physical memory on the system, and the Configuration setting Max cache engine Memory Usage is set to a value greater than 40%. Your exact optimal settings will depend on the size of your data files, the number of other applications running on the system, and the amount of memory installed in the computer.

The database engine initially sets this value the first time it starts and writes the value to the Registry. The initial value is set to 20% of physical memory. After the Registry setting is initialized, whenever the engine starts up, it reads the value from the Registry. The engine never re-calculates the setting. Changing the value using Configuration updates the value in the Registry. If you add or remove memory from the system, you must modify this setting manually to take best advantage of the new amount of memory available.

Note If you use Pervasive PSQL Clients prior to Pervasive PSQL v10, the value for cache allocation size must be specified in bytes, with a minimum of 64 KB (65,536 bytes). The maximum is limited by the amount of memory.

Max MicroKernel Memory Usage

Type	Range	Default	Units	Requires Database Engine Restart
Numeric	0-100	60	Percent	Not applicable

This setting specifies the maximum proportion of total physical memory that the cache engine is allowed to consume. L1, L2, and all miscellaneous memory usage by the cache engine are included. The database engine uses less if the specified proportion is not needed or not available.

If the value zero (0) is specified, then dynamic caching is turned off. In this case, the only cache available is L1, the size of which is specified by Cache Allocation Size.

For more information on tuning performance, please see Tuning Performance.

Minimal State Delay

This setting displays only if the Workgroup engine is running.

Type	Range	Default	Units	Requires Database Engine Restart
Numeric	0 - 2147483647	300	milliseconds	Not applicable

This setting specifies how long the cache engine waits during a period of inactivity before returning to a minimal state. (This is the initial state in which the cache engine begins.) By returning to a minimal state, the cache engine frees considerable memory and thread resources to the system. In some cases, you may not want the cache engine to return to a minimal state. For example, you may be running a batch file that uses the cache engine repeatedly. The cache engine reallocates resources when another client becomes active.

This setting is ignored if the value of Back to Minimal State if Inactive is set to Off (the default).

Cache Engine Debugging

These settings apply only when the cache engine is running. The Workgroup engine doubles as a cache engine. Note, however, that the cache engine is not used if a database server engine is running.

The settings available under Cache Engine Debugging perform the same functions for the client cache as similar settings under Server Debugging perform for the main database engine. For more information about each setting, see the related server setting:

- Number of Bytes from Data Buffer
- Number of Bytes from Key Buffer
- Select Operations
- Trace File Location
- Trace Operation

Communication Protocols

Communication Protocols contains the following configuration settings:

- Enable Auto Reconnect
- Supported Protocols
- Connection Timeout

Enable Auto Reconnect

Type	Range	Default	Units	Requires Engine Restart
Boolean	On Off	Off	None	Not applicable

This setting specifies whether you want the client to attempt to auto-reconnect during a network outage. A setting of On means Auto Reconnect is enabled.

Auto Reconnect is not in effect unless this setting is also enabled in the server configuration.

Supported Protocols

Type	Range	Default	Units	Requires Engine Restart
Multiple select	See below	All 3 options below	None	Not applicable

This setting specifies the protocols that are used by the client. If more than one protocol is specified, the client attempts to connect using all available protocols. When the first protocol succeeds, that protocol is used for the remainder of the session. The available options are:

- TCP/IP
- SPXII
- NetBIOS

Note You must have at least one protocol enabled at both the client and the server or they cannot communicate. NetBIOS is valid only for Pervasive PSQL Workgroup, not Pervasive PSQL Server. TCP/IP is the only supported protocol for Pervasive PSQL running on a Linux platform. Therefore, the Supported Protocols setting is not available on Linux.

Connection Timeout

Type	Range	Default	Units	Requires Engine Restart
Numeric	1 to 2147483647	15	seconds	Not applicable

The value of this setting specifies how long the client waits while searching for or connecting to a remote database engine. If this value is set too low, the client may return spurious "server not found" errors, because it is timing out before it has a chance to complete the connection. If the value is set too high, when the client attempts to connect to a server that is not reachable, you may encounter lengthy delays before receiving an error. Generally speaking, a value between 15 and 30 seconds is adequate for most networks. If you receive many "server not found" errors, try a higher setting.

This setting was previously named: TCP/IP Timeout for Communication Requester.

Performance Tuning

Performance Tuning contains the following configuration setting:

- Use Cache Engine

Use Cache Engine

Type	Range	Default	Units	Requires Database Engine Restart
Boolean	On Off	Off	None	Not applicable

This setting specifies whether the client cache should be used. If this setting is Off, then the client caches single records in a relatively small fixed-size cache on the client workstation. If this setting is On, then the client uses the Cache Engine, if it is loaded in memory. If the Cache Engine is not loaded, this setting has no effect.

The client cache is similar in many ways to the Workgroup engine. By default, it auto-loads into memory when an application first accesses the database, and it unloads a few minutes after that application is stopped.

You may wish to keep the client cache in memory at all times to avoid the performance cost of re-populating the cache with each usage session. If you want to keep the client cache loaded, run the following command from a command prompt: *file_path*\PSQL\bin\w3dbsmgr -btrv.

For default locations of Pervasive PSQL files, see Where are the Pervasive PSQL files installed? in *Getting Started With Pervasive PSQL*. See also the discussion of client cache under the setting Cache Allocation Size.

After the Cache Engine starts, a tray icon appears, allowing you to control the client cache from the Windows task bar. To stop the client cache, right-click on the client cache tray icon then click Stop Engines and Exit.

Note Pervasive PSQL synchronizes the client cache with the database engine cache and other client cache locations. This behavior is fully automatic and entirely transparent. However, there is a maximum delay of 5 seconds between any database change happening in the database engine cache and it being reflected in all client cache locations. If the possibility of such stale pages existing in the cache for a maximum of 5 seconds is unacceptable in your system, do not use the cache engine.

The following operations are not stored in the client cache:

- everything inside a transaction
- operations with a lock bias
- write operations such as insert, update, delete
- opens and close operations

Security

Security contains the following configuration setting:

- Runtime Server Support

Runtime Server Support

Type	Range	Default	Units	Requires Engine Restart
String	Yes No user_name,password	Yes	None	Not applicable

This setting controls runtime server support. If enabled with the value Yes, the current user name and password for the drive on which you are presently running are used. To enable RTSS with a different username, enter "*user_name,password*."

Note that you may use a fully qualified NDS user name in the format CN=*user_name*.O=*organization,password*. The user name may also be a simple Bindery name. The first entry in the Bindery context list must contain the simple name or the NDS login fails. If the NDS login fails for a simple name, a Bindery login is attempted. The Bindery login may cause delays while the login attempt is processing.

SUPERVISOR and ADMIN are not valid user names, even if supplied with the correct password. If the requester cannot find a login user name other than SUPERVISOR or ADMIN, it does not attempt to login.

Application Characteristics

Application Characteristics contains the following configuration settings:

- Embedded Spaces
- Splash Screen
- Verify Key Length

Embedded Spaces

Type	Range	Default	Units	Requires Engine Restart
Boolean	On Off	On	None	Not applicable

This option instructs the transactional interface to allow embedded spaces in file names for transactional interface operations.

Splash Screen

Type	Range	Default	Units	Requires Engine Restart
Boolean	On Off	Off	None	Not applicable

This setting controls whether or not the transactional interface splash screen displays. The splash screen displays the first time a client requester loads.

Verify Key Length

Type	Range	Default	Units	Requires Engine Restart
Boolean	On Off	On	None	Not applicable

This option can be used for legacy Btrieve applications to prevent the requester from verifying that the index key length passed to the client requester is large enough to hold the key. Setting this option to “off” may allow such applications to avoid status 21 errors.

Caution If set to “off,” this option disables the check by the Pervasive requester to prevent memory overwrites. A memory overwrite can cause a general protection fault (GPF) among other undesirable conditions.

Linux Client Configuration Parameters

You can configure both Pervasive PSQL Clients and Servers using the graphical utility Pervasive PSQL Control Center or the command-line interface utility `bcfg`. For PCC, see Using Pervasive PSQL Control Center in *Pervasive PSQL User's Guide*. For `bcfg`, see Configuration Through CLI Utility.

Case of Configuration Values

When checking or editing the values of settings, the Linux client performs a case-insensitive comparison. For example, entering 'Yes' or 'yes' for a setting value is interpreted identically by the Linux client.

Client Performance Affected by "Local" Setting

When the Linux client interface is first invoked, it populates its default settings in the Pervasive registry. The Pervasive PSQL Client does not have knowledge on whether its installation includes a server engine or not. Therefore, it sets the "Local" setting to yes. This can have an impact on the performance of your Linux client.

If the machine on which you are using the client does not have a server engine, you should set the Local setting to no. See Use Local MicroKernel Engine.

File Names with Embedded Spaces

By default, the Linux client interface does supports file names that contain embedded spaces.

For example:

```
/mymount/usr/gary/file with spaces.mkd
```

If you want to use file names without embedded spaces, you need to change the "Embedded Spaces" setting. See Embedded Spaces.

Configuration Reference

The following table lists the configuration options for the Linux client.

Table 14 Linux Client Configuration Settings

Configuration Option	Parameter Name
Access	Use Local MicroKernel Engine
	Use Remote MicroKernel Engine
	Use IDS
	Wire Encryption
	Wire Encryption Level
Communication Protocols	Enable AutoReconnect
Application Characteristics	Embedded Spaces
	Verify Key Length

Access

Access contains the following configuration settings:

- Use Local MicroKernel Engine
- Use Remote MicroKernel Engine
- Use IDS
- Wire Encryption
- Wire Encryption Level

Use Local MicroKernel Engine

See Use Local MicroKernel Engine.

Use Remote MicroKernel Engine

See Use Remote MicroKernel Engine.

Remote Engine and UNC Paths

For UNC paths to work properly from a client, the following steps must be performed:

- You must be running an engine on the same computer as the file that you are trying to access
- You must set Use Remote MicroKernel Engine to “on.”

Note You cannot send use a UNC path that points to the local Linux machine. However, you can use a path that is in the UNC style such as

```
//localhost/usr/local/psql/data/samples/sample.btr
```

If you do not want an engine on your file server (that is, you want to use the client's local engine), then you will need to mount the remote file system on the client, and modify the path so that it is a "native format" path and not UNC format. For example, the following path is a native Linux format:

```
/mnt/myremotedata/sample.btr
```

Use IDS

See Use IDS.

Wire Encryption

See Wire Encryption.

Note Client-side wire encryption settings are not used by the Pervasive JDBC and ADO.NET access methods. For them, encryption can be specified using the connection string. See Connection String Overview in *JDBC Driver Guide* and Defining Basic Connection Strings in *Data Provider for .NET Guide*.

Wire Encryption Level

See Wire Encryption Level.

Note Client-side wire encryption settings are not used by the Pervasive JDBC and ADO.NET access methods. For them, encryption can be specified using the connection string. See Connection String Overview in *JDBC Driver Guide* and Defining Basic Connection Strings in *Data Provider for .NET Guide*.

Communication Protocols

Communication protocols contains the following configuration setting:

- Enable AutoReconnect

Enable AutoReconnect

Type	Range	Default	Units	Requires Engine Restart
Boolean	On Off	Off	None	Not applicable

This setting specifies whether you want the client to attempt to auto-reconnect during a network outage. A setting of on means Auto Reconnect is enabled.

Auto Reconnect is not in effect unless this setting is also enabled in the server configuration.

Note The Pervasive Linux client supports this auto-reconnect feature, but currently the Linux server does not. Therefore, you can only use the AutoReconnect (PARC) feature from a Linux client connecting to Windows servers.

Application Characteristics

Application characteristics contains the following configuration settings:

- Embedded Spaces
- Verify Key Length

Embedded Spaces

See Embedded Spaces.

Verify Key Length

See Verify Key Length.

chapter

5 Performance

Analyzing and Tuning Database Performance

This chapter covers the following topics:

Analyzing Performance

Pervasive PSQL Server for Windows provides performance counters for use with the Windows Performance Monitor. The Pervasive PSQL performance counters are supported only on Windows Vista or later Windows operating systems. The performance counters measure state or activity of the database engine, which allows you to analyze performance of your application. Windows Performance Monitor requests the current value of the performance counters at specified time intervals.

Pervasive PSQL provides data only for display by the Performance Monitor and cannot modify the counter properties. Performance Monitor controls the following:

- The display of data is in three formats: line graph (default), histogram, and as a text report.
- The display fields are labeled "Last," "Average," "Minimum," and "Maximum."
- The scaling of values for display. Pervasive PSQL provides a default scale for each counter. Performance Monitor allows you to change the scaling of individual counters. See To Change a Counter Scale.

The counter values reflect all calls into the database engine regardless of their source. That is, the transactional interface, relational interface, native Btrieve applications, utilities, and so forth, all contribute to the counter values. Counter values are collected for all files. Counters on a per-file basis are not currently supported.

Note that the use of performance counters is an advanced feature intended primarily for application developers and other technical staff. Refer to the Microsoft documentation for details about the Windows Performance Monitor and on the use of counters in general.

Registration During Installation

By default, the Pervasive PSQL installation registers the Pervasive PSQL performance counters with Performance Monitor. The counters are available for use after installation completes.

Note that response to customer needs may result in additional Pervasive PSQL collector sets or counters being installed that are not discussed in this chapter. If so, refer to the description of the collector set or counter provided in Windows Performance Monitor. See Add Sets or Individual Counters To Monitor.

Data Collector Sets

A data collector set organizes multiple counters into a single component that can be used to review or log performance. Pervasive PSQL provides the following data collector sets.

- Pervasive PSQL MicroKernel Btrieve Operations
- Pervasive PSQL MicroKernel Cache
- Pervasive PSQL MicroKernel I/O
- Pervasive PSQL MicroKernel Locks and Waits
- Pervasive PSQL MicroKernel Transactions

Pervasive PSQL MicroKernel Btrieve Operations

These counters are useful for characterizing the behavior of client applications in terms of the transactional (Btrieve) interface. The counters report the types of operations being processed by the database engine at a given point in time.

See also Btrieve API Operations in *Btrieve API Guide*.

Table 15 Counters for MicroKernel Btrieve Operations

Counter	Description	Typical Use
Btrieve Close Operations per Second	The number of Btrieve Close operations per Second	To provide insight into the behavior of client applications. As a first step in troubleshooting issues, you may find it helpful to analyze your application behavior in terms of Btrieve operations.
Btrieve Get/Step Operations per Second	The number of Btrieve Get and Step operations per second. See Btrieve API Operations in *Btrieve API Guide* for the various Get and Step operations.	
Btrieve Open Operations per Second	The number of Btrieve Open operations per Second	
Btrieve Records Deleted per Second	The number of Btrieve records deleted per second	
Btrieve Records Inserted per Second	The number of Btrieve records inserted per second	
Btrieve Records Updated per Second	The number of Btrieve records updated per second	
Change Operations per Second	The number of Btrieve operations that modify the data files per second	
Operations per Second	The number of Btrieve operations executed per second	
Page Server Requests Per Second	The number of page server requests received per second	

Pervasive PSQL MicroKernel Cache

The database engine uses a two-level memory cache system to increase performance of data operations. The two caches are called Level 1 (L1) Cache and Level 2 (L2) Cache.

The more frequently the engine must read a page from disk to complete a user request, the lower the performance. These counters can be used collectively to view how successfully the database engine avoids disk reads and to determine if any changes need to be made to the cache size settings.

The best performance occurs when all data is stored in the L1 Cache. Because of the sizes of data files, however, the L1 cache cannot always hold all of the data pages, so the database engine also uses a second level cache. Pages in the L2 Cache are stored in a compressed format, allowing for more pages to fit in memory. Consequently, it is lower performing that the L1 Cache, but higher performing than the database engine reading the pages from disk.

See also To calculate the ideal size of the database memory cache.

Table 16 Counters for MicroKernel Cache

Counter	Description	Typical Use
Level 1 Cache Dirty Percentage	The percentage of the Level 1 Cache in use that contains dirty pages	To help determine if heavily accessed pages are continuously being forced out of the cache, which may adversely affect performance. Dirty pages, ones with changes that have not been written to disk, may only reside in the L1 Cache. Under heavy write loads, the L1 Cache may predominately contain dirty pages. This forces pages out of the L1 Cache and into the L2 Cache, if configured, or out of the L1 Cache entirely. The database engine writes dirty pages to disk at scheduled intervals or when the L1 Cache gets close to full. Frequently writing pages to disk may also adversely affect performance. It may benefit performance to adjust the L1 Cache size so that the percentage of dirty pages is not always high. See also Cache Allocation Size.
Level 1 Cache Hits per Second	The number of Level 1 Cache hits per second	To help determine how successfully the database engine finds requested pages in L1 Cache. A higher rate of hits-to-misses indicates that the engine is finding pages in L1 Cache rather than needing to access the L2 Cache or physical storage.
Level 1 Cache Hit Ratio	The percentage of cache hits to total cache access for the L1 cache The percentage displayed applies to the life of the database engine since the MicroKernel was last started.	
Level 1 Cache Misses per Second	The number of Level 1 Cache misses per second	

Table 16 Counters for MicroKernel Cache *continued*

Counter	Description	Typical Use
Level 1 Cache Usage	The percentage of Level 1 Cache currently in use	To aid in adjusting the size of the L1 Cache to fit your application(s). For example, applications that use small or predominately read-only data files may not fill up the L1 Cache as configured by default. The unused memory is not available to the operating system or to other applications. You can change the L1 Cache size to release the memory back to the operating system. Conversely, if you want to have an entire database in memory, you can monitor this value to know when the setting is as desired.
Level 2 Cache Hits per Second	The number of Level 2 Cache hits per second	To help determine how successfully the database engine finds requested pages in L2 Cache. A higher rate of hits-to-misses indicates that the engine is finding pages in L2 Cache rather than needing to access physical storage.
Level 2 Cache Hit Ratio	The percentage of cache hits to total cache access for the L2 cache The percentage displayed applies to the life of the database engine since the MicroKernel was last started.	
Level 2 Cache Misses per Second	The number of Level 2 Cache misses per second	
Level 2 Cache Raw Size	The current size of the Level 2 Cache in bytes	To help determine the size of the optional L2 Cache. The L2 Cache is one component of the setting for Max MicroKernel Memory Usage. That setting specifies the maximum proportion of total physical memory that the database engine is allowed to consume, which includes L1 Cache, L2 Cache, and all miscellaneous memory usage by the database engine. If the setting for Max MicroKernel Memory Usage is non-zero, the L2 Cache sizes itself to stay within the memory limit of the setting. The L2 Cache monitors memory consumption of the system and resizes itself as needed. The memory used by the L2 Cache may also be swapped out by the operating system.
Level 2 Cache Raw Usage	The amount of the Level 2 Cache currently in use in bytes	
Level 2 Cache Size Relative to Memory	Level 2 Cache size presented as a percentage of total system memory	To show what percentage of the total system memory the L2 Cache is using.
Level 2 Cache Usage	The percentage of Level 2 Cache currently in use	To show what percentage of the Level 2 Cache is currently being used.

Pervasive PSQL MicroKernel I/O

The counters in this set are useful for understanding the interactions of the database engine and data read and written to physical storage. The pages reported by the counters are data file pages. These counters do not report data for pages in files used for archival logging or for transaction logging.

See also Pages in *Pervasive PSQL Programmer's Guide*.

Table 17 Counters for MicroKernel Input/Output

Counter	Description	Typical Use
Pages Read per Second	The number of pages read from disk per second	To determine the interaction of the database engine and data read and written to physical storage.
Pages Written per Second	The number of pages written to disk per second	

Pervasive PSQL MicroKernel Locks and Waits

Client requests may be delayed by waiting for a resource to become available. These counters give insight into the types of database resources on which a client request may have to wait until the resource is available. As such, these counters may provide insight into the behavior of the database engine when multiple clients access it. A value close to or equal to the number of clients may indicate collisions for the same resources. Any corrective actions that can be done to alleviate these collisions may improve responsiveness.

The counters Waits on Page Buffers and Waits on Page Reads are waits on a global resource. All of the other counters in this grouping apply to multiple clients, but each client may be waiting on resources that differ from client to client.

See also Data Integrity and Supporting Multiple Clients, both in *Pervasive PSQL Programmer's Guide*.

Table 18 Counters for MicroKernel Locks and Waits

Counter	Description	Typical Use
Client Record Locks	The number of records explicitly locked by clients	To provide insight into the work load of client applications.
Waits on Active Reader Lock	The number of clients waiting on the Active Reader Lock. Multiple clients may hold the Active Reader Lock at the same time; however, the Active Reader Lock and the Active Writer Lock are exclusive. Consequently, a single client that holds the Active Reader Lock prevents any client from obtaining the Active Writer Lock. A single client that holds the Active Writer Lock prevents multiple clients from obtaining the Active Reader Lock. Each file has its own reader (and writer) lock. See also Waits on Active Writer Lock counter.	
Waits on Active Writer Lock	The number of clients waiting on the Active Writer Lock. Only one client may hold the Active Writer Lock for a file at a time. Each file has its own writer (and reader) lock. See also Waits on Active Reader Lock counter.	
Waits on File Locks	The number of clients currently waiting on a file lock	

Table 18 Counters for MicroKernel Locks and Waits continued

Counter	Description	Typical Use
Waits on Page Buffers	The number of clients waiting on a page buffer to become available. If a page is not available to service a request, the request blocks until the MicroKernel is able to make a page available.	To indicate whether or not the database engine has a page buffer available in the cache. Use this value along with the memory cache counters to decide if the caches are sized appropriately for the work load. Increasing the cache size will increase the total number of available pages, which can reduce the waits on page buffers. Three things may cause this value to spike when pages are not in cache: • a data file was recently opened • first time or infrequent access of a data page • the caches may be too small to contain all of the pages frequently accessed and modified. The spike for the first two items cannot be avoided because of accessing a file for the first time. The third item can be avoided by using a larger cache. If the caches are full and the cache misses are high, it is possible that the caches may be too small to contain all the pages frequently accessed and modified. See also Counters for MicroKernel Cache.
Waits on Page Locks	The number of clients currently waiting on page locks	To provide insight into the work load of client applications.
Waits on Page Reads	The number of clients waiting to read a page from disk. If a client is already in the process of reading the page, other clients must wait for the in-progress read to complete.	To help determine the number of clients trying to read the same page of the same file at the same time.
Waits on Record Locks	The number of clients currently waiting on record locks	To provide insight into the work load of client applications.

Pervasive PSQL MicroKernel Transactions

These counters are useful for understanding the behavior of client applications in terms of transactions. For example, a few long-lasting transactions that involve many changes cause a different behavior than many short-lived transactions.

See also Begin Transaction (19 or 1019), End Transaction (20), and Abort Transaction (21) in *Btrieve API Guide*, and Transactional Interface Fundamentals in *Pervasive PSQL Programmer's Guide*.

Table 19 Counters for MicroKernel Transactions

Counter	Description	Typical Use
System Transactions in Progress	The number of system transactions in progress. A system transaction is a special type of transaction that prepares data file changes then persists the changes to the file.	To help determine if system transactions are occurring too frequently or not often enough. The database engine writes changes to the data files during a system transaction. The frequency in which a system transaction occurs is determined by two server configuration parameters—Initiation Time Limit and Operation Bundle Limit—or triggered by a small amount of free space in the L1 Cache. In general, running the system transaction too frequently or not often enough adversely affects performance. Typically, you will notice that the number of page writes per second may increase, the number of Btrieve operations that modify records may decrease, and the number of clients waiting on the Active Writer Lock may increase. It may take experimentation to determine an ideal interval for a particular work load.
Transaction Commits per Second	The number of commits executed per second	To determine the number of application transaction commits. See also End Transaction (20) in *Btrieve API Guide*.

Using Windows Performance Monitor

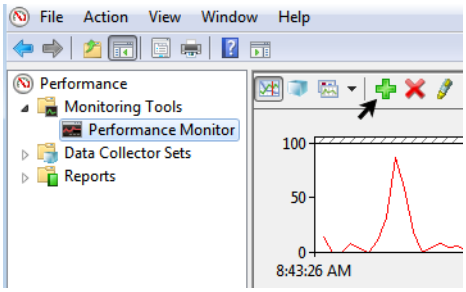
This section provides some rudimentary instructions on using Windows Performance Monitor to get started with the Pervasive PSQL performance counters. Refer to the Microsoft document for complete details on using Windows Performance Monitor.

The following steps assume that the Pervasive PSQL performance counters have been registered with Windows Performance Monitor by the Pervasive PSQL installation.

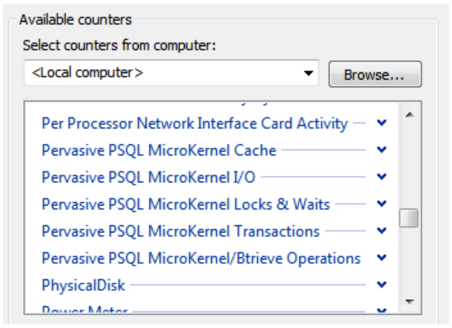
➤ Display Pervasive PSQL Data Collector Sets

1 Start Windows Performance Monitor. The steps vary depending on the operating system, but generally the utility can be started from Control Panel --> Administrative Tools. You may also try the command "perfmon" in the Run window (Start --> Run).

2 In the tree on the left, click "Performance Monitor," then click the plus sign on the right.



3 In the "Available counters" group, scroll to the Pervasive PSQL data collector sets.

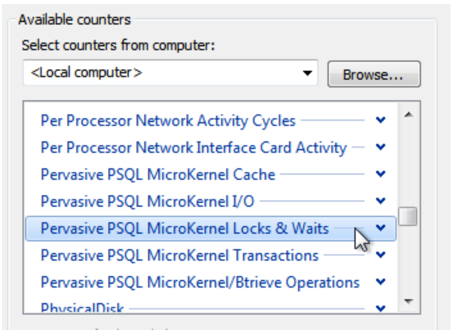


Per Processor Network Interface Card Activity
Pervasive PSQL MicroKernel Cache
Pervasive PSQL MicroKernel I/O
Pervasive PSQL MicroKernel Locks & Waits
Pervasive PSQL MicroKernel Transactions
Pervasive PSQL MicroKernel/Btrieve Operations
PhysicalDisk

➤ Add Sets or Individual Counters To Monitor

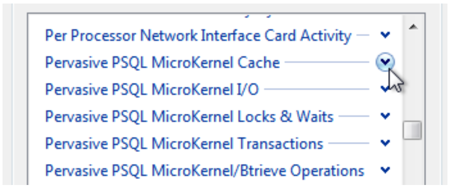
1 Perform one of the following:

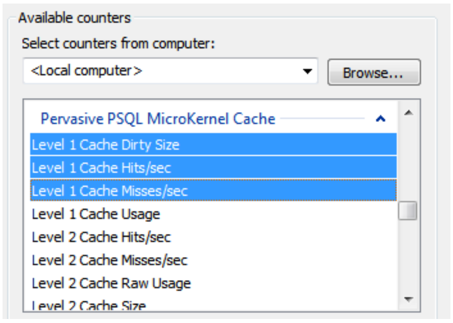
a. To add an entire set, click the desired set in the "Available counters" group.



Per Processor Network Activity Cycles
Per Processor Network Interface Card Activity
Pervasive PSQL MicroKernel Cache
Pervasive PSQL MicroKernel I/O
Pervasive PSQL MicroKernel Locks & Waits
Pervasive PSQL MicroKernel Transactions
Pervasive PSQL MicroKernel/Btrieve Operations
PhysicalDisk

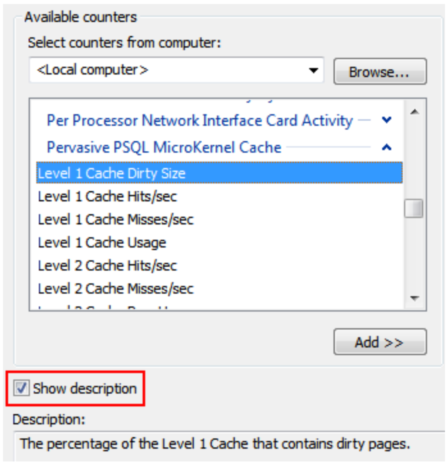
b. To add individual counters, expand the desired set, click (or multi-click) the desired counters.


Per Processor Network Interface Card Activity
Pervasive PSQL MicroKernel Cache
Pervasive PSQL MicroKernel I/O
Pervasive PSQL MicroKernel Locks & Waits
Pervasive PSQL MicroKernel Transactions
Pervasive PSQL MicroKernel/Btrieve Operations



Pervasive PSQL MicroKernel Cache
Level 1 Cache Dirty Size
Level 1 Cache Hits/sec
Level 1 Cache Misses/sec
Level 1 Cache Usage
Level 2 Cache Hits/sec
Level 2 Cache Misses/sec
Level 2 Cache Raw Usage
Level 2 Cache Size

To view a description of the counter, ensure that the Show description option is selected.

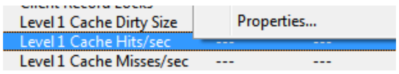


The percentage of the Level 1 Cache that contains dirty pages.

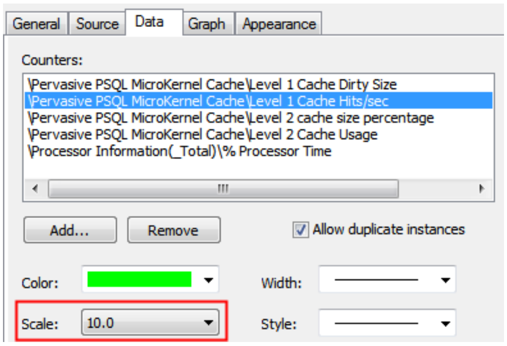
2 Click Add, then OK.

➢ To Change a Counter Scale

1 Right-click on the desired counter, then click Properties.



2 On the “Data” tab, click the “Scale” list, then click the desired value.



\Pervasive PSQL MicroKernel Cache\Level 1 Cache Dirty Size
\Pervasive PSQL MicroKernel Cache\Level 1 Cache Hits/sec
\Pervasive PSQL MicroKernel Cache\Level 2 cache size percentage
\Pervasive PSQL MicroKernel Cache\Level 2 Cache Usage
\Processor Information(_Total)\% Processor Time

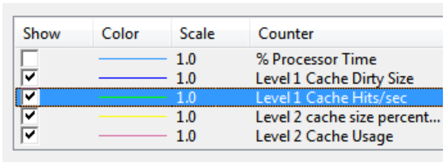
Scale: 10.0

You may need to adjust the Scale to display two or more counters on the same graph that have vastly different ranges. The counter value is multiplied by the Scale value before the data is graphed. For example, assume that one counter outputs values of 53 and

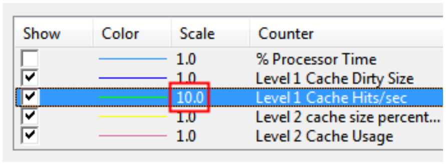
99, and a second counter outputs 578 and 784. You may want to set the Scale for the first counter to 10 so that its output is 530 and 990. This lets you look at the data from both counters more comparably (530, 990, 578, and 784).

3 Click OK.

Note that the scale on the display changes from its original value ("1" in this example) to the new value ("10" in this example):



Show	Color	Scale	Counter
☐	━	1.0	% Processor Time
✓	━	1.0	Level 1 Cache Dirty Size
✓	━	1.0	Level 1 Cache Hits/sec
✓	━	1.0	Level 2 cache size percent...
✓	━	1.0	Level 2 Cache Usage



Show	Color	Scale	Counter
☐	━	1.0	% Processor Time
✓	━	1.0	Level 1 Cache Dirty Size
✓	━	10.0	Level 1 Cache Hits/sec
✓	━	1.0	Level 2 cache size percent...
✓	━	1.0	Level 2 Cache Usage

4 On the "Graph" tab, set the desired values for Maximum and Minimum of the "Vertical scale."

You may want to change the vertical scale if what is being graphed is very small (or very large) so you can easily see when the values change. For example, if the counter values are always under 20, you may want to change the vertical scale to be Maximum 20 and Minimum 0.

5 Click OK.

Tuning Performance

This section provides some general tips on how to maximize performance on the initial database connection and on runtime operations. While we can offer some general guidelines, the performance of any specific application depends on a great number of factors, including but not limited to the following:

- Network bandwidth and use
- Coding techniques in the application
- Physical storage space available
- Memory available
- Processor speed
- Application usage patterns (such as write-heavy, read-heavy, transactions used/not used, small record size, large record size, complex queries, simple queries, ODBC, Btrieve only, and so forth)
- Unrelated applications competing for CPU cycles
- Database engine configuration

As you can see, the engine configuration plays a relatively limited role in the overall performance of any given application. Further, the database engine dynamically manages a variety of resources based on usage patterns. It tunes itself to your environment as needed. The following sections provided are offered only as helpful guidelines and are not a guarantee of any specific level of performance.

Spotting Performance Bottlenecks

You can use Monitor utility to expose performance bottlenecks related to certain database engine configuration options. You can start Monitor from the operating system Start menu or Apps screen or from the Tools menu in Pervasive PSQL Control Center.

Monitor Displays and Configuration Parameters

Two different Monitor menu selections display performance readings related to configuration options:

- MicroKernel ▸ Resource Usage
- MicroKernel ▸ Communications

The database engine dynamically manages several server configuration options, as shown in the following table.

Table 20 Dynamically Managed Settings Displayed in Monitor

Dynamically Managed Setting	Value Displayed in Resource Usage Window	Value Displayed in Communications Window
Files	✓	
Handles	✓	
Clients	✓	
Worker Threads	✓	
Total Remote Sessions		✓

Interpreting the Displays and Taking Action

You can make use of the information displayed in Monitor. Monitor displays three pieces of information about each type of resource. For example, the Total Remote Sessions display shows:

- *Current*. The current number of actual remote sessions operating.
- *Peak*. The highest number of actual remote sessions that have been used since the engine was started.
- *Maximum*. The maximum number of remote sessions allowed.

If the Peak value for a resource is the same as the Maximum value, then you may want to set the configuration property to increase the Maximum value for the resource, thus allowing the database engine to allocate additional instances of that particular resource when it needs to.

Before You Modify Configuration Parameters

The following sections assume the following:

1. Pervasive PSQL Control Center (PCC) is already open.

   If you need assistance with this task, see Starting PCC on Windows of *Pervasive PSQL User's Guide*.

2. You have already registered (if applicable) the engine you wish to configure.

If you need assistance with this task, see To register a remote server engine of *Pervasive PSQL User's Guide*.

3 You have appropriate operating system privileges to configure the given engine.

If you need assistance with this task, see Granting Administrative Rights for the Database Engine of *Pervasive PSQL User's Guide*.

4 For some engine settings, you must restart the database engines after making configuration changes.

Minimizing Initial Connection Time

The theory underlying minimal connection time revolves around three requirements. These requirements are summarized next, and detailed procedures follow:

- *Known communications protocol.* You do not want the client or server to spend additional time trying to connect via protocols that are not supported in your environment. By removing client/server support for unavailable protocols, you prevent the networking components from trying to use them.
- *Known location of database engine.* You do not want the client to attempt to connect to an engine that does not exist. By specifying Workgroup-only or Server-only support, as appropriate, you prevent the client from timing out while attempting non-existent connections. In environments where you have both unshared and shared databases, you can use Gateway Durability to force the database engine to keep track of machines where no database engine is running, so that it never attempts to connect to an engine on these machines, but uses another method to access the data.
- *Database engine ready to execute.* When a sleeping engine receives a new connection request, it takes time to re-allocate resources and return to a runtime state. If connection speed is more important than resource usage on the server, you can prevent the server engine from sleeping when it is not in use.

Client Parameters

You must be at the client machine to change the client parameters. You must change the parameters at each workstation whose settings you wish to change.

➢ To minimize client-side connection delays

1. In Pervasive PSQL Explorer, expand the Local Client node in the tree (click the expand icon to the left of the node).
2. Right-click on MicroKernel Router.
3. Click Properties.
4. Click Communication Protocols in the tree.
5. For Supported Protocols, ensure that the desired protocols are selected (check marked) and the protocols not being used are not check marked.
6. Click Apply.

   The client is now prevented from attempting to communicate on protocols that are not being used.
7. Click Access in the Properties tree.
8. If you are using only a remote Server or remote Workgroup engine, ensure that Use Local MicroKernel Engine is not check marked. (That is, it is set it to Off.)

   If you are using only a local Workgroup engine, ensure that Use Remote MicroKernel Engine is not check marked. (That is, it is set it to Off.).

   If you sometimes use a Workgroup engine and you sometimes connect to a Server engine or a remote Workgroup engine, you must leave both settings On (check marked).

   In such a mixed environment with shared and unshared data, you can set Gateway Durability to On at each client. This setting forces the client software to keep a list of the names of any machines on which it is unable to connect to a database engine. In order for the client software to determine no engine exists on a given computer, it waits for all of its network protocol requests to time out.

   If your data is stored on a server that does not have a Pervasive database engine on it, and you have set Use Remote MicroKernel Engine to Yes, the client must time out at least once to discover that there is no engine on that machine. Gateway Durability ensures that this time-out only happens the first time your application tries to access that data.

Note Using Gateway Durability fixes the network topology. If you later install a Server or Workgroup engine on the remote computer, you must turn off Gateway Durability on each client so that the list of computers without database engines is deleted (thus allowing you to connect to the new database engine). You may turn Gateway Durability back on immediately, but it starts with an empty list.

9 Click OK.

The client is now prevented from attempting to connect to any database engine types that are not in use.

Server Parameters

➢ To minimize server-side connection delays

1 In Pervasive PSQL Explorer, expand the Engines node in the tree (click the expand icon to the left of the node).

2 Right-click on the database engine for which you want to specify configuration settings.

3 Click Properties.

4 For Supported Protocols, ensure that the desired protocols are selected (check marked) and the protocols not being used are not check marked.

5 Click Apply.

The server is now prevented from attempting to communicate on protocols that are not being used.

Note Ensure that at least one protocol you have selected for the Server configuration is the same one as selected for the Client configuration. Your client and server cannot communicate if they are not using the same protocol.

6 Click Memory Usage in the Properties tree.

7 Select Allocate Resources at Startup to set the value to On (check box selected).

This option specifies that the database engine should allocate all necessary memory when it starts up, rather than when the first connection request comes in. Choosing this value requires more memory, but from the client perspective allows the engine to become operational faster.

8 Ensure that Back to Minimal State if Inactive is set to Off (check box cleared).

   This option specifies that the database engine should not release resources back to the operating system if the engine is inactive. All resources remain allocated and ready for use at the next client connection.

9 Click OK.

10 Click Yes to restart the engine for these changes to take effect.

Maximizing Runtime Throughput

The theory behind maximum throughput relies on too many variables to list here. Several of the most significant factors are:

- *Adequate physical memory.* If your host system has too little RAM, the system spends most of its time and CPU cycles swapping memory to disk and back, as different users and processes compete for limited resources.
- *Adequate CPU capacity.* If your CPU cannot keep up with the inflow of data processing requests, application performance suffers.
- *Adequate network bandwidth.* If your network is slow or suffers from a high collision rate, the database engine may sit idle between data access requests, while each client seems to display poor performance.
- *Minimal disk I/O.* Disk I/O is significantly slower than memory I/O. You want to avoid accessing the disk as much as possible, by having sufficient cache.
- *Adequate resource allocations.* Even with massive physical memory available, database performance may suffer if database engine configuration parameters are set artificially low.

In the end, optimal performance is a balancing act among network bottlenecks, disk I/O bottlenecks, memory bottlenecks, and CPU bottlenecks. This section provides some guidelines on how to reduce memory and disk I/O bottlenecks.

Fast Disk versus Fast CPU

If you want to maximize the effect of your hardware investment for performance gains, you must understand the existing constraints on your performance. If you have a database that is so large that you cannot reasonably buy and install enough memory to cache a significant part of the database, then performance is likely to be constrained by the disk I/O. Under these conditions, you may be better off to invest in a fast RAID disk array to maximize performance of the disk I/O.

In addition, if your application uses the SRDE and forces temporary files to be created frequently, you may want to ensure that the directory where these files are created is located on a fast disk drive. For more information about the location of this directory and the types of queries that generate temporary files, see Temporary Files in *SQL Engine Reference*.

If your database is small enough to be fully or near-fully cached in memory, then adding a fast disk array is unlikely to provide a significant performance boost. Under these conditions, upgrading the CPU or adding an additional CPU may provide the best performance improvement value.

Ensuring Adequate Physical Memory and Database Cache

Starting with Pervasive.SQL V8, the database engine offers Level 2 dynamic cache in addition to the Level 1 cache specified by the configuration setting, Cache Allocation Size. Assuming you do not turn off the Level 2 dynamic cache by setting Max MicroKernel Memory Usage to zero, the need to manually adjust the Level 1 cache size is much less critical than in previous releases. With that in mind, this section explains how to ensure that you have enough memory available for optimal performance of the database engine.

Ideally, your database engine should be able to allocate enough memory to cache full copies of every database it hosts, thus avoiding as much disk I/O as possible. Obviously, caching one or more entire databases is not practical in some situations, particularly when database size is very large. In addition, such measures as adding RAM to the machine only improve performance if the existing system resources are heavily loaded under normal usage.

The database engine dynamically selects a Level 1 cache size value when it starts up the first time. However, this value is based on available memory and may not be the ideal amount of cache for your environment.

➢ To calculate the ideal size of the database memory cache

1 Start by adding up the file sizes of all the data files serviced by the database engine.

Note If you have more than one database serviced by the engine, but they are never used at the same time, add up the file sizes of just the largest database.

For example, assume there are two databases on your server, with the following file sizes, and users access both databases at the same time:

Database A		**Database B**	
file1.mkd	223 MB	Afile.mkd	675 MB
file2.mkd	54 MB	Bfile.mkd	54 MB
file3.mkd	92 MB	Cfile.mkd	318 MB
file4.mkd	14 MB		

The sum of all these files is 1,430 MB.

The number you have now is the maximum amount of memory that the database engine would use if it cached all its hosted data. This number can be referred to as *MaxCache*.

You would never want to specify a value greater than this for Cache Allocation Size, because you would be allocating memory to the database engine that it would likely never use. A reasonable rule of thumb is to set Cache Allocation Size to about 20% to 70% of *MaxCache*. Lower values in this range are best for read-intensive applications, and higher values are best for write-intensive applications since all write/update operations take place in the Level 1 cache.

Note File pages are only written to the database cache when they are accessed. Thus, for a database engine to use *MaxCache* amount of memory requires every page in the database to be accessed. This system of estimating assumes a long-term steady state for database usage. If you bring the database engine down nightly or weekly, it may be unlikely that the database engine would access every page in the database within the given period of uptime.

If this situation applies to you, you may wish to estimate the average number of distinct pages that your application accesses within the given uptime period, multiply that by the page size, and obtain a more realistic value of *MaxCache* for your particular uptime scenario.

See also Counters for MicroKernel Cache.

On Windows 32-bit operating systems, all user processes are limited to 2 GB of memory. If you have calculated a value of *MaxCache* larger than 2 GB, and your database engine runs on a 32-bit Windows operating system, then you should use the value 2 GB for *MaxCache*.

➢ To determine how much total physical memory you need

Use the following equation to determine the approximate amount of total physical memory required by the database engine.

Maximum Database Memory Usage = *L1_cache_size* + *internal_allocations* + *L2_cache_size*

where:

L1_cache_size is the Cache Allocation Size

internal_allocations is approximately 25% of the size of the L1 cache

L2_cache_size is the amount of memory that expands and contracts based on memory load of the system

Note the following:

- The L1 cache is a fixed size based on Cache Allocation Size. It does not expand or contract based on database operations. If your application performs numerous WRITE operations, increase the L1 cache as much as possible.
- The greatest performance is obtained if all of the data can fit into the L1 cache. If all of the data will not fit into the L1 cache, adjust Cache Allocation Size and Max MicroKernel Memory Usage to use a reasonable amount of system memory.
- The L2 cache expands and contracts based on memory load of the system. For example, if other applications require more memory, the L2 cache contracts. If ample memory is available, the L2 cache reaches a maximum based on the equation above. The expansion and contraction affects performance. Contraction causes data pages to be removed from the L2 cache, for example. Reading the pages back from disk storage takes longer than if the pages could have been retained in the cache.
- The L2 cache contains compressed data pages (more pages in less space). Accessing pages from the L2 cache takes longer than from the L1 cache, but is faster than accessing the pages from disk storage. The L2 cache is helpful for applications that perform numerous READ operations but cannot fit all of the read data pages into the L1 cache.

Minimizing Disk I/O

Reading and writing data to/from disk is much slower than reading and writing to/from memory. Thus, one way to optimize performance is to minimize disk activity.

An important consideration in your attempts to minimize disk I/O is recoverability of data. Disk I/O is a direct trade off against transaction durability and recoverability. The more data you keep in memory without pausing to log changes to disk, the faster the database performs. On the other hand, the more data you keep in memory without pausing to log changes to disk, the more data you lose if the system experiences a failure.

➤ To reduce disk I/O

1 As discussed in the previous sub-section, Ensuring Adequate Physical Memory and Database Cache, one of the most important considerations is to ensure you have enough database memory cache to avoid frequently swapping data pages between disk and cache. See that section for details.

   One of the best ways to reduce disk I/O is to make sure that the dynamic Level 2 cache is turned on. The Level 2 cache adjusts its size dynamically as application usage changes, storing as much data as possible in memory and thus avoiding disk I/O when cache demands exceed the capacity of the Level 1 fixed cache. By default, the Level 2 cache is turned on. To verify that your database engine is using Level 2 cache, check the properties configuration setting Max MicroKernel Memory Usage (see Max MicroKernel Memory Usage).

2 Next, consider how much logging you require and what quantity of database operations you are willing to lose in a system failure. The greater the quantity of changes you are willing to lose, the more you can risk in the pursuit of performance.

   Using Archival Logging, Transaction Durability, and Transaction Logging all require log files. By default, archival logging is turned off. Turn it on only if you perform regular backups and you need the capability to restore data up to the moment of a system failure. When you specify the files to be logged, be sure to specify only the files for which you absolutely must have logging. See Chapter 8, Logging, Backup, and Restore, for more information.

   By default, transaction logging is turned on. Turning off transaction logging should improve performance slightly, but does not guarantee multi-file consistency and transaction atomicity. Before turning off transaction logging, check with your application vendor to be sure they allow the application to run without this feature.

Caution The consistency of any multi-file database cannot be guaranteed if transaction logging is disabled.

By default, transaction durability is turned off. Turn on this feature only if your application requires completed transaction operations to be durable through a system crash. Transaction durability entails the highest performance penalty, and the trade off is the highest safety of your completed transactions.

3. If you have any logging features turned on, you can specify how much data the engine stores in memory before writing to disk. This feature is important because the changed data builds up over time. The more log data you allow to build up in memory, the less frequent the disk writes are.

   The setting Log Buffer Size specifies the number of bytes of database operations that the engine stores in memory before writing them out to the log files. (Click Performance Tuning on the server Properties tree.)

   If a system failure occurs, the data in the log buffer is lost.

4. If you have transaction durability turned on, you can specify the maximum size of the log segments on disk. Specifying a larger log segment size can improve performance slightly, because fewer log segments have to be created and closed over time.

   The setting Transaction Log Size specifies the maximum number of bytes that can be stored in a log segment before closing it and opening a new segment. (Click Performance Tuning on the server Properties tree.)

5. If your database is highly used, consider configuring your system to maintain the logs on a separate physical volume from the volume where the data files are located. Under heavy load, performance is typically better when the writes to the log files and to the data file are split across different drives instead of competing for I/O bandwidth on a single drive. The overall disk I/O is not reduced, but the load is better distributed among the disk controllers.

6. If your application usage is weighted heavily in favor of database read operations, you can increase performance by turning on Index Balancing. (Click Performance Tuning on the server Properties tree.) Over time, index balancing increases the number of nodes on the average index page, allowing read

operations to occur faster. However, for insert, update, and delete operations, additional time and disk I/O may be required because the engine balances the index nodes across adjacent pages.

7 Be sure that tracing is turned off, both in the MicroKernel and/or at the ODBC level. Tracing may cause a significant reduction in performance because it can introduce a large amount of disk I/O.

To ensure ODBC tracing is turned off, start ODBC Administrator from Pervasive PSQL Control Center. In ODBC Administrator, click on the Tracing tab. If tracing is off, you should see a button labeled “Start Tracing Now,” and thus you should click Cancel. If tracing is on, click Stop Tracing Now, then click OK.

To ensure MicroKernel tracing is turned off, set the properties configuration Trace Operation to Off (not check marked). (Click Debugging on the server Properties tree.)

Ensuring Adequate Resource Allocation

If your database server platform has adequate memory and CPU power, you should ensure that your database engine can take full advantage of the available hardware resources to service multiple clients and multiple data files most efficiently.

➢ To configure multiple client and file handling

1 The setting Number of Input/Output Threads allows you to specify how many threads are available to handle file operations. (Click Performance Tuning on the server Properties tree.)

As a guideline, the value of this setting should be about 1/8 the number of files the application has open, on average. For example, if the application has 40 files open most of the time, I/O Threads should be set to 5.

Using Monitor, click MicroKernel ▸ Resource Usage from the menu. In the window that appears, the Files: display shows you current and peak number of files open. You can generate an average reading by recording several Current values over time. Then you can specify an appropriate setting for I/O Threads based on the average value.

Large System Cache

Some Windows operating systems provide a Large System Cache setting that allows the system to take advantage of free memory to cache recently accessed data. By default on certain server editions, this setting is "on," which favors simple file sharing and can result in very aggressive system cache growth.

The aggressive use of memory for file caching can swap out Pervasive PSQL, which can cause a substantial performance issue with the database. You may notice a performance decrease if Large System Cache is "on," and the Pervasive PSQL setting **System Cache** is also set to "on" (either explicitly or you have set **Max MicroKernel Memory Usage** to zero). One possible solution to increase database performance is to turn off Large System Cache.

To turn off the cache, access the system properties (from example, from the Control Panel or from the properties for My Computer). Click the **Advanced** tab, then the **Settings** button for "Performance." On "Performance Options," click the **Advanced** tab.

Under "Memory Usage," if the **System Cache** option is selected, Large System Cache is turned "on." To turn it "off," click the *other* option for "Memory Usage:" **Programs**. Click **OK** as required to close the series of open dialogs, then restart the operating system. Note that a reboot is required for the operating system setting to take effect.

See also System Requirements for Xtreme I/O Driver.

Performance on Hypervisor Products

Pervasive PSQL Vx Server is the database product intended for use with hypervisor products and an environment of virtual machines (VMs). To achieve the best performance for Pervasive PSQL Vx Server, ensure the following:

- Adherence to the performance best practices recommendations from the hypervisor vendor.
- The VM hosting Pervasive PSQL Vx Server has ample memory (RAM).
- The hypervisor host has enough virtual CPUs to minimize virtual CPU contention among all of the VMs on the same machine. This prevents contention with the VM running Pervasive PSQL Vx Server. If you use affinity rules, ensure that all cores are running on the same socket.
- The Pervasive PSQL Vx Server data files reside on very fast physical storage and minimize spindle contention and controller contention for the physical storage device.

Xtreme I/O Driver

The Pervasive PSQL 32-bit Server product for Windows includes an optional database accelerator called Xtreme I/O (XIO). If the system meets the minimum requirements for XIO, you may install this option using the Custom installation. XIO increases database performance by accelerating disk access time for Pervasive PSQL data files.

XIO and the database engine work together to boost performance. The engine notifies XIO when a data file is opened. From that point on, XIO accelerates disk access for the data file. XIO works transparently—no intervention is required by a user or an application.

XIO also lets you exclude data files that you do not want to accelerate. Specifying exclusions is as simple as updating a text file and restarting the database engine.

The following topics provide additional details about XIO:

- Considerations
- System Requirements
- XIO Memory Cache
- Frequently Asked Questions
- Utilities
- Exclusions File
- Pvsw.log Message
- Event Log Messages
- Troubleshooting XIO

See also the Pervasive PSQL Technical Papers listed on the Pervasive Web site for the XIO technical paper. The paper covers technical details beyond the scope of this section.

Considerations

Typically, XIO increases performance for most applications with large data sets. The following table lists considerations for the use of XIO.

Table 21 Considerations for the Use of XIO

Condition	Discussion
Your application use a random access pattern with its data (the data access tends not to be sequential)	Such patterns are characteristic of an application using a database management system.
Your data set is larger than will fit completely in the Windows system cache	The larger the data set size compared to the size of the Windows system cache, the more disk reads and writes occur. XIO is then able to cache the reads and writes. If the data resides entirely in the Windows system cache, XIO does not process the read or write request.
Your application performs frequent disk access operations (reads and writes)	Disk access is often the slowest aspect of an application.
You already use a third-party program to accelerate disk input and output.	The use of multiple programs to accelerate disk I/O is highly discouraged. Such programs can interfere with one another and produce unpredictable results. For this reason, XIO should be the only disk I/O program running.

System Requirements

XIO can be installed only on platforms that meet the following requirements:

- Windows server class 32-bit operating system (XIO is not supported on 64-bit platforms)
  - Windows Server 2008, RTM (6.0.6001), or Service Pack 2 (SP2, 6.0.6002), or greater
  - Windows Server 2003 (with latest Service Pack)
- CPU must be a Pentium 3 or newer.
- 4 GB of available system RAM, minimum. Note that XIO also checks the memory requirement at runtime. If memory is below the 4 GB minimum at runtime, XIO does not run.
- The Pervasive PSQL data files must reside in a NTFS file system. Data files on a FAT32 file system are not supported. (Refer to the operating system documentation for “file system” for further information.)

After installing XIO, you need to ensure the following system configurations:

- The operating system Large System Cache must be turned "off." That is, the LargeSystemCache setting in the Windows Registry must be set to zero. Note that, if XIO is installed, the Pervasive PSQL installation turns off Large System Cache.
- The Pervasive PSQL L2 cache must be turned "off." That is, the setting for "Max MicroKernel Memory Usage" must be set to zero. See Max MicroKernel Memory Usage. Note that, if XIO is installed, the Pervasive PSQL installation turns off the L2 cache.

XIO Memory Cache

XIO uses block-level caching, but only for the specific files that the database engines needs to accelerate. The XIO memory cache is dedicated to Pervasive PSQL data files. You cannot, for example, use XIO as a generic disk access accelerator for non-Pervasive files.

XIO manages its cache using sophisticated tracking and caching algorithms that are beyond the discussion scope of this section. XIO's use of memory, however, can help you better understand how the driver functions.

Memory Usage

XIO can use extended memory, standard memory, or a combination of the two.

Extended Memory

XIO first uses extended memory for its cache if extended memory is available. Note that extended memory is also referred to as physical address extension (PAE) memory. Extended memory is any RAM above 4 GB.

XIO reserves as much extended memory as the operating system allows up to the value specified in the registry for MaxPAEMemMB. See Registry Settings. XIO retains the extended memory until the system is shut down. That is, if the cache is held totally in extended memory, the cache size remains static and does shrink or expand.

Standard Memory

If extended memory does not exist, XIO acquires its cache from standard memory. Standard memory is any RAM up to 4 GB. With standard memory, XIO balances the memory demands of the database engine with the memory requirements for the entire system. The XIO cache shrinks and expands as other system resources also acquire and release memory.

If the Registry value for MaxCacheSizeMB is -1 (the default), XIO XIO adjusts, by increasing or decreasing, the size of its cache based on the current state of the system. The maximum cache size in this instance is approximately 80% of physical memory.

If MaxCacheSizeMB is set to a number of megabytes, XIO expands only up to that value as the operating system allows.

If MaxCacheSizeMB is set beyond the amount of memory installed, an error is written to the Windows Event Log and the driver does not load. See Event Log Messages.

MaxCacheSizeMB is the maximum size of the cache based on the combination of standard memory and PAE memory, if PAE memory exists. The cache is not allowed to grow beyond the value of MaxCacheSizeMB regardless from the memory originates. See Registry Settings.

Combination Memory

If extended memory exists, but the operating system cannot allocate the value specified for MaxPAEMemMB totally from it, XIO uses a combination of extended and standard memory. XIO consumes extended memory above 4 GB as available from the operating system to fulfill the MaxCacheSizeMB setting before it uses standard memory below 4 GB. The portion of the XIO cache that resides in standard memory shrinks and expands as required.

Registry Settings

The Windows Registry contains the configuration parameters for XIO. The majority of parameters are reserved and must not be altered.

However, the following registry entries are configurable: MaxCacheSizeMB and MaxPAEMemMB.

Registry Key[1]	Purpose	Valid Values	Discussion
MaxCacheSizeMB	Specifies the maximum number of megabytes (MB) of physical memory that XIO can use for its cache	-1or the value in MB that you want Default: -1	This setting is for the maximum combination of standard memory and PAE memory if PAE memory exists. -1 instructs XIO to dynamically grow and shrink its cache in standard memory as required Pervasive recommends that MaxCacheSizeMB be set to -1 to allow XIO to adjust the cache dynamically.
MaxPAEMemMB	Specifies the maximum number of megabytes (MB) of physical physical address extension (PAE) memory that XIO uses for its cache	0 or the value in MB that you want Default: 8192	PAE memory is any RAM above 4 GB
[1]HKEY_LOCAL_MACHINE\SOFTWARE\PERVASIVE SOFTWARE\XIO			

Caution Do not modify any XIO registry entries other than those listed in the table above. Unpredictable results can occur.

Editing the registry is an advanced procedure. If done improperly, the editing could cause your operating system not to boot. If necessary, obtain the services of a qualified technician to perform the editing.

Frequently Asked Questions

This section discusses some of the common questions about XIO.

Question	Answer
Can I use XIO in a clustering environment?	**No**. Xtreme I/O must **not** be installed if Pervasive PSQL is being used in a clustering environment. A node with XIO installed can hang when the machine comes online through a failover and leave the shared storage inaccessible. Therefore, on the installation **Setup Type** dialog for Pervasive PSQL, select **Custom**. If “Pervasive Xtreme I/O” displays as an available installation option, click that option. Select “This feature will not be available.” Complete the rest of the Pervasive PSQL installation. No further customizing is required.
Can I use XIO on a Virtual Machine?	**No**. Xtreme I/O must **not** be installed if Pervasive PSQL is being used on a Virtual Machine.
Is XIO included with Pervasive PSQL Vx Server?	No. Although Pervasive PSQL Vx Server Vx can be installed on a physical machine, it is primarily intended for virtual environments. Since XIO must not be used in virtual environments it is not included as part of the Pervasive PSQL Vx Server installation.
How do I know if XIO is installed?	Check for the XIO message in the pvsw.log file. See Pvsw.log Message. Or, at a command prompt, execute the command xiomgr. If the operating system reports the help information for xiomgr, then the XIO driver is installed.
How do I know if XIO is enabled?	Run the utility xiomgr with the “query” option: xiomgr -query. The utility reports the current state of XIO (enabled or disabled) and whether it is running or not. See Xiomgr. In addition, you can check for the XIO message in the pvsw.log file. See Pvsw.log Message.
How do I know if XIO is running?	
How do I know how much memory the XIO cache is using?	Run the utility Xiostats. The “Cache Size” statistic tells you the size of the XIO cache in megabytes (MB). See also Xiostats Statistics.

Question	Answer
How do I know how efficient the XIO cache is?	In general, check the percentage for the "Read Hit %" statistic. The larger the percentages, the more that the XIO cache is being used, and the more efficiently XIO increases performance. To a lesser extent, you can also check the "Cacheable IO %" statistic, which indicates the percentage of all I/O requests that pertain exclusively to Pervasive PSQL data. A high percentage indicates that the majority of disk access requests involve Pervasive PSQL data. See also Xiostats Statistics.
How do I know what files are cached in the XIO cache?	Run the utility Xiostats. Click **View** then **Open Files**. See also Tour of Features.
Why does the "Open Cached Files" statistic show more or fewer files than the number of files I think I have open?	The database engine may open a file and then close it, in which case it will not be counted among the open cached files. Opening a segmented Pervasive PSQL of four segments indicates that four files are open, not just one. The database engine performs a file open operation for each segment. System files, System files and data dictionary files may also be open, which are included in the total. See also Xiostats Statistics.

Utilities

XIO provides two utilities for working with the driver: xiomgr and xiostats.

Xiomgr

Availability

Windows (32-bit)	Linux	Clients	Server Database Engine
Yes	No	No	Yes

Description

Xiomgr manages the XIO driver.

Synopsis

```
xiomgr -<query | start | stop | enable | disable | help>
```

Options

-query	Report the current state of the XIO driver, such as whether or not it is running or enabled.
-start	Start the XIO driver. If issued following an xiomgr -stop command, ensure that the database engine services are started first. See also Troubleshooting XIO.
-stop	Stop the XIO driver. The database engine services must be stopped first. See also Troubleshooting XIO.
-enable	Start the XIO driver when the operating system starts. The enable option takes effect the next time you boot the operating system.
-disable	Prevent the XIO driver from starting when the operating system starts. The disable option takes effect the next time you boot the operating system.
-help	Show the utility usage information.

Xiostats

This utility displays statistical information about the XIO cache.

Note that Xiostats is primarily an advanced utility intended for users who have a thorough understanding of statistics and viewing graphed data. Even so, the utility also provides some basic statistical information. See also Frequently Asked Questions. for some general tips on using Xiostats.

Statistics

The main purpose of Xiostats is to provide statistical information about XIO and the XIO cache. This information appears as a matrix in the main window of the utility. The following table explains the statistics.

Table 22 Xiostats Statistics

Statistic	Meaning
Time	The system date and time.
Elapsed Seconds	The number of seconds elapsed since Xiostats was invoked. That is, how long in seconds it has been running.
Physical Memory	The approximate total physical memory, including extended memory, on the machine.
Cache Size	The size of the XIO cache in megabytes. This value can vary depending on which memory the cache is using. See Memory Usage.
Open Cached Files	The number of Pervasive PSQL files open and actively being cached (the file is being read from or written to). Note that the total number of opened cached files may differ from the number you think are open. Opening a file may result in multiple physical files being opened. For example, a segmented Pervasive PSQL of four segments indicates that four files are open, not just one. The database engine performs a file open operation for each segment.
Compression Ratio	The amount of data compression performed by the cache. For example, suppose that the Compression Ratio is 8 (meaning 8 to 1). If your cache is 1 GB in size and your compression ration is 8, the cache is storing 8 GB of data. This ratio depends on the characteristics of the data. Some data can be compressed, other data cannot.
Read Hit %	“Hit” refers to XIO reading the data from its cache not from the physical disk. In general, the higher the percentage, the more efficiently XIO is performing. Note: If the data resides totally in the Windows system cache, XIO does not process the read request.
Dirty Buffers %	The amount of data in the cache that has been written to the cache but not yet written to disk.

Table 22 Xiostats Statistics

Statistic	Meaning
Cacheable IO %	The percentage of all I/O requests that pertain exclusively to Pervasive PSQL data. (XIO is aware of all disk access requests but acts only on those pertaining to Pervasive PSQL data.) If your server is dedicated exclusively to Pervasive PSQL, Cacheable IO % should show a high percentage because the majority of disk access requests involve Pervasive PSQL data.
Cache Read Bytes	The number of bytes read from the cache.
Cache Write Bytes	The number of bytes written to the cache.

Tour of Features

The following table provides a brief tour of the utility features that support the statistical reporting.

Feature	Description
Options	The Options dialog lets you customize certain aspects of the utility, such as the interval in which Xiostats polls its cache. The **Options** command is accessed from the **File** menu.
Parameters	The Parameters list shows you the various Registry settings for Xiostats. You can customize only two of the settings. See Registry Settings. Do **not** modify any XIO registry entries except the two listed under Registry Settings. Unpredictable results can occur. The **Parameters** command is accessed from the **View** menu.
Opened Files	The Opened Files list is useful to view which files are currently opened and cached. The **Opened Files** command is accessed from the **View** menu.
PerfMon	The PerfMon command provides a convenient way to access the counters for the PerfMon utility. The PerfMon utility is included as part of the Windows operating system. Refer to its documentation for the use of counters.
Graph	The Graph command lets you graph the statistical data and view it different ways. You can view data by graphing the variable, derivative, or integral. You can also graph statistical data that has been saved to an Xiostats log. An Xiostats log is a text file saved in comma separated value (csv) format that can be viewed in a spreadsheet program. You open and close log files (csv files) with the commands in the **File** menu.
Log File	The Log File command lets you start logging statistical information, stop logging, and set a logging schedule. An Xiostats log is a text file saved in comma separated value (csv) format that can be viewed in a spreadsheet program. You open and close log files (csv files) with the commands in the **File** menu. Note: If your logging interval is very frequent, the log file can grow very large in a short period.

Exclusions File

XIO includes a text file, xioexclude.lst, that allows you to specify data files not to accelerate. Typically, you do not need to add exclusions. However, if you choose to exclude files, follow these steps:

1 Open the file in a text editor.

By default, the file is located in Pervasive Software\PSQL under %allusersprofile%. Ensure that you search for hidden files because, by default, the operating system hides certain folders under %allusersprofile%.

2 Add file names by following the instructions in xioexclude.lst.

3 Reboot the operating system.

Pvsw.log Message

During installation of the database engine, a message is written to the pvsw.log file if XIO is installed and the database engine is able to cache files in the XIO cache. The log file contains the following message:

```
The MicroKernel has acquired an active linkage to the XIO
Cache driver.
```

Note If XIO is installed but the pvsw.log does not contain the message, then the database engine is unable to communicate with XIO and no files will be cached. One possible corrective action is to stop and then start the transactional service. (See Starting and Stopping the Server Engine on a Windows Server in *Pervasive PSQL User's Guide*.) Upon restart, if the database engine can communicate with XIO, the message is written to pvsw.log.

Event Log Messages

XIO writes its error messages to the Windows Event Log as explained in the following table.

Table 23 Xiostats Event Log Messages

Message	Corrective Action
XIO started.	None required.
XIO did not shut down properly.	Contact Pervasive Technical Support if error occurs consistently.
XIO failed to load because a memory allocation of %2 bytes for %3 failed.	Verify the amount of system memory installed and the settings for MaxCacheSizeMB and MaxPAEMemMB.
XIO detected insufficient RAM (%2MB). It requires %3MB to operate.	Increase the system RAM to the required minimum of 2 gigabytes (GB).
XIO encountered an unrecoverable system error. %2.	Contact Pervasive Technical Support.
XIO detected the parameter %2 has an invalid value %3. The legal range is %4 to %5. The current setting has been coerced to the default value %6.	Set the parameter to a value within the legal range.
NT OS Version %2.%3 is not a Server Build. XIO detected the parameter %2 has an invalid value %3. The legal range is %4 to %5. The current setting has been coerced to the minimum value %6.	Set the parameter to a value within the legal range.
XIO detected that the installed memory size changed from %2MB to %3MB.	Verify the amount of installed memory and ensure that the minimum amount, 2 GB, is available.
The maximum cache size parameter (%4MB) may need adjustment.	Check the setting MaxCacheSizeMB and adjust as required based on the amount of system memory and the data set.

Troubleshooting XIO

This section offers suggestions on what to do if you encounter problems using XIO.

Table 24 XIO Troubleshooting

Situation	Discussion
XIO is enabled but the operating system does not load when booted	1. Boot the operating system into safe mode (typically, press the F8 key as the system is attempting to boot). 2. At a command prompt, execute the command **xiomgr -disable** to prevent the XIO driver from loading. (By default, xiomgr is located in the PSQL\bin\ directory in the Pervasive tree under Program Files. See also Where are the Pervasive PSQL files installed? in *Getting Started With Pervasive PSQL*.) 3. Reboot the operating system, which should load without starting XIO.
XIO cache not responding to reads or writes from database engine	This situation can occur if the communication between the database engine and the XIO cache becomes unlinked. Use the following sequence of actions to reestablish the communication between the database engine and the XIO cache: 1. Stop the Pervasive PSQL services. 2. Issue the Xiomgr -stop command. 3. Issue the Xiomgr -start command. 4. Start the Pervasive PSQL services. The unlinking can occur when the actions are performed in the wrong sequence, such as: A. Pervasive PSQL services stopped. B. Xiomgr -stop command issued. C. Pervasive PSQL services started. D. Xiomgr -start command issued. The problem is that steps C and D are reversed in sequence. Following an Xiomgr -stop command, you must first issue the Xiomgr -start command and *then* start the Pervasive PSQL services.

chapter

6

Setting Up Referential Integrity

An Introduction to Referential Integrity Structures

Referential Integrity is a system of checks and balances that you can create in your database to ensure that tables with related data remain synchronized.

Concepts of Referential Integrity

Referential Integrity (RI) allows you to modify or prohibit updates, inserts, or deletes based on whether identical field values exist in the same or other tables.

Definitions

A good understanding of RI depends upon a clear understanding of several important terms:

Rule

A *rule* is a simple statement of cause and effect, carried out by the RI system defined in the database.

Example A

For example, a *delete rule* defines what happens to records containing a foreign key when a record containing a primary key is deleted: “When the record containing ‘Bhargava Building’ is deleted, all rows in Table A that reference that record are deleted.”

A delete rule can also prohibit the row containing the primary key value from being deleted if there are any foreign key values that reference the given primary key value.

Example B

An *update rule* defines what happens to a record containing a foreign key when a user attempts to update the record or add a new record: “When a user attempts to insert a new record to Table B, reject the attempt if the building name does not exist in Table C.”

Primary key

A *primary key* is the column or columns upon which a rule depends. Only one primary key is permitted in any table, and the primary key must not allow duplicate values. For an update rule, the primary key is the column or columns against which updated or inserted columns are compared to determine if the updated or inserted record should be allowed.

In Example A, the column containing “Bhargava Building” is the primary key.

In Example B, the column in Table C that contains the building name is the primary key.

Foreign key

A *foreign key* is the column or columns that are compared against a primary key to determine how to proceed.

In Example A above, the column in Table A that may contain the value “Bhargava Building” is the foreign key.

In Example B above, the column in Table B that contains the building name is the foreign key.

Cascade

A *cascade* rule is a rule in which the database permits the desired operation to occur, then enforces RI by changing other tables or rows to synchronize with the first operation. For example, if a *delete cascade rule* is defined, deleting a record in the primary key table causes the database to find and delete all rows throughout the database that have foreign key values the same as the primary key value of the deleted row.

Restrict

A restrict rule is a rule in which the database decides whether or not to permit the desired operation based on existing values in the database. For example, if an *update restrict rule* is defined, an attempt to add a row to a table containing a foreign key causes the database engine to compare the value in the foreign key field to the values in the primary key. If there is no primary key row with the same value, the new row is not permitted to be added to the foreign key table.

Understanding Keys and Rules

This section explores the concepts behind primary keys and foreign keys in further detail.

Table 25 Primary and Foreign Keys

Table A		Table B	
• student_ID	• Name	• stud_ID	• Class
20543	John	20543	ENG-101
20577	Mary	20543	AST-202

In the example shown above, the column named `student_ID` in Table A (`A.student_ID`) is an IDENTITY data type that does not allow two rows to the have the same value. Every student has a unique ID number. We will define `student_ID` as the primary key of Table A.

We can then define the column named `stud_ID` in Table B (`B.stud_ID`) as a foreign key that references `A.student_ID`. Note that the data type of `stud_ID` must be a type that can be compared with IDENTITY, such as INTEGER. The data types of primary and foreign keys must be compatible. You can have as many foreign keys as you need in order to enforce your desired referential integrity scheme. Multiple foreign keys can reference the same primary key.

The table with the primary key can be referred to as the parent table, while the table with the foreign key is called the child table. Once the keys are defined, we have a range of behaviors to choose from, as shown in Table 26. You can define as many rules as fit your needs, but you can only have one of each type. For example, if you define a delete restrict rule, you cannot define a delete cascade rule on the same keys, because the two behaviors are mutually exclusive.

Table 26 Choices for RI Rules

If you want this behavior...	... define this rule:
Do not allow a row to be inserted or updated in Table B unless the proposed value of B.stud_ID matches any value in A.student_ID.	Update Restrict
Do not allow a row to be deleted from Table A if any value of B.stud_ID matches that row.	Delete Restrict
If a row is deleted from Table A, delete all rows from Table B in which B.stud_ID matches the value of A.student_ID in the deleted row.	Delete Cascade

Update Restrict

Continuing with the example, setting an update restrict rule ensures that the value of `B.stud_ID` in any new or updated row must first exist in `A.student_ID`. It follows, then, that you must have rows in Table A before you can add any rows in Table B. Stated another way, you must create at least one parent row before you can create a child row.

Delete Restrict

In the example, setting a delete restrict rule ensures that a row from Table A cannot be deleted if any rows in Table B reference that row. You cannot delete the row with Name value "John" because John's student ID is referenced in Table B.

Once all rows from Table B that reference John's student ID are deleted, then John's row can be deleted from Table A.

Delete Cascade

In the example, setting a delete cascade rule ensures that both records in Table B are deleted if the row with Name value "John" is deleted.

Pervasive PSQL allows a circular delete cascade on a table that references itself. Because of this, use delete cascade with caution. Ensure that you do not inadvertently delete all records in the parent table, the child table, or both.

An example helps clarify how such cascading deletion could occur. Suppose that you create the following table, d3, with two columns:

```
CREATE TABLE d3 (c1 INT PRIMARY KEY, c2 INT)
INSERT INTO d3 VALUES (2,2)
INSERT INTO d3 VALUES (3,2)
INSERT INTO d3 VALUES (1,3)
INSERT INTO d3 VALUES (4,1)
```

You then alter the table to add a foreign key with a delete cascade rule:

```
ALTER TABLE d3 ADD FOREIGN KEY (c2) REFERENCES d3 ON
   DELETE CASCASE
```

The following statement deletes *all* rows in the table:

```
DELETE FROM d3 WHERE c1 = 2
```

Why are all rows deleted instead of just the row where c1 =2?

Delete cascade deletes any row with a foreign key equal to the primary key that is deleted. The second row has a foreign key relationship to the first row. Similarly, the third row has a foreign key relationship with the third, and the fourth row with the third. Because of the foreign key relationships, the delete cascade rule traversed all of the rows, causing the second row to be deleted because of the first, the third because of the second, and the fourth because of the third.

Pervasive PSQL does not allow circular delete cascade on tables that reference each other. For example, consider the following scenario in which you have tables d1 and d2:

```
CREATE TABLE d1 (c1 INT PRIMARY KEY, c2 INT)
CREATE TABLE d2 (e1 INT PRIMARY KEY, e2 INT)
```

The following alter statement is allowed:

```
ALTER TABLE d1 ADD FOREIGN KEY (c2) REFERENCES d2 ON
   DELETE CASCADE
```

The following alter statement is not allowed because tables d1 and d2 already have a delete cascade relationship:

```
ALTER TABLE d2 ADD FOREIGN KEY (e2) REFERENCES d1 ON
   DELETE CASCADE
```

Setting up Primary Keys

You can create primary keys using SQL statements or Pervasive PSQL Control Center. See Columns Tasks in *Pervasive PSQL User's Guide*.

Creating a Primary Key During Table Creation

You can create a primary key when you create a table, by using the PRIMARY KEY keywords in your CREATE TABLE statement. A primary key can consist of one or more columns. The following example shows the column named `id` being created then being designated the primary key:

```
CREATE TABLE mytable (id INTEGER,
    myname CHAR(20),
    PRIMARY KEY(id))
```

The next example shows how to create a primary key using more than one column as the unique key value:

```
CREATE TABLE mytable (id INTEGER,
    myname CHAR(20),
    PRIMARY KEY(id, myname))
```

Regardless of whether you specify the UNIQUE attribute on the column or columns that you designate as a primary key, the database engine automatically creates an index on the designated columns that does not allow duplicate values or null values in the columns. Null values are never allowed in a key column. Every primary key value must be unique.

For more examples, see CREATE TABLE in *SQL Engine Reference*.

Adding a Primary Key to an Existing Table

You can add a primary key to an existing table through PCC or by using the ALTER TABLE statement with ADD PRIMARY KEY. In *Pervasive PSQL User's Guide*, see To set or remove a column as a primary key and SQL Editor.

You must create the primary key on a column or columns that do not allow duplicate values or null values.

If necessary, you can modify the column attributes and make the column the primary key at the same time. Here is an example using SQL:

```
ALTER TABLE mytable MODIFY id INTEGER UNIQUE NOT NULL
    PRIMARY KEY
```

If you want to add a primary key consisting of more than one column, you must add the key separately:

```
ALTER TABLE mytable ADD PRIMARY KEY(id, myname)
```

For more examples, see ALTER TABLE in *SQL Engine Reference*.

Setting up Foreign Keys

You can create foreign keys using SQL statements or Pervasive PSQL Control Center. When you create a foreign key, you may define an associated rule at the same time. You can define multiple rules on the same key. If you create a foreign key without specifying associated rules, the default referential integrity is restrict for both update and delete.

Creating a Foreign Key During Table Creation

You can create a foreign key when you create a table, by using the REFERENCES keyword in your column definition. A foreign key can consist of one or more columns. The data types of the column(s) must be the same as the primary key that this foreign key references. The example next shows the column named `your_id` being created then being designated the foreign key, referencing `mytable.id`:

```
CREATE TABLE yourtable (your_id INTEGER REFERENCES
   mytable(id) ON DELETE CASCADE, yourname CHAR(20))
```

You can also add the foreign key designation at the end of the statement. You must use this technique if you wish to use multiple columns in the key:

```
CREATE TABLE yourtable (your_id INTEGER,
   yourname CHAR(20),
   FOREIGN KEY(your_id, yourname) REFERENCES
   mytable(id, myname) ON DELETE CASCADE)
```

When you create a foreign key, the database engine adds an index on the designated columns.

For more examples, see CREATE TABLE in *SQL Engine Reference*.

Adding a Foreign Key to an Existing Table

You can add a foreign key to an existing table with PCC or by using the ALTER TABLE statement with ADD FOREIGN KEY. In *Pervasive PSQL User's Guide*, see Foreign Keys Tasks and SQL Editor.

In the following example, two rules are defined for this foreign key, both a delete rule and an update rule:

```
ALTER TABLE yourtable ADD FOREIGN KEY (your_id,yourname)
   REFERENCES mytable(id,myname) ON DELETE CASCADE ON
   UPDATE RESTRICT
```

Use DELETE CASCADE with caution. See examples in Delete Cascade.

For more examples, see ALTER TABLE in *SQL Engine Reference*.

Interactions Between Btrieve and Relational Constraints

While Pervasive PSQL is designed to support concurrent access to the same data through both the relational interface and the transactional interface, some features of the relational (SQL) database architecture may interfere with Btrieve access to the data. For example, features that are designed to limit relational access, such as Referential Integrity, may also limit Btrieve access in the interest of preserving data integrity.

You should fully understand Integrity Enforcement, Bound Databases, ODBC/SQL Security, Triggers, Referential Integrity and Owner Names before implementing these features on a database that is used by a transactional (Btrieve) application. In most cases you can get “Best of Both Worlds” access to your database, but since Security, Referential Integrity, and Triggers can put constraints on access or operations, some Btrieve operations may be restricted or prevented depending on the implementation.

In some cases using Integrity Enforced, Bound Databases, Security, Triggers, or Referential Integrity may cause Btrieve access to the data and/or file to be restricted or prevented when Btrieve access would violate the bounds and restrictions placed on that data. Triggers and RI mainly limit the ability to manipulate data via the Btrieve API.

Security and owner names can limit access and/or the ability to manipulate that data without the proper account, rights, and password. There are many possible combinations of these features, so only the most common ones are listed here.

Table 27 Interactions Between Relational Restrictions and Btrieve Access

CONDITIONS						RESULTS	
DDFs Exist?	**Integrity Enforced?**	**Bound Database?**	**Relational Security Used?**	**Triggers Used?**	**RI Used?**	**Btrieve Access allowed?**	**SQL/ODBC Access Allowed?**
No	-	-	-	-	-	Yes	No
Yes	No	No	No	No	-	Yes	Yes
Yes	No	No (1)	No	Yes (2)	-	Yes (2)	Yes
Yes	Yes	No	No	No	No	Yes	Yes
Yes	Yes	No	Yes	No	No	Yes (3)	Yes (3)
Yes	Yes	No (1)	Yes	No	Yes	Yes (4)	Yes (3) (4)
Yes	Yes	No (1)	Yes	Yes (2)	No	Yes (1)	Yes (3)
Yes	Yes	Yes	No	No	No	Yes	Yes
Yes	Yes	Yes	Yes	No	No	Yes (3)	Yes (3)
Yes	Yes	Yes (1)	Yes	No	Yes	Yes (2) (4)	Yes (3) (4)
Yes	Yes	Yes (1)	Yes	Yes (2)	No	Yes (2) (3)	Yes (3)

(1) Regardless of the Bound Database setting for a database, the database engine automatically stamps a data file as bound if it has a trigger, a foreign key, or a primary key that is referenced by a foreign key. For more information on the meaning of a bound database or file, see Bound Databases.

(2) Adding triggers on a table prevents access to that file from the Btrieve interface, for any operations that would cause the trigger to execute. Because triggers do not react to database operations coming through the Btrieve interface, this lock-out behavior preserves the consistency of the data. See Bound Database versus Integrity Enforced for more information.

(3) When a database or file is secured, access is allowed as long as the user has permissions (that is, a relational user name and password or a valid Btrieve owner name) to that file. Files that are in a secure database but do not have Btrieve owner names set are accessible to Btrieve users. When relational security is first set up for a file that already has a Btrieve owner name, the Master user must grant relational permissions to users using the file's Btrieve owner name. See Pervasive PSQL Security for more information.

(4) If a table contains referential integrity constraints, and Integrity Enforced is turned on for the given database, both Btrieve and SQL operations that would violate the constraints are disallowed. This mechanism preserves the integrity of the data regardless of the method of access.

Bound Database versus Integrity Enforced

If you do not specify the attribute "Integrity Enforced" for a named database, the database engine does not enforce any referential integrity, triggers, or security rules. If you specify the attribute "Integrity Enforced" for a named database, the MicroKernel enforces the database's defined security, RI, and triggers, regardless of the method you use to access the data. The MicroKernel enforces these rules as follows:

- Btrieve users are not subject to relational security. If you have owner names on the files, they remain in effect. If you do not have owner names on the files, any Btrieve user can access the data regardless of relational security constraints. Btrieve operations are subject to all the RI and other constraints defined in the database as well as the Trigger restrictions listed below.

- If constraints exist on a given file, Btrieve access is permitted as follows:

Table 28 Constraints on Btrieve Access - Integrity Enforced

Constraint on File	Level of Access Permitted Using Btrieve
RI constraints defined	User can access the data and perform any operations within RI constraints.
INSERT triggers defined	Read-only, update, and delete operations permitted.
UPDATE triggers defined	Read-only, insert, and delete operations permitted.
DELETE triggers defined	Read-only, update, and insert operations permitted.

If more than one constraint exists on the bound file, the access level follows the most restrictive constraint or combination of constraints. For example, if a file has both INSERT and UPDATE triggers defined, then Btrieve users have only read-only and delete access.

“Integrity Enforced” is not directly related to “Bound Database.” A database can be bound without enforced integrity, or a database can have integrity enforced without being bound.

Bound Databases

If you specify the attribute “Bound” for a named database, the DDFs and data files in that database cannot be associated with any other database. Also, a bound data file cannot be associated with more than one table definition in the database. When you add new tables or DDFs to a bound database, the database engine automatically binds the new objects. This behavior prevents conflicts that could cause unpredictable behavior or data integrity corruption. For example, if you used the same data file for two different table definitions in the same database, you could define RI rules on one table but not on the other. In this case, inserting a row into the table without the RI rules would violate the RI rules on the other table. Binding the data files and DDFs prevents such conflicts.

DDFs and data files can be individually bound. The database engine automatically marks a data file as bound if it has a trigger, has a foreign key, or has a primary key that is referenced by a foreign key.

These files cannot be shared with another database or associated with more than one table definition.

Whether a data file is bound has no direct affect on Btrieve access to that data file. However, files that are bound often have other constraints that may limit Btrieve access.

See Also

For information on how to manipulate the “Integrity Enforced” and “Bound Database” settings for a given database, see New Database GUI Reference.

chapter

Pervasive PSQL Security

7

Concepts and Tasks Related to Security for the Transactional and Relational Interfaces

Pervasive PSQL provides support for Btrieve owner names as well as a full implementation of database security that can be used by either Btrieve or SQL-based applications. This chapter explains the relationship between the two, and how to work with both.

Database Security

By default, database security is turned off when you create a new database with Pervasive PSQL v11 SP3. You turn it on by suppling a password for the “Master” user. See table Identifier Restrictions by Identifier Type for the restrictions pertaining to passwords.

Master User

Database security is based on the existence of a default user named “Master” who has full access to the database when security is turned on. By default, no password is set for the Master user. Security is enabled, or turned on, once you specify a password for the Master user.

The Master user can create groups and other users and define sets of data access permissions for these groups and users. You can add users and groups by executing SQL statements or by using Pervasive PSQL Control Center (PCC).

The PUBLIC Special Group

If you want to grant the same permissions to all users, you can grant them to a special group named “PUBLIC.” The database engine automatically creates the special group PUBLIC when you turn on security. Initially, no permissions are assigned to PUBLIC.

PUBLIC is a special group because it provides default permissions for *all* users and groups. The database engine always checks permissions assigned to PUBLIC first. A couple of examples help clarify how PUBLIC permissions apply.

Suppose in PCC that you assign the CREATE TABLE permission to PUBLIC. You then create a user named “myuser” whose permissions in PCC do *not* include individual rights to create a table. Myuser *can* create a table because the database engine first checks default permissions in PUBLIC, and PUBLIC, in this case, grants rights to create a table.

Conversely, if a permission is *not* granted to PUBLIC, then the permission granted to the individual user or group applies. For example, suppose in PCC that you do *not* assign the CREATE TABLE permission to PUBLIC. No user can create a table unless the permissions for the user, or the group to which the user belongs, allow creating a table.

Users and Groups

After you turn on database security, you can then define groups and users. Nodes for Groups and Users appear in Pervasive PSQL Explorer in PCC. See User and Group Tasks in *Pervasive PSQL User's Guide*.

Restrictions

- A given user cannot be a member of more than one group.
- All users in a group have exactly the permissions defined for that group. You cannot grant or revoke individual permissions for a user who is a member of a group.
- You cannot add a group to another group.

Security Models and Concepts

This section details the available security models for the SQL (relational) and Btrieve (transactional) interfaces. Both interfaces share the same level of granularity in choosing how rights are assigned to users. Both interfaces support database security. The transactional interface has additional security policies that can determine how access is granted. The relational interface supports column-level security.

Note Specifying a security policy for the transactional interface has no effect on relational interface security. For purposes of discussion, however, you can think of the Database policy that is discussed under transactional interface security as the same type of security for the relational interface. A key difference between security for the two interfaces is that you cannot change security policies for the relational interface. Security is either on or off. If on, security is analogous to that of the Database policy type for the transactional interface.

Available Model for the Relational Interface

For the relational interface, security is either turned on or off (see Note above). By default, security is turned off. Security is turned on by suppling a password for the Master user.

With security on, you need to define, at a minimum, users through PCC who are authorized to log in to the database. For each user, you may set permissions for certain objects. In addition, you may define groups of users and set object permissions for each group.

In *SQL Engine Reference*, the following content applies to security for the relational interface:

- Permissions on Views and Stored Procedures
- ALTER GROUP
- ALTER USER
- CREATE GROUP
- CREATE USER
- DROP GROUP
- DROP USER

- GRANT
- REVOKE
- SET PASSWORD
- SET SECURITY
- psp_groups
- psp_procedure_rights
- psp_table_rights
- psp_view_rights
- psp_users

You may access data from more than one database provided the databases are on the same machine. However, you can be logged in to only one database at a time. The following situations apply to database access based on the security of each database.

Security for Logged-in Database	Security for Database Not Logged In	Discussion
On	Off	Access granted for all rights.
On	On	User name and password must be identical in *both* databases.
Off	On	Access denied.

The security discussion in the rest of this chapter applies only to the transactional interface. If you are interested only in the relational interface, you can skip to Data Encryption.

Available Models for the Transactional Interface

The authentication and authorization models that are available for transactional interface include the following:

- Classic
- Mixed
- Database

This topic, and the security discussion in the rest of this chapter, applies to applications that use only the transactional interface. The term *credentials*, *login credentials*, or *user credentials* refers to a valid user name and password pair.

Pervasive PSQL v11 SP3 supports OS-independent database authentication and authorization capabilities for the transactional interface. The original (operating system) authentication model is still available in this release, but now you can instead choose a model in which Btrieve users and privileges are not derived from file system users and privileges. You can allow users access to the database without allowing them operating system access to the data files.

Current Btrieve applications can take advantage of the new security models without requiring any changes to the application code.

Classic

Classic security is the Btrieve security model that was provided in previous releases of the product. For Btrieve users, authentication is performed by the operating system, and data access privileges are determined by file system rights for the given user. The only authorization capability provided by the database engine independent of the operating system is Btrieve owner names, which are essentially file access passwords.

Under this security model, any user who is authenticated by the operating system has the same rights to access the data through Btrieve as he or she has to read and/or write the data files through the operating system. Btrieve owner names are an exception to this rule, allowing an additional level of authorization. However, this level of authorization is not related to the user’s identity. It is related only to whether the application or the user can supply the owner name for a given file.

For more information on Btrieve owner names, see Owner Names.

Setting up Classic Security

Under Classic security, you set up database users and access permissions simply by creating users and assigning file permissions in the operating system. There are no separate actions to take to configure the database engine.

Refer to your operating system documentation for instructions on how to set up user accounts and assign permissions.

Mixed

In the Mixed security model, when a database login occurs, the database engine passes the user name and password entered by the user to the operating system authentication service. If the operating system authenticates the user name and password, then the database engine uses the users and rights table for the database to determine the specific access rights of the given user. Thus, each user's data access privileges must be defined within the database. In turn, the database engine enforces the defined privileges regardless of the given user's file system privileges on the data files.

Database authorization for Btrieve applications is provided by extending the relational interface security model so that it also can be used for Btrieve applications. The ability to create and define users and set permissions is provided through PCC and through SQL statements such as GRANT, REVOKE, ALTER GROUP, CREATE USER, ALTER USER, DROP USER.

Under the mixed security model, any user names defined in the database must correspond exactly with the same user names defined in the operating system. During a database login, the database engine simply passes the user name and password entered by the user to the operating system authentication module. If the operating system authenticates the credentials, then the database uses its own users and rights table to determine the specific access permissions of the given user. Each user must be added to the database. Instead of defining individual permissions for each user, you can define the permissions once using the default group PUBLIC. Valid users automatically inherit the permissions granted to the PUBLIC group.

For detailed procedures on how to set up a Mixed security environment, see Setting up Mixed or Database Security.

Database

Under the Database security model, the database engine authenticates and authorizes users of Btrieve data files. A user's ability to connect to and access data is unrelated to the user's operating system account identification and file system privileges, as long as the user can successfully login to the computer on which his/her application runs.

Database authentication and authorization for Btrieve applications is provided by extending the relational interface security model so that it also can be used for Btrieve applications. The ability to define users and set permissions is provided through PCC and through SQL statements such as GRANT and REVOKE.

Note To create new databases, a user is still required to have administrator-level privileges in the operating system.

For detailed steps on how to set up a Database security environment, see Setting up Mixed or Database Security.

Notes on the Mixed and Database Security Models

For each database, a set of users must be defined, and for each user, a set of access permissions must be defined. The simplest case for assigning permissions is to assign them to the special group PUBLIC. All users inherit the default privileges from PUBLIC. In addition, you must specify the file system directory or directories that contain the data files that should be considered as members of the given database.

The database engine (or operating system in the case of Mixed security) performs user authentication and authorization for each attempt to access any data file within the directory tree. Without this association between databases and directories, when a Btrieve application attempts to open a specific data file, the database engine has no database context from which to determine the applicable set of defined users and permissions.

You can use the Mixed or Database security models only with Btrieve data files that reside in directories that have been defined as belonging to a given database, including the default database DefaultDB described in The Default Database and the Current Database. Data files residing in directories that have not been associated with a database can be accessed only with the Classic security model.

One of the primary advantages of these models is the ability to restrict operating system users' access to the data files, while still allowing full access to the data through the database engine. In contrast, according to the Classic model, any user permitted to add records to the data file must necessarily also have the ability to copy or delete the data file from the operating system.

Note Since the Workgroup engine performs no operating system authentication, the behavior of the Classic and Mixed security policies using the Workgroup engine are the same. If you with to secure a Btrieve database using the Workgroup engine, you must use the Database security policy.

Setting up Mixed or Database Security

Migrating to mixed or database security requires that you make a number of choices and plan carefully. In a well-established environment, you may have to plan how your Btrieve files will be grouped together into databases, and schedule the migration so that you do not disrupt your production environment.

For complete information on making a transition from Classic to Mixed or Database security, see Security Tasks. The next section provides a brief overview of the material contained in the Security Tasks.

Owner Names

An owner name is a password required to gain access to a Btrieve file. There is no relation between an owner name and any system user name or relational database user name. You should think of an owner name as a file password.

A “short” owner name can be up to 8 bytes. A “long” owner name can be up to 24 bytes. Note, however, that once a long owner name is specified, the data file cannot be read by a database engine prior to Pervasive PSQL v10.10. Also, a data file with a long owner name cannot be rebuilt to a file format prior to 9.5 unless the owner name is first removed. An owner name, long or short, with less than the maximum allowed bytes is padded with spaces to the maximum length (8 or 24 bytes).

PCC currently does not provide a way to specify an owner name through the security properties of a file. However, you can use a GRANT statement in PCC SQL Editor to supply an owner name. See Owner Name in *SQL Engine Reference*. You can also set or clear an owner name on a file with the Maintenance Utility or the Function Executor utility. See Manipulating Btrieve Data Files with Maintenance.

An owner name can have several attributes, as shown in Table 29.

Table 29 Owner Name Options

Option	Description
Read-only	Without specifying the password, users can perform data access operations that do not modify the data file.
Read-only encrypted	Without specifying the password, users can perform data access operations that do not modify the data file. When you set this option, the database engine encrypts every record in the file using the owner name as a key. Records added later are also encrypted.
Normal	Without specifying the password, users cannot perform any file access operations.
Normal encrypted	Without specifying the password, users cannot perform any file access operations. Any records inserted or updated are encrypted using the password. When you set this option, the database engine encrypts every record in the file using the owner name as a key. Records added later are also encrypted.

Remarks

When you first set an owner name with encryption on a file, the database engine encrypts the entire file. The larger the file is, the longer this procedure takes.

Data access operations to an encrypted file are slower than to a normal file. The database engine must decrypt each page as it reads it from disk, and encrypt it again before writing it back to disk.

Caution Remember and keep track of a file's owner name, especially with encryption turned on. There is no way to find out the owner name, and no way to access to the data without it.

Owner Names and Security

If you have a Btrieve owner name set on a file that is a table in a secure database, the Master user of the database must use the owner name in any GRANT statement to grant privileges on the given table to any user, including the Master user.

After the GRANT statement containing the owner name has been issued for a given user, that user can access the specified table by logging into the database, without specifying the owner name each time.

If a user tries to access a table through ODBC that has a Btrieve owner name, the access will not be allowed unless the Master user has granted privileges on the table to the user, with the correct owner name in the GRANT statement.

If a table has an owner name with the Read-Only attribute, the Master user automatically has SELECT rights on this table without specifically granting himself/herself the SELECT rights with the owner name.

If no owner name is set on a data file, when relational security is enabled on that file, Btrieve access to the file is no longer permitted. You must set an owner name on that file in order to restore Btrieve access for those users who can supply the owner name when accessing the file. This behavior prevents default Btrieve users from circumventing relational security.

Examples

For examples of granting access to files with Btrieve owner names, see GRANT in *SQL Engine Reference*.

Accessing Data in More Than One Database

You may access data from more than one database provided the databases are on the same machine. However, you can be logged in to only one database at a time. The following situations apply to database access based on the security of each database.

Table 30 Access Rights to Databases Based on Security Settings

Security for Logged-in Database	**Security for Database Not Logged In**	**Discussion**
Enabled (either mixed or database security model)	None	Access granted for all rights.
Enabled (either mixed or database security model)	Enabled (either mixed or database security model)	User name and password must be identical in *both* databases.
None	Enabled (either mixed or database security model)	Access denied.

Planning Security for the Transactional Interface

After you install Pervasive PSQL v11 SP3, the default behavior for security is the same as the previous release. That is, the database engine uses Classic or OS-based authentication and authorization. Any user with permission to access a given data file through the operating system will have the same level of permission to access the data records contained within the file, unless you are using Btrieve owner names to restrict access to the data files.

This section describes the steps you must follow to set up the default database, authorized users, and other aspects of the Btrieve security policies.

Available Options

There are three security options available to you. The features of these options are described next to help you choose which is best for you. Encryption is optional in every configuration.

Table 31 Feature Comparison of Security Configurations

Feature	Classic	Mixed	Database
Administrator must set up separate operating system (OS) and database user accounts for each user		✓	✓
Database user accounts are derived directly from OS user accounts	✓	✓	
Users' data access rights are unrelated to users' file system rights; administrator must assign data access privileges through the database to each user		✓	✓
Users' data access rights are derived directly from OS users' file system rights	✓		
Supports automatic login dialog for entering database user name and password from any Pervasive-based Windows application	✓[1]	✓[1]	✓
Database accepts successful OS login as valid database user	✓	✓	

Table 31 Feature Comparison of Security Configurations

Feature	Classic	Mixed	Database
User must log into database separately from logging into computer			✓
[1] The login dialog may appear if the requester cannot establish an identity through the operating system.			

Under Database security, database user accounts are completely unrelated to OS user accounts.

In contrast, under Classic security, a user who successfully logs into the computer has access to the database contents, at whatever level of file system rights that the user has been assigned to the file that contains the data.

Lastly, the Mixed security policy has aspects of both of the other policies. Under this scheme, users log in using their OS user names and passwords, but then the users access rights to the data are governed by user permissions set up in the database.

Choosing Your Policy

This section describes some of the major reasons you might choose one security policy over another.

Reasons to Choose Classic

- You are comfortable with your users having file system access to your data files. For example, any user with rights to delete records from the data file can also delete the entire file from your operating system.
- You want the minimum administrative hassle; you don't want to set up both OS user accounts for each user and at least one database account.
- You do not need to have a variety of data access rights that vary from each user's file system rights.
- You don't want your users to have a separate login for the database.

Reasons to Choose Mixed

- You don't want your users to have a separate login for the database.

- You want to prevent valid database users from having any rights to the data files on the operating system. For example, you can prevent users who have all rights in the database from having rights to delete data files from the operating system.
- You are willing to set up database user accounts that have the same user names as OS user accounts, and you are willing to assign permissions to each database user. If you choose, all of your users can have the same level of permissions by inheriting them from the special group PUBLIC.

Reasons to Choose Database

- You want to have a separate login for the database. That is, after logging into the operating system, users must login again to the database. This behavior is useful when some authorized computer users are permitted access to the database and some are not.
- You want to prevent valid database users from having any rights to the data files on the operating system. For example, you can prevent users who have all rights in the database from having rights to delete data files from the operating system. You can also achieve this goal using the Mixed security policy.
- You want database user accounts that use different names than the operating system accounts. For example, operating system user “jsmith” might be required to login to the database as “john.”
- The users and their permissions stay with the database, not with the server or machine. This allows you to move a database from one machine to another without having to re-create the users and their permissions for the database.

Preparing to Set Up Security

Setting up security for the transactional interface is a simple process, but it affords enough flexibility that some preparation is necessary. This section describes the information you should know before you begin to set up Btrieve security.

How Many Databases?

For Mixed or Database security, you must either assign all users the same level of permissions, or create a set of defined users for each database.

In some cases where your Btrieve data files encompass two or more completely unrelated bodies of data, you may want to set up two or more separate databases, each with its own set of authorized users. Generally speaking, however, you want to minimize the number of separate databases so that you do not have to create and maintain multiple sets of defined users. Often, a single database is sufficient. User permissions within the database will allow you to regulate each user's access to the database, so you do not need to create separate databases just to limit certain users' access.

If you determine that you need only one database, you may use the pre-existing database, DefaultDB, as the database associated with your Btrieve files. You may also set up your own named database instead.

Where are the Data Files?

You associate a Btrieve data file with a database by specifying the directory containing the data file as a Data Directory for the given named database. Thus, you need to know the directories containing all the data files that you want to associate with the database. If all the data files reside in a sub-directory tree within a specific directory, all you need to know is the top-level directory path name. You can even use "C:\" if you wish to include *all* data files on the hard drive.

What are the User Names?

If you plan to use Mixed security, you must either assign all users the same permissions, or set up user accounts for the users whose rights differ. If you are going to set up individual users, you must have a list of the operating system user names that you want to make into database user names. The database user names that you set up must match the operating system user names exactly. You can always add additional user names later, but it is more efficient to create several users at once.

What Security Policy?

Before you set up security, you must know what policy you plan to use. The setup process varies somewhat for each policy. Considerations in choosing a policy are presented in Choosing Your Policy.

Process Overview

This section outlines the high-level procedure used to set up security for a database. Detailed, step-by-step instructions are provided in the section that follows.

1. Preparation. As specified above in Preparing to Set Up Security, gather the information you need and make the decisions necessary to get started. How many databases? Where are the Btrieve files located? What are the user names? What security policy will you use?
2. Select a database to use with your Btrieve files, and populate the database with the data directory specifying the location of your data files. This step is only necessary for Mixed or Database security.

   For details on this step, see To use an existing database, including the pre-defined DefaultDB, with your Pervasive PSQL files in *Pervasive PSQL User's Guide*.
3. Turn on security.

   For details on this step, see To turn on security using Pervasive PSQL Explorer in *Pervasive PSQL User's Guide*.
4. Create users and permissions. Using SQL statements or PCC, create your user accounts and/or relevant user privileges. This step is only necessary for Mixed or Database security.

   For the fastest, easiest way to grant users access, see To assign permissions to all users using Pervasive PSQL Explorer in *Pervasive PSQL User's Guide*.
5. Set the Btrieve Security for your database to Mixed or Database.

   For details on this step, see To set or change the security policy for a database in *Pervasive PSQL User's Guide*.
6. Secure the data files in the operating system. For Mixed or Database security, users now can access the data without having any rights to access the data files in the operating system. Refer to your operating system documentation for information on securing access to files.

Summary of Tasks for Transactional Interface Security

The following table illustrates the basic level of effort required using the different security models. The tasks required to implement the security models, see Security Tasks.

Table 32 Summary of Security Set-up Tasks

Security Model	Authentication/ Authorization	Summary of Behavior and High-Level Setup Tasks
Classic	Operating system/ Operating system	• Give users file permission access to all database files. • Add an owner name to Btrieve files to further limit access (optional)
Mixed	Operating system/ Database	• Note that this security model behaves the same as Classic when using the Workgroup engine. • Set up users in operating system. Users will be authenticated against this user name and password. • If you want individual user security, set up like-named users in the database security using the Pervasive Control Center. Although authentication occurred at OS level, database permissions are stored in the database, so the operating system user name and database user name must match. • Define each user's database permissions using Pervasive Control Center or SQL statements. Alternatively, define a set of rights for the group PUBLIC. Each authenticated OS user inheriting from the group PUBLIC will have the same rights as PUBLIC. No user can have rights defined that are lower than that of PUBLIC.
Database	Database/ Database	• Operating system user names and passwords are not relevant to the Pervasive PSQL database security. • Set up users using the Pervasive Control Center utility or SQL statements. • Define the database permissions using Pervasive Control Center or SQL statements. • Using the Pervasive Control Center Configuration tool, specify how authentication credentials are passed. This step refers to the new configuration parameters Prompt for Client Credentials and Allow Client-stored Credentials.

Transactional Interface Security Quick Start

This section provides step-by-step instructions on the fastest, easiest way to secure your Btrieve data files in the operating system while still allowing database users to access the data.

When this procedure is complete, you can revoke operating system user rights to the data files without affecting database user rights to access the data through an application.

Note You must be logged into the computer where the database engine is installed, as an operating system user with administrative rights or as a user who is a member of the Pervasive_Admin security group.

1. Start Pervasive PSQL Control Center (PCC). For how to start PCC, see Starting PCC on Windows in *Pervasive PSQL User's Guide*.
2. If the database engine you wish to work with is not registered with PCC, register it now. For how to register a database engine, see To register a remote server engine in *Pervasive PSQL User's Guide*.
3. Expand the databases for the registered engine (click the expand icon to the left of the node).
4. In PCC, right-click on the database "DefaultDB" then click Properties.
5. Click Directories then click New.
6. Type a path for the Btrieve files then click Apply.

   If your files are spread over many directories, specify a high-level directory that they all have in common. You can specify a root level if necessary, but doing so includes in DefaultDB all Btrieve files at the root level and its subordinate directories. For example, a root level could be C:\ for Windows. See To use an existing database, including the pre-defined DefaultDB, with your Pervasive PSQL files in *Pervasive PSQL User's Guide*.

You do not need to enter every directory, just the lowest level directory that is common to all Btrieve files you want to include in the database.

7 Enable security on DefaultDB: click the "Security" node on the Properties dialog tree.

8 Click the "Database Security" tab.

9 Click Enable Security.

10 Type a password that you wish to use for the Master user, twice as prompted. Click OK.

   Now security is turned on, but access is based on OS user rights by default, so your users currently have the same access that they had before. The next step addresses this situation.

   Note that passwords are limited to a maximum of 8 bytes. You may use any displayable character in a password except for the semicolon (;) and the question mark (?).

11 Click OK to close the Properties dialog.

12 Expand the Groups for DefaultDB (click the expand icon to the left of the node), then right-click on the group PUBLIC.

13 Click Properties then Permissions in the tree.

14 Click the "Database" tab.

15 Click the desired permissions.

   For example, if you want to grant read-only rights to all authenticated users, click Select. This option will give all users read-only rights to the data. To give all users update permission, click Update, and so forth.

   If you need to grant individual users varying rights, then you must create group accounts (if desired) and individual user accounts using the GRANT statement in SQL or using PCC. (See Security Tasks.

16 Click OK.

17 Right-click on the database "DefaultDB" then click Properties.

18 Click Security then click the "Btrieve Security" tab.

19 Click Mixed then OK.

Note Do not change the Btrieve Security policy setting until you have completed step 15 as instructed. If you have not created user accounts or granted rights to the group PUBLIC, changing the security policy will prevent all your users from accessing the data.

You have now granted login access only to those users who are authenticated by the operating system, and you have specified that the access rights of those users are defined by the permissions you granted to them in the database.

20 Secure the data files in the operating system according to your operating system instructions. You can now deny operating system users from having any rights to the data files, without affecting their ability to access the data through the database engine.

Caution Be sure to secure the data files in the operating system. If you do not perform this step, the users still can access the files through the operating system with the same level of permissions that they had prior to this procedure. You must revoke the users' operating system privileges to the data files if you want to prevent users from being able to delete or modify the files directly.

Security Tasks

See Security Tasks in *Pervasive PSQL User's Guide*.

Data Encryption

Pervasive PSQL v11 SP3 supports encrypting the database-related network traffic that occurs when using Pervasive PSQL. This type of encryption is often called *wire encryption* because it protects the data when it is traveling on the network wire, or on any intervening network infrastructure, including wireless. While the use of wire encryption is not required, it provides additional deterrence against unauthorized access to the data transmitted by your application over a network.

This encryption feature is not directly related to the security models. Any of the security models can be used with or without wire encryption turned on.

Configuration Parameters for Wire Encryption

There are two configuration settings associated with wire encryption. The settings must be configured at each client machine as well as at the server. For more information on these settings, see

- Wire Encryption
- Wire Encryption Level

➢ To access wire encryption settings

1. In PCC Pervasive PSQL Explorer, perform one of the following:
   a. For a server, right-click on the server name under the Engines node. (Click the plus (+) signs to expand the nodes.)
   b. For a client, right click on MicroKernel Router under the Local Client node. (Click the plus (+) signs to expand the nodes.)
2. Click Properties.
3. Click Access in the tree.

Encryption Notes

This release of the product uses a well-known and time-tested public domain encryption algorithm called “Blowfish” to perform the encryption before data passes over the network.

Encryption using a 40-bit key provides the least amount of protection for the data. Encryption using a 56-bit key is more difficult to compromise. Finally, encryption using the 128-bit key is the generally considered very difficult to compromise.

Note Using encryption slows the network throughput of your data.

Backward Compatibility

Because previous versions of Pervasive PSQL did not support wire encryption, they will be unable to communicate with a client or server from this release that requires encryption. Any client or server that does not support encryption will return an error if it attempts to connect to a client or server that requires encryption.

Setting Up Encryption

Before turning on the encryption settings in your environment, think about your encryption needs first. You can set up your encryption environment in a variety of ways, depending on your situation. There are four general schemes possible:

- no encryption
- all communications encrypted
- encryption to/from specific clients
- encryption to/from specific servers

No Encryption

First of all, consider whether your data has characteristics that would favor encryption. Is your data confidential or proprietary? Is it valuable in the hands of unauthorized users? Can it be used to harm your organization? If you answer no to these question and others like them, then your data may not need to be encrypted at all. Under these circumstances, there may be no reason to incur the performance trade-off that encryption entails. If you aren’t sure, consult a data security expert.

Assuming your data does need to be protected, you still may not need encryption. If your applications run solely on a LAN, and you are comfortable with the physical security of your network infrastructure, encryption may not be necessary.

Encryption to/from Specific Clients

Now suppose that you have one major customer at a remote site that has a connection to your database. You may wish to use encryption only for the communications that go to/from that remote client. You can achieve this affect by setting Wire Encryption at the remote client to Always and setting the server values accessed by that remote client to If Needed. All your internal clients would be set to Never. Thus, the servers will only use encryption when communicating with the remote client that requires encryption.

Encryption to/from Specific Servers

Now, suppose the situation is reversed and your environment includes one or more remote servers that are accessed by network infrastructure that you do not trust 100%. In this case, you can set those server values to Always, and set the local client values to If Needed. The result is encrypted communications only to those remote servers that require it.

All Communications Encrypted

Finally, if your Pervasive-based applications often run over WAN, VPN, or other external networks that you do not trust 100%, then you may wish to encrypt 100% of your database communications. In this scenario, you would set Wire Encryption to Always at *all* clients and servers.

Choosing an Encryption Level

Once you have decided which clients and servers require encrypted communications, you must decide what level of deterrence is appropriate for your needs.

While Pervasive Software Inc. cannot offer advice regarding the encryption level that meets your specific needs, we can provide some guidelines to help inform your discussions with an appropriate data security expert. These guidelines do not represent a guarantee or warranty from Pervasive that no third party will be able to intercept and/or decode your encrypted data. As with any encryption scheme, there is no such thing as an “unbreakable” code, only varying levels of difficulty to compromise different types of encryption. Pervasive PSQL’s 128-bit encryption would be considered “very difficult” to decode using techniques and equipment available to a highly sophisticated individual hacker.

Low (40-bit) Encryption

Consider using this level of encryption in cases where your data has limited ability to harm your organization or your customers if it falls into the wrong hands. Another reason to consider a Low level of encryption is if you wish simply to prevent a casual observer on your network from being able to read your data as it travels over the wires.

Medium (56-bit) Encryption

Consider using this level of encryption in situations where you believe you need somewhat more protection than against just a casual observer, but you do not believe you require the strongest level of security.

High (128-bit) Encryption

Consider using this level of encryption in situations where your data contains very sensitive information such as credit card numbers, social security numbers, financial account numbers, or other information protected by law. Especially consider this level of encryption if your database is associated with an entity on the network that is well-known to contain sensitive data, such as an Internet shopping web site or an online securities brokerage web site. Consider this level of encryption if your organization has previously suffered attempts to compromise its data security.

Effects of Encryption

Using encryption reduces client/server performance. With encryption turned on, each piece of data must be encoded at the source and decoded at the destination. This process requires additional CPU cycles when compared to the same operations performed without encryption. The level of encryption should not affect the performance. The performance drop in using encryption is roughly the same no matter which of the three encryption levels you choose.

Owner Name Encryption

Pervasive PSQL offers encryption of data files on disk. To require that your data files be encrypted when written to disk, you must set an owner name on each file.

See Owner Names for more information.

chapter

Logging, Backup, and Restore

8

Understanding Logs, Backups, and Data Restoration

Pervasive PSQL provides several powerful features to ensure data integrity and to support online backups and disaster recovery.

Transaction Logging and Durability

Pervasive PSQL offers two levels of data integrity assurance for database operations that involve transactions: Transaction Logging and Transaction Durability.

This section contains the following sub-topics:

- Using These Features
- Feature Comparison
- Which Feature Should I Use?
- How Logging Works
- See Also

Using These Features

Both of these features can be turned on or off in the database engine using configuration within Pervasive PSQL Control Center, or programmatically using the Distributed Tuning Interface. See Transaction Durability and Transaction Logging.

The default value for Transaction Durability is Off, and the default value for Transaction Logging is On.

Feature Comparison

Both features offer multi-file transaction atomicity, to ensure that the data files remain consistent as a set and that incomplete transactions are never written to any data files.

Atomicity means that, if any given data operation within a transaction cannot successfully complete, then none of the operations within the transaction are allowed to complete. An atomic change does not leave partial or ambiguous effects in the database. Changes to individual files are always atomic whether Transaction Logging and Transaction Durability are on or off. But transactions make it possible to group changes to multiple files into one atomic group. The atomicity of these multi-file transactions are assured by the MicroKernel only when using transactions in your application, and Transaction Logging or Transaction Durability is turned on.

In addition to these benefits, Transaction Durability guarantees that, in the event of a system crash, the data files will contain the full results of any transaction that returned a successful completion status code to the application prior to the crash.

In the interest of higher performance, Transaction Logging does not offer this guarantee. Whereas Transaction Durability ensures that a completed transaction is fully written to the transaction log before the engine returns a successful status code, Transaction Logging returns a successful status code as soon as the logger thread has been signaled to flush the log buffer to disk.

Transaction Logging is a sub-set of Transaction Durability; that is, if Transaction Durability is turned on, then logging takes place and the Transaction Logging setting is ignored by the database engine.

The main differences between Transaction Logging and Transaction Durability are shown in the following tables:

Table 33 Transaction Logging vs. Transaction Durability: Benefits

Feature	**Guaranteed data consistency and transaction atomicity across multiple files**	**Guaranteed commit for all completed transactions that have returned a successful status code**
Transaction Logging	Yes	No
Transaction Durability	Yes	Yes

Table 34 Transaction Logging vs. Transaction Durability: Function

Feature	**Timing of log buffer writes to disk**
Transaction Logging	The log buffer is written to the log file when the log buffer is full or Initiation Time Limit is reached. A successful status code for each End Transaction operation is returned to the application as soon as the logger thread has been signaled to flush the buffer to disk.
Transaction Durability	The log buffer is written to the transaction log file with each End Transaction operation. A successful status code for each End Transaction operation is not returned to application until the log disk write is successful. For insert or update operations that are not part of a transaction, the log buffer is written to the log file when the log buffer is full or Initiation Time Limit is reached.

Which Feature Should I Use?

For the fastest performance, you want to use the lowest level of logging that meets your transaction safety needs. The best way to determine your appropriate level of logging is to ask your application vendor. If you have multiple applications that use Pervasive PSQL on the same computer, you must use the highest level of logging required by any of the applications.

If you only have one data file, or if none of your applications perform transactions involving multiple data files, you generally do not need to use Transaction Durability or Transaction Logging. Under these circumstances, Pervasive PSQL guarantees the internal consistency of each data file, with or without logging.

Transaction Logging

Turn on Transaction Logging if at least one of your Pervasive PSQL applications performs transactions across multiple data files. Without Transaction Logging, Pervasive PSQL cannot guarantee multi-file atomicity of transactions or multi-file data integrity.

In the event of a system crash, this level of logging does not guarantee that every completed transaction has been written to the data files.

Transaction Durability

Turn on Transaction Durability if at least one of your Pervasive PSQL applications requires that completed transactions across multiple data files be absolutely guaranteed to have been written to the data files under almost any circumstances.

In the event of a system crash, this level of logging guarantees that every transaction that has been successfully completed has been written to the data files.

How Logging Works

Note that these features ensure atomicity of transactions, not of operations. If you are using SQL, a transaction is defined as a set of operations that take place between a BEGIN statement or START TRANSACTION statement, and an END or COMMIT statement. If you are using Btrieve, a transaction is defined as a set of operations that take place between a Start Transaction operation and an End Transaction operation.

All data file inserts and updates are stored in the log buffer. When a transaction is completed (Transaction Durability) or when the buffer gets full or the Initiation Time Limit is reached (Transaction Durability or Transaction Logging), the buffer is flushed to the transaction log file.

In the case of Transaction Logging, when the engine receives the operation ending the transaction and successfully signals the logger thread to flush the log buffer to disk, the engine returns a successful status code to the application that initiated the transaction. In the case of Transaction Durability, the engine does not return the successful status code until the logger thread signals that is has successfully written the buffer to disk.

Transaction log file segments are stored in the location specified in the setting Transaction Log Directory. The log segments are named *.LOG, where the prefix can be 00000001 through FFFFFFFF.

Note All operations, regardless of whether they take place within a transaction, are written to the log file when Transaction Logging or Transaction Durability is in effect. However, only operations executed within a transaction are guaranteed to be atomic. In the case where a system crash has occurred and the transaction log is being rolled forward, only completed transactions are committed to the data files. All operations without an associated End Transaction operation are rejected, and are not committed to the data files.

Tip If your database is highly used, consider configuring your system to maintain the transaction logs on a separate physical volume from the volume where the data files are located. Under heavy load, performance is typically better when the writes to the log files and to the data file are split across different drives instead of competing for I/O bandwidth on a single drive. The overall disk I/O is not reduced, but the load is better distributed among the disk controllers.

You can specify the location of the transaction logs using the configuration setting Transaction Log Directory.

If a system failure occurs after the log file has been written but before the “committed” operations are flushed to the data files in a system transaction, the “committed” operations are not lost. In order to flush the committed operations the affected files need to be opened and operations performed after the system failure. When the files are opened and operations attempted, it is then that the data is rolled forward to the files affected at the time of system failure. Simply restarting the database engine will not invoke the roll forward operation nor will it make the data consistent.

Note Log files associated with the rolled forward files will not be automatically deleted, as they may be associated with more than one data file.

This feature allows individual client transactions to receive a successful status code as soon as possible while at the same time taking advantage of performance gains offered by grouping multiple client transactions together and writing them to the data files sequentially.

If your database server suffers a disk crash of the volume where the data files are stored, and you have to restore the data from an archival log, the engine does not roll forward the transaction log file. The archival log contains all the operations in the transaction log, so there is no need to roll forward the transaction log.

Tip After a system failure, open all data files and perform a stat or read operation on those files. Once you are certain that all data has been restored, old log files may then be stored in a safe location.

See Also

For further information, see:

Transaction Durability

Transaction Logging

Transaction Log Directory

Understanding Archival Logging and Continuous Operations

The product offers two mutually exclusive features to support online backups and disaster recovery.

If your situation is like this...	... use this feature:
You must keep your database applications running while performing backups.	Continuous operations
You are able to shut down the database engine to perform backups	Archival logging

Archival Logging allows you to keep a log of database operations since your last backup. In case of a system failure, you can restore the data files from backup then roll forward the changes from the log file to return the system to the state it was in prior to the system failure.

Caution Archival logging does not guarantee that all your data files will be in a consistent state after restoring from an archival log. In the interest of speed, the database engine does not wait for a successful status code from the logging function before emptying the log buffer. Thus, in rare circumstances such as a full disk or a write error in the operating system, updates that were successful in the data files may not be recorded in the archival log. In addition, archival logging does not require you to log all of your files, so a transaction that updates more than one file may not be completely recorded in the archival log if you are only archival logging some of those files. As a result, one file may not be consistent with another. If you use transactions and require multi-file transaction atomicity, see Transaction Logging and Durability.

Continuous Operations allows you to backup database files while the database engine is running and users are connected. After starting Continuous Operations, the database engine closes the active data files and stores all changes in temporary data files (called *delta* files). While Continuous Operations are in effect, you perform a backup of the data files. The delta files record any changes made to the data files while the backup is taking place.

When the backup is complete, you turn off Continuous Operations. The database engine then reads the delta file and applies all the changes to the original data files. The temporary delta file may surpass the size of the original data file if users make extensive changes to the file during continuous operation.

A file put into continuous operations locks the data file from deletion through the relational interface and the transactional interface. In addition, the file is locked from any attempts to change the file structure, such as modifying keys and so forth.

Note Archival Logging and Continuous Operations are mutually exclusive features and cannot be used at the same time.

Difference Between Archival Logging and Transaction Logging

Transaction Logging is another feature designed to protect the integrity of your data in the event of a system failure, but it is not directly related to Archival Logging. You can have Transaction Logging in effect at the same time as either Archival Logging or Continuous Operations. Transaction Logging uses a short-term log file to ensure that transactions are safely written to disk. The transaction log is reset frequently as completed client transactions are rolled into the physical data files by way of system transactions. In the event of a system failure, when the database engine starts up again, it reads the transaction log and flushes to the data files the transactions that were completed prior to the system failure.

The archival log is written to at the conclusion of each system transaction, so the archival log and the transaction log should remain properly synchronized unless a system failure occurs exactly during the system transaction.

For more information on Transaction Logging, see Transaction Logging and Durability.

What if a File Restore is Needed

In the event of a system crash that requires restoring data files from backup, Archival Logging allows you to restore from backup and then recover database activity up to the moment of the crash.

If you experience a similar crash without Archival Logging (for example if you use Continuous Operations to perform backups), then you will not be able to recover database activity that took place between the last backup and the system crash.

Table 35 Data Restore Limits After Crash

If Archival Logging is...	... this much data will be unrecoverable after a crash:
On	Unfinished transactions at the moment of failure.
Off	All database operations that have occurred after the last backup of the data files.

The remainder of this chapter describes the options and procedures associated with Archival Logging and Continuous Operations.

Using Archival Logging

This section explains the procedures you must follow to set up Archival Logging, make backups, and restore data files. It is divided into the following sub-topics:

- General Procedures
- Setting up Archival Logging
- Roll Forward Command

General Procedures

For Archival Logging to work properly, you must follow a clearly defined procedure to set it up, and another procedure in the event that a restore from backup is necessary.

Caution If any steps of the procedures are omitted or compromised, you may not be able to restore your data to its pre-crash state.

➢ To use Archival Logging properly

1. Turn on Archival Logging, if it is not already in effect. See Setting up Archival Logging for the detailed set-up procedure.
2. Shut down the database engine.
3. Backup the data files.
4. After a successful backup, delete all existing archival logs.

Caution Delete the corresponding log files *before* you resume working with the data files. Synchronizing the backup data files and the corresponding log files is a critical factor of successful recovery.

5. Restart the database engine.

➢ To restore data files from backup and apply changes from the archival logs

Note You cannot use this procedure to roll forward the archival logs if you experienced a hard disk crash and your archival logs and data files were both located on the lost hard disk.

1. When the computer re-starts after the system failure, ensure that the database engine is not running, and ensure no other database engine is accessing the data files you wish to restore.
2. Restore the data files from backup.
3. Start the database engine, ensuring that no applications of any kind are connected to the engine.

Caution It is crucial that no database access occurs before the archival logs have been applied to the data files. Make sure no other database engine accesses the files. You must roll forward the archival logs using the same engine that encountered the system failure.

4. Issue the Roll Forward command as described in Roll Forward Command.
5. After the Roll Forward completes successfully, stop the database engine and make a new backup of the data files.
6. After you have successfully backed up the data files, delete the archival log files. You may now re-start the database engine and allow applications to access the data files.

Setting up Archival Logging

Setting up Archival Logging requires two steps:

- turning on the Archival Logging feature
- specifying the files to archive and their respective log files

Note To perform these procedures, you must have full administrative permissions on the machine where the database engine is running or be a member of the Pervasive_Admin group on the machine where the database engine is running.

➤ To turn on Archival Logging

1. Access Control Center from the operating system Start menu or Apps screen.
2. In Pervasive PSQL Explorer, expand the Engines node in the tree (click the expand icon to the left of the node).
3. Right-click on the database engine for which you want to specify archival logging.
4. Click Properties.
5. Click Data Integrity in the tree to display the settings for that category of options.
6. Click Archival Logging Selected Files.
7. Click OK.

   A message informs you that the engines must be restarted for the setting to take effect.
8. Click Yes to restart the engine.

➤ To specify files to archive

You specify the files for which you want the MicroKernel to perform Archival Logging by adding entries to an archival log configuration file you create on the volume that contains the files. To set up the configuration file, follow these steps:

1. Create the directory \BLOG in a real root directory of the physical drive that contains data files you want to log. (That is, do not use a mapped root directory.) If your files are on multiple volumes, create a \BLOG directory on each volume.

   For example, if you have data files located on C:\ and D:\, and both drives are physical drives located on the same computer as the database engine, then you would create two BLOG directories, as next:

   ```
   C:\BLOG\
   D:\BLOG\
   ```

Note On Linux, the log directory must be named `blog` and must be created in the directory specified by the PVSW_ROOT environment variable (by default, `/usr/local/psql`).

2. In each \BLOG directory, create an empty BLOG.CFG file. You can use any text editor, such as Notepad, to create the BLOG.CFG file. On Linux, the file must be named `blog.cfg` (lowercase).
3. In each BLOG.CFG file, create entries for the data files on that drive for which you want to perform Archival Logging. Use the following format to create each entry:

   \path1\dataFile1[=\path2\logFile1]

path1	The path to the data file to be logged. The path cannot include a drive letter.
dataFile1	The name of the data file to be logged.
path2	The path to the log file. Because the log file and the data file can be on different drives, the path can include a drive letter.
logFile1	The name of the log file. If you do not specify a name, the default value is the same directory and file name prefix as the data file, but replace the file name suffix with ".log." You may specify a different physical drive, so that the log and the data files are not on the same drive. Each data file being logged requires a different log file.

A single entry cannot contain spaces and must fit completely on one line. Each line can contain up to 256 characters. If you have room, you can place multiple entries on the same line. Entries must be separated by white space.

Caution You must use a different log file for every data file that you wish to log. If you use the same log file for more than one data file, the MicroKernel cannot use that log file in the event that a roll-forward is needed.

If you do not provide a name for a log file, the MicroKernel assigns the original file name plus a.LOG extension to the log file when you first open it. For example, for the file B.BTR, the MicroKernel assigns the name B.LOG to the log file.

Caution You are not required to log every file in your database. However, if your database has referential integrity (RI) rules defined, you must log all or none of the files involved in each RI relationship. If you log only a sub-set of the files involved in a given RI relationship, rolling the archival logs forward after a system crash may result in violations of your RI rules.

Examples

The following examples show three sample entries in the BLOG.CFG file on drive C. All three entries produce the same result: activity in the file C:\DATA\B.BTI is logged to the file C:\DATA\B.LOG.

```
\data\b.bti
\data\b.bti=\data\b.log
\data\b.bti=c:\data\b.log
```

The next example directs the engine to log activity in the file C:\DATA\B.BTI to the log file D:\DATA\B.LGF. This example shows that archival log files do not have to reside on the same drive as the data file and do not require the .LOG extension. (The .LOG extension is the default.)

```
\data\b.bti=d:\data\b.lgf
```

Tip Writing the log to a different physical drive on the same computer is recommended. If you experience a hard disk crash, having the log files on a different physical disk protects you from losing your log files and your data files at the same time.

The next example shows a BLOG.CFG file that makes the MicroKernel log multiple data files to a different drive (drive D:), assuming this BLOG.CFG file is on drive C:

```
\data\file1.mkd=d:\backup\
\data\file2.mkd=d:\backup\file2.log
\data\file3.mkd=d:\backup\file3.log
```

Roll Forward Command

The Btrieve Maintenance utility (GUI or BUTIL command line) provides a command allowing you to roll forward archival log files into the data files. See Performing Archival Logging.

Using Continuous Operations

Continuous Operations provides the ability to backup data files while database applications are running and users are connected. However, in the event of a hard drive failure, if you use Continuous Operations to make backups, you will lose all changes to your data since the last backup. You cannot use Archival Logging and the Maintenance utility Roll Forward command to restore changes to your data files that occurred after the last backup.

Pervasive PSQL provides a backup command, BUTIL, for Continuous Operations. (Note that Pervasive PSQL also provides a product, Pervasive Backup Agent, to set and manage continuous operations. See the documentation provided with that product, *Pervasive Backup Agent Guide*, for details.)

Note A file put into continuous operations locks the data file from deletion through the relational interface and the transactional interface. In addition, the file is locked from any attempts to change the file structure, such as modifying keys and so forth.

This section is divided into the following sub-topics:

- Starting and Ending Continuous Operations
- Backing Up a Database with BUTIL
- Restoring Data Files when Using Continuous Operations

Starting and Ending Continuous Operations

This section provides detailed information on the commands: Startbu and Endbu.

Table 36 Commands to Start and Stop Continuous Operation

Command	Description
Startbu	Starts continuous operation on files defined for backup (BUTIL).
Endbu	Ends continuous operation on data files defined for backup. (BUTIL).

Caution The temporary delta files created by Continuous Operations mode have the same name as the corresponding data files but use the extension “.^^^” instead. No two files can share the same file name and differ only in their file name extension if both files are in the same directory. For example, do not use a naming scheme such as INVOICE.HDR and INVOICE.DET for your data files. If you do, the MicroKernel returns a status code and no files are put into Continuous Operations.

Continuous operation mode does not significantly affect MicroKernel performance; however, using a server to back up files can affect performance.

➢ To protect against data loss using Continuous Operation

1. Use the **startbu** command to put your files in continuous operation. See Startbu for an explanation of the command syntax with **butil**.
2. Back up your data files.
3. Use the **endbu** command to take your files out of continuous operation. See Endbu for an explanation of the command syntax with **butil**.

Backing Up a Database with BUTIL

This section provides detailed information on backing up a database using the following **butil** commands: Startbu and Endbu.

Startbu

The butil **startbu** command places a file or set of files into continuous operation for backup purposes.

Format

```
butil -startbu <sourceFile | @listFile> [/UID<name> </PWD<word>>
    [/DB<name>]]
```

sourceFile	The fully qualified name of the data file (including the drive specification for Windows platforms) on which to begin continuous operation for backup. This fully qualified name must reside on the same machine as the one from which you are running butil. You cannot used mapped drives with the startbu command.
listFile	The name of a text file containing the fully qualified names of files on which to begin continuous operation. Separate these file names with a carriage return/line feed. (Although the utility accepts a blank space separator as well, future versions of Pervasive PSQL may accept blank characters in file names. For compatibility with future versions of Pervasive PSQL, use the carriage return/line feed separator.) If the Maintenance utility cannot put all of the specified files in continuous operation, the utility does not put any of the files in continuous operation.
/UID<*name*> /UID*uname*	Specifies the name of the user authorized to access a database with security enabled.
/PWD<*word*> /PWD*pword*	Specifies the password for the user who is identified by *uname*. *Pword* must be supplied if *uname* is specified.
/DB<*name*> /DB*dbname*	Specifies the name of the database on which security is enabled. If omitted, the default database is assumed.

Note The startbu command begins continuous operation only on the files you specify. You cannot use wildcard characters with the startbu command.

On Linux distributions, all "/" parameters use the hyphen ("-") instead of the slash. For example, the /DB parameter is -DB.

File Considerations

When selecting files for backup, we recommend that the temporary delta files created by Continuous Operations mode be excluded since they are open and in use during backup. If the delta files are included in the backup, they should be deleted before the database engine is started after the restore.

Examples for Windows Server

Example A The first example starts continuous operation on the COURSE.MKD file.

For Windows Server:

```
butil -startbu file_path\PSQL\Demodata\course.mkd
```

(For default locations of Pervasive PSQL files, see Where are the Pervasive PSQL files installed? in *Getting Started With Pervasive PSQL*.)

Example B The following example starts continuous operation on all files listed in the STARTLST.FIL file.

```
butil -startbu @startlst.fil
```

The STARTLST.FIL file might consist of the following entries:

```
file_path\PSQL\Demodata\course.mkd
file_path\PSQL\Demodata\tuition.mkd
file_path\PSQL\Demodata\dept.mkd
```

Endbu

The **endbu** command ends continuous operation on a data file or set of data files previously defined for backup. Issue this command after using the **startbu** command to begin continuous operation and after performing your backup.

Format

```
butil -endbu </A | sourceFile | @listFile> [/UID<name> </
    PWD<word>> [/DB<name>]]
```

`/A`	If you specify `/A`, the utility stops continuous operation on all data files initialized by **startbu** and currently running in continuous operation mode.
sourceFile	The fully qualified name of the data file (including the drive specification for Windows platforms) for which to end continuous operation. This fully qualified name must reside on the same machine as the one from which you are running butil. You cannot used mapped drives with the endbu command.

`@`*listFile*	The name of a text file containing a list of data files for which to end continuous operation. The text file must contain the fully qualified file name for each data file, and you must separate these file names with a carriage return/line feed. (Although the utility accepts a blank space separator as well, future versions of Pervasive PSQL may accept blank characters in file names. For compatibility with future versions of Pervasive PSQL, use the carriage return/line feed separator.) Typically, this list of data files is the same as the list used with the **Startbu** command.
`/UID`<*name*> `/UID`*uname*	Specifies the name of the user authorized to access a database with security enabled.
`/PWD`<*word*> `/PWD`*pword*	Specifies the password for the user who is identified by *uname*. *Pword* must be supplied if *uname* is specified.
`/DB`<*name*> `/DB`*dbname*	Specifies the name of the database on which security is enabled. If omitted, the default database is assumed.

Note On Linux distributions, all "/" parameters use the hyphen ("-") instead of the slash. For example, the /A parameter for is -A, as in butil -endbu -A.

Example for Windows Server

The following example ends continuous operation on the COURSE.MKD file.

```
butil -endbu file_path\PSQL\Demodata\course.mkd
```

However, you can also just enter `butil -endbu course.mkd` instead of the full path if your current directory is `f:\demodata`.

Restoring Data Files when Using Continuous Operations

If you are using Continuous Operations for your backup strategy, then you have no recovery log that can be used to recover changes since your last backup. All database changes since your last backup are lost, with the possible exception of any transactions stored in the transaction log. Any such transactions are automatically rolled forward by the database engine when it starts up.

➢ To restore data and normal database operations

1 Resolve the failure.

Perform the maintenance required to make the failed computer operational again.

2 Restore the data files from backup, or restore the hard drive image from backup, as appropriate.

3 Re-install Pervasive PSQL if it was not restored as part of a disk image.

Caution If the delta files were included in the backup, they should be deleted before the database engine is started in the next step.

4 Re-start the database engine.

Any database operations performed since the last backup must be performed over again.

Data Backup with Backup Agent and VSS Writer

In addition to the topics previously discussed in this chapter, both Pervasive PSQL Server SP2 and Pervasive PSQL Vx Server also provide the following solutions for data backup:

- Pervasive Backup Agent
- Pervasive PSQL VSS Writer

If your backup software is *not* aware of the Microsoft Volume Shadow Copy Service (VSS), you can use Pervasive Backup Agent with your backup software. The VSS framework is included with Windows Server 2003 and newer operating systems.

If your backup software *is* VSS aware, Pervasive PSQL VSS Writer is automatically invoked during VSS backups. You do not need to use Pervasive Backup Agent if your backup software is already VSS aware.

Pervasive Backup Agent and Pervasive PSQL VSS Writer can be used together, but there is no advantage in doing so. Your backup process will be more streamlined if you select one method or the other.

Pervasive Backup Agent

Pervasive Backup Agent is an optional product included with Pervasive PSQL v11 SP3 Server. Pervasive Backup Agent is *not* included with Pervasive PSQL Workgroup. Backup Agent is offered for purchase as a separate product for use with Pervasive PSQL Workgroup.

By default, Pervasive Backup Agent is not installed. You must install it from the Pervasive PSQL v11 SP3 media after you install Pervasive PSQL Server. Select **Pervasive Backup Agent** on the installation selection dialog.

No separate license for Pervasive Backup Agent v3.1 is required if it is installed on the same machine as Pervasive PSQL v11 SP3 Server. This also applies if you upgrade Pervasive PSQL v11 Server or v11 SP1 Server to Pervasive PSQL v11 SP3 Server.

Pervasive Backup Agent provides a quick and simple method for you to set and manage Continuous Operations on your Pervasive PSQL database files. Setting and managing Continuous Operations is a critical piece when backing up your Pervasive PSQL databases without using Microsoft Volume Shadow Copy Service. Backup

Agent handles setting and managing Continuous Operations on your open files so that your data is still available from your application during your backup. Once the backup procedure is complete, stopping Backup Agent automatically takes the files out of Continuous Operations and rolls in all the changes captured during the backup.

Pervasive Backup Agent is compatible with many popular backup applications on the market. Note that the backup application must be able to issue commands to start and stop other applications (so that the commands can start and stop Pervasive Backup Agent).

For details on Pervasive Backup Agent, see *Pervasive Backup Agent Guide*, which is available on the Pervasive Software Website (http://www.pervasivedb.com).

Pervasive PSQL VSS Writer

The Microsoft Volume Shadow Copy Service (VSS) consists of Writer, Provider, and Requestor components. Pervasive PSQL v11 SP3 supports VSS with only a Writer component, Pervasive PSQL VSS Writer.

Pervasive PSQL VSS Writer is a feature of the database engine and is enabled for Pervasive PSQL v11 SP3 Server. Pervasive PSQL VSS Writer is available for use after that product is installed. Pervasive PSQL VSS Writer is currently not available for use with Pervasive PSQL Workgroup.

Pervasive PSQL VSS Writer is available only on Windows operating systems. For more information on Volume Shadow Copy Service, refer to the Microsoft Website document, *A Guide for SQL Server Backup Application Vendors.*

Overview

During VSS snapshots, Pervasive PSQL VSS Writer quiesces all disk I/O *write* activity to all Pervasive PSQL data and transaction log files, regardless of the volume on which they reside. After the snapshot is taken, Pervasive PSQL VSS Writer allows all disk I/O to resume; this includes any writes that were deferred during the quiesced period.

Pervasive PSQL VSS Writer never quiesces disk I/O *read* activity, allowing normal database processing to continue during the quiesced period as long as writes are not required. Pervasive PSQL VSS Writer operates normally during the backup phase, although performance may likely be reduced due to the backup activity of the VSS service and VSS Requestor.

The Microsoft Volume Shadow Copy facility allows Backup and Restore products to create a shadow copy for backup in which the files are in either one of the following states:

1. A well-defined and consistent state
2. A crash-consistent state (possibly not suitable for a clean restore).

Files in the VSS snapshot will be in the well-defined and consistent state if all of the following are true:

1. The file's writer is VSS-aware.
2. The Backup and Restore product recognizes and notifies the VSS-aware writer to prepare for a snapshot.
3. The VSS-aware writer successfully prepares for the snapshot.

Otherwise the writer's files are backed up in the crash-consistent state.

VSS Writer Details

The following items discuss specifics about Pervasive PSQL VSS Writer.

- Supported Operating Systems

  The same Windows operating systems that support the Pervasive PSQL server products also support Pervasive PSQL VSS Writer. The VSS framework is included with Windows Server 2003 and newer operating systems.

  Pervasive PSQL VSS Writer is functional on the same bitness as the machine's operating system and the installed Pervasive PSQL server product. Pervasive PSQL VSS Writer 32-bit is supported only on 32-bit machines, and 64-bit is supported only on 64-bit machines. If the bitness does not match, Pervasive PSQL functions properly, but VSS Writer is unavailable.

- Supported Backup Types

Pervasive PSQL VSS Writer supports manual or automatic backups of data volumes. Pervasive PSQL VSS Writer is supported on Full and Copy Volume backups. Incremental, Differential, and Log backups are not supported. VSS recognizes Pervasive PSQL VSS Writer as a component. However, Pervasive PSQL VSS Writer does not support component backups. If the VSS Requestor does call Pervasive PSQL VSS Writer in a component backup, the VSS Writer performs the same actions as in a Full or Copy Volume backup.

- Virtualized Environment Support

  Pervasive PSQL VSS Writer supports VSS Requesters that trigger VSS backups in virtualized environments. Performing a VM snapshot does not invoke a VSS backup.

- Multiple Volume Pervasive PSQL Data Files

  Pervasive PSQL files and transaction logs can reside on multiple volumes. When backing up Pervasive PSQL files, remember to backup the transaction logs and related files on other volumes simultaneously. Files that are independent of one another may not need to be backed up at the same time as related Pervasive PSQL files.

- Backup Solution Compatibility

  To determine if a particular backup product recognizes Pervasive PSQL VSS Writer and will notify the Writer to prepare for a snapshot, start a backup with the product. After the backup is in progress, consult the PVSW.LOG to determine if the PSQL VSS Writer logged the Frozen or Thawed states. If the backup and restore product did not notify PSQL VSS Writer to prepare for the backup, another solution must be used. For example, you could use Pervasive PSQL Backup Agent to backup PSQL data files in the well-defined and consistent state.

- Pervasive PSQL VSS Writer and Restore Operations

  Stop the Pervasive PSQL services prior to performing a Restore operation with the Backup software. Failure to do so causes the VSS Writer to inform the VSS Requestor that it cannot participate in the Restore. Transaction logs will need to be restored along with the data files to guarantee the integrity of the data. If Pervasive PSQL data and transaction log files are restored while Pervasive PSQL is running, the results are unpredictable and could lead to data corruption.

- Pervasive PSQL VSS Writer and Pervasive Continuous Operations

  You may have an existing backup process that already uses Pervasive Continuous Operations or Pervasive Backup Agent. If you choose, you can continue to use that process with Pervasive PSQL and Pervasive PSQL VSS Writer. Pervasive PSQL VSS Writer does not interfere with Continuous Operations or Backup Agent. However, there is no advantage to using *both* Pervasive PSQL VSS Writer and Continuous Operations (or Backup Agent) together. Your backup process will be more streamlined if you select one method or the other.

  When Pervasive PSQL VSS Writer is called and files are in Continuous Operations, be aware that VSS Writer operates independently from any Continuous Operations. If files *are* in Continuous Operations when a VSS backup is in progress, view PVSW.LOG after the backup completes. Ensure that the Frozen and Thawed states completed successfully and that the data is in a well-defined and consistent state.

  Also note that Pervasive PSQL VSS Writer requires the Microsoft VSS framework. Backup Agent does not use the Microsoft VSS framework. Consequently, Backup Agent does not participate in the backup when the VSS framework calls Pervasive PSQL VSS Writer and I/O operations are quiesced. Backup Agent must be added separately to the backup process. The backup process must also start and stop Backup Agent.

- Pervasive PSQL VSS Writer and Xtreme I/O Driver

  The 32-bit version of Pervasive PSQL VSS Writer can be used with Pervasive PSQL Server 32-bit and the database accelerator Xtreme I/O (XIO). See Xtreme I/O Driver in *Advanced Operations Guide*.

chapter

High Availability Support 9

Using Pervasive PSQL in High Availability Environments

This chapter includes the following sections:

Overview of Technologies

Pervasive PSQL is compatible with numerous solutions that maximize uptime in physical and virtual environments. Such solutions continually evolve but can be classified generally as high availability, fault tolerance, and disaster recovery.

High Availability

The definition of “high availability” can differ depending on the software vendor that provides high availability solutions. In general, it refers to a systems design approach for a predictable baseline level of uptime, despite hardware failure, software failure, or required maintenance.

A common approach to ensure high availability in a physical environment is failover clustering. A common approach in a virtual machine (VM) environment is migration.

Failover Clustering

Pervasive PSQL is designed to function as a resource in a failover cluster environment in which only one server node at a time accesses the shared storage subsystem. If the primary node fails, a failover (or switch) to a secondary node occurs. Failover clustering allows a system to remain available while you perform software upgrades or hardware maintenance.

Pervasive PSQL is compatible with Microsoft Failover Cluster Services and with Linux Heartbeat. Refer to the documentation from those vendors for the specific manner in which they define and implement failover clustering. Pervasive PSQL Server is the recommended product if the failover cluster uses physical nodes. Pervasive PSQL Vx Server is recommended for clusters that use VM nodes.

See Failover Clustering.

Migration

In general terms, migration allows a running VM or application to be moved between different physical machines without disconnecting the client or application. The memory, storage, and network connectivity of the VM are typically migrated to the destination.

Pervasive PSQL Vx Server is compatible with the migration capability offered by Microsoft Hyper-V, VMware vSphere, and Citrix XenServer. As long as virtual MAC addresses and host names remain the same after the VMs are moved, PSQL Vx Server continues to operate normally. Refer to the documentation from those vendors for the specific manner in which they define and implement migration.

See Migration.

Fault Tolerance

While high availability aims for a predictable baseline level of uptime, fault tolerance is the uninterrupted operation of a system even after the failure of a component. Fault tolerance requires synchronized shared storage. In virtualized environments, the VM that fails must be on a different physical host from the VM that replaces it.

Fault tolerance can be achieved using just physical machines. However, virtual environments lend themselves so readily to maintaining virtual servers in lockstep with each other that exclusively physical environments are increasingly less common. Pervasive PSQL Server is compatible with fault tolerance capabilities in an exclusively physical environment.

For virtual environments, Pervasive PSQL Vx Server is compatible with the fault tolerance capability offered by VMware vSphere and Citrix XenServer. Refer to the documentation from those vendors for the specific manner in which they define and implement fault tolerance.

See Fault Tolerance.

Disaster Recovery

Disaster recovery involves duplicating computer operations after a catastrophe occurs and typically includes routine off-site data backup as well as a procedure for activating vital information systems in a new location.

Pervasive PSQL Vx Server is compatible with major hypervisors that support disaster recovery technology that initializes backup physical or virtual machines. As long as all virtual MAC addresses and host names remain the same after the VMs are moved, PSQL Vx Server continues to operate normally. This allows rapid server replacement and recovery time. Pervasive PSQL Server is compatible with major hypervisors that support disaster recovery technology on physical machines.

Refer to the documentation from the hypervisor vendors for the specific manner in which they define and implement disaster recovery.

Another offering for Pervasive PSQL to help with disaster recovery is Pervasive PSQL Insurance. Pervasive PSQL Insurance gives you a way to get back online right away to keep your business going until you can restore the original Pervasive PSQL licenses. Pervasive PSQL Insurance provides a 7-day temporary license that allows 3 separate uses and is available for Windows and Linux 32-bit or 64-bit environments. See www.pervasivedb.com for details.

See Disaster Recovery.

Hardware Requirements

For all of the technologies mentioned in this section, Pervasive Software recommends that you select servers, disk subsystems, and network components from the hardware compatibility list provided by the vendor. Pervasive Software follows this practice when testing compatibility with vendor's products.

Failover Clustering

Failover clustering provides for multiple physical servers (nodes) to access a common, shared storage subsystem that contains one or more file shares or volumes. The failover services ensure that only one server controls the file shares or volumes at a time. Control of the shared storage subsystem is passed automatically from a failed server to the next surviving server in the cluster.

Pervasive PSQL must be licensed separately on each cluster node where you install the database engine. This applies whether the node is a physical machine or a virtual machine. See also License Models in *Pervasive PSQL User's Guide*. (The failover clustering being discussed refers to Microsoft Failover Clustering or Cluster Service and to Linux Heartbeat. This is distinct from other high availability solutions that may incorporate VM-based clusters.)

This section contain the following topics:

- Microsoft Failover Clustering for Windows Server 2008 and Later
- Microsoft Cluster Service for Windows Server 2003
- Linux Heartbeat
- Managing Pervasive PSQL in a Cluster Environment

Microsoft Failover Clustering for Windows Server 2008 and Later

This topic discusses adding the Pervasive PSQL services to Failover Clustering and assumes the following:

- You know how to install and configure Failover Clustering and need only the information required to add and manage the Pervasive PSQL services.
- You are familiar with using Pervasive PSQL and its primary utilities such as Pervasive PSQL Control Center (PCC).
- You can set up DSNs using ODBC Administrator.

Differences Between Windows Server Versions

Failover Clustering is essentially the same for Windows Server 2008, Windows Server 2008 R2, and Windows Server 2012.

Note the following differences with Windows Server 2012:

- In Failover Cluster Manager, “Services and Applications” are called “Roles.”
- Registry Replication is not supported for Generic Services. The Pervasive PSQL database engine must be manually configured on all nodes as explained in Configure Database Engine Properties with PCC.

Preliminary Requirements

It is essential that Failover Clustering functions correctly before you add the Pervasive PSQL services. For example, verify that the failover completes and that all resources are available. Complete the action again and failover back to the original node. Refer to the Microsoft documentation for how to set up Failover Clustering, verify it is working correctly, and perform tasks with it.

Just as you would for any service, set up the essential clustering components before you add the Pervasive PSQL services. As you set up the components, check the following:

- Modify the NTFS user permissions, if required, for the shared disk where you want the Pervasive PSQL data to reside. The Pervasive PSQL transactional and relational services typically run under the Local System Account. Ensure that the Local System Account has permissions to read and write to the shared disk.
- Select “SMB” for the share protocol and modify the SMB permissions if required.
- Skip DFS Namespace Publishing. DFS is not required for the Pervasive PSQL services.

After setting up the components, a good practice is to verify that the machines on which the Pervasive PSQL client is installed can communicate with the Client Access Point. Also, verify that the machines can browse to the share name.

Recommended Installation Process

The following table explains the recommended process to add Pervasive PSQL to Cluster Services on Windows Server 2008. The process for Windows Server 2012 is essentially the same with differences noted above.

Table 37 Adding Pervasive PSQL to Cluster Services on Windows Server 2008 and Later

Action	**Discussion**
Install Pervasive PSQL on the Cluster Nodes	Install Pervasive PSQL Server on each cluster node and choose identical options for each installations. • Do **not** install Pervasive PSQL on the cluster shared storage, where the Pervasive PSQL data resides. • Do **not** install the Pervasive PSQL component called Xtreme I/O (XIO). A node with XIO installed can hang when the machine comes online through a failover and leave the shared storage inaccessible. After installation, the Pervasive PSQL transactional service and the relational service are both set to start automatically when the operating system starts. Change the startup type to **manual**. The Pervasive PSQL transactional and relational services typically run under the Local System Account. Check the domain permissions for your cluster node accounts if you encounter problems installing Pervasive PSQL.
Add a Cluster Resource for Pervasive PSQL and Set the Properties	The transactional service of Pervasive PSQL is always required as a cluster resource. The relational service is optional and is needed only if your application uses the relational interface. Include the following as you specify properties for the cluster resource: • Select the option **Use network name for computer name**. • For the transactional service, use **Software\Pervasive Software** for the Root Registry Key. If you include the relational service, decide how you want to handle data source names (DSNs) for Registry Keys. Perform *one* of the following: • Specify the key SOFTWARE\ODBC if you want to affect *all* ODBC data sources and ODBC providers installed on the cluster node. Add the following key depending on the operating system architecture: Software\ODBC\ODBC.INI for 32-bit Windows or Software\Wow6432Node\ODBC\ODBC.INI for 64-bit Windows • To specify separate DSNs, do **not** add any key(s) for the registry. Instead, you must first configure the database engines with PCC (see Configure Database Engine Properties with PCC). After that, create the DSNs on an active cluster node, initiate failure, and create the same DSNs on the surviving node. Repeat this until all cluster nodes contain the DSNs. **Note:** Because of the dependencies, bring the Pervasive PSQL resources online in the following order (and stop them in the reverse order): first the Pervasive PSQL Transactional Engine then the Pervasive PSQL Relational Engine.

Table 37 Adding Pervasive PSQL to Cluster Services on Windows Server 2008 and Later continued

Action	Discussion
Ensure the Shared Storage Has the Necessary Files and Directories	The Pervasive PSQL transactional and relational services typically run under the Local System Account. Ensure that the Local System Account has permissions to read and write to the shared disk. Copy the DBNAMES.CFG file from the Application Data area on the active node where you installed Pervasive PSQL to a directory of your choice on the shared storage. Copy the following directories from the Application Data area on the same node to the same directory on the shared storage. For convenience, you can copy them to the same directory as DBNAMES.CFG, but that is optional. • defaultdb • Demodata • tempdb • Transaction Logs If you want to use Pervasive System Analyzer to perform transactional or relational tests, also copy the Pervasive Software\PSQL\Samples directory.
Configure Database Engine Properties with PCC	You configure the database engine with Pervasive PSQL Control Center (PCC) to add certain configuration settings to the registry. Configure the engine on the active node in your cluster, then initiate a failure to migrate the settings to the next node(s) in your cluster. In PCC, set the following engine properties for **Directories**. When PCC prompts you to restart the services, select **No**. • For **Transaction Log Directory**, specify the location on the shared disk where you copied the Transaction Logs directory. • For **DBNames Configuration Location**, specify the location on the shared disk where you copied the DBNAMES.CFG file. In the Failover Cluster Management console, take the Pervasive PSQL resources offline and back online. In PCC, set the following engine properties for Databases: • For **DEFAULTDB**, set **Dictionary Location** to the location on the shared disk where you copied the defaultdb directory. For **Data Directory**, add the location on the shared disk where you copied the defaultdb directory and remove the default data directory. • Set Dictionary Location and Data Directory for databases DEMODATA and TEMPDB to the location on the shared disk where you copied them. For DEMODATA, specify “Demodata” for the Dictionary Location and Data Directory. For TEMPDB, specify “tempdb” for both.

Table 37 Adding Pervasive PSQL to Cluster Services on Windows Server 2008 and Later continued

Action	Discussion
Migrate the Database Engine Configuration Settings	Migrate the database engine configuration settings to the other node(s) in the cluster. In the Failover Cluster Management console, perform the action **Move the service or application** to move the Pervasive PSQL service to another node in the cluster. Verify that the failover completes and that all resources are available. Continue to move the service to each desired node and verify that all resources are available until you failover back to the original node. Pervasive PSQL is now configured for a Failover Cluster.

Microsoft Cluster Service for Windows Server 2003

This topic discusses adding the Pervasive PSQL services to Failover Clustering and assumes the following:

- You know how to install and configure Cluster Service and need only the information required to add Pervasive PSQL to a Cluster Service group.
- You are familiar with using Pervasive PSQL and its primary utilities such as Pervasive PSQL Control Center (PCC).
- You can set up DSNs using ODBC Administrator.

Preliminary Requirements

It is essential that Cluster Service functions correctly before you add Pervasive PSQL. For example, verify that the failover completes and that all resources are available. Complete the action again and failover back to the original node. Refer to the Microsoft documentation for how to set up Cluster Service, verify it is working correctly, and perform tasks with it.

Just as you would for any application, set up the essential clustering components before you add Pervasive PSQL. As you set up the components, modify the user permissions, if required, for the shared disk where you want the Pervasive PSQL data to reside. The Pervasive PSQL transactional and relational services typically run under the Local System Account. Ensure that the Local System Account has permissions to read and write to the shared disk.

After setting up the components, access a Pervasive PSQL client and verify that it can communication with the cluster shared storage. A Pervasive PSQL client must be able to communicate with a cluster shared storage before and after a cluster node failover. The cluster is functioning correctly if you can execute a command on the shared storage subsystem from a Pervasive PSQL client computer before and after failover.

Recommended Installation Process

The following table explains the recommended process to add Pervasive PSQL to Cluster Service on Windows Server 2003.

Table 38 Adding Pervasive PSQL to Cluster Service on Windows Server 2003

Action	Discussion
Add a Cluster Group for Pervasive PSQL	With Microsoft Cluster Administrator, create a cluster group to which you will add the Pervasive PSQL resources. Because all resources within a cluster group fail together, we suggest that you create a separate cluster group for Pervasive PSQL. This is not mandatory, but is a good administrative method. At a minimum, ensure that the cluster group for Pervasive PSQL contains the following resources. • IP address of the shared storage subsystem. • Network name (the name of the shared storage subsystem). • Physical disk (the disk subsystem that contains the Pervasive PSQL database). Ensure that the shared storage is a mounted drive not a mapped drive. The Pervasive PSQL Services are configured under Local System Account by default. That account cannot access mapped drives that were mapped under a different user account. • File share for you data files. In addition, you may want to enable failback for the group and specify a preferred controlling node. See also Pervasive PSQL Failure Behavior.
Install Pervasive PSQL on the Cluster Nodes	Install Pervasive PSQL Server on each cluster node and choose identical options for each installations. • Do **not** install Pervasive PSQL on the cluster shared storage, where the Pervasive PSQL data resides. • Do **not** install the Pervasive PSQL component called Xtreme I/O (XIO). A node with XIO installed can hang when the machine comes online through a failover and leave the shared storage inaccessible. The Pervasive PSQL transactional and relational services typically run under the Local System Account. Check the domain permissions for your cluster node accounts if you encounter problems installing Pervasive PSQL.

Table 38 Adding Pervasive PSQL to Cluster Service on Windows Server 2003 continued

Action	**Discussion**
Add Pervasive PSQL Transactional Service to Cluster Group	The transactional service of Pervasive PSQL is always required as a cluster resource. In Microsoft Cluster Administrator**,** add a new **Resource** and specify **Generic Service** for the resource type. Select the desired group. Do ***not*** check the option **Run this resource in a separate Resource Monitor**. Specify the nodes that can function as possible owners for the resource. For **Dependencies**, add the following to the list of resource dependences: • IP Address • Network Name • File Share For **Generic Services Parameters**, specify “Pervasive.SQL (transactional)” for Service name. Leave the **Start parameters** blank. Select the option **Use Network name for computer name**, which allows Pervasive PSQL to open files directly on the shared storage. Add the following for **Registry Key**: SOFTWARE\Pervasive Software. After you add the resource, select its properties. Select the options **Restart** and **Affect the group**. Optionally, you may set the **Threshold** and **Period** values to your choice.
Optionally, Add Pervasive PSQL Relational Service to Cluster Group	The relational service is optional and is needed only if your application uses the relational interface. Follow the same procedure as list for Add Pervasive PSQL Transactional Service to Cluster Group with the following exceptions. For **Dependencies**, select the “Pervasive PSQL transactional resource” In the **Available resources** list. You do not need to add the IP Address, Network Name, and File Share for the resource because they are dependencies of the transactional resource. For **Generic Services Parameters**, specify “Pervasive.SQL (relational)” for Service name. The **Registry Replication**, decide how you want to handle data source names (DSNs) for Registry Keys. Perform *one* of the following: • Specify the key SOFTWARE\ODBC if you want to affect *all* ODBC data sources and ODBC providers installed on the cluster node. Add the following key depending on the operating system architecture: Software\ODBC\ODBC.INI for 32-bit Windows or Software\Wow6432Node\ODBC\ODBC.INI for 64-bit Windows • To specify separate DSNs, do **not** add any key(s) for the registry. Instead, you must first configure the database engines with PCC (see Configure the Engines with PCC). After that, create the DSNs on an active cluster node, initiate failure, and create the same DSNs on the surviving node. Repeat this until all cluster nodes contain the DSNs.

Table 38 Adding Pervasive PSQL to Cluster Service on Windows Server 2003 continued

Action	Discussion
Bring Pervasive PSQL Services Online Using Cluster Administrator.	After installation, both the transactional and relational services are set to start automatically when the operating system starts. Through the operating system, stop both services and change their startup type to **Manual**. After you stop the services at the operating system, bring them online using Cluster Administrator.

Table 38 Adding Pervasive PSQL to Cluster Service on Windows Server 2003 continued

Action	Discussion
Ensure the Shared Storage Has the Necessary Files and Directories	The Pervasive PSQL transactional and relational services typically run under the Local System Account. Ensure that the Local System Account has permissions to read and write to the shared disk. Copy the DBNAMES.CFG file from the Application Data area on the active node where you installed Pervasive PSQL to a directory of your choice on the shared storage. Copy the following directories from the Application Data area on the same node to the same directory on the shared storage. For convenience, you can copy them to the same directory as DBNAMES.CFG, but that is optional. • defaultdb • Demodata • tempdb • Transaction Logs If you want to use Pervasive System Analyzer to perform transactional or relational tests, also copy the Pervasive Software\PSQL\Samples directory.
Configure the Engines with PCC	You need to configure the database engine with Pervasive PSQL Control Center (PCC) to add certain configuration settings to the registry. Configure the engine on the active node in your cluster, then initiate a failure to migrate the settings to the next node(s) in your cluster. Create a new server using Pervasive PSQL Explorer in PCC and specify the network name of the cluster shard storage for the server name. Access the properties of the server you just added and select **Directories**. • For **DBNames Configuration Location**, specify the location on the cluster shared drive where you copied the files listed in Ensure the Shared Storage Has the Necessary Files and Directories. Ensure that the shared storage is a mounted drive not a mapped drive. The Pervasive PSQL Services are configured under Local System Account by default. That account cannot access mapped drives that were mapped under a different user account. • For **Transaction Log Directory**, specify a directory on the cluster shared drive where you want the log to reside. • For **Communication Protocols**, ensure that TCP/IP Multihomed is “on.” In Cluster Administrator, take the Pervasive PSQL transactional service offline, which also takes the Pervasive PSQL relational service offline. Bring both services online. In Cluster Administrator, initiate a failure so that the next surviving node becomes the new controlling node of the cluster. Repeat this until you initiate failure to each cluster node. Pervasive PSQL is now configured for a Failover Cluster.

Linux Heartbeat

The Heartbeat program is one of the core components of the Linux-HA (High-Availability Linux) project. Heartbeat runs on all Linux platforms and performs death-of-node detection, communications and cluster management in one process. Pervasive PSQL Server is the recommended product if the Heartbeat cluster uses physical nodes. Pervasive PSQL Vx Server is recommended for clusters that use VM nodes.

This topic discusses adding the Pervasive PSQL services to Linux Heartbeat and assumes the following:

- You know how to install and configure the Heartbeat program and need only the information required to add Pervasive PSQL to a Cluster Service group.
- You are familiar with using Pervasive PSQL and its primary utilities such as Pervasive PSQL Control Center (PCC).

Preliminary Requirements

It is essential that Linux Heartbeat be functioning correctly before you add Pervasive PSQL to the cluster. Refer to the documentation from the High Availability Linux Project (www.linux-ha.org) for how to install Heartbeat, verify it is working correctly, and perform tasks with it.

Just as you would for any application, set up the essential clustering components before you add Pervasive PSQL.

Recommended Installation Process

The following table explains the recommended process to add Pervasive PSQL to Linux Heartbeat.

Table 39   Adding Pervasive PSQL to Linux Heartbeat

Action	Discussion
Install Pervasive PSQL on the Cluster Nodes	Install Pervasive PSQL Server on each cluster node and choose identical options for each installations. Do **not** install Pervasive PSQL on the cluster shared storage, where the Pervasive PSQL database(s) resides. After installation, the database engine is set to start automatically when the operating system starts. With clustering, however, Linux Heartbeat controls starting and stopping the database engine. The controlling node in the cluster starts the engine, the other nodes do not. After you install Pervasive PSQL Server, ensure that the Group IDs for “pvsw” and “pvsw-adm” and the UID for “psql” match on all nodes. If required, change the IDs to ensure they are the same.
Configure the Shared Storage	The shared storage is where is the Pervasive PSQL database resides. Shared storage for Heartbeat can be implemented many different ways. The multitude of possible implementations is beyond the scope of this document. This section assumes that an NFS mount is being used. Create (or at least identify) a location on shared storage where you want the database to reside. The location is your choice. Ensure that user **psql** has read, write, and execute authority for the location. Create two groups and a user on the shared storage to ensure that each cluster node can access the database files. • Groups **pvsw** and **pvsw-adm** must match **pvsw** Group ID and **pvsw-adm** Group ID, respectively, on the cluster nodes. • User **psql** must match **psql** UID on the cluster nodes.
Create the Directory for the Shared Storage Mount	On each cluster node, log in as user **psql** then create a directory that will be mounted to the shared storage. (User **psql** has no password and can only be accessed through the “root” account with the **su** command.) The name of the directory is your choice.
Configure Heartbeat Server	Configure the Heartbeat server *on each of the nodes* that will control the Pervasive PSQL database engine. Configure the following: • Nodes. Add all nodes that you want in the cluster. • Authentication. Specify the type of authentication to use for the network communication between the nodes. • Media. Specify the method Heartbeat uses for internal communication between nodes. • Start-up. Specify the setting for when the Heartbeat Server starts. Set this to **on**, which means that the “server starts now and when booting.”

Table 39 Adding Pervasive PSQL to Linux Heartbeat *continued*

Action	Discussion
Assign Password for Heartbeat User	Linux Heartbeat provides a default user named "hacluster" for logging in to the Heartbeat Management Client**.** Assign a password to user "hacluster" *on each of the nodes* from which you want to run Heartbeat Management Client.
Add a Resource Group for Pervasive PSQL	Log in as root and start the Heartbeat Management Client on one of the cluster nodes. Log in as user "hacluster" and add a new group. For **ID**, specify a name for the Pervasive PSQL group. Set **Ordered** and **Collocated** to "true."
Add the Resources to the Group	Add three resources to the Pervasive PSQL group: • IPaddr • Filesystem • Psql (OCF resource agent) IPaddr In the Heartbeat Management Client, add a new "native" item. For **Belong to group**, select the group you added for Pervasive PSQL. For **Type**, select "IPaddr." On the resource you just added, specify the IP address of the cluster for the **IP Value**. Use the IP address assigned to the *cluster* (not the node) when Linux Heartbeat was installed and configured. Filesystem Add another new "native" item. For **Belong to group**, select the group you added for Pervasive PSQL. For **Type**, select "Filesystem" and delete the parameter "fstype," which is not required. Add a new parameter and select "device" for **Name**. For **Value**, specify the device name of the shared storage, a colon, and the share mount location. Add another new parameter and select "directory" for **Name.** For **Value**, specify the directory to use with the NFS mount. Psql (OCF resource agent) Add another new "native" item. For **Belong to group**, select the group you added for Pervasive PSQL. For **Type**, click on "psql" with a **Description** of "PSQL OCF Resource Agent." No additional parameters are required for the parameter.
Create the Subdirectories on the Mounted Shared Storage	Now that you have added the Filesystem resource, the mount exists between the cluster server and the shared storage. On one of the cluster nodes, log in as user **psql**. Under the shared storage mount, create a directory named "log" and another named "etc." For example, if the mount directory is "/usr/local/psql/shared," you would add directories /usr/local/psql/shared/log and /usr/local/psql/shared/etc.

Table 39 Adding Pervasive PSQL to Linux Heartbeat continued

Action	Discussion
Configure the Cluster Server in PCC	On each of the cluster nodes, you need to configure the cluster server with Pervasive PSQL Control Center (PCC). Place all cluster nodes into standby mode except for the one from which you will run PCC. As user **psql**, start PCC on the one active node or from a client that can access the active node. In Pervasive PSQL Explorer, add a new server and specify the name (or IP address) of the *cluster*. Access the properties for the server you just added. If prompted to log in, log in as user “admin.” Leave the password blank. Access the **Directories** Properties. For **Transaction Log Directory**, specify the directory that you created for the “log” location. For **DBNames Configuration Location**, specify the directory that you created for the “etc” location. See Create the Subdirectories on the Mounted Shared Storage. Use PCC to add a new server and set its properties from each of the other cluster nodes. Place all nodes into standby mode except for the one from which you run PCC.
Create the Database on the Shared Storage	From the operating system on one of the cluster nodes, log on as user **psql** and create the directory under the file system share where you want the database to reside. (If you create the directory as user **root**, ensure that user **psql** has read, write, and execute authority on the directory.) Place all cluster nodes into standby mode except for the one from which you will run PCC. As user **psql**, start PCC on the one active node or from a client that can access the active node. Create a new database for the server you added in Configure the Cluster Server in PCC. For **Location**, specify the directory you created where you want the database to reside. Specify the other database options as desired. For the new database, create tables as desired.
Verify Access to the Database from each Node	Each cluster node must be able to access the Pervasive PSQL database on the shared storage. Place the cluster node from which you created the database into standby mode. This is the node running the “psql” resource (the database engine). Fail over to the next node in the cluster. Verify that the next node receives control of running the “psql” resource. Repeat the standby, fail over and verification process for each node in the cluster until you return to the node from which you began.

Managing Pervasive PSQL in a Cluster Environment

After you install Pervasive PSQL in a failover cluster environment, you can manage Pervasive PSQL as a resource. The following items discuss common management topics.

- Pervasive PSQL Licensing and Node Maintenance
- Pervasive PSQL Failure Behavior
- Restoring Pervasive PSQL on a Failed Node
- Stopping or Restarting the Pervasive PSQL Transactional Service
- Pervasive PSQL Configuration Changes
- Cluster Environment with a Proxy Server
- Software Upgrades

Pervasive PSQL Licensing and Node Maintenance

The normal procedure pertaining to Pervasive PSQL licensing and machine maintenance also applies to the nodes in a failover cluster environment. Deauthorize the Pervasive PSQL key before you modify the configuration of the physical or virtual machine on which the database engine is installed. Reauthorize the key after the changes are complete.

See To Deauthorize a Key and To Authorize a Key in *Pervasive PSQL User's Guide*.

Pervasive PSQL Failure Behavior

If a cluster node fails, a Pervasive PSQL client does not automatically reconnect to the Pervasive PSQL engine on the surviving node. Your application must reconnect the client to the Pervasive PSQL database or you must restart the application. This applies even if Enable Auto Reconnect is turned on for the database engine.

If transaction durability is turned off and a failure occurs before a transaction completes, the transaction is automatically rolled back to its state before the transaction began. That is, to the last completed check point. The rollback occurs when the active server requests access to the data file.

If transaction durability was turned on, completed changes can be recovered that occurred between the time of the cluster node failure and the last check point. Transaction durability must be configured the same way on all nodes and the transaction log located on the shared storage. Transactions that had not completed at the time of the cluster failure, however, are lost even if transaction durability was in effect.

Restoring Pervasive PSQL on a Failed Node

Your failover cluster may have a primary node from which you prefer to run. If the primary node fails, you would want to restore it as quickly as possible rather than using secondary nodes. For such a situation you may want to consider Pervasive PSQL Insurance to help establish a primary node with a temporary license for Pervasive PSQL.

Pervasive PSQL Insurance gives you a way to get back online right away to keep your business going until you can restore the original Pervasive PSQL license on the primary node. Pervasive PSQL Insurance provides a 7-Day temporary license that allows 3 separate uses and is available for Windows and Linux 32-bit or 64-bit environments. See www.pervasivedb.com for details.

Stopping or Restarting the Pervasive PSQL Transactional Service

A cluster failover occurs from the active node if you manually stop the Pervasive PSQL transactional service through the operating system. If you are performing service node maintenance and want to avoid such a failover, stop the Pervasive PSQL transactional service through the cluster utilities.

Pervasive PSQL Configuration Changes

Configuration Changes that Require Database Engine Restart

Some configuration changes require that you restart the database engine. For such changes, perform the changes on an inactive mode. Otherwise, the restart could cause a failover to occur. See Configuration Reference chapter.

Adding a User Count Increase (UCI) Key

You can add an increase key to Pervasive PSQL at any time on either the active node or an inactive node. Adding a UCI key does not require an engine restart and takes effect immediately. See also Increase User Count, Session Count, or Data In Use in *Pervasive PSQL User's Guide*.

Cluster Environment with a Proxy Server

If your cluster environment also incorporates a proxy server, see Authorization Access Through A Proxy Server in *Pervasive PSQL User's Guide*.

Software Upgrades

At some point, you may need to upgrade Pervasive PSQL or the failover cluster software. For Pervasive PSQL, ensure that you upgrade the database engine on an inactive node. See also the release notes for the upgrade version. For the failover cluster software, refer to the recommended procedure from the software vendor.

Migration

Migration moves a VM running Pervasive PSQL from one physical host to another. The memory, storage, and network connectivity of the VM are typically migrated to the destination. Depending on the hypervisor, migration is sometimes referred to as “live” migration or “hot” migration.

With a “live” or “hot” migration, client connections to Pervasive PSQL remain intact. This allows changes to hardware or resource balancing. With a “cold” migration, network connectivity is interrupted because the VM must boot. Client connections to Pervasive PSQL must be reestablished.

A migration environment has only one instance of Pervasive PSQL running, which makes the environment somewhat vulnerable if the host machines crashes or must be quickly taken offline. Also, if the shared storage fails, the database engine cannot process reads from or writes to physical storage. Some hypervisors offer a migration solution that does not use shared storage.

Pervasive PSQL Vx Server is the preferred product for migration environments. As long as virtual MAC addresses and host names remain the same after the VM migrates, PSQL Vx Server continues to operate normally. The product key remains in the “active” state.

You can use Pervasive PSQL Server, but the product key changes to “failed validation” state when a migration occurs to another host. The database engine runs for a limited time (the failed-validation period) with a key in failed validation. Provided that you migrate back to the original host before the failed-validation period expires, the database engine operates normally.

No special steps are required to install or configure Pervasive PSQL in a migration environment. Refer to the hypervisor documentation.

Fault Tolerance

A fault tolerant environment is similar to a migration environment but includes additional features to ensure uninterrupted operation even after the failure of a component. A fault tolerant environment ensures network connections, continuous service, and data access through synchronized shared storage. If a component switch occurs, client machines and applications continue to function normally with no database engine interruption.

Pervasive PSQL Vx Server is the preferred product for fault tolerant environments for the same reason as discussed in Migration.

No special steps are required to install or configure Pervasive PSQL in a fault tolerant environment. Refer to the hypervisor documentation.

Disaster Recovery

Disaster recovery includes data recovery and site recovery. Data recovery is how you protect and restore your data. Site recovery is how you protect and restore your entire site, including your data.

Data recovery is facilitated with the hypervisor's shared storage and Pervasive PSQL transaction logging and transaction durability. See Transaction Logging and Durability. You can use transaction logging and transaction durability with Pervasive PSQL Server and Server Vx.

Site recovery can be accomplished with both Pervasive PSQL Server and Server Vx. With Pervasive PSQL Server, a separate product key is required for a physical machine. If the recovery involves a VM from the original site, the Pervasive PSQL product key changes to "failed validation" state when the VM boots. The database engine runs for a limited time (the failed-validation period) with a key in failed validation. Provided that you migrate back to the original host before the failed-validation period expires, the database engine operates normally. However, with site recovery, the original host may be lost.

Pervasive PSQL Vx Server operates normally provided virtual MAC addresses and host names remain the same in the recovered site VM as they were in the original VM. The product key remains in the "active" state.

No special steps are required to install or configure Pervasive PSQL in a disaster recovery environment. Refer to the hypervisor documentation.

chapter

Workgroup Engine in Depth 10

Technical Details and Advanced Procedures for the Workgroup Engine

This chapter explains how to get the most out of your Workgroup engine.

Networking

Both the server and workgroup products are shipped with the same networking components. So you can upgrade a workgroup engine to a server engine. The client side requestors can connect to either type of engine.

NetBIOS

The Pervasive Network Services Layer searches for an engine on the network using NetBIOS as well as the other protocols previously supported; Named Pipe, DNS, and NDS. The NetBIOS and DNS protocols can be used to contact a workgroup engine. Server engines on Windows advertise themselves with Named Pipes, so NetBIOS is not needed.

Once the client requestor has found an IP, SPX or NetBEUI address, it will try to establish a connection to a MicroKernel engine using that transfer protocol.

MicroKernel Router Decision Algorithm

The client side MicroKernel router discovers Gateway ownership of files by following a well-established algorithm.

Table 40 Gateway Discovery Priorities

Priority	Procedure
1	Try to connect to a database engine on the same computer as the data files.
2	Try to open the data files using the local engine (on the client machine).
3	Find and connect to the Gateway engine that owns the files.

The first thing the client-side router always tries is to connect to an engine on the same computer as the data. Because of this procedure, it is always more efficient to have an engine running where the data is.

Because the Pervasive Network Services layer uses so many different methods to find and connect to a remote database engine, there may be a time delay on the first attempt to open a file on a file server that does not have a database engine running. If Gateway Durability is turned on, that connection will not be attempted thereafter because the router remembers each machine on which it fails to locate an engine.

If the router cannot connect to an engine on the remote file server, the router then allows the local engine to attempt to open the remote files. The local engine first attempts to create a new locator file and take ownership of the remote directory. If the directory is already owned by another MicroKernel, the local engine returns Status Code 116 to the router.

Finally, the router attempts to discover the Gateway computer. It opens the locator file and reads the name of the Gateway engine. Then it sends the request to that engine. Notice that the router never tries to read a locator file unless it has received Status Code 116 from a MicroKernel first. This behavior means that in order to use the Gateway feature, you must have a local workgroup engine installed. If the attempt to open the remote files with the local engine fails because there is no local engine, the router does not try to read the locator file and no Gateway engine is found.

Technical Differences Between Server and Workgroup

The Server Engine and Workgroup Engine have a few significant differences that this section explains.

Platforms

The Server Engine has both 32-bit and 64-bit editions available, both on Linux and Windows. The Workgroup Engine has only a 32-bit Windows edition available. Although the Workgroup Engine can be run on a 64-bit Windows operating system, it can only use up to 2 GB of memory and cannot take advantage of the larger amounts of memory typically installed on such systems.

User Interface

The Server Engine for Windows is installed to run as a Windows Service. The Workgroup Engine can be installed to run as an application or as a service. See Configuring the Workgroup Engine in *Getting Started With Pervasive PSQL*. If installed to run as an application, the Workgroup Engine uses a tray icon for an interface.

Authentication and Btrieve Security Policies

The Server Engine enforces file permissions set up in the operating system. The Workgroup Engine does not authenticate users on its own. If the Workgroup Engine can access the computer on the network, it can get to the data. This relaxed security is intended for small offices where security is less of an issue and ease of use is more important.

The lack of operating system authentication with the Workgroup Engine means that the Mixed security policy for Btrieve is the same as the Classic security policy. See Security Models and Concepts in *Advanced Operations Guide*. This difference in security policy is a behavior difference between the Server and Workgroup Engines.

Gateway Support

The Workgroup Engine creates locator files everywhere it opens files, both locally and remotely, allowing the Engine to dynamically adjust gateway ownership daily. By default, the Workgroup Engine also runs under a user ID, which can be authenticated on other computers and network devices. This makes the Workgroup Engine ideal for use in a gateway environment. See Setting Up a Gateway Configuration in *Getting Started With Pervasive PSQL*.

The Server Engine does not always create or honor gateway locator files. As such, it is not designed or tested for use in a gateway environment. Therefore, replacing a Workgroup Engine with a

Server Engine as a gateway in a workgroup environment is not supported.

Asynchronous I/O

The Server Engine for Windows makes use of Asynchronous I/O. Furthermore, coalescing of database page writes is done only by the Server Engine. These features can provide a significant performance advantage for the Server Engine over the Workgroup Engine during heavy I/O usage.

Default Configurations

The default values for some database settings (such as cache size and system cache) are different between Server Engine and Workgroup Engine. The default values for Workgroup Engine settings are set to consume less system resources. See Configuration Reference in *Advanced Operations Guide*.

Xtreme I/O (XIO) Support

XIO is supported only by the Windows 32-bit Server Engine. See Xtreme I/O Driver in *Advanced Operations Guide*.

License Model

Pervasive PSQL Server and Pervasive PSQL Workgroup use a user count license model. Pervasive PSQL Vx Server uses a capacity-based license model. See License Models in *Pervasive PSQL User's Guide*. For details about Pervasive PSQL Vx Server, see *Pervasive PSQL Vx Product Guide*.

Troubleshooting Workgroup Issues

This section provides a few tips on troubleshooting problems in a Workgroup environment.

Time delay on first connection

If you are regularly experiencing a delay when the first file-open request is issued, see if these techniques help.

If possible, make sure there is an engine running where the data is

Connecting to an engine on the same machine as the data is the client's first priority when deciding where to send a file-open request. To ensure a Workgroup Engine is running as an application, put an engine icon into the startup folder with the command:

```
W3dbsmgr.exe
```

Another option is to install the Workgroup Engine as a service. See *Getting Started With Pervasive PSQL*. Also, for default locations of Pervasive PSQL files, see Where are the Pervasive PSQL files installed? in *Getting Started With Pervasive PSQL*.

If you are running a gateway topology

If you cannot run an engine where the data is, then the time delay during the first connection is a more important issue. Here are a few things you can do.

1. Reduce the supported protocols in the client settings so that protocols that are not used in your network are not attempted.
2. Use Gateway Durability. Gateway Durability is a client configuration setting that allows you to virtually eliminate the delay in making the first connection in a gateway environment. If Gateway Durability is turned on, it forces the client router to write into the registry the names of computers it finds that do not have an engine running. Once a failure to connect happens, instead of remembering this server name only while the router is running in-process, it saves the name in the registry. The next time the application starts up, it does not try to connect to the engine where the data is. It immediately goes to the next step of determining the identity of the current Gateway.

You can turn this setting on in PCC. Within PCC Pervasive PSQL Explorer, expand Local Client node then right-click on MicroKernel Router. Click Properties then click Access. Click the Gateway Durability option to set it to "on" (a check mark indicates that the setting is "on") then click OK.

Note This feature is OFF by default since it fixes the topology. If you add a server engine or a Workgroup engine where the data is, you must turn this setting back to OFF on each of the clients where you turned it ON. Turning the setting off erases the registry of computers without an engine running, so you can turn it back ON immediately and a new list will be generated based on the new topology.

Status Code 116

Status 116 is a MicroKernel Status Code which means that the file is being used by another MicroKernel engine acting as a Gateway. If your application receives a status code 116, it means that the MicroKernel router can read the locator file but cannot contact the engine running on the gateway computer.

The first thing you need to do is find out who the gateway is. You can perform this task with the Gateway Locator utility.

Next, use PSA network tests to try to connect to that computer. PSA can provide valuable information to isolate the problem.

One situation when this could occur is when the two computers are separated by a router such that they can both see the file server but they cannot see each other.

Re-directing Locator Files

This feature of Gateway engine operation guarantees transaction atomicity for multi-directory databases and also makes it easy to change the name of a Gateway engine across multiple data directories.

Recall that the Pervasive PSQL client uses the following approach to access remote data files:

- First, attempt to connect to a database engine on the same computer as the data files.
- Second, if no database engine is available on the remote machine, attempt to use a local engine to take ownership of the remote directory and create a Locator File. If a Gateway Locator File already exists, the local engine is not used.
- Third, try to use the specified Gateway engine.

It is important to remember that the Gateway configuration only goes into effect when there is no database engine available on the same computer as the data files.

This feature allows a dynamic (floating) Gateway engine while at the same time preserving transaction durability for multi-directory databases on the same volume. This benefit is provided by a new type of Gateway Locator File that points to another Gateway Locator File. The new type is called a *Redirecting Locator File*. By having Redirecting Locator Files in directories A, B, and C that point to the Locator File in directory D, you can ensure that the Gateway engine specified by the Locator File in directory D services data files in the other directories as well.

Regardless of whether the Locator file in directory D specifies a permanent Gateway or is dynamically created by the first engine to open those files, this architecture ensures that all the specified directories use the same Gateway engine. Likewise, if you decide to change the permanently assigned Gateway engine for several directories, Redirecting Locator Files allow you to do so by changing only one Locator File, rather than all of them. Thus, it is possible to specify that all data files on a given hard drive must use the same Gateway engine, with or without designating a permanent Gateway.

Redirecting Locator File Requirements

The first line of a Redirecting Locator File must start with "=>" and be followed by a path specifying another Locator File, which must be on the same drive. You can use any combination of forward slash and back slash in the path name. All slashes are converted to the type of separator used by the local operating system.

If your specified path ends with a slash, the database engine assumes the default Locator File name (~PVSW~.LOC) and appends it to the path. If the specified path does not end with a slash, the database engine assumes that the path already contains the file name.

The following table lists the ways a Redirecting Locator File path can be specified:

Table 41   Redirecting Locator File Path Descriptions

Path	Meaning
=>\path_name	Specifies the path from the root of the drive where the current Locator File is stored.
=>.\path_name	Specifies the path relative to the current directory.
=>..\path_name	Specifies the path relative to the parent directory of the current directory.

You can assign multiple levels of redirection to these Locator Files. For example, you can have the first Locator File pointing to a second Locator File, the second Locator File pointing to a third Locator File, and so on. Each workgroup engine opens each Locator File sequentially, looking for the actual Gateway name. It stops searching once it has found the locator file that does not start with "=>". The engine then assumes this Locator File specifies the Gateway engine.

Creating Redirecting Locator Files

As with any Locator File, a Redirecting Locator File is a plain text file. You can create Redirecting Locator Files by hand or programmatically. A Redirecting Locator File must be flagged as read-only, or it will be overwritten by the first engine to attempt to access the data files in that directory.

➢ To Create a Redirecting Locator File

1 Open Notepad or a text editor, and open a new text file.

2 Decide where you are going to save the file when you are finished. You will save the file in the same directory as the data files which you want to redirect to another locator file.

For example, if you want to ensure that the data files in C:\data are accessed by the same Gateway engine as other data files, then you will want to keep in mind the folder C:\data.

3 Type in => and the path name of the next Locator File. Continuing the example from the previous step, if you want the current data files in C:\data to be owned by the Gateway engine specified in the Locator File located in c:\moredata, then you would type the following:

`=>..\moredata\` *(recommended) or*

`=>\moredata\` *(not recommended)*

In the first case, you are specifying a relative path from the current directory. In the second case, you are specifying an absolute path from the root of the current drive. In this particular example, both cases resolve to the same target directory.

Note Pervasive strongly recommends that you use relative path names (starting with ./ or ../) in your Redirecting Locator Files, and that you use the same share names on all workstations to access the same data. Following these two recommendations can prevent errors that may occur with network path name resolution over mapped drives.

4 Save the file as ~PVSW~.LOC in the directory where the data files exist that you want to specify a Gateway engine for.

5 Close Notepad or the text editor.

6 Flag the text file as read-only.

To mark the file as read-only on Windows, you can use the Properties dialog box (right-click on the file icon) in Windows Explorer, or you can use the ATTRIB command in a DOS session or in a program:

```
ATTRIB +R ~PVSW~.LOC
```

➢ To synchronize many data directories on a permanent Gateway

1 Either by hand or by using the Gateway Locator program, create a read-only (permanent) Locator File that does not redirect. It must specify a Workgroup engine to use as the Gateway.

For example, your locator file may specify the computer named “workgroup1” as the Gateway engine, and the file may be located in C:\DATA\DB1.

2 For each of the other data directories that you want to use the Gateway engine specified in the previous step, you need to create a Redirecting Locator File in that directory. Each Redirecting Locator File must point to the file you created in the previous step.

Continuing the example, each Redirecting Locator File in C:\DATA\DB2 and C:\DATA\DB3 would then contain the following text:

```
=>..\DB1\
```

This causes any engine reading this file to follow the relative path and search the specified directory C:\DATA\DB1 for another Locator File. In this case, the specified directory contains a Locator File that names “workgroup1” as the Gateway computer.

➢ To synchronize many data directories on a dynamic Gateway

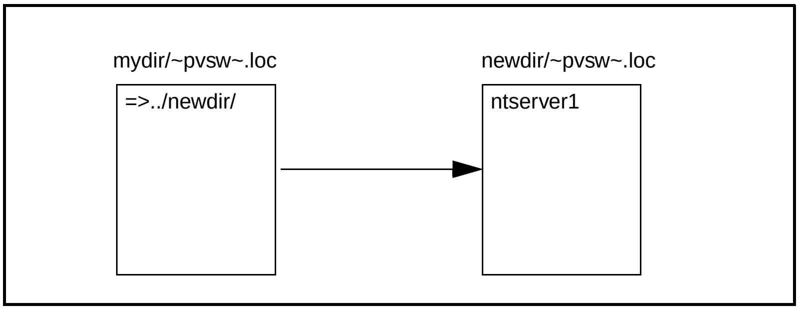
1 Follow the steps above, only in step #1, ensure that the Locator File is writable, not permanently-assigned.

In this case, remember that if no engines are accessing any data files in the redirecting hierarchy, then there will be no Locator File in the target directory. This is normal. The dynamic Locator File is created each session by the first engine to access the data, and the file is deleted when the last user session ends. It is permissible to have Redirecting Locator Files that point to a data directory that has no Locator File in it. In this case, the first engine to open those data files creates the Locator File.

Example

Using the example Locator Files shown in Figure 4, the Redirecting Locator File on the left forces the database engine to go up one directory, then look in the sub-directory `newdir` for another Locator File with the default name (~PVSW~.LOC). This Locator File, in turn, specifies that the Workgroup engine on the computer named `ntserver1` is the correct Gateway engine. As a result, the database engine on `ntserver1` is used to access the data files in the directory `mydir`.

Figure 4 Redirecting Locator File Example



chapter 11

Monitoring Database Resources

Using Monitor to Oversee Database Resources

This chapter includes the following sections:

Monitor Overview

Monitor is a utility that allows you to monitor certain activities and attributes of the database engine. The utility provides information that is useful for both database administration and application programming diagnostics. The utility can monitor aspects of the transactional interface and the relational interface.

Interface Versions

Monitor is provided with three interfaces, all of which provide the same functionality. A graphical interface presents information in a series of dialog boxes. A command line interface uses an executable program that directs the information to a configurable location. A third interface is integrated into Pervasive PSQL Control Center and accessed from the context menu for a database engine.

- For information about the graphical user interface, see Monitor Graphical User Interface.
- For information about the command line interface, see Monitor Command Line Interface.
- For information about Monitor integrated into PCC, see Monitor in *Pervasive PSQL User's Guide*.

Monitor Graphical User Interface

The Monitor graphical user interface (GUI) is a 32-bit Windows application that runs on Windows 32-bit and 64-bit platforms.

Monitor provides a "snapshot" of server activity at a point in time. How recent the snapshot is depends on the interval for the refresh rate. The default is every four seconds. See Setting Monitor Options for how to set the refresh rate.

Starting Monitor

Access Monitor from the operating system Start menu or Apps screen or from the Tools menu in Pervasive PSQL Control Center.

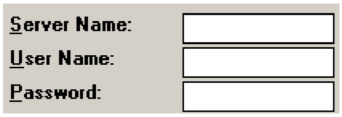
Monitor connects to the local database engine by default. However, you can also monitor resources of a remote database engine by connecting to a remote server.

➢ To connect to a remote server

1 Ensure that no dialogs are currently open in Monitor.

You cannot connect to a remote server if dialogs are open.

2 Click Connect from the Options menu. The Connect to Remote Server dialog displays.



Server Name:	
User Name:	
Password:	

3 Type the name or IP address of the server to monitor in the Server Name field.

4 Type a user name and password for that server in the User Name and Password fields, respectively.

To be authenticated, the user specified must have full administrator-level rights on the machine where the database engine is running or be a member of the Pervasive_Admin group on that machine.

5 Click OK.

➢ To disconnect from a server

1 Ensure that no dialogs are currently open in Monitor.

You cannot disconnect from a server if dialogs are open.

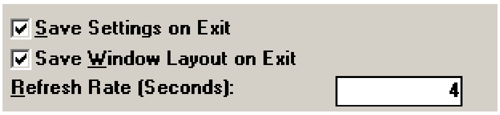
2 Click Disconnect from the Options menu.

3 Click Yes.

Setting Monitor Options

➢ To configure Monitor options

1 Click Settings from the Options menu. The Monitor Settings dialog displays the current settings.



☑ Save Settings on Exit
☑ Save Window Layout on Exit
Refresh Rate (Seconds): 4

2 Specify the following options:

Save Settings on Exit	Select this option to save all configuration settings when you close Monitor. Monitor saves both the settings on this dialog and the automatic refresh option on the various dialogs.
Save Window Layout on Exit	Select this option to save the state (open or closed) and screen location of all open dialogs. When you start Monitor again, the dialogs are automatically opened and positioned. This enables you easily to reproduce your preferred layout.
Refresh Rate (Seconds)	Specifies the time interval with which Monitor refreshes its display. The refresh rate is measured in seconds. The default setting is 4. You can specify integer numbers only. If you set this number too low, Monitor may refresh itself so frequently that it affects the performance of the database engine. This is especially true if monitoring the local database engine.

3 Click OK to save the settings.

Monitoring Transactional Interface Resources

This section describes the following options for monitoring the transactional interface (MicroKernel):

- Setting Dialog Refresh Options
- Viewing Active Files
- Viewing Session Information
- Viewing Resource Usage
- Viewing Communications Statisticss

Setting Dialog Refresh Options

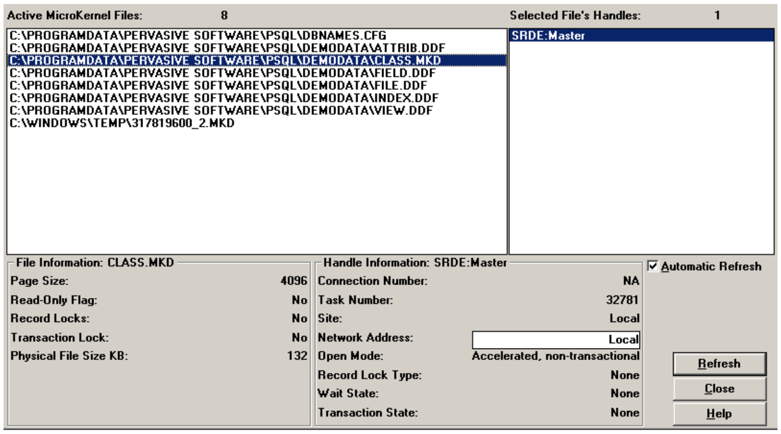
You can refresh the information in Monitor dialogs either automatically or manually, as follows.

- Automatically: select the Automatic Refresh option. The utility updates the dialog at the Refresh Rate specified in the Monitor options (see Setting Monitor Options).
- Manually: click Refresh.

Viewing Active Files

Click Active Files from the MicroKernel menu. The MicroKernel Active Files dialog displays and shows all of the files currently open by the MicroKernel.

Figure 5 Active MicroKernel Files Dialog



Active MicroKernel Files: 8
Selected File's Handles: 1

```
C:\PROGRAMDATA\PERVASIVE SOFTWARE\PSQL\DBNAMES.CFG
C:\PROGRAMDATA\PERVASIVE SOFTWARE\PSQL\DEMODATA\ATTRIB.DDF
C:\PROGRAMDATA\PERVASIVE SOFTWARE\PSQL\DEMODATA\CLASS.MKD
C:\PROGRAMDATA\PERVASIVE SOFTWARE\PSQL\DEMODATA\FIELD.DDF
C:\PROGRAMDATA\PERVASIVE SOFTWARE\PSQL\DEMODATA\FILE.DDF
C:\PROGRAMDATA\PERVASIVE SOFTWARE\PSQL\DEMODATA\INDEX.DDF
C:\PROGRAMDATA\PERVASIVE SOFTWARE\PSQL\DEMODATA\VIEW.DDF
C:\WINDOWS\TEMP\317819600_2.MKD
```

SRDE:Master

File Information: CLASS.MKD

Page Size:	4096
Read-Only Flag:	No
Record Locks:	No
Transaction Lock:	No
Physical File Size KB:	132

Handle Information: SRDE:Master

Connection Number:	NA
Task Number:	32781
Site:	Local
Network Address:	Local
Open Mode:	Accelerated, non-transactional
Record Lock Type:	None
Wait State:	None
Transaction State:	None

[✓] Automatic Refresh

Files List

In the upper left of the dialog, Monitor displays the list of Active MicroKernel Files. This scrollable list contains the complete path of all open files in alphabetic order.

➢ To view information about a file

1 Click on the desired file in the list.

2 View the information about the file in the lower left of the dialog, the File Information box.

Page Size	Indicates the size in bytes of each page in the file.
Read-Only Flag	Indicates whether the file is flagged as read-only by the operating system.
Record Locks	Indicates whether any of the active handles for the selected file have record locks. Any application can read a locked record, but only the application that placed the lock can modify or delete the record. A record lock exists only as long as the application that opened the file is updating a record. “Yes” indicates that one or more record locks are applied to the file. “No” indicates that no records are locked.
Transaction Lock	Indicates whether any of the active handles for the selected file have a transaction lock. A transactional file lock exists only as long as the application that opened the file is processing a transaction.
Physical File Size KB	Indicates the size of the file in kilobytes (KB). This information is particularly useful for the capacity-based license model if you want to review data in use on a file-by-file basis. See also Capacity-based License Model in *Pervasive PSQL User's Guide*. Note that Monitor uses kilobytes (KB) for the size of an individual file and megabytes (MB) as the units for resource usage (Viewing Resource Usage). License Administrator uses gigabytes (GB) as the units because that is how data in use is associated with a key. The different contexts require units appropriate for each context. Note that, if a file is immediately closed after you insert a large number of records, Monitor does not immediately reflect the changes in file size. For example, the statistics for “Physical File Size KB” are not refreshed for that file until the next time the file is opened for reading or writing.

File Handles List

In the upper right of the MicroKernel Active Files dialog, Monitor displays the list of Selected File's Handles. This scrollable list contains the active handles associated with the selected file. Each handle is represented by a name (typically the login ID of the user), or by an index into the Client list of the database engine.

➤ To view information about a file handle

1. Click on the desired handle in the list.
2. View the information about the handle in the lower right of the dialog, the Handle Information box.

Connection Number	Displays the network connection number of the client. If the client does not have a network connection, this field displays "NA" (for not applicable).
Task Number	Displays the process-supplied task number for processes originating at the server, or a Windows Client.
Site	Specifies the location of the user process (local or remote).
Network Address	Identifies the location of the calling process on the network. If the calling process is SPX, the network node/network address is preceded by S: such as *S: 65666768 00000000001*. If the calling process is TCP/IP, the address is preceded by T: such as *T: 180.150.1.24*, *T: 1234:5678:0000:0000:0000:0000:9abc:def0*, or *T: <mymachine.mydomain.mycompany>.com*.
Open Mode	Indicates the method the application uses to open the specified handle of the file. Valid open modes are: Normal – The application that opened the file has normal shared, read/write access to it. Accelerated – The application that opened the file has shared read/write access. Read-only – The application that opened the file has read-only access; it cannot modify the file. Exclusive – The application that opened the file has exclusive access. Other applications cannot open the file until the calling application closes it. Monitor also specifies all open modes as *non-transactional* or *shared locking* when applicable.

Record Lock Type	Displays the type of record lock(s) currently held by the handle. The possible record lock types are Single, Multiple, and None. Single-record locks enable a user to lock only one record at a time. Multiple-record locks enable a user to lock more than one record at a time.
Wait State	Indicates whether the user is waiting because of some type of lock on this handle: Waits for Record Lock, Waits for File Lock, or None.
Transaction State	Displays the state of the transaction lock currently held by the handle. The possible transaction types are Exclusive, Concurrent, or None.

Viewing Session Information

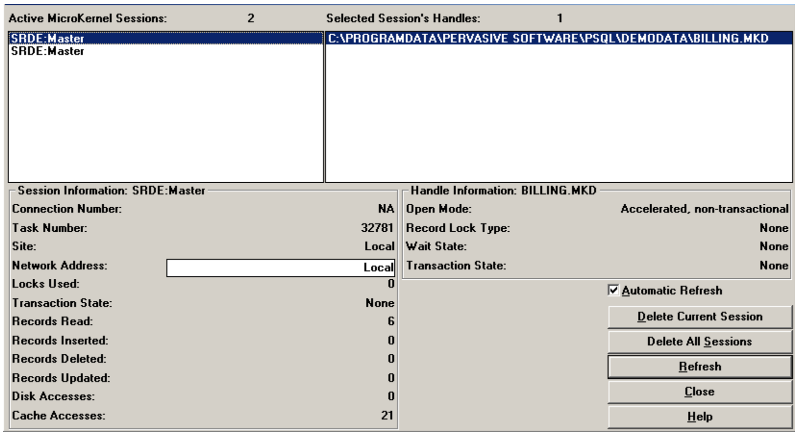
You can view a list of current sessions and files, as well as file handles for each session. A "session" is defined as a client ID used by the transactional engine interface or a connection to the relational engine interface. "Client ID" is defined as a 16-byte structure that combines elements provided by the application, by the client platform, and by the database engine to uniquely identify a database transaction context.

Note that the session information reflects the sessions established through the transactional interface and through the relational interface. (If you want to view sessions established only through the relational interface, see Viewing SQL Active Sessions.)

➤ To view sessions

Click Active Sessions from the MicroKernel menu. The MicroKernel Active Sessions dialog appears.

Figure 6 Active MicroKernel Sessions Dialog


Active MicroKernel Sessions: 2
Selected Session's Handles: 1

SRDE:Master
SRDE:Master

C:\PROGRAMDATA\PERVASIVE SOFTWARE\PSQL\DEMODATA\BILLING.MKD

Session Information: SRDE:Master

Connection Number:	NA
Task Number:	32781
Site:	Local
Network Address:	Local
Locks Used:	0
Transaction State:	None
Records Read:	6
Records Inserted:	0
Records Deleted:	0
Records Updated:	0
Disk Accesses:	0
Cache Accesses:	21

Handle Information: BILLING.MKD

Open Mode:	Accelerated, non-transactional
Record Lock Type:	None
Wait State:	None
Transaction State:	None

☑ Automatic Refresh

Sessions List

In the upper left of the dialog, Monitor displays the list of Active MicroKernel Sessions. This scrollable list contains the names of active sessions in alphabetic order. Each session is represented by a name (typically the login ID of the user) or by an index into the Client list of the database engine.

➢ To view information about a session

1 Click on the desired session.

2 View the information about the session in the lower left of the dialog, the Session Information box.

Connection Number	Displays the network connection number of the session. If the session does not have a network connection, this field displays NA (for not “applicable”).
Task Number	Displays the process-supplied task number for processes originating at the server, or from a Windows Client.
Site	Specifies the location of the session process (local or remote).

Network Address	Identifies the location of the calling process on the network. If the calling process is SPX, the network node/ network address is preceded by S: such as *S: 65666768 00000000001*. If the calling process is TCP/IP, the address is preceded by T: such as *T: 180.150.1.24*, *T: 1234:5678:0000:0000:0000:0000:9abc:def0*, or *T: <mymachine.mydomain.mycompany>.com*. If multiple clients from a single machine connect by different TCP/IP addresses, each address is valid for that client. However, internally to the database engine, an address associated with a client may not be the actual address used by that client. This is because of the way the database engine identifies and manages multiple clients from the same machine. Consequently, since Monitor is reporting engine information, the utility may display an associated address instead of the actual address.
Locks Used	Indicates the number of locks the session is currently using.
Transaction State	Displays the type of transaction lock the session currently holds. The possible transaction types are Exclusive, Concurrent, or None.
Records Read	Displays the number of records read since the session first opened a file.
Records Inserted	Displays the number of records the session has inserted.
Records Deleted	Displays the number of records the session has deleted.
Records Updated	Displays the number of records the session has updated.
Disk Accesses	Indicates the number of times the session required a disk access. You will not see any information for disk accesses for files that have just been opened.
Cache Accesses	Indicates the number of times this client experiences a miss of the L1 cache and moves a page from either L2 cache or the disk into the L1 cache in order to fulfill the request.

Session File Handles

In the upper right of the dialog, Monitor displays the Selected Session’s Handles list. This scrollable list contains the active file handles associated with the selected session. The MicroKernel creates a handle each time a session opens a file. A single session can have several handles for the same file.

➤ To view information about a session file handle

1. Click on the desired session file handle.
2. View the information about the handle in the center right portion of the dialog, the Handle Information box.

Open Mode	See Open Mode.
Record Lock Type	See Record Lock Type.
Wait State	See Wait State.
Transaction State	See Transaction State.

Deleting Current Sessions

Deleting a current session removes the session from the list of active sessions and terminates the session's connection to the database engine. All open files for the session are closed and all allocated resources are freed.

Caution Deleting a current session can result in incorrect data, incomplete records or aborted transactions depending on the what processing is currently occurring.

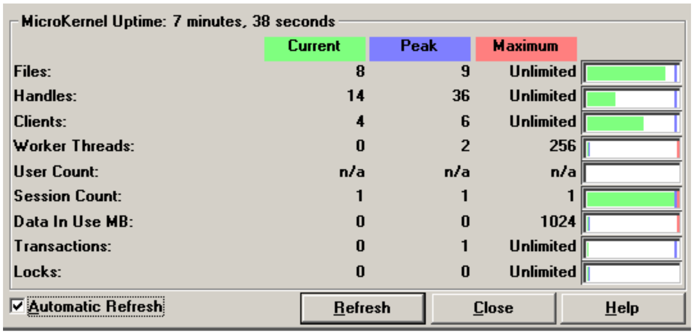
➤ To delete a session

1. Click on the desired session name.
2. Perform one of the following actions:
   - Click Delete Current Session to delete the selected session.
   - Click Delete All Sessions to delete all of the current sessions.

Viewing Resource Usage

Click Resource Usage from the MicroKernel menu. The MicroKernel Resource Usage dialog box displays.

Figure 7 MicroKernel Resource Usage Dialog



MicroKernel Uptime: 7 minutes, 38 seconds

	Current	Peak	Maximum
Files:	8	9	Unlimited
Handles:	14	36	Unlimited
Clients:	4	6	Unlimited
Worker Threads:	0	2	256
User Count:	n/a	n/a	n/a
Session Count:	1	1	1
Data In Use MB:	0	0	1024
Transactions:	0	1	Unlimited
Locks:	0	0	Unlimited

☑ Automatic Refresh

This dialog displays the resources in use by the MicroKernel since it was last started. The **MicroKernel Uptime** lists the amount of time in weeks, days, hours, and minutes that the MicroKernel has been running.

The dialog shows the following statistics for each resource:

- Current – Shows the present value for the resource.
- Peak – Shows the highest value for the resource since the MicroKernel was started.
- Maximum – Shows the highest value allowed for the resource.

The database engine dynamically controls the maximum values for some of these resources. The maximum value for User Count, Session Count, and Data In Use depends on the product license. See License Models in *Pervasive PSQL User's Guide*.

If a resource does not apply to the type of Pervasive PSQL product being monitored, “n/a” (“not applicable”) appears for each statistic. For example, “User Count” does not apply to Pervasive PSQL Vx Server. Therefore, “n/a” appears as the Current, Peak, and Maximum value for “User Count” if Pervasive PSQL Vx Server is being monitored. Similarly, “n/a” appears as the Maximum value for “Session Count” and “Data in Use MB” if Pervasive PSQL Server is being monitored.

However, if you are considering using Pervasive PSQL Vx Server, you need the ability to estimate Current and Peak values for “Session Count” and “Data in Use MB”; consequently, those statistics are displayed for the PSQL Server without being enforced. No notifications are sent about them regardless of their values.

Usage information is displayed for the following resources.

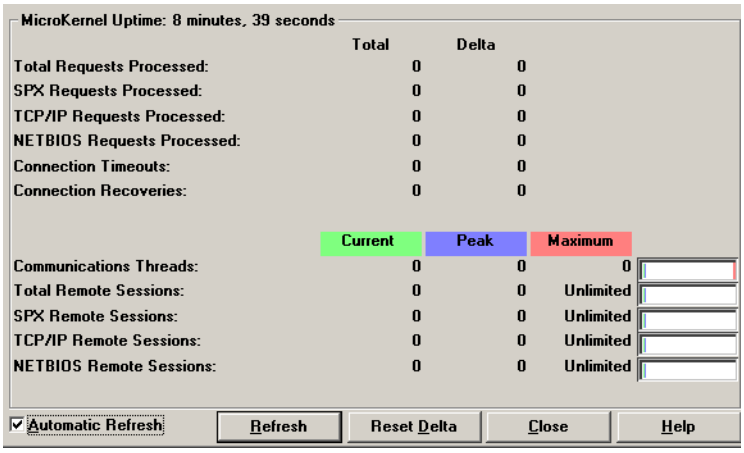
Files	Indicates the number of files currently open by the MicroKernel.
Handles	Indicates the number of active handles. The MicroKernel creates a handle each time a user opens a file. A single session can have several handles for the same file.
Clients	Indicates the number of clients accessing the MicroKernel. A machine can have multiple clients accessing the database engine simultaneously. The engine dynamically manages the client list. The number of clients is limited only by the memory in the computer. Note that “client” indicates a session established by a client ID (transactional engine interface) or a connection to the relational engine interface. The database engine uses various client sessions for its own internal processes, such as for accessing Pervasive PSQL system files, metadata files, dbnames.cfg, and default system databases. The number of clients indicates both internal client sessions and non-internal client sessions (see Session Count).
Worker Threads	Indicates the number of concurrent MicroKernel processes.
User Count	Indicates the number of concurrently connected users. The maximum value shows the maximum permitted users as granted by a license agreement.
Session Count	Indicates the number of sessions in use by the database engine. For brevity, “number of sessions in use” is also referred to “session count.” The maximum value shows the maximum permitted sessions as granted by a license agreement. The maximum is also called the “session count limit.” Note that session count reflects all sessions whether established through the transactional interface or through the relational interface. Messages pertaining to session count are logged to the various Pervasive PSQL logging repositories. See Pervasive PSQL Message Logging in *Pervasive PSQL User's Guide*. The database engine uses various sessions for its own internal processes, such as for accessing Pervasive PSQL system files, metadata files, dbnames.cfg, and default system databases. These internal sessions do not consume any session counts.

Data In Use MB	Indicates in megabytes (MB) the size of all concurrently open data files. The maximum value is the maximum permitted amount of all concurrently open data files as granted by a license agreement. The maximum is also called the “data in use limit.” The value for data in use increases when a data file is first opened. Subsequent opens to an already open data file do not add to the total. Data in use also increases if an open file increases in size. Operations on an already open file continue to be permitted even if the size of the open file increases beyond the data in use limit. The value for data in use decreases when a data file is closed by the final user to have the file open. Since more than one user can access the same data file, *all* opens must be closed before data in use decreases. Messages pertaining to data are logged to the various Pervasive PSQL logging repositories. See Pervasive PSQL Message Logging in *Pervasive PSQL User's Guide*. The database engine uses various files for its own internal processes, such as Pervasive PSQL system files, metadata files, dbnames.cfg, and default databases. Files used for internal processes do not increase the value for data in use. Note that, if a file is immediately closed after you insert a large number of records, Monitor does not immediately reflect the changes in file size. For example, the statistics for “Data in Use MB” are not refreshed for that file until the next time the file is opened for reading or writing.
Transactions	Indicates the number of transactions. The maximum for this resource is unlimited.
Locks	Indicates the number of record locks. The maximum for this resource is unlimited.

Viewing Communications Statistics

Click Communications from the MicroKernel menu. The MicroKernel Communications Statistics dialog displays.

Figure 8 MicroKernel Communications Statistics Dialog



MicroKernel Uptime: 8 minutes, 39 seconds

	Total	Delta
Total Requests Processed:	0	0
SPX Requests Processed:	0	0
TCP/IP Requests Processed:	0	0
NETBIOS Requests Processed:	0	0
Connection Timeouts:	0	0
Connection Recoveries:	0	0

	Current	Peak	Maximum
Communications Threads:	0	0	0
Total Remote Sessions:	0	0	Unlimited
SPX Remote Sessions:	0	0	Unlimited
TCP/IP Remote Sessions:	0	0	Unlimited
NETBIOS Remote Sessions:	0	0	Unlimited

☑ Automatic Refresh

This dialog displays communications statistics for the database engine since the last time the MicroKernel was started. The **MicroKernel Uptime** lists the amount of time in weeks, days, hours, and minutes that the MicroKernel has been running.

Where applicable, the dialog shows the following statistics for a resource:

- Current – Shows the most recent value for the resource.
- Peak – Shows the highest value for the resource since the MicroKernel was started.
- Maximum – Shows the highest value allowed for the resource.

You can monitor the activity of the following communications resources.

MicroKernel Uptime	Lists the amount of time in weeks, days, hours, and minutes that the MicroKernel has been running.

Total Requests Processed	Indicates the number of requests the database engine has handled from workstations or remote, server-based applications. Total – Indicates the number of requests processed since the database engine was started. Delta – Indicates the number of requests since you invoked the **Communications Statistics** dialog. To reset this number to zero, click **Reset Delta**.
SPX Requests Processed	Indicates the number of SPX requests the database engine has handled from clients or remote, server-based applications. Total – Indicates the number of requests processed since the database engine was started. Delta – Indicates the number of requests since you invoked the **Communications Statistics** dialog. To reset this number to zero, click **Reset Delta**.
TCP/IP Requests Processed	Indicates the number of TCP/IP requests the database engine has handled from clients or remote, server-based applications. Total – Indicates the number of requests processed since the database engine was started. Delta – Indicates the number of requests since you invoked the **Communications Statistics** dialog box. To reset this number to zero, click **Reset Delta**.
NetBIOS Requests Processed	Indicates the number of NetBIOS requests the database engine has handled from clients or remote, server-based applications. Total – Indicates the number of requests processed since the database engine was started. Delta – Indicates the number of requests since you invoked the **Communications Statistics** dialog. To reset this number to zero, click **Reset Delta**.
Connection Timeouts	Indicates the number of times Auto Reconnect has timed out when attempting to reconnect to Clients. See also Auto Reconnect Timeout. Total – Indicates the number of requests processed since the database engine was started. Delta – Indicates the number of requests since you invoked the **Communications Statistics** dialog. To reset this number to zero, click **Reset Delta**.

Connection Recoveries	Indicates the number of times the AutoReconnect feature has successfully recovered from a connection timeout. Total – Indicates the number of requests processed since the database engine was started. Delta – Indicates the number of requests since you invoked the **Communications Statistics** dialog. To reset this number to zero, click **Reset Delta**.
Communications Threads	Indicates the number of remote requests that the MicroKernel is currently processing. Local requests are not included in this statistic. For the total number of remote and local threads being processed, see Viewing Resource Usage. The database engine dynamically increases the number of communications threads as needed up to the maximum allowed. For Windows and Linux platforms, the maximum is 1,024. Worker threads are also used to process Monitor requests, so you may not see the number of current worker threads drop below one. This is normal.
Total Remote Sessions	Indicates the number of remote clients connected to the database engine. The maximum number is dynamic and displays as zero.
SPX Remote Sessions	Indicates the number of remote clients connected through the SPX protocol to the database engine.
TCP/IP Remote Sessions	Indicates the number of remote clients connected through the TCP/IP protocol to the database engine.
NetBIOS Remote Sessions	Indicates the number of remote clients connected through the NetBIOS protocol to the database engine.

Monitoring Relational Interface Resources

This section describes monitoring of the relational interface.

- Viewing SQL Active Sessions
- SQL Session Information

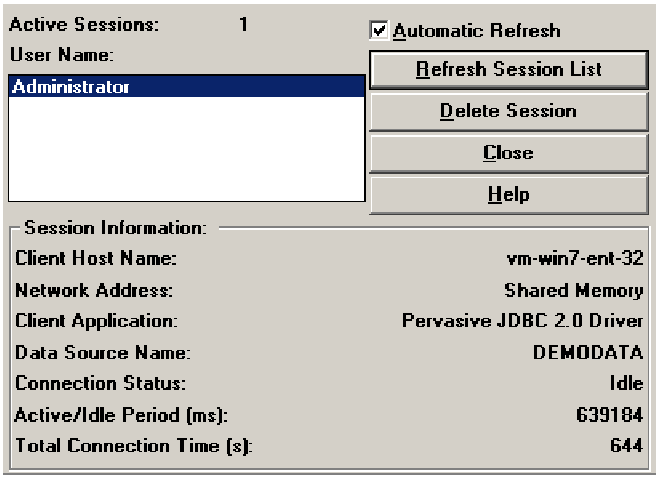
Viewing SQL Active Sessions

The SQL active sessions displays only sessions established through a connection to the relational interface. To view *all* sessions—whether established through the transactional interface or through the relational interface—see Viewing Session Information.

➤ To view SQL active sessions

Click Active Sessions from the SQL menu. The SQL Active Sessions dialog displays.

Figure 9 SQL Active Sessions Dialog



Client Host Name: vm-win7-ent-32
Network Address: Shared Memory
Client Application: Pervasive JDBC 2.0 Driver
Data Source Name: DEMODATA
Connection Status: Idle
Active/Idle Period (ms): 639184
Total Connection Time (s): 644

SQL Session Information

The Active Sessions label at the top of the dialog displays the number of SQL active sessions. The User Name box displays the list of user names connected to the database engine. User Name is set by default to the Windows login ID. If this is unavailable, User Name is set to "unknown."

Additional information about the selected User Name is provided in the Session Information box.

Client Host Name	Identifies the name of the Client machine for the selected User Name. If unavailable, this is set to "Unknown."
Network Address	Identifies the Client machine's IP or SPX address for the selected User Name. If unavailable, this is set to "Unknown." Values displayed include IP, SPX, Shared Memory and Unknown.

Client Application	Identifies the connected application or module. If unavailable, this is set to “Unknown.”
Data Source Name	Identifies the name of the DSN referenced by the Client application.
Connection Status	Specifies the connection status for the selected User Name. A status may be any of the following: Active – The session has files open. and that Idle means that the session has no files open. Idle – The session has no files open. Dying – A temporary status that indicates an active session has been deleted but has not finished processing the SQL code. At a suitable termination point, the session is no longer listed on the SQL Active Session dialog. Unknown – Status is unavailable.
Active/Idle Period	Displays the duration of time, in milliseconds, since the connection has been active or idle.
Total Connection Time	Displays the duration of time, in seconds, since the connection has been established.

➢ To refresh the SQL active sessions list

1. Click Refresh Session List.
2. Another method is to ensure that the Automatic Refresh option is selected and wait for the refresh rate to activate the refresh. See To configure Monitor options.

➢ To delete an SQL active session

1. Click on the desired user name in the User Name list.
2. Click Delete Session.

   If a large SQL block is being processed by an active session when you delete the session, the session may have a temporary connection status of “Dying.” The session should disappear from the dialog when the database engine reaches an appropriate termination point.

Caution Deleting an active session can result in incorrect data, incomplete records or aborted transactions depending on the what processing is currently occurring.

Monitor Command Line Interface

The command line interface (CLI) version of Monitor provides the same monitoring functionality as the GUI version.

CLI Monitor runs on the Windows and Linux platforms supported by Pervasive PSQL:

- On Windows, the executable program is bmon.bat and is installed, by default, in the `\bin` directory of the Pervasive PSQL installation directory. See Where are the Pervasive PSQL files installed? in *Getting Started With Pervasive PSQL*.
- On Linux, the executable program name is bmon and is located, by default, in the `/usr/local/psql/bin` directory. Certain requirements must be met before you can run bmon on Linux. These requirements are the same as for another Java utility, bcfg. See Requirements for Running bcfg on Linux, and Troubleshooting Guide for Running bcfg on Linux.

Configuration File

Bmon requires a configuration file to provide its settings. Pervasive PSQL provides a sample configuration file named monconfig.txt. It is located, by default, in the `\bin` directory of the Pervasive PSQL installation directory. See Where are the Pervasive PSQL files installed? in *Getting Started With Pervasive PSQL*.

Refer to the comments in the sample configuration file for the settings that you can configure.

Monitoring Output

Output from Bmon can be directed to the console, a log file, or both. An application could, for example, check for a particular condition from the console or in a log file, then take appropriate action.

The configuration file specifies where to direct the output.

Command Syntax

```
bmon -f [filepath]config_file [-runonce]
```

Options

-f	This is a required parameter to specify that a configuration file is providing input to the utility.
filepath	The path to the configuration file. If omitted, Bmon checks the local directory for the configuration file.
config_file	The name of the configuration file. The file name is of your choosing.
-runonce	This is an optional parameter that instructs the utility to run once, then exit. The runonce parameter is particularly useful when Bmon is used in a batch file. See also Keyboard Key Response If Runonce Parameter Omitted.

Keyboard Key Response If Runonce Parameter Omitted

The runonce parameter is optional. If omitted, the utility executes the settings in the configuration file, then pauses for the duration of the refresh rate. During the pause, you can send the utility a valid keyboard key response as shown in Table 42.

If the refresh rate is set to zero, the utility pauses indefinitely until it receives a valid keyboard key response. The **refreshrate** setting in the configuration file specifies how many seconds to pause. By default, refreshrate is set to the minimal allowed value of 5 seconds.

Table 42 Bmon Refresh Rates and Keyboard Key Responses

Refresh Rate	Keyboard Key Response
refreshrate=0 (pause until valid keyboard key response received)	**Q** (or **q**) + **Enter** stops execution of bmon **R** (or **r**) + **Enter** refreshes the monitoring (runs bmon again)
refreshrate=*seconds_to_pause* where *seconds_to_pause* is a whole number 5 or greater (pause for *seconds_to_pause* seconds)	**Q** (or **q**) + **Enter** stops execution of bmon

chapter

Testing Btrieve Operations 12

How to Perform Btrieve Operations with the Function Executor Utility

This chapter discusses the following topics:

Function Executor Concepts

This section contains the following topics:

- Overview
- What Function Executor Can Do
- Function Executor Features
- Automatic Mode in Function Executor
- Where to Learn More

Overview

Function Executor runs on Windows. With this interactive utility, you can learn how Btrieve operations work. (This chapter refers to operations for the transactional interface as “Btrieve operations.”)

By allowing execution of Btrieve operations one at a time, Function Executor enables application developers to simulate the operations of a Btrieve application. This simulation can isolate the database calls from the rest of your application, which can help in testing and debugging your program.

Function Executor is primarily a tool for application developers. This chapter assumes that you have a basic knowledge of Btrieve operations. For more information about Btrieve operations, refer to the *Btrieve API Guide* that is available in the Developer Reference.

What Function Executor Can Do

- Perform Btrieve operations while monitoring the contents of memory structures.
- Allow you to capture a series of Btrieve operations and save them as a history file for later playback
- Display the Btrieve version for clients, and local and remote engines.
- Display the Btrieve characteristics of data files and allow you to save those characteristics as a template (description file) or create a new file based on those characteristics. See File Statistics for more information.

Function Executor Features

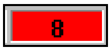
Function Executor features include the following:

- Editor Status Bar
- Statistics
- Get and GetExt

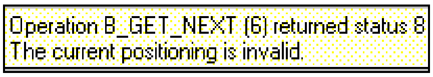
- Transaction Toolbar
- Login Dialog
- History Log
- Viewing as Any Data Type

Editor Status Bar

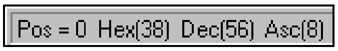
The status bar contains the following elements:



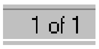
The last/current status code is shown in the editor window's status bar at the bottom of the window for the open file, and appears red if the last status was not zero.


Operation B_GET_NEXT (6) returned status 8
The current positioning is invalid.

Placing the mouse cursor over the status code shows a description of the status and what operation caused it. You can also click on the display in red in order to display the full help for the status code. See To get help for a status code for more information.

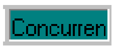

Pos = 0 Hex(38) Dec(56) Asc(8)

When your cursor is in the input area on the main window of Function Executor, the status bar displays the offset within the buffer: the hex, the decimal, and the ASCII value of the byte you are presently on.



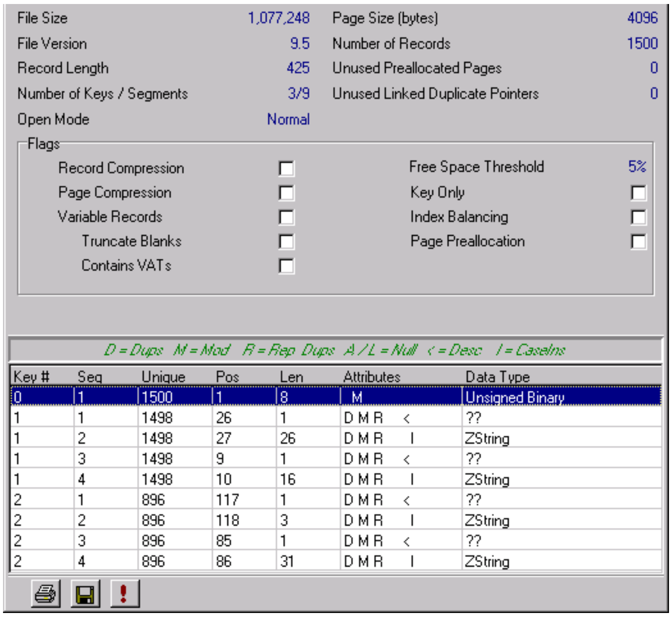
The status bar also indicates how many operations have been performed when there are multiple items in the queue. Normally this displays 1 of 1, but if you are executing multiple operations, it will display the count as the operations are executed.

The status bar also displays when you are in a transaction.



Statistics

Clicking on the File Statistics icon displays a dialog box listing the currently-open file's statistics. You can print these statistics to a text file or save them to a description file usable by BUTIL -CREATE (you may also create a new blank file with the same characteristics.)



File Size	1,077,248	Page Size (bytes)	4096
File Version	9.5	Number of Records	1500
Record Length	425	Unused Preallocated Pages	0
Number of Keys / Segments	3/9	Unused Linked Duplicate Pointers	0
Open Mode	Normal		

Flags

Record Compression	☐	Free Space Threshold	5%
Page Compression	☐	Key Only	☐
Variable Records	☐	Index Balancing	☐
Truncate Blanks	☐	Page Preallocation	☐
Contains VATs	☐		

D = Dups M = Mod R = Rep Dups A / L = Null < = Desc I = CaseIns

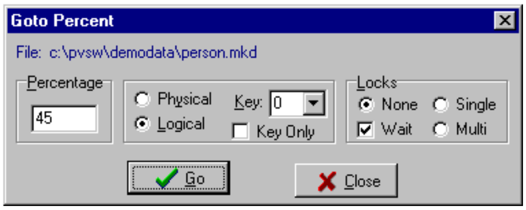
Key #	Seq	Unique	Pos	Len	Attributes	Data Type
0	1	1500	1	8	M	Unsigned Binary
1	1	1498	26	1	D M R <	??
1	2	1498	27	26	D M R I	ZString
1	3	1498	9	1	D M R <	??
1	4	1498	10	16	D M R I	ZString
2	1	896	117	1	D M R <	??
2	2	896	118	3	D M R I	ZString
2	3	896	85	1	D M R <	??
2	4	896	86	31	D M R I	ZString

Get and GetExt

From the Get menu, you can retrieve the First, Next, Previous, and Last records in the table. The GetExt menu includes the Goto Percent, Get Position, and Find Percent commands.

The Get and GetExt commands are available from both the menu bar and toolbar. The toolbar offers Step (Physical) and Get (Logical), allowing you to move either through the natural order of the file (physical) or in a specific order (logical).

Goto Percent allows you to choose whether to jump to a point within the physical layout of the file, or down any key path, limited to the keys defined in the file. You can also set lock biases using the option buttons in the Locks group box.



File: c:\pvsw\demodata\person.mkd

Percentage: 45

Physical [✓ Logical]

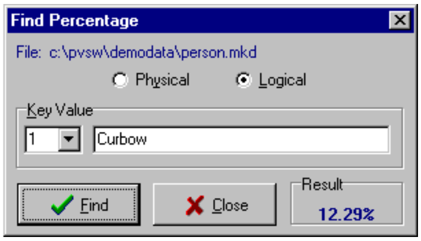
Key: 0

Key Only

Locks: [✓ None] Single

[✓ Wait] Multi

Find Percentage is the opposite of Goto Percent. It tells you how far into the data you are, depending on whether you are stepping through the file logically or physically.



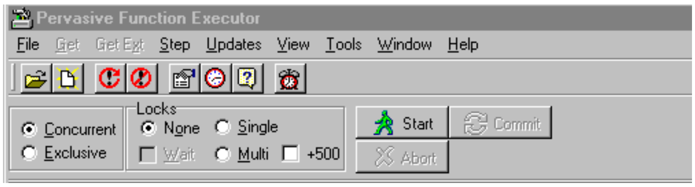
File: c:\pvsw\demodata\person.mkd

Physical [✓ Logical]

Key Value: 1 Curbow

Result: 12.29%

Transaction Toolbar



[✓ Concurrent] Exclusive

Locks: [✓ None] Single Wait Multi +500

The Transaction toolbar lets you start, stop, and abort transactions. You can set all aspects of the Transaction API through this toolbar, and the operation is executed immediately. The Transaction status also appears on the main window status bar, since it affects all open files for the client ID.

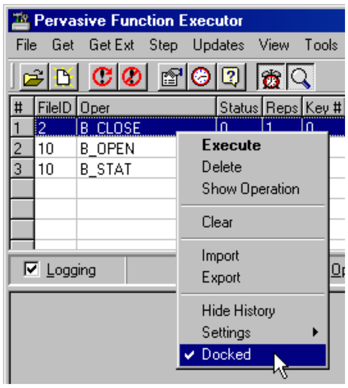
Login Dialog

The Login dialog box allows you to perform the Btrieve login operation via a GUI interface. See the following topics for more information about the Login dialog box:

- Login and Logout
- Pervasive PSQL Databases
- Pervasive PSQL Security

History Log

When you perform operations using the Function Executor utility, they are recorded in a History log. You can use this log to perform the operations contained therein, or save the history as a file that you can later reload and step through.



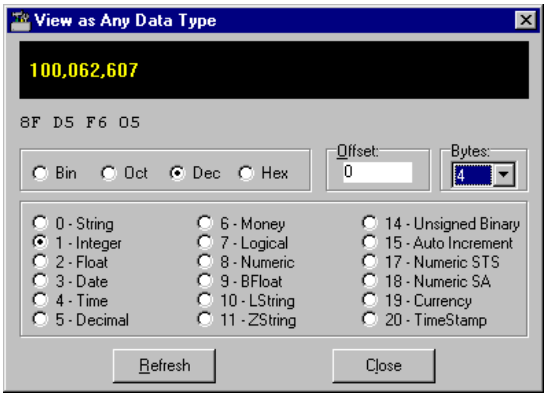
#	FileID	Oper	Status	Reps	Key #
1	2	B_CLOSE	0	1	0
2	10	B_OPEN			
3	10	B_STAT			

See the following topics for more information about the History log:

- History
- History Tasks

Viewing as Any Data Type

When a file is open, you can right-click on any position in the buffer and select Show As. A dialog box appears in which you can view the bytes at the chosen buffer position as any data type.



100,062,607

8F D5 F6 05

○ Bin ○ Oct [✓ Dec] ○ Hex

Offset: 0

Bytes: 4

○ 0 - String
[✓ 1 - Integer]
○ 2 - Float
○ 3 - Date
○ 4 - Time
○ 5 - Decimal
○ 6 - Money
○ 7 - Logical
○ 8 - Numeric
○ 9 - BFloat
○ 10 - LString
○ 11 - ZString
○ 14 - Unsigned Binary
○ 15 - Auto Increment
○ 17 - Numeric STS
○ 18 - Numeric SA
○ 19 - Currency
○ 20 - TimeStamp

Table 43 lists controls available Function Executor.

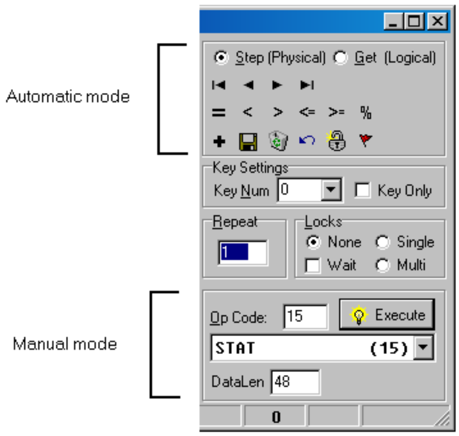
Table 43 Function Executor Controls

Control	Description
Repeat	Allows you to repeat commands.
Create	Allows you to create a new file.
File Statistics	Gives information from the BSTAT function. You can print these statistics.
MDI	The Multiple Document Interface permits the opening of multiple files.
Reset	Reset Client ID
Stop	Btrieve Stop
Version	Btrieve Version

Automatic Mode in Function Executor

For each open file (see Application Window), you have the option of performing Btrieve operations with or without the assistance of Function Executor. You do not need to make any configuration changes to use one method or the other. Whether you use automatic mode or manual mode depends on which GUI controls you use.

Figure 10 Automatic Mode and Manual Mode Controls



Note Selections from the menus (see Application Window) also are part of the automatic mode.

When you click a button in the automatic mode area, the following assistance is provided by the utility:

- Data buffers and data lengths are set automatically to prevent Status code 22.
- Information is requested appropriate to the operation.

Where to Learn More

Function Executor is a valuable tool for program developers, but it assumes you have a working knowledge of Btrieve fundamentals. Refer to the following topics to understand all the features of this utility:

- The chapter Transactional Interface Fundamentals in *Pervasive PSQL Programmer's Guide*. That guide is part of the Pervasive PSQL Developer Reference.
- The chapter Btrieve API Operations in *Btrieve API Guide*. That guide is part of the Pervasive PSQL Developer Reference.
- The chapter Pervasive PSQL Security.

Function Executor Graphical User Interface

This section describes the objects on Function Executor graphical user interface (GUI).

- Application Window
- Main Window
- Login and Logout
- Open File Dialog
- Create a Btrieve File
- Create a File Dialog GUI Reference (Advanced)
- Transactions
- File Statistics
- History

Application Window

The table below the following image explains the window components. Click on an area of the image for which you want more information.

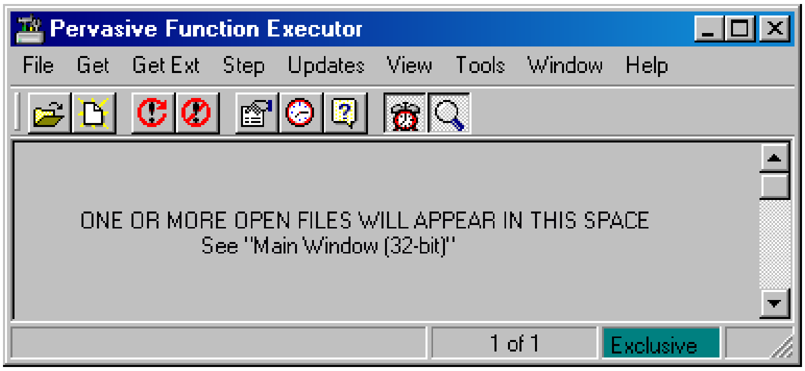

Pervasive Function Executor
File
Get
Get Ext
Step
Updates
View
Tools
Window
Help
ONE OR MORE OPEN FILES WILL APPEAR IN THIS SPACE
See "Main Window (32-bit)"
1 of 1
Exclusive

Table 44   Function Executor Application Window

GUI Object	Description	Related Information
File menu	Allows you to perform the following commands and Btrieve operations: • Login and Logout • Open and Close • New • Print Setup • Set Owner Name and Clear Owner Name • Start Continuous Operations or End Continuous Operations • Reset, Stop, and Exit	Performing Operations Tasks Opening a File Tasks
Get menu	Allows you to perform the following Btrieve operations: • Get First and Get Next • Get Previous and Get Last • Get Greater Than and Get Greater or Equal • Get Less and Get Less or Equal	Performing Operations Tasks
GetExt menu	Allows you to perform the following Btrieve operations: • Goto Percent • Get Position • Find Percent	Performing Operations Tasks
Step menu	Allows you to perform the following Btrieve operations: • Step First and Step Next • Step Previous and Step Last	Performing Operations Tasks
Updates menu	Allows you to perform the following Btrieve operations: • Insert, Update, and Delete You can also release locks using this menu.	Performing Operations Tasks
View menu	Allows you to display GUI elements: • Toolbars (main and transactions) • History window • File statistics window • Engine version using the Btrieve Version operations	History Tasks
Tools menu	Allows you to perform the following Btrieve operations: • Get Directory and Set Directory	

Table 44 Function Executor Application Window continued

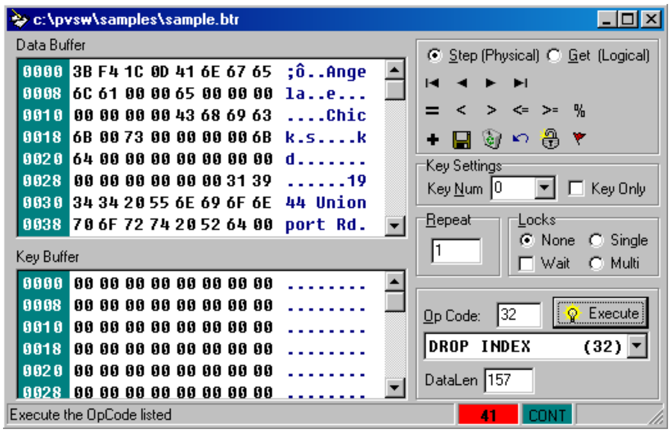
GUI Object	Description	Related Information
Window menu	Allows you to perform windowing operations: • Cascade windows and Tile windows • Select from a list of open windows	
Help menu	Allows you to select from a list of help resources for this utility.	To get help for a status code
Open	Displays a dialog box from which you select a Btrieve file to open.	Opening a File Tasks
Create	Displays a dialog box with which you can create a new Btrieve file.	Creating a Btrieve File Tasks
Reset	Resets the current client connection (Btrieve operation 28) and closes all files opened with that client ID.	
Stop	Terminates transactional services (Btrieve operation 25) and closes all open files.	
Statistics	Displays a dialog box listing the currently opened file's statistics. You can print these statistics to a text file or save them to a description file usable by BUTIL -CREATE	
Version	Displays information about the version of Pervasive PSQL (using Btrieve operation 26) that you are running. If no file is open, you will see information about the requester DLLs and any local MicroKernel engine. If you open a file on a remote server, you will see information about the server and requester DLLs.	
Status Codes Help	If no file is open, displays Status Codes help file. If file is open and a status code is active, displays help for that particular status code.	
Show help	Toggles whether a pop-up dialog box displays when a non-zero status code is received.	
Show history	Toggles whether the History window is displayed.	To display the History window History History Log

Table 44 Function Executor Application Window continued

GUI Object	Description	Related Information
Operation count	Indicates the current operation number. This is used when you set the Repeat to a value greater than one.	Performing Operations Tasks
Transaction state Exclusive	Indicates the current state of any transactions. Can be: • Blank, if no transaction is in effect • Concurrent • Exclusive	Performing Operations Tasks Transactions

Main Window

A main window displays for every open file. Click on an area of the image for which you want more information.



c:\pvsw\samples\sample.btr

Data Buffer

```
0000 3B F4 1C 0D 41 6E 67 65  ;ô..Ange
0008 6C 61 00 00 65 00 00 00  la..e...
0010 00 00 00 00 43 68 69 63  ....Chic
0018 6B 00 73 00 00 00 00 6B  k.s....k
0020 64 00 00 00 00 00 00 00  d.......
0028 00 00 00 00 00 00 31 39  ......19
0030 34 34 20 55 6E 69 6F 6E  44 Union
0038 70 6F 72 74 20 52 64 00  port Rd.
```

Key Buffer

```
0000 00 00 00 00 00 00 00 00  ........
0008 00 00 00 00 00 00 00 00  ........
0010 00 00 00 00 00 00 00 00  ........
0018 00 00 00 00 00 00 00 00  ........
0020 00 00 00 00 00 00 00 00  ........
0028 00 00 00 00 00 00 00 00  ........
```

[✓ Step (Physical)] Get (Logical)

Key Settings: Key Num 0; Key Only ☐

Repeat: 1

Locks: [✓ None] Single; Wait ☐ Multi

Op Code: 32 Execute

DROP INDEX (32)

DataLen 157

Execute the OpCode listed 41 CONT

Table 45 Function Executor Main Window for an Open File

GUI Object	Description	Related Information
Title Bar	Lists the full path of the open data file.	To open a data file with Function Executor
Data Buffer	Specifies a data value. For read and write operations, the Data Buffer contains records. For other operations, the Data Buffer contains file specifications, filtering conditions, and other information the database engine needs for processing the operation. This control corresponds with the Data Buffer parameter.	
Key Buffer	Specify the path for the data file for which you want to perform a Btrieve operation.	

Table 45 Function Executor Main Window for an Open File continued

GUI Object	Description	Related Information
Step vs. Get	Toggles between Step and Get operations	
Get/Step First	Performs the Get or Step Next operation	Performing Operations Tasks
Get/Step Prev	Performs the Get or Step Previous operation	Performing Operations Tasks
Get/Step Next	Performs the Get or Step Next operation	Performing Operations Tasks
Get/Step Last	Performs the Get or Step Last operation	Performing Operations Tasks
Get Equal	Performs the Get Equal operation	Performing Operations Tasks
Get Less Than	Performs the Get Less Than operation	Performing Operations Tasks
Get Greater Than	Performs the Get Greater Than operation	Performing Operations Tasks
Get Less or Equal Than	Performs the Get Less or Equal Than Operation	Performing Operations Tasks
Get Greater or Equal Than	Performs the Get Greater or Equal Than Operation	Performing Operations Tasks
Get/Find Percent	Performs the Get or Find Percent operations	Performing Operations Tasks
Insert	Performs the Insert operation	Performing Operations Tasks
Update	Performs the Update operation	Performing Operations Tasks
Delete	Performs the Delete operation	Performing Operations Tasks
Cancel	Cancels the recent changes	
Unlock	Releases any locks.	
Set or Goto Bookmark	Sets or positions at a previously defined bookmark.	
Key Num	For most Get operations, specifies a key number, or index path, to follow for the current operation. For other operations, specifies such information as file open mode, encryption, or logical disk drive. This control corresponds with the Key Number parameter.	
Key Only	Specifies to get key only, not data.	

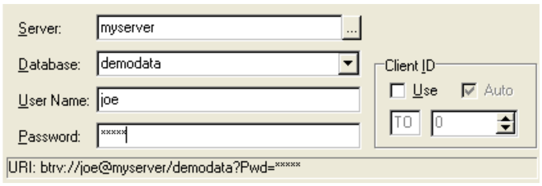
Table 45 Function Executor Main Window for an Open File *continued*

GUI Object	Description	Related Information
Repeat	Repeats the operation the number of times you specify.	
Locks	Specifies the locking behavior you want in for the current operation.	
Op Code	Specifies the current operation code plus its bias (if any). The default is **0**. If you are familiar with Btrieve operation codes, you can enter the desired code. Otherwise, use the **List** box to specify an operation. This control corresponds with the **Operation Code** parameter.	Performing Operations Tasks
Execute button	Performs the currently specified operation.	Performing Operations Tasks
Operations list	Lists all Btrieve operations and their codes. The default is **Open** (0). You can move quickly through the list by entering the first letter of the operation you want to perform.	Performing Operations Tasks
DataLen	Specifies the length (in bytes) of the Data Buffer. The default is 1024. For every operation that requires a data buffer, you must specify a buffer length. On many operations, the database engine returns a value to the Data Length. Generally, you should always specify a Data Length before you execute an operation. This control corresponds with the Data Buffer Length parameter.	Performing Operations Tasks
Status Code Indicator	Displays a numeric status code returned by the database engine and a brief message explaining the result of a Btrieve operation. For detailed information about these status codes and messages, refer to the *Status Codes and Messages* manual.	To get help for a status code
Continuous Operations Indicator	Displays the following on the bottom row of the file window if the file is in Continuous Operations mode (operation 42).	Using Continuous Operations

Login and Logout

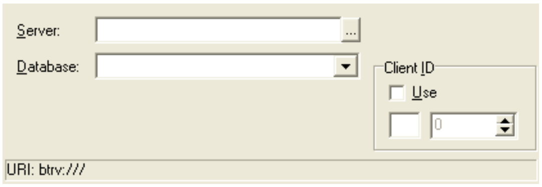
The Login and Logout dialog boxes allows you to perform the Btrieve login and logout operations, respectively, for the database engine. Click on an area of the image for which you want more information.

Figure 11 Login Dialog



Server: myserver
Database: demodata
User Name: joe
Password: *****
Client ID: TO 0
URI: btrv://joe@myserver/demodata?Pwd=*****

Figure 12 Logout Dialog



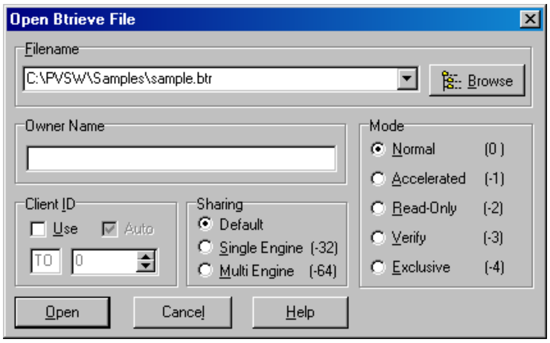
URI: btrv:///

Table 46 Function Executor Login and Logout Dialogs

GUI Object	Description
Server	Specifies the server where the database resides that you wish to login to or logout from. Note that a server name is required to access a database on a Linux operating system. See also Database URIs in *Pervasive PSQL Programmer's Guide*.
Database	Specifies the database on the server to which you want to authenticate.
User Name	The user name you want to authenticate against the database.
Password	The password for the user name.
Client ID	If you want this login or logout to apply to a specific client ID, click Use and specify the range. Otherwise, leave as is. See Client ID in *Btrieve API Guide*.
URI String	As you enter information in the forms, the URI resulting from your selections is shown in this area.

Open File Dialog

This dialog box allows you to open a file. Click on an area of the image for which you want more information.



Filename: C:\PVSW\Samples\sample.btr

Owner Name:

Mode: [✓ Normal (0)] Accelerated (-1) Read-Only (-2) Verify (-3) Exclusive (-4)

Client ID: Use [✓ Auto] TO 0

Sharing: [✓ Default] Single Engine (-32) Multi Engine (-64)

Table 47   Function Executor Open File Dialog

GUI Object	Description	Related Information
Filename	Specifies the location and name of the file that you want to open.	Opening a File Tasks
Owner name	Specifies a password to associate with the Btrieve file. If specified, the owner name is required to gain access to the Btrieve file. Owner name has no relation to any system user name. You can think of an owner name as a file password. A “short” owner name can be up to 8 bytes. A “long” owner name can be up to 24 bytes. Note, however, that once a long owner name is specified, the data file cannot be read by a database engine prior to Pervasive PSQL v10.10. Also, a data file with a long owner name cannot be rebuilt to a file format prior to 9.5 unless the owner name is first removed. An owner name, long or short, with less than the maximum allowed bytes is padded with spaces to the maximum length (8 or 24 bytes).	Opening a File Tasks See also the chapter Pervasive PSQL Security.
Mode	Specifies the state of the file when it is opened. Based on the state, the database engine knows certain conditions that apply to the opened file. For example, a condition could be that the file can be read but not updated (read-only).	Opening a File Tasks See Open Modes in *Btrieve API Guide* in the Developer Reference for an explanation of the modes.
Client ID	If you want this login to apply to a specific client ID, click Use and specify the range. Otherwise, leave as-is.	Opening a File Tasks
Sharing	The database engine ignores the “Sharing” options. The “Sharing” options applied only to a legacy version of the engine, Btrieve 6.15.	Opening a File Tasks

Create a Btrieve File

This dialog box allows you to create a Btrieve file. Click on an area of the image for which you want more information.

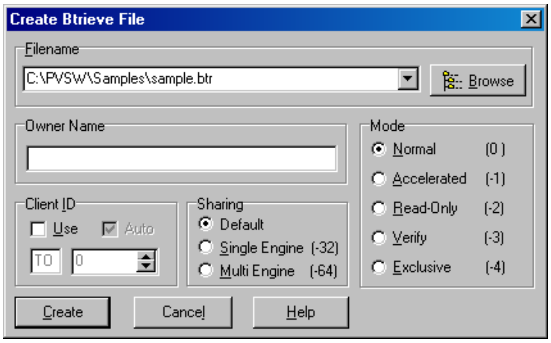


Table 48 Function Executor Create File Dialog

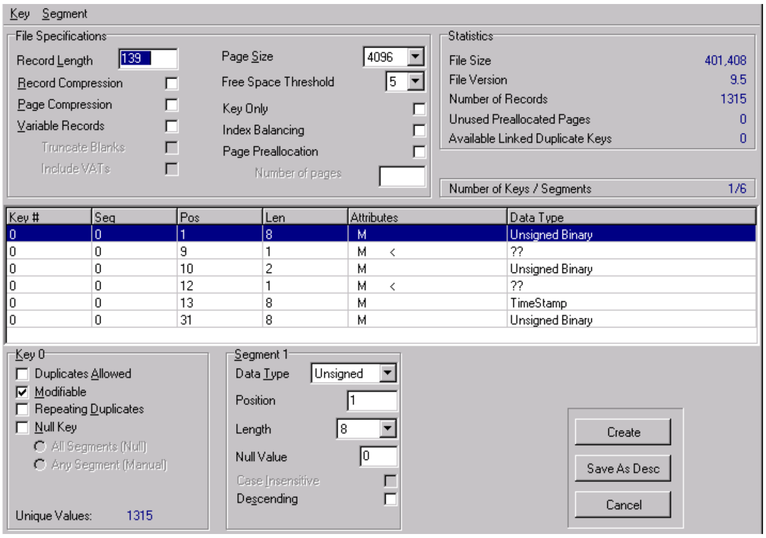
GUI Object	Description	Related Information
Filename	Specifies the location and name of the file that you want to create.	Creating a Btrieve File Tasks
Owner name	Specifies a password to associate with the Btrieve file. If specified, the owner name is required to gain access to the Btrieve file. Owner name has no relation to any system user name. You can think of an owner name as a file password. A “short” owner name can be up to 8 bytes. A “long” owner name can be up to 24 bytes. Note, however, that once a long owner name is specified, the data file cannot be read by a database engine prior to Pervasive PSQL v10.10. Also, a data file with a long owner name cannot be rebuilt to a file format prior to 9.5 unless the owner name is first removed. An owner name, long or short, with less than the maximum allowed bytes is padded with spaces to the maximum length (8 or 24 bytes).	Creating a Btrieve File Tasks See also the chapter Pervasive PSQL Security.
Mode	Specifies the state of the file when it is opened. Based on the state, the database engine knows certain conditions that apply to the opened file. For example, a condition could be that the file can be read but not updated (read-only).	Creating a Btrieve File Tasks See Open Modes in *Btrieve API Guide* in the Developer Reference for an explanation of the modes.

Table 48 Function Executor Create File Dialog continued

GUI Object	Description	Related Information
Client ID	If you want this login to apply to a specific client ID, click Use and specify the range. Otherwise, leave as-is.	Creating a Btrieve File Tasks
Sharing	The database engine ignores the “Sharing” options. The “Sharing” options apply only to a legacy version of the database engine, Btrieve 6.15.	

Create a File Dialog GUI Reference (Advanced)

This dialog box allows you to specify additional characteristics for the file being created. Click on an area of the image for which you want more information.



File Specifications

Record Length 139
Record Compression ☐
Page Compression ☐
Variable Records ☐
Truncate Blanks ☐
Include VATs ☐
Page Size 4096
Free Space Threshold 5
Key Only ☐
Index Balancing ☐
Page Preallocation ☐
Number of pages

Statistics

File Size	401,408
File Version	9.5
Number of Records	1315
Unused Preallocated Pages	0
Available Linked Duplicate Keys	0
Number of Keys / Segments	1/6

Key #	Seg	Pos	Len	Attributes	Data Type
0	0	1	8	M	Unsigned Binary
0	0	9	1	M <	??
0	0	10	2	M	Unsigned Binary
0	0	12	1	M <	??
0	0	13	8	M	TimeStamp
0	0	31	8	M	Unsigned Binary

Key 0

☐ Duplicates Allowed
☑ Modifiable
☐ Repeating Duplicates
☐ Null Key
○ All Segments (Null)
○ Any Segment (Manual)

Unique Values: 1315

Segment 1

Data Type Unsigned
Position 1
Length 8
Null Value 0
Case Insensitive ☐
Descending ☐

Table 49 Function Executor Create File Dialog (Advanced)

GUI Object	Description	Related Information
Key and Segment commands	Allow you to add or delete a key or to add, insert, or delete a key segment.	Creating a Btrieve File Tasks
File Specifications	Displays and allows you to modify characteristics of the file.	Creating a Btrieve File Tasks Record and Page Compression
Statistics	Provides read-only information about the file.	Creating a Btrieve File Tasks

Table 49 Function Executor Create File Dialog (Advanced) continued

GUI Object	Description	Related Information
Key and segment matrix	Displays the keys and segments for the file, listing the starting position, length, attributes, and data type for them. Clicking on a row allows you to see and, modify if you want, information in the Key and Segment blocks.	Creating a Btrieve File Tasks
Key	Displays and allows you to modify characteristics of a key.	Creating a Btrieve File Tasks
Segment	Displays and allows you to modify characteristics of a key segment.	Creating a Btrieve File Tasks
Command buttons	Allow you create a data file, a description, or to cancel the dialog box.	Creating a Btrieve File Tasks

Transactions

This dialog box allows you to control transactions during your Function Executor session. Click on an area of the image for which you want more information.

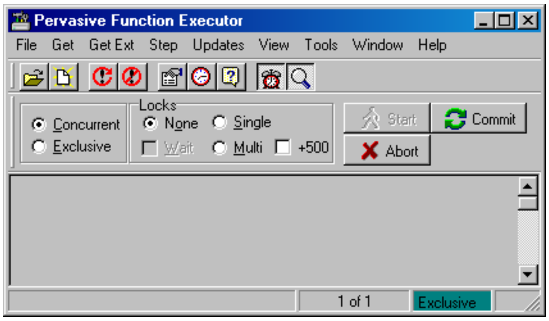

Pervasive Function Executor
File Get Get Ext Step Updates View Tools Window Help
Concurrent
Exclusive
Locks
None
Single
Wait
Multi
+500
Start
Commit
Abort
1 of 1
Exclusive

Table 50 Function Executor Transactions Dialog

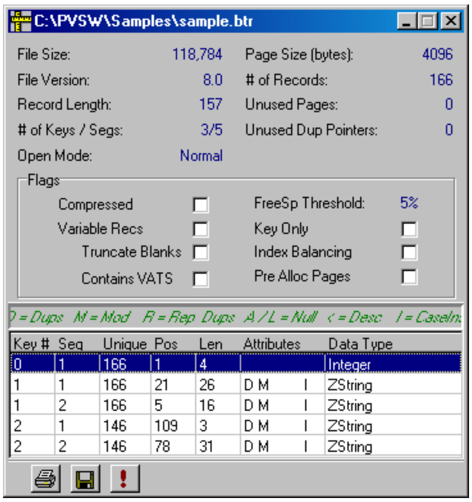
GUI Object	Description	Related Information
Main application window	Main features of the program.	Application Window
Transaction type	Specifies whether you want an exclusive or concurrent transaction.	
Lock information	Specifies the type of locking you want in the transaction.	
Start transaction button	Starts a transaction.	

Table 50   Function Executor Transactions Dialog continued

GUI Object	Description	Related Information
Commit transaction button	Commits the active transaction.	
Abort transaction button	Cancels the active transaction and rolls back any changes made.	
File area	This area contains one or more open files.	Main Window
Transaction indicator	Indicates whether you are currently in a transaction. If you are in a transaction, this display will show either Concurrent or Exclusive.	

File Statistics

This dialog box allows you to see the statistics for a Btrieve file. Click on an area of the image for which you want more information.


C:\PVSW\Samples\sample.btr

File Size:	118,784	Page Size (bytes):	4096
File Version:	8.0	# of Records:	166
Record Length:	157	Unused Pages:	0
# of Keys / Segs:	3/5	Unused Dup Pointers:	0
Open Mode:	Normal		

Flags

Compressed	☐	FreeSp Threshold:	5%
Variable Recs	☐	Key Only	☐
Truncate Blanks	☐	Index Balancing	☐
Contains VATS	☐	Pre Alloc Pages	☐

D = Dups M = Mod R = Rep Dups A / L = Null < = Desc I = CaseIn

Key #	Seq	Unique	Pos	Len	Attributes	Data Type
0	1	166	1	4		Integer
1	1	166	21	26	D M I	ZString
1	2	166	5	16	D M I	ZString
2	1	146	109	3	D M I	ZString
2	2	146	78	31	D M I	ZString

Table 51   Function Executor File Statistics Dialog

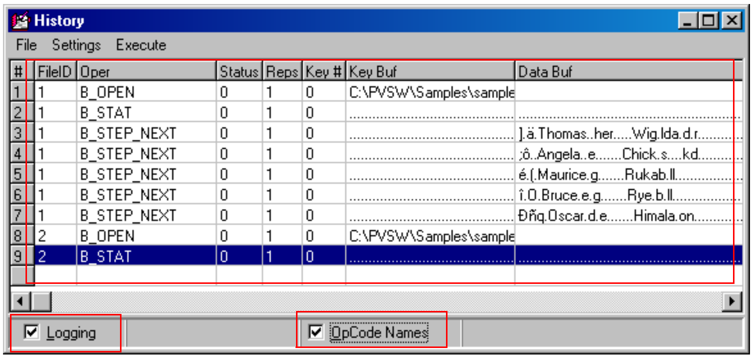
GUI Object	Description
File information	Displays statistical information about the file.
Flags	Allows you to view the flags set for this file. Any flag that is set will have a check mark next to its listing in the dialog box.
Keys	Allows you to view the keys defined in this file.

Table 51 Function Executor File Statistics Dialog *continued*

GUI Object	Description
Key legend	Describes the single letter values that indicate Key attributes for the file. • D = DUP (Duplicatable) • M = MOD (Modifiable) • R = REPEAT_DUPS_KEY (repeating duplicates key) • A= NUL (All segment Null key) • L = MANUAL_KEY (any segment null key) • < = DESC_KEY (descending key value) • I = NOCASE_KEY (case-insensitive key) See also Key Attributes in *Pervasive PSQL Programmer's Guide*.
Print button	Allows you to print the file statistics. Set up the printer using the File menu.
Save button	Allows you to save the current file statistics to a description file, which you can later use to make a new file with the same characteristics.
Exclamation point (create new file)	Allows you to create a new file based on these file statistics.

History

This dialog box allows you to see all the operations you have performed. Click on an area of the image for which you want more information.



#	FileID	Oper	Status	Reps	Key #	Key Buf	Data Buf
1	1	B_OPEN	0	1	0	C:\PVSW\Samples\sample	
2	1	B_STAT	0	1	0	....	....
3	1	B_STEP_NEXT	0	1	0	....	].ä.Thomas..her.....Wig.Ida.d.r..........
4	1	B_STEP_NEXT	0	1	0	....	;ô..Angela..e.......Chick.s....kd..........
5	1	B_STEP_NEXT	0	1	0	....	é.(.Maurice.g.......Rukab.ll..............
6	1	B_STEP_NEXT	0	1	0	....	î.0.Bruce.e.g.......Rye.b.ll..............
7	1	B_STEP_NEXT	0	1	0	....	Ðñq.Oscar.d.e.......Himala.on..........
8	2	B_OPEN	0	1	0	C:\PVSW\Samples\sample	
9	2	B_STAT	0	1	0	....	....

☑ Logging ☑ OpCode Names

Table 52   Function Executor History Dialog

GUI Object	**Description**	**Related Information**
File menu	Allows you to perform the following operations: • Import a history file • Export a history file • Close the history window	
Settings menu	Allows you to specify the visual attributes of the History window. • Save on Exit - specifies whether you want your customization of the History window to be saved between sessions. • Defaults - Resets the History window to default settings. This removes any settings you specified. • Docked - Toggles the state of the History window between a separate window and one that is attached to the Application Window. • Stay On Top- toggles the state of the History window between one that can lose focus and one that cannot.	• To toggle the docking status of the History window • To toggle the Always On Top status of the History window • To reset the History window to default settings
Execute command	Loads the History Playback window	
List of operations	Lists operations that you have recently performed. Each operation is logged with the following information: • FileID • Operation name or number depending on the status of the OpCodeNames check box. • Status code when that operation was performed • Number of times that operation was performed. • Key number set for the operation. • Contents of the key buffer. • Contents of the data buffer.	• History Tasks • History
Logging	Toggles the inclusion of future operations in the history list.	
OpCode Names	Toggles the display in the Operation column between operation code names (such as B_OPEN) and operation code numbers (such as 0 for B_OPEN)	

Function Executor Tasks

Function Executor tasks are grouped into the following categories:

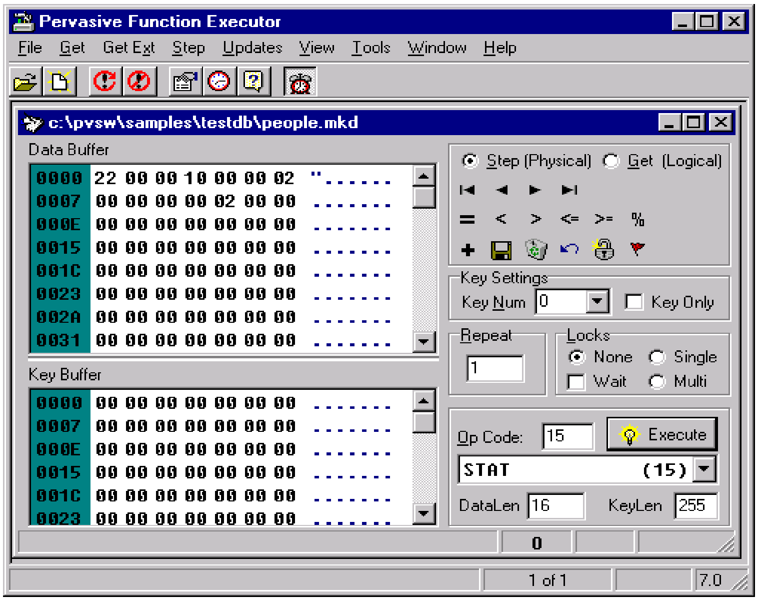
- Starting Function Executor Tasks
- Performing Operations Tasks
- Opening a File Tasks
- Creating a Btrieve File Tasks
- History Tasks

Starting Function Executor Tasks

➤ **To start the Function Executor utility**

1. Access Function Executor from the operating system Start menu or Apps screen or from the Tools menu in Pervasive PSQL Control Center.
2. The main window (Figure 13) appears.

Figure 13 Function Executor Main Window



Data Buffer

```
0000 22 00 00 10 00 00 02 ".......
0007 00 00 00 00 02 00 00 .......
000E 00 00 00 00 00 00 00 .......
0015 00 00 00 00 00 00 00 .......
001C 00 00 00 00 00 00 00 .......
0023 00 00 00 00 00 00 00 .......
002A 00 00 00 00 00 00 00 .......
0031 00 00 00 00 00 00 00 .......
```

Key Buffer

```
0000 00 00 00 00 00 00 00 .......
0007 00 00 00 00 00 00 00 .......
000E 00 00 00 00 00 00 00 .......
0015 00 00 00 00 00 00 00 .......
001C 00 00 00 00 00 00 00 .......
0023 00 00 00 00 00 00 00 .......
```

[✓ Step (Physical)] Get (Logical)

Key Num: 0 — Key Only ☐

Repeat: 1

Locks: [✓ None] Single Multi — Wait ☐

Op Code: 15 — STAT (15)

DataLen: 16 — KeyLen: 255

0

1 of 1 — 7.0

Performing Operations Tasks

Because Btrieve provides many operations, this chapter cannot explain them all. The following sections discuss some common operations as well as some new ways of performing them with the Function Executor.

Note Selecting options from all menus performs the intended operation immediately. It does not fill in the grid and wait for you to execute the command as in previous versions. Also, closing the form closes each open file. No longer do you need to manually perform the close operation.

General Operations-Related Tasks

- To get help for a status code

For other tasks, see these sections:

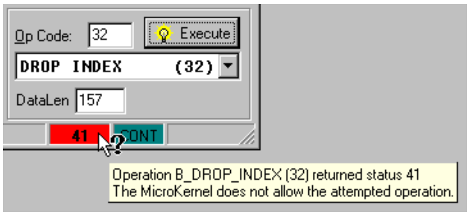
- Opening a File Tasks
- Creating a Btrieve File Tasks
- History Tasks

➤ To get help for a status code

1 When a status code is received using Function Executor, it is displayed on the status bar of the open file.

Move your mouse so it hovers over the status code that is displayed in red.

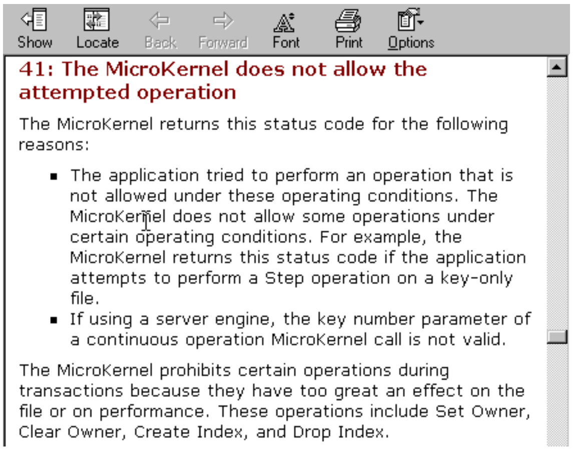
Figure 14 Status Code Received



Operation B_DROP_INDEX (32) returned status 41
The MicroKernel does not allow the attempted operation.

2 If you click on the status code indicator, the full documentation for the status code is displayed as shown in Figure 15.

Figure 15 Status Code Documentation



41: The MicroKernel does not allow the attempted operation

The MicroKernel returns this status code for the following reasons:

- The application tried to perform an operation that is not allowed under these operating conditions. The MicroKernel does not allow some operations under certain operating conditions. For example, the MicroKernel returns this status code if the application attempts to perform a Step operation on a key-only file.
- If using a server engine, the key number parameter of a continuous operation MicroKernel call is not valid.

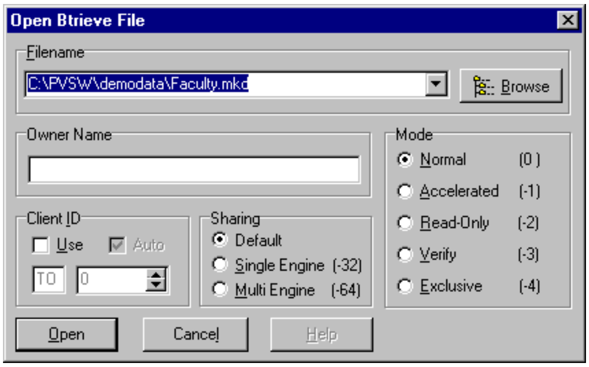
The MicroKernel prohibits certain operations during transactions because they have too great an effect on the file or on performance. These operations include Set Owner, Clear Owner, Create Index, and Drop Index.

Opening a File Tasks

➤ To open a data file with Function Executor

1 From the File menu, select Open. The following dialog box appears:

Figure 16 Open Btrieve File Dialog Box



Filename: C:\PVSW\demodata\Faculty.mkd

Mode: [✓ Normal (0)] Accelerated (-1) Read-Only (-2) Verify (-3) Exclusive (-4)

Sharing: [✓ Default] Single Engine (-32) Multi Engine (-64)

Client ID: Use [ ] Auto [✓] TO 0

Note Client ID: If you have Use disabled, Function Executor will use a BTRV() function call. If Use is enabled, it will use a BTRVID() function call for each operation you execute on this file. With Auto enabled, Function Executor will generate a client ID for you. If you have Auto disabled, then you may enter values manually.

2 Click Browse.

3 Double-click on the desired filename.

Other Ways to Open a File with Function Executor

1) You can drag a file from Windows Explorer or from an operating system folder view into the Open dialog box. This step fills in the filename for you.

2) You can drag one or more files into the main window.

3) After opening one file (so you have the editor window available), you can use the OpCode 0 to open another file. The file will appear in a new window.

4) You can run Function Executor from the DOS command line and specify a list of filenames to open. For example, you could use the following command line to open two files from the DEMODATA sample database:

```
WBExec32 person.mkd billing.mkd
```

You can even use wildcard characters, as in the example:

```
WBExec32 *.mkd
```

Running this command allows you to associate file extensions (types) with Function Executor. For example, you can associate MKD, BTR, DAT, or any other extension with Function Executor. Thus, when you double-click the file in Explorer, it automatically opens the file with Function Executor.

Creating a Btrieve File Tasks

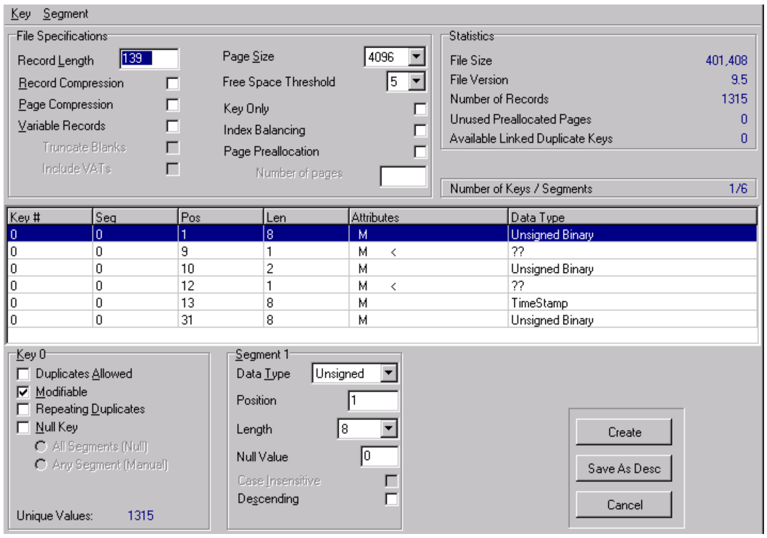
There are two options in creating a Btrieve file with Function Executor. If a file is already open, you can clone it; otherwise you can start from scratch.

Caution In the same directory, no two files should share the same file name and differ only in their file name extension. For example, do not name a data file Invoice.btr and another one Invoice.mkd in the same directory. This restriction applies because the database engine uses the file name for various areas of functionality while ignoring the file name extension. Since only the file name is used to differentiate files, files that differ only in their file name extension look identical to the database engine.

Method 1: Using a current file as a template

1 From the File menu, select New. The following dialog box will appear:

Figure 17 Modify File Definition Dialog Box



File Specifications

Record Length	139	Page Size	4096
Record Compression	☐	Free Space Threshold	5
Page Compression	☐	Key Only	☐
Variable Records	☐	Index Balancing	☐
Truncate Blanks	☐	Page Preallocation	☐
Include VATs	☐	Number of pages	

Statistics

File Size	401,408
File Version	9.5
Number of Records	1315
Unused Preallocated Pages	0
Available Linked Duplicate Keys	0
Number of Keys / Segments	1/6

Key #	Seq	Pos	Len	Attributes	Data Type
0	0	1	8	M	Unsigned Binary
0	0	9	1	M <	??
0	0	10	2	M	Unsigned Binary
0	0	12	1	M <	??
0	0	13	8	M	TimeStamp
0	0	31	8	M	Unsigned Binary

Key 0

- ☐ Duplicates Allowed
- ☑ Modifiable
- ☐ Repeating Duplicates
- ☐ Null Key
- ○ All Segments (Null)
- ○ Any Segment (Manual)

Unique Values: 1315

Segment 1

Data Type	Unsigned
Position	1
Length	8
Null Value	0
Case Insensitive	☐
Descending	☐

2 You can manipulate keys from this dialog box as well. You can Add, Create, or Insert Segments from the Key menu. You can also save the new file as a description for use with BUtil create. Select Save As Desc and indicate the name and location where you would like the file saved.

3 To create the file, click Create. This will open the file and display a message indicating success.

Method 2: Creating a new file from scratch

1 Click the Create icon on the main toolbar; or, if no file is open yet, you may click File and then New, as before.

2 If a file is already open on screen, a drop down box will appear. Choose Create New File from Scratch.

3 The same dialog box as before will appear, but it will be blank - allowing you to input brand new values.

4 Start by adding a new Key using the Key menu - or press Ctrl-A.

5 Fill in the attributes for the key in the lower section of the dialog box.

6 Continue adding or removing new keys and segments as desired, using the menus or right-clicking on the key in the list.

7 Now click the Create button to execute the B_Create (14) operation. This will automatically open the file on screen as well.

History Tasks

The following tasks are related to the History feature:

- To display the History window
- To toggle the docking status of the History window
- To toggle the Always On Top status of the History window
- To reset the History window to default settings

➢ To display the History window

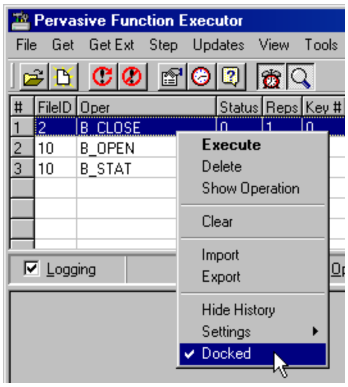
1 Click View ▸ History or click the History button.

➢ To toggle the docking status of the History window

1 If the History window is not visible, display it. (see To display the History window).

2 In the history items window, right-click on the display and check or clear the Docked option as shown in the following figure:

Figure 18 Undocking the History window



When docked, the History window is connected to the application window as shown in Figure 18. When not docked, the History window is a distinct window. When undocked, the History window has menu items that duplicate the commands seen from the right-click menu in Figure 18.

➢ To toggle the Always On Top status of the History window

1 If the History window is not visible, display it. (see To display the History window).

2 This feature only applies to the History window when it is in the undocked state. (see To toggle the docking status of the History window)

3 In the history items window, right-click on the display and check or clear the Stays On Top selection.

➢ To reset the History window to default settings

1 If the History window is not visible, display it. (see To display the History window).

2 In the history items window, right-click on the display and select Settings ▸ Defaults.

chapter

Manipulating Btrieve Data Files with Maintenance

13

Handling Btrieve Files with the Maintenance Utility

This chapter discusses the following topics:

Maintenance Utilities Overview

Pervasive PSQL provides both an interactive Maintenance utility and a command-line Maintenance utility. Both Maintenance utilities perform the following common file and data manipulations:

- Create new data files based on file and key specifications you define.
- Provide file and key specifications for existing data files.
- Set and clear owner names for data files.
- Create and drop indexes on data files.
- Import and export ASCII sequential data.
- Copy data between Pervasive PSQL data files.
- Recover changes made to a file between the time of the last backup and a system failure.

While both utilities provide the same core functionality, minor differences exist. For example, the interactive Maintenance utility allows you to create description files based on file and key specifications you define. The command-line Maintenance utility allows you to start and stop continuous operation on a file or set of files locally on the server.

Before you use either Maintenance utility, you should be familiar with Btrieve fundamentals, such as files, records, keys, and segments. For information about these topics, refer to the *Pervasive PSQL Programmer's Guide*.

Note The Pervasive PSQL product provides two categories of maintenance utilities: Btrieve and SQL. The SQL Maintenance Utility supports data source names (DSNs), which are used for relational access through ODBC.

Btrieve Interactive Maintenance Utility

The Interactive Maintenance utility is a Windows application that runs on Windows 32-bit and 64-bit platforms. Use this utility if you prefer a graphical interface or if you want to create a description file. This section contains the following major topics:

- File Information Editor
- Owner Names
- Statistics Report
- Indexes
- Data

Each major topic contains tasks specific to that topic.

Extended File Support

The size of a MicroKernel data file can be larger than the operating system file size limit. When you export data from an extended MicroKernel file to an unformatted file, the size of the unformatted file can exceed the database engine file size limit because of the differences in the physical format.

When you are exporting large files, the Interactive Maintenance utility detects when the unformatted file exceeds a 2 GB file size limit and starts creating extension files. This process is transparent. Extension files and the original unformatted file must reside on the same volume. (The size limit for a file varies depending on the operating system and file system. The 2 GB size is simply the limit enforced by the database engine.)

The extension file uses a naming scheme in which the file names are similar to the base file name. In contrast to native MKDE extension files which use a caret "^" to indicate extension file status, the unformatted extension files use a tilde "~" to avoid overwriting any existing extended MKDE files with the same base file name. The first export extension file is the same base file name with ".~01" extension. The second extension file is ".~02," and so on. These extensions are appended in hexadecimal format.

The naming convention supports up to 255 extension files, thus supporting files as large as 256 GB.

Additionally, when you import data from an unformatted file, the utility detects whether the file has extensions and loads the data from the extension file.

Long File Names and Embedded Spaces Support

Long file name support, including support for embedded spaces is available in all supported operating system environments. All references to files can contain embedded spaces and be longer than 8 bytes.

Older versions of Btrieve allowed spaces to be added at the end of a file name in path-based operations such as Open and Create. This is still the default behavior. Existing applications will not break. However, if you want to take advantage of file and directory names with embedded spaces, set the Embedded Spaces configuration setting for the client requester to On. Note that On is the default setting.

Even when you turn the option off an application that accesses a file having a name with embedded spaces can enclose that name in double quotes while making the BTRV/BTRVID/BTRCALL/ BTRCALLID call to open or create the file.

Record and Page Compression

Pervasive PSQL provides two types of data compression: record and page. These two types may be used separately or together. The primary purpose for both compression types is to reduce the size of the data files and to provide faster performance depending on the type of data and on the type of data manipulation.

Record Compression

Record compression requires a file format of 6.0 or later. Record compression can result in a significant reduction of the space needed to store records that contain many repeating characters. The database engine compresses five or more of the same contiguous characters into 3 bytes.

When creating a file, the database engine automatically uses a page size larger than what is specified to allow room for the specified record length. If the uncompressed record length is too large to fit on the largest available page, the database engine automatically turns on record compression.

Because the final length of a compressed record cannot be determined until the record is written to the file, the database engine creates a file with record compression as a variable-length record file. Compressed images of the records are stored as variable-length records. Individual records may become fragmented across several file pages if your application performs frequent insertions, updates, and deletions. The fragmentation can result in slower access times because the database engine may need to read multiple file pages to retrieve a single record.

See also Choosing a Page Size, Estimating File Size, and Record Compression, all in *Pervasive PSQL Programmer's Guide* in the Developer Reference.

Page Compression

Page compression requires a file format of 9.5 or later. Internally, a Pervasive PSQL data file is a series of different types of pages. Page compression controls the compression and decompression of data pages within a file.

As a file is read from physical storage, data pages are decompressed and held in a memory cache. Record reads and updates are performed against the uncompressed data in the memory cache. When a write action occurs, the data page is compressed then written to physical storage. Depending on cache management, the compressed page is also retained in memory until accessed again.

If the type of data cannot be significantly compressed, the database engine writes the data to physical storage uncompressed.

Deciding When To Use Compression

The benefits obtained by using record compression, page compression, or both depends entirely on the type of data being compressed. Given that, the following table discusses some *general* factors to consider when deciding to use data compression or not.

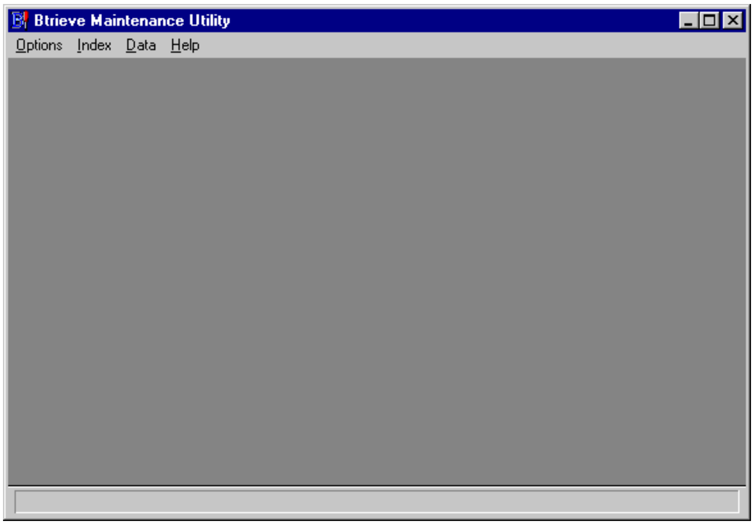
Table 53 Factors To Consider Pertaining to Data Compression

Compression		Factors to Consider
Record	Page	
✓		Record compression is most effective for the following conditions: • Each record has the potential for containing a large number of repeating characters. For example, a record may contain several fields, all of which may be initialized to blanks by your task when it inserts the record into the file. Record compression is more efficient if these fields are grouped together in the record, rather than being separated by fields containing other values. • The computer running the database engine can supply the extra memory required for compression buffers. • The records are read much more frequently than they are changed. If the fixed length portion of a record is longer than the page size minus overhead, compression is used automatically. Note that you cannot use record compression for key-only files or for files that use blank truncation.
	✓	Page compression is most effective for the following conditions: • Data is highly compressible using a ZIP-type compression algorithm. When the file size can be significantly decreased because of page compression, such as 4 to 1 compression, file performance can be increased significantly. • The pages are read much more frequently than they are inserted, updated, or deleted. Note that the database engine writes data pages to physical storage uncompressed if the data cannot be significantly compressed.
✓	✓	The use of record compression and page compression is most effective when records contain a large proportion of blank space and the pages are read much more frequently than they are inserted, updated, or deleted.

The Btrieve Maintenance Utility Interface

Access Maintenance from the operating system Start menu or Apps screen or from the Tools menu in Pervasive PSQL Control Center. The utility's main window displays as shown next.

Figure 19 Btrieve Maintenance Utility Main Window



Menu Options

The interactive Maintenance utility provides the following menus:

Options	Allows you to display the **File Information Editor**, set and clear owner names, generate statistics reports, and exit the utility.
Index	Allows you to create and drop indexes.
Data	Allows you to load data from ASCII files, save data to ASCII files, copy records between data files, and perform a roll forward operation to recover changes made to a data file between the time of the last backup and a system failure.
Help	Provides access to the Maintenance utility help system.

Getting Help

To access the Maintenance utility help system, click Help in the dialog box for which you want help, or choose a command from the Help menu, as follows:

Contents	Provides a list of Maintenance utility help topics.
About	Displays copyright information and the product version number.

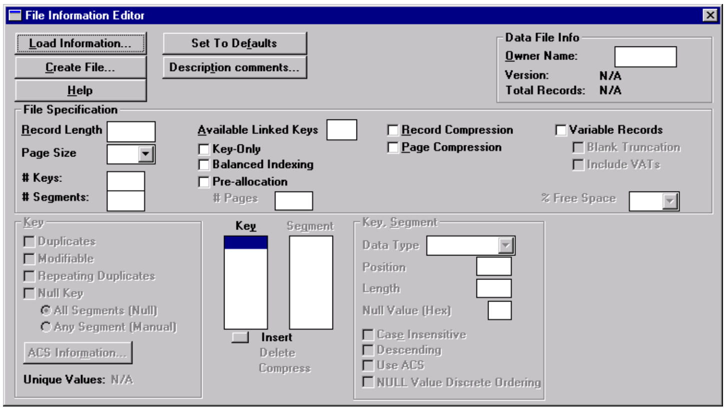
File Information Editor

This section provides general information about the File Information Editor with which you can create new files based on file and key specifications you construct. Because this Editor allows you to load information based on an existing file, it is also useful for viewing file and key specifications on existing data files. You can also create a new file based on the file and key specifications of an existing file (similar to the CLONE command for BUTIL, the command-line Maintenance utility).

Caution No two files can share the same file name and differ only in their file name extension if both files are in the same directory. For example, do not name a data file Invoice.btr and another one Invoice.mkd in the same directory. This restriction applies because the database engine uses the file name for various areas of functionality while ignoring the file name extension. Since only the file name is used to differentiate files, files that differ only in their file name extension look identical to the database engine.

Open the File Information Editor by clicking Options ▸ Show Information Editor.

Figure 20 File Information Editor



File Information Editor Dialog Elements

At the top of the Editor, the following buttons appear:

Load Information	Loads information based on an existing file. When you load information, you are not editing the existing file. Instead, you are loading a copy of the information about that file.
Create File	Creates a new file based on current information in the dialog box.
Set To Defaults	Sets the controls to default values.
Description Comments	If you are creating a description file, allows you to enter notes about the file.
Help	Displays help for the **File Information Editor** dialog box.

Data File Info

The Data File Info area, also at the top of the File Information Editor, contains the following controls:

Owner Name	Provides a text box you can use to specify the owner name, if applicable, for an existing file.
Version	Earliest version of the database engine that can read all the attributes of the file. For example, if you created a file using the 9.5 database engine but did not use any attributes specific to 0.5, the Maintenance utility displays 9.0 as the version number. See File Version Notes for additional information about file format versions.
Total Records	Total number of records in the file.

File Specification

The File Specification area is in the middle of the File Information Editor. Table 54 describes the controls in this box.

Table 54 File Specification Controls

Control	Description	Range	Default
Record Length	Specifies the logical data record length (in bytes) of the fixed-length records in a file. For information about record length and overhead, see “Record Length” in *Pervasive PSQL Programmer's Guide*, which is part of the Pervasive PSQL Developer Reference.	Minimum is 4 bytes. Maximum is variable. If the record length specified exceeds the page size minus overhead, the database engine automatically tries the next available page size for the file format. If the record length exceeds the maximum page size minus overhead, the engine turns on record compression.	100
Page Size	Specifies the physical page size (in bytes) for the file.	512 – 4096 for file versions prior to 9.0 (a multiple of 512 bytes up to 4096) 512, 1024, 1536, 2048, 2560, 3072, 3584, 4096, or 8192 for file version 9.0. 1024, 2048, 4096, 8192, or 16384 for file versions 9.5 and newer.	4,096
# Keys	Indicates the number of distinct keys (as opposed to key segments) currently defined in the Editor. Reflects the number of keys in the Key list.	0 – 119	0
# Segments	Indicates the number of key segments currently defined in the Editor. Reflects the number of segments in the Segment list.	0 – 119 for file versions prior to 9.5. 0 – 420 for file versions 9.5 and newer. Note that, for all file versions, the maximum number of segments for the relational interface is 119.	0

Table 54 File Specification Controls

Control	Description	Range	Default
Available Linked Keys	Specifies how many 8-byte place holders you want to reserve for future linked-duplicatable keys. If you are loading information based on an existing data file, this value reflects the number of place holders currently available in that file. (The number of originally reserved place holders is not stored in the file.)	0 – 119	3
Key-Only	Indicates whether the file is key-only. Not applicable if you turn Record Compression on, if you turn Variable Records on, or if you define more than one key for the file.	On or Off	Off
Balanced Indexing	Specifies that the file uses the balanced indexing method of managing key pages.	On or Off	Off
Pre-allocation	Specifies that the file uses preallocated pages.	On or Off	Off
# Pages	Specifies the number of pages you want preallocated when you create the file. Applicable only if Pre-allocation is turned on. If you are loading information based on an existing data file, this value reflects the number of unused, preallocated pages left in that file. (The number of originally preallocated pages is not stored in the file.)	1 – 65,535	0
Record Compression	Specifies that the file uses record compression. Not applicable for key-only files or files that use blank truncation. See also Record and Page Compression.	On or Off	Off
Page Compression	Specifies that the file uses page compression. See also Record and Page Compression.	On or Off	Off
Variable Records	Specifies that the file can contain variable-length records.	On or Off	Off
Blank Truncation	Specifies whether the file uses blank truncation on variable records to conserve disk space. Applicable only if Variable Records is turned on.	On or Off	Off

Table 54   File Specification Controls

Control	Description	Range	Default
Include VATs	Specifies whether the file supports Variable-tail Allocation Tables for faster access to data in very long records. Applicable only if Variable Records is turned on.	On or Off	Off
% Free Space	Specifies the amount of unused space a file's variable pages must have available before the database engine creates a new variable page. Applicable only if Record Compression or Variable Records are turned on.	5, 10, 20, or 30	5

Key

At the bottom left in the dialog box is the Key group box. Table 55 describes the controls in this area. These controls are specific to the key highlighted in the Key list, not just to the current key segment. When you change the setting for one of these controls, the change affects *all* segments of the specified key.

Table 55   Key Controls

Control	Description	Default
Duplicates	Specifies that the key can have duplicate values (linked duplicates). See Methods for Handling Duplicate Keys.	On
Modifiable	Specifies that the key value can be modified after creation. Allowing modification of key values does not affect performance. Key pages are only updated if the actual key value changes, not if non-key fields in a particular record are changed.	On
Repeating Duplicates	Specifies that the database engine uses the repeating duplicates method of storing duplicate key values. See Methods for Handling Duplicate Keys.	Off
Sparse Key (Null Key)	A sparse key contains fewer key values than the number of record in the file. To specify which key values are excluded from the index, see the next two controls. Applicable only to keys that contain nullable segments.	Off
All Segments (Null)	Specifies that if all key segments in the record contain a null value, the database engine does not include that record in the index. Applicable only if Sparse Key (Null Key) is turned on. Equivalent to key flag 0x0008. Whether a segment is evaluated as null is determined solely by the null indicator segment for that field; the contents of the field are not evaluated.	Off

Table 55 Key Controls

Control	Description	Default
Any Segment (Manual)	Specifies that if one or more key segments contains a null value, the database engine does not include that record in the index. Applicable only if Sparse Key (Null Key) is turned on. Equivalent to key flag 0x0200. Whether a segment is evaluated as null is determined solely by the null indicator segment for that field; the contents of the field are not evaluated.	Off
ACS Information	Allows you to specify an alternate collating sequence (ACS) for the key. Applicable only if the **Use ACS** check box is selected for a segment of the key.	Off
Unique Values	Indicates the number of unique key values in the file. Applicable only if you are loading information based on an existing data file.	N/A

Key List and Segment List

At the bottom middle of the dialog box, the Key list shows the key numbers defined in a file. (For 6.*x* and later files, these key numbers do not have to be consecutive; they can have gaps between them.) The Maintenance utility displays the highlighted key's specifications in the Key box at the bottom left of the dialog box.

Also at the bottom middle of the dialog box, the Segment list shows the key segment numbers defined for the key highlighted in the Key list. The Maintenance utility displays the highlighted segment's specifications in the Segment box at the bottom right of the dialog box.

In addition, the following buttons appear under the Key and Segment lists:

Insert	Defines a new key or segment.
Delete	Removes the highlighted key or segment specification.
Compress	Renumbers the keys consecutively. You can use this button to remove gaps that result from deleting a key specification.

Because these buttons control key specifications for a file you want to create, you cannot use them to operate on keys in an existing file. If you want to create or drop an index on an existing file, refer to Index Tasks.

Key Segment

At the bottom right in the dialog box is the Key Segment group box. Table 56 describes the controls in this area. These controls are specific to the segment highlighted in the Segment list),

Table 56 Key Segment Specification Controls

Control	Description	Default
Data Type	Specifies a data type for the key segment. The NULL data type indicates that the index is one byte Null indicator segment. It must be in a multi-segment key and it must precede another key segment that is not a NULL type. The number used in the Btrieve API for this key type is 255.	String
Position	Specifies by number the relative starting position of the beginning of this key segment in the record. The value cannot exceed the record length.	1
Length	Specifies the length (in bytes) of the key segment. This value cannot exceed the limit dictated by the data type for the segment. The total of key position and key length cannot exceed the record length.	10
Null Value (Hex)	Specifies the null character value (in hexadecimal) for the key segment. Applicable only if the **Null Key** check box is selected for the key.	Binary zero
Case Insensitive	Specifies whether the segment is sensitive to case. Applicable only for STRING, LSTRING, and ZSTRING data types or for keys that do not use an ACS.	On
Descending	Specifies that the database engine sort the key segment values in descending order (that is, from highest to lowest).	Off
Use ACS	Specifies that the segment uses the alternate collating sequence defined for the key. Applicable only for `string`, `lstring` and `zstring` data types that are case sensitive.	Off
NULL Value Discrete Ordering	NULL Value Discrete Ordering is used for the null indicator segment (NIS) to determine whether the MKDE should treat the NIS as a boolean value, where any non-zero value is considered NULL, or as a one byte integer, where zero is considered non-null and all other values are considered different types of null. In this case they are sorted as discrete values. The Btrieve API uses the NO_CASE flag, 0x0400, to indicate discrete ordering should be performed, because that flag was previously unused for integer values.	Off

Methods for Handling Duplicate Keys

Multiple records may carry the same duplicated value for index keys. The two methods to keep track of the records with duplicate key values are called linked duplicates and repeating duplicates.

Linked Duplicates

The linked duplicates method uses a chain technique in which each record in the group connects to its neighbors by means of pointers. Each entry on an index page contains a pair of record pointers that indicate the first and last links in the chain of records that duplicate that key's value. This makes each key page entry 4 bytes longer than a repeating duplicates index. In addition, each record on the data page requires an extra 8 bytes of overhead for each linked duplicates index. These 8 bytes consist of two record pointers that point to the next and previous records in the chain.

The first record pointer holds the address of the first, or oldest, record stored. The second pointer holds the address of the most recent, or newest record. After the first record is written but before any others are added, both pointers on the key page entry hold the first record’s address. Subsequent records cause the second pointer to be changed to point to each record as it is added. This permits the record pointer for the last record to be used as the previous-record link of the chain built in the data page when the record is added, and also to be used to locate that previous record.

Repeating Duplicates

With the repeating duplicates method, each duplicate key value is stored on both the index page and within the record on the data page. Each key value has only one record pointer instead of two. This method requires no chaining within the data records and saves the 8 bytes of overhead per index within each record. Since the key value is repeated for each duplicate record, the indexes affected increase in size.

Method Comparisons

The linked duplicates and repeating duplicates methods can be compared based on the following criteria:

- Ordering
- Storage
- Performance
- Concurrency

Ordering

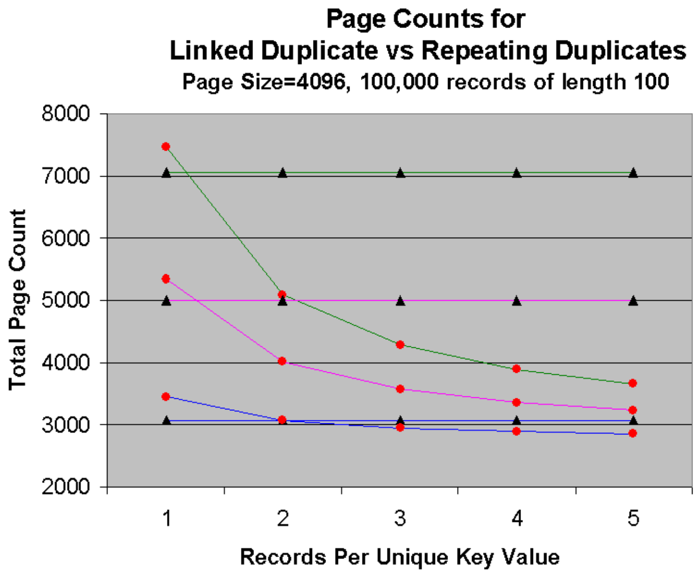
A linked duplicates index retrieves duplicates in the order in which they were inserted. A repeating duplicates index retrieves duplicates in the order in which they are located within the file. Since location with a file cannot be controlled, the ordering must be considered as random.

Storage

A linked duplicates index requires 12 more bytes for the first occurrence of each duplicate key value. That includes 8 extra bytes on each record and 4 extra bytes for the key page entry. But each duplicate record requires no additional space in the key page, and adds only 8 bytes per record. Therefore, as the number of duplicates per key value increases, and as the size of the key value increases, linked duplicate indexes can save significant storage space used by key pages. However, storage space can increase if your file contains very few records with duplicate keys, the key length is very short, or both.

The following figure exemplifies the amount of storage space saved using linked duplicate indexes. Note that linked duplicate indexes take more space if duplicate records per key value are few. As the number of duplicate records per key value increases, however, linked duplicate indexes require less pages, providing significant space savings.

Figure 21 Comparison of Page Counts for Duplicate Key Methods



Legend: ● = linked duplicates ▲ = repeating duplicates

Top two lines represent a key length of 100
Middle two lines represent a key length of 50
Bottom two lines represent a key length of 4

Performance

Faster performance results when fewer pages are involved in an index search because fewer pages must be read from disk. The linked duplicates method generally uses less physical storage space and therefore provides faster performance. The repeating duplicates method provides a performance advantage if only a small number of keys have duplicates.

Concurrency

The database engine provides page-level concurrency when several concurrent transactions are active on the same file at the same time. This applies to most changes to key pages and for all changes to data pages. The concurrency means that the same page can contain pending changes from separate transactions at the same time, and the transactions can be committed in any order. Repeating duplicate indexes take the most advantage of this concurrency.

Linked duplicate indexes add another limitation on concurrency that does not exist with repeating duplicates. When a new duplicate is created, the new record is linked to another record at the end of the list. This record linking causes two records to be locked instead of one. Since all duplicates are added to the end of the chain of linked records, only one duplicate can be inserted at a time.

Such a record lock conflict usually causes other clients to wait until the first transaction is committed. In a concurrent environment, if all new records use the same duplicate value, then concurrency can effectively be reduced to one transaction at a time. And if transactions are large or long lasting, this serialization can affect performance tremendously.

Performance is typically better if you use repeating duplicate indexes for databases that are updated in a concurrent environment. Therefore, unless you have a compelling reason to use the linked duplicates method, you should use repeating duplicate indexes for databases that are updated in a concurrent environment.

Information Editor Tasks

You perform the following tasks with the File Information Editor:

- Loading Information from an Existing Data File
- Creating a New File
- Compacting Btrieve Data Files
- Specifying a Key’s Alternate Collating Sequence

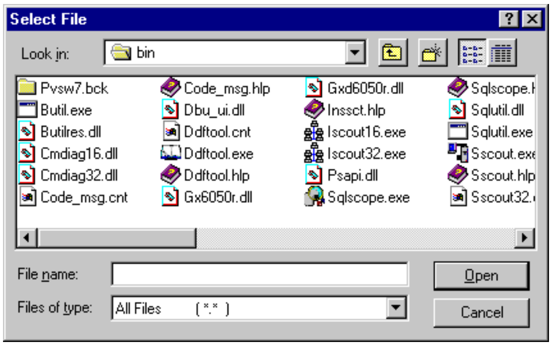
Loading Information from an Existing Data File

When you load information from an existing file, you are not editing the existing file. Instead, you are loading a copy of the information about that file. Generally, you want to load a data file before performing other tasks with the File Information Editor, but this is not mandatory.

➢ To load information from an existing data file into the File Information Editor

1 Click Load Information at the top of the File Information Editor. The Select File dialog box appears.

Figure 22 Select File Dialog Box



2 Specify the name and path of the file for which you want to load information. (By default, data files have the `.mkd` extension.)

The Maintenance utility first attempts to open the specified file as a data file. If the file requires an owner name, the utility prompts you for one. (Because owner names are optional, the file you open may not require an owner name.) If the specified file is not a data file, the utility then attempts to open the file as a description file.

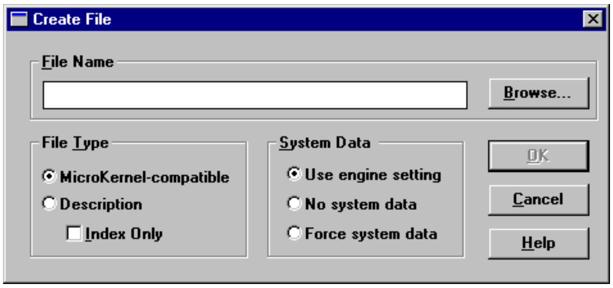
Creating a New File

You can create a new file based on the current information in the File Information Editor or on new information you provide.

➤ To create a new file based on the current information in the File Information Editor

1 Click Create File at the top of the File Information Editor dialog box. The Create File dialog box appears.

Figure 23   Create File Dialog Box



File Name

File Type
[✓ MicroKernel-compatible]
Description
Index Only

System Data
[✓ Use engine setting]
No system data
Force system data

2 Specify the controls in the Create File dialog box, which are described in Table 57.

Table 57   Create File Dialog Controls

Control	Description	Default
File Name	Specifies a name and path for the file. By default, data files have the `.mkd` extension.	N/A
File Type	Specifies the type of file to create. If you are creating a description file, you can use the **Index Only** option, which creates a description file you can use with the BUTIL utility to add an index to an existing data file. (For more information, refer to Creating Indexes.)	MicroKernel-compatible
System Data	Determines whether the utility includes system data in the file. If you choose **Use Engine Setting**, the utility uses the setting for the **System Data** configuration option described. If you choose **No System Data**, the utility does not create system data, regardless of the engine configuration. If you choose **Force System Data**, the utility creates system data, regardless of the engine configuration. This is applicable only if the file type is MicroKernel-compatible.	Use Engine Setting

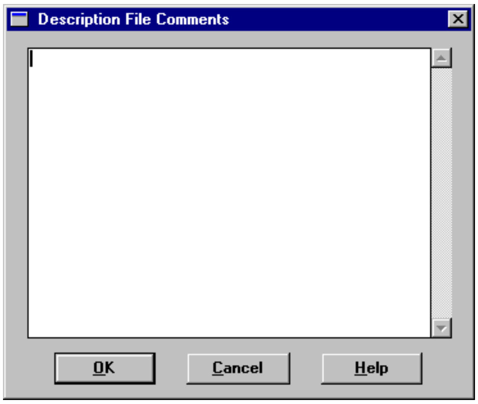
Adding Comments to a Description File

The comments are written to the top of the description file when you create the description file. For example, the comment, "This is my file," appears at the top of the description files as `/* This is my file */`. If you add additional comments after creating the description file, you need to create the file again to include the additional comments.

➢ To add comments to a description file

1 Click Description Comments. The Description File Comments dialog box appears.

Figure 24 Description File Comments Dialog Box



2 Enter a block of comments up to 5,120 characters long.

3 Click OK when you are finished entering comments.

Compacting Btrieve Data Files

You can compact a Btrieve data file to remove unused space in it, which typically decreases the file size. You can also perform this procedure using the command-line Maintenance utility (see To compact a Btrieve data file).

➢ To compact a Btrieve file

1 Click Load Information in the File Information Editor and select the file you want to compact.

2 Click Create File, give the file a new name (which creates a clone) in the Create File dialog box, and click OK.

3 From the Data menu on the main window, select Save. In the Save Data dialog box, enter the name of the original file in the From MicroKernel File box and then specify a name for the output file (for example, <*original file*>.out) in the To Sequential File box.

4 Click Execute. The Save Data dialog box displays the results of the save. Click Close.

5 From the Data menu, select Load. In the Load Data dialog box, enter the name of the sequential data file you just saved in the From Sequential File box. Then enter the name of the clone file you created in Step 2 in the To MicroKernel File box.

6 Click Execute. The Loading Data dialog box displays the results of the load. Click Close.

   You can now compare the size of the original file to the clone file to verify the reduction in size.

Specifying a Key's Alternate Collating Sequence

You can use an alternate collating sequence (ACS) to sort string keys (types STRING, LSTRING, and ZSTRING) differently from the standard ASCII collating sequence. By using one or more ACSs, you can sort keys as follows:

- By your own user-defined sorting order, which may require a sorting sequence that mixes alphanumeric characters (A-Z, a-z, and 0-9) with non-alphanumeric characters (such as #).
- By an international sorting rule (ISR) that accommodates language-specific collations, including multi-byte collating elements, diacritics, and character expansions and contractions.

Files can have a different ACS for each key in the file, but only one ACS per key. Therefore, if the key is segmented, each segment must use either the key's specified ACS or no ACS at all. For a file in which a key has an ACS designated for some segments but not for others, Btrieve sorts only the segments that specify the ACS.

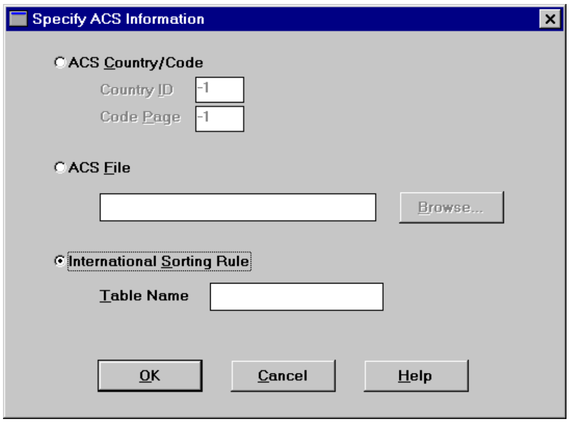
The ISR tables are provided with Pervasive PSQL and are based on ISO-standard locale tables. ISR tables are stored in the COLLATE.CFG file, which is installed with the Pervasive PSQL database engine. Multiple data files can share a single ISR.

➢ To specify a key’s alternate collating sequence

1 Click ACS Information.

The Maintenance utility displays the Specify ACS Information dialog box.

Figure 25 Specify ACS Information Dialog Box


Specify ACS Information

ACS Country/Code
Country ID: -1
Code Page: -1

ACS File

[✓ International Sorting Rule]
Table Name

2 You can specify either a Country ID and Code Page, an ACS File name, or an International Sorting Rule (ISR) as follows:

Table 58 ACS Information Controls

Control	Description	Default
ACS Country/Code		
Country ID	An Intel-format number that identifies your country. Refer to your operating system’s documentation for specific information.	-1
Code Page	An Intel-format number that identifies the code page you want to use. Refer to your operating system’s documentation for specific information.	-1
ACS File	Specifies the fully qualified file name of the alternate collating sequence file.	N/A
International Sorting Rule	When you click this radio button you can specify a specific ISR table for sorting international data. Pervasive PSQL provides a set of pre-generated ISR tables, which are listed in the *Pervasive PSQL Programmer's Guide*.	

3. When you specify a Country ID and Code Page ID, the database engine stores the locale-specific collating sequence in the data file. Moreover, the database engine can insert new key values correctly, even if the locale changes.
4. When you specify an ACS file name for a data file, the database engine copies the contents of the ACS file into the data file. (That is, the data file does not contain the file name of the ACS file.) The ACS identifies itself using an eight-digit name (such as UPPER). Subsequently, when you view the ACS information for a data file, the Maintenance utility displays this eight-digit name, not the file name of the original ACS.
5. When you specify an ACS File for a description file, the Maintenance utility copies the actual path and file name of the ACS file into the description file. Subsequently, when you view the ACS information for a description file, the Maintenance utility attempts to locate the specified ACS file.

   To specify an ACS that sorts string values using an ISO-defined, language-specific collating sequence, you must specify an ISR table name. The Table Name field is limited to 16 characters. For more information on ISRs, refer to the *Pervasive PSQL Programmer's Guide* in the Developer Reference.

Owner Names

The MicroKernel allows you to restrict access to files by specifying an owner name. Because owner names are optional, the files you use with the utility may or may not require an owner name. Owner names are case-sensitive.

Conceptually, owner names are like passwords. They are not the same as user or group names, which you can set in the PCC. For example, an owner name of “Master” is not the same as the default user Master.

A “short” owner name can be up to 8 bytes. A “long” owner name can be up to 24 bytes. Note, however, that once a long owner name is specified, the data file cannot be read by a database engine prior to Pervasive PSQL v10.10. Also, a data file with a long owner name cannot be rebuilt to a file format prior to 9.5 unless the owner name is first removed. An owner name, long or short, with less than the maximum allowed bytes is padded with spaces to the maximum length (8 or 24 bytes).

With relational access, an ODBC error results if you attempt to manipulate a table that is restricted by an owner name. (For example in the PCC, if you double-click the table name or attempt to delete the table.) You can supply owner names with the GRANT statement or the SET OWNER statement.

Use the GRANT statement to grant access to a particular user or group, and then manipulate the table via relational access through ODBC. The Master user must supply the GRANT statement with the correct owner name. See GRANT in *SQL Engine Reference*.

Use SET OWNER to specify one or more owner names to use during the current database connection. See SET OWNER in *SQL Engine Reference*.

Owner Names Tasks

Owner names can be set and cleared.

Setting or Clearing an Owner Name

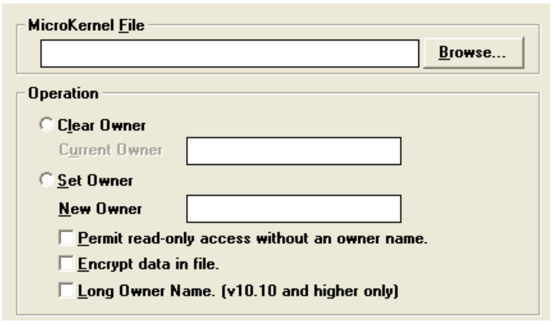
You set an owner name to restrict access to a data file. You clear an owner name to remove the access restriction.

Note You can also use a GRANT statement to supply an owner name. See Owner Name in *SQL Engine Reference*. PCC currently does not provide a way to specify an owner name through the security properties of a file.

➢ To set or clear an owner name

1 Click Options ▸ Set - Clear Owner from the menu bar. The Set - Clear Owner Name dialog appears.

Figure 26 Set/Clear Owner Name Dialog


MicroKernel File

Browse...

Operation

( ) Clear Owner

Current Owner

( ) Set Owner

New Owner

[ ] Permit read-only access without an owner name.

[ ] Encrypt data in file.

[ ] Long Owner Name. (v10.10 and higher only)

2 In the MicroKernel File box, specify the file for which you want to set or clear an owner name. Then, to clear the owner name, click Clear Owner and specify the file's owner name in the Current Owner field.

3 To set the owner name, click Set Owner, specify the file's new owner name in the New Owner field, then select any desired options.

- Select Permit read-only access without an owner name to allow all users read-only access to the data file.
- Select Encrypt data in file to ensure that unauthorized users do not examine your data using a debugger or a file dump utility. Only select this option if data security is important to your environment because encryption and decryption require additional processing time.

- Select Long Owner Name to create an owner name up to 24 bytes. (A “short” owner name can be up to 8 bytes.) Once a long owner name is specified, the data file cannot be read by a database engine prior to Pervasive PSQL v10.10. Also, a data file with a long owner name cannot be rebuilt to a file format prior to 9.5 unless the owner name is first removed.

4 Click Execute to apply the options.

Statistics Report

Generating a statistics report is a good way to determine whether a file can be logged by the database engine's transaction durability feature. The report shows whether the file has system data and if a key is unique. (A unique key lacks the "D" flag, which indicates that duplicates are allowed.) The statistics report provides metadata about the file. This information can be used when you troubleshoot problems or to help you create similar files.

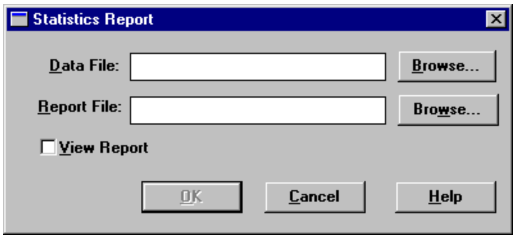
Statistics Report Tasks

The following task lists the steps to create a statistics report.

➢ To create a statistics report for an existing data file

1 Click Options ▸ Create Stat Report from the menu on the main window. The Maintenance utility displays the Statistics Report dialog box.

Figure 27 Statistics Report Dialog Box



2 Specify a data file to use and a report file name. If you want to view the report when it is created, select the View Report check box.

If you choose to view the report, the Maintenance utility displays the View File window shown next.

Figure 28   Statistics Report Example

```
File Statistics for person.mkd

File Version = 9.50
Page Size = 4096
Page Preallocation = No
Key Only = No
Extended = No
Total Number of Records = 1500
Record Length = 333
Record Compression = No
Page Compression = No
Variable Records = Yes
```

The informational headings in a status report correspond to the controls in the File Information Editor, which is described in File Information Editor.

The legend at the bottom of the statistics report explains the symbols used in the key/segment portion of the report. This information includes items such as the number of keys and key segments, the position of the key in the file, and the length of the key:

```
Legend:
< = Descending Order
D = Duplicates Allowed
I = Case Insensitive
M = Modifiable
R = Repeat Duplicate
A = Any Segment (Manual)
L = All Segments (Null)
* = The values in this column are hexadecimal.
?? = Unknown
-- = Not Specified
```

Indexes

An *index* is a structure that sorts all the key values for a specific key. Btrieve access permits overlapping indexes (an index that includes a partial column). Relational access through ODBC does not permit overlapping indexes. (You can create an overlapping index with the File Information Editor, which you can display by clicking the Goto Editor button.)

Index Tasks

You perform the following tasks pertaining to indexes:

- Creating Indexes
- Dropping Indexes

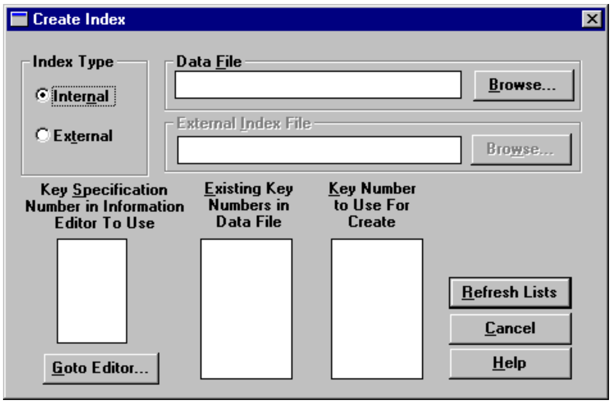
Creating Indexes

You cannot create an index for a file unless the file has at least one key defined. You can create a key with the File Information Editor (see File Information Editor).

➢ To create an index

1 Click Index ▸ Create from the main menu, which opens the Create Index dialog box.

Figure 29 Create Index Dialog Box



2 Complete the following options in the Create Index dialog box.

Index Type	Specify whether to create an internal or external index. Internal indexes are dynamically maintained as part of the data file. External indexes are separate files you generate as needed. An external index file is a standard data file that contains records sorted by the key you specify. Each record consists of the following: • A 4-byte address identifying the physical position of the record in the original data file • A key value
Data File	Specify the name of the data file for which you want to create the index.
External Index File	Specify the name of the file to generate for an external index. Not applicable for internal indexes.
Key Specification Number in Information Editor to Use	Lists the key numbers defined in the **File Information Editor**.
Existing Key Numbers in Data File	Click **Refresh Lists** to display the key number defined for the file. If the file contains a system-defined log key, this list includes SYSKEY.
Key Number to Use For Create	Click **Refresh Lists** to display the key numbers available (that is, not defined for the file). Highlight the key number you want to use when creating the index. If the file contains a system-defined log key (also called system data) but the key has been dropped, this list includes SYSKEY, which you can select to re-add the system-defined log key to the file.

3 You can click Go To Editor to display the File Information Editor dialog box, which shows more complete information about the key. You can click Refresh Lists to read key information from the data file and refresh the Existing Key Numbers in Data File and Key Number to Use For Create lists. You must click Refresh Lists before you can create an index.

4 When you have completed the Create Index dialog box, click Execute to create the index. The amount of time required to create the index depends on how much data the file contains.

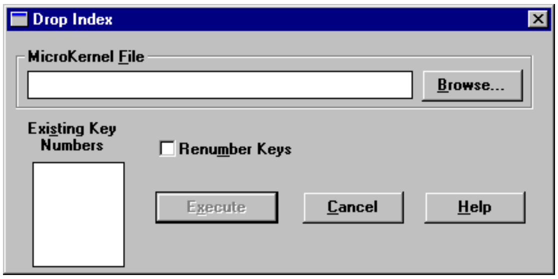
Dropping Indexes

Ensure that you understand the access performed by an application program before dropping an index. Certain functions fail (such as GET NEXT) if a required index is missing. This can result in an application program not functioning correctly.

➤ To drop an index

1 Click Index ▸ Drop from the main menu. The Drop Index dialog box appears.

Figure 30 Drop Index Dialog Box



2 Complete the following options in the Drop Index dialog box.

MicroKernel File	Specify the name of the data file from which you want to drop the index.
Existing Key Numbers	Click **Refresh List** to display the key number defined for the file. Highlight the number of the key whose index you want to drop. If the file contains a system-defined log key, this list includes **SYSKEY**, which you can select to drop the system-defined log key from the file.
Renumber Keys	Renumbers the keys consecutively. Select this check box to remove gaps that result from deleting an index.

3. Click Refresh List to get the key information from the file you have specified.

Data

The commands in the Data menu allow you to import, export, and copy records in data files. You can also recover data after a system failure with the Roll Forward feature. See Roll Forward Command for a discussion of Roll Forward.

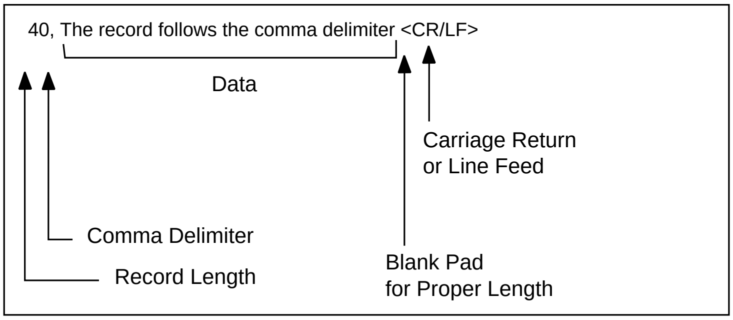
Importing and Exporting ASCII File Format

When you save data, records in the ASCII file have the following format. You can use an ASCII text editor to create files that you can load, as long as they adhere to these specifications. Note that most text editors do not support editing binary data.

- The first field is a left-adjusted integer (in ASCII) that specifies the length of the record. (When calculating this value, ignore the carriage return/line feed that terminates each line.) The value in this first field matches the record length specified in the data file.
    - For files with fixed-length records, the length you specify should equal the record length of the data file.
    - For files with variable-length records, the length you specify must be at least as long as the fixed-record length of the data file.
- A separator (a comma or a blank) follows the length field.
- The record data follows the separator. The length of the data is the exact number of bytes specified by the length field. If you are creating an import ASCII file using a text editor, pad each record with blank spaces as necessary to fill the record to the appropriate length.
- A carriage return/line feed (0D0A hexadecimal) terminates each line. The Maintenance utility does not insert the carriage return/line feed into the data file.
- The last line in the file must be the end-of-file character (CTRL+Z or 1A hexadecimal). Most text editors automatically insert this character at the end of a file.

Figure 31 shows the correct format for records in the input ASCII file. For this example, the data file has a defined record length of 40 bytes.

Figure 31 Format for Records in Input Sequential Files


40, The record follows the comma delimiter <CR/LF>
Data
Carriage Return or Line Feed
Comma Delimiter
Record Length
Blank Pad for Proper Length

Data Tasks

You can perform the following data tasks with the Maintenance utility:

- To import ASCII data
- To export ASCII records
- To copy records between MicroKernel data files
- To recover (Roll Forward) changes made to a data file between the time of the last backup and a system failure, see the Logging, Backup, and Restore chapter.

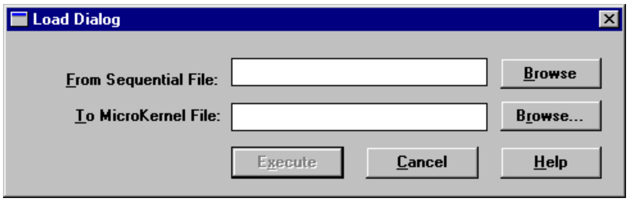
Importing Records From an ASCII File

You can use the Maintenance utility to import records from an ASCII file to a standard data file. This operation does not perform any conversions on the data. You can create an import file using a text editor or the Maintenance utility (see Exporting Records to an ASCII File).

➢ To import ASCII data

1 Click Data ▸ Load from the main menu. The Load dialog box appears.

Figure 32 Load Dialog Box



The ASCII file you specify must adhere to the specifications explained in Importing and Exporting ASCII File Format. The record length of the standard data file you specify must be compatible with the records in the ASCII file.

2 Click Execute to import the records.

While importing data, the Maintenance utility shows the number of records being imported, the percentage of records imported, and a status message. You can continue working in the Maintenance utility (for example, you can open another Load dialog box).

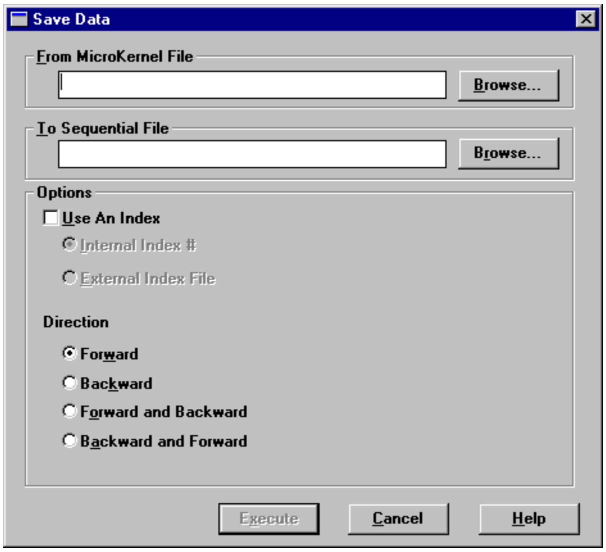
Exporting Records to an ASCII File

You can use the Maintenance utility to export records from a data file to an ASCII file.

➤ To export ASCII records

1 Click Data ▸ Save from the main menu. The Save Data dialog box appears.

Figure 33 Save Data Dialog Box



2 In the Save Data dialog box, specify the following options.

From MicroKernel File	Specifies the name of the existing MicroKernel-compatible file you want to save.
To Sequential File	Specifies the name of the sequential file to create.
Use An Index	Uses a specified index when sorting the records for export. By default, the Maintenance utility does not use an index, meaning that records are exported according to their physical position in the data file.
	Internal Index #: Uses the specified key number. Click **Refresh Index List** to update the available indexes if you change file in the **From MicroKernel File** box.
	External Index File: Uses the specified external index. (To create an external index, refer to Creating Indexes.)
Direction	Forward: This is the default setting and indicates the utility recovers the file from the beginning. Backward: This option recovers data from the end of the file. Forward and Backward: This option reads the file forward until it fails. Then it starts at the end of the file and reads the file backward until it reaches the record that failed previously or encounters another failure. Backward and Forward: Indicates the utility reads the file backward until it fails. Then it starts at the beginning of the file and reads the file forward until it reaches the record that failed previously or encounters another failure.

3 Click Execute to export the data. The Maintenance utility creates the specified ASCII file using the format described in Importing and Exporting ASCII File Format. You can then edit the ASCII file and use the Load command to import the edited text to another standard data file

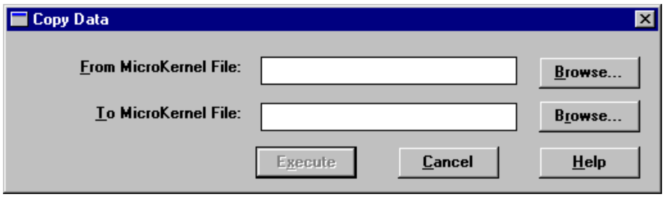
Copying Records Between Data Files

You can use the Maintenance utility to copy data from one MicroKernel data file to another. The record lengths for both data files you specify must be the same.

➢ To copy records between MicroKernel data files

1 Click Data ▸ Copy from the main menu. The Copy Data dialog box appears.

Figure 34 Copy Data Dialog Box



2 Enter the name of the file you want to copy in the From MicroKernel File box and then specify the path where you want to copy the file in the To MicroKernel File box.

The record lengths for both data files you specify must be the same.

Recovering (Roll Forward) Changes to a Data File

See the Logging, Backup, and Restore.

Btrieve Command-Line Maintenance Utility (butil)

Use this utility if you prefer a command-line interface or if you want to start or stop continuous operation. The Btrieve Maintenance utility is also available in a command-line format that runs on the server (from a DOS command prompt on Windows platforms) or locally on DOS, Linux and Windows clients. You can execute Maintenance utility commands from the command line or through a command file you create. Before you perform commands in the Btrieve Maintenance utility, also referred to as butil, it is important you understand some concepts and elements addressed in the Commands.

The Btrieve Command-Line Maintenance utility performs the following common file and data manipulations:

- Importing and Exporting Data
- Creating and Modifying Data Files
- Viewing Data File Statistics
- Displaying Btrieve Interface Module Version
- Unloading the Btrieve Interface and Requester (DOS only)
- Performing Continuous Operations

Return Codes

When butil finishes executing, it returns an exit code or DOS "errorlevel" return code to the operating system. The return codes are as follows:

Table 59 BUTIL Return Codes

Code	Meaning
SUCCESS_E = 0	Requested operation succeeded.
PARTIAL_E = 1	Requested operation completed, but with errors.
INCOMPLETE_E = 2	Requested operation did not complete.
USAGE_E = 3	Syntax error in input, display usage screen and exit.

Commands

The following table lists the commands that you can use with the Command-line Maintenance Utility.

Table 60 Command-Line Maintenance Utility Commands

Command	Description
Clone	Creates a new, empty data file using an existing file's specifications.
Clrowner	Clears the owner name of a data file.
Copy	Copies the contents of one data file to another.
Create	Creates a data file.
Drop	Drops an index.
Endbu	Ends continuous operation on data files defined for backup.
Index	Creates an external index file.
Load	Loads the contents of an unformatted file into a data file.
Recover	Reads data sequentially from a data file and writes the results to an unformatted file. (The DOS version does not support ROLLFWD.) Use this command if you have a damaged file.
Rollfwd	Recovers changes made to a data file between the time of the last backup and a system failure. See Performing Archival Logging.
Save	Reads data along a key path and writes the results to a sequential file.
Setowner	Assigns an owner name to a data file.
Sindex	Creates an index.
Startbu	Starts continuous operation on files defined for backup. See the chapter Logging, Backup, and Restore.
Stat	Reports statistics about file attributes and current sizes of data files.
Stop (DOS only)	Unloads the Btrieve Interface and requester.
Ver	Displays the version of the Database Engine and Btrieve Interface Module that is loaded at the server.

Viewing Command Usage Syntax

To view a summary of each command usage, enter the following command at the file server: butil

Command Format

The format for the Maintenance utility command line is as follows:

```
butil [–command [parameter ...]] | @commandFile
```

–command	A Maintenance utility command, such as COPY. You must precede the command with a dash (–), and you must enter a space before the dash. Table 60 lists the commands.
parameter	Information that the command may require. Discussions of the individual commands provide details when applicable.
@commandFile	Fully qualified file name of a command file.

Command Files

You can use a command file to do the following:

- Execute a command that is too long to fit on the command line.
- Execute a command that you use often (by entering the command once in the command file and then executing the command file as often as you want).
- Execute a command and write the output to a file, using the following command format:

  ```
  butil @commandFile [commandOutputFile]
  ```

  For each command executed, the resulting output file shows the command followed by its results. All messages appear on the server console screen, as well.
- Execute multiple commands sequentially.

Command files contain the same information as that required on the command line.

Rules for Command Files

Observe the following rules when creating a Maintenance utility command file:

- You cannot split a single parameter across two lines.
- You must end each command with `<end>` or `[end]`. You must also end each command with an <end> when trying to execute multiple commands. The `<end>` or `[end]` must be lowercase.

Command File Example

The following is an example command file, COPYCRS.CMD. The file calls the BUTIL -CLONE command to create the NEWCRS.MKD file by cloning the COURSE.MKD file, and the -CREATE command to create the NEWFILE.DTA file by using the description provided in the NEWFILES.DES description file.

```
-clone newcrs.mkd course.mkd <end>
-create newfile.dta newfiles.des <end>
```

The following command uses the COPYPATS.CMD file and writes the output to the COPYPATS.OUT file:

```
butil @copypats.cmd copypats.out
```

Description Files

Description files are ASCII text files that contain descriptions of file and key specifications that the Maintenance utility can use to create data files and indexes. Some users employ description files as a vehicle for archiving information about the data files they have created. For more information about the description file format, see Description Files.

Extended File Support

The size of the database engine data file can be larger than the operating system file size limit. When you export data from an extended MicroKernel file to an unformatted file, the size of the unformatted file can exceed the database engine file size limit because of the differences in the physical format.

When you are exporting large files, the Interactive Maintenance utility detects that the unformatted file has exceeded the operating system file size limit (2 GB) and starts creating extension files. This process is transparent. Extension files and the original unformatted file must reside on the same volume. The extension file uses a naming scheme in which the file names are similar to the base file name. In contrast to native MKDE extension files which use a caret “^” to indicate extension file status, the unformatted extension files use a tilde “~” to avoid overwriting any existing extended MKDE files with the same base file name. The first export extension file is the same base file name with “.~01” extension. The second extension file is “.~02,” and so on. These extensions are appended in hexadecimal format.

While the naming convention supports up to 255 extension files, the current maximum number of extension files is 64, thus supporting files as large as 128 GB.

To Save or Recover huge files to unformatted files, see the respective command. Also, when you import data from an unformatted file, the utility detects if the file has extensions and loads the data from the extension file.

Owner Names

The MicroKernel allows you to restrict access to files by specifying an owner name. Because owner names are optional, the files you use with the utility may or may not require an owner name.

A "short" owner name can be up to 8 bytes. A "long" owner name can be up to 24 bytes. Once a long owner name is specified, the data file cannot be read by a database engine prior to Pervasive PSQL v10.10. Also, a data file with a long owner name cannot be rebuilt to a file format prior to 9.5 unless the owner name is first removed. An owner name, long or short, with less than the maximum allowed bytes is padded with spaces to the maximum length (8 or 24 bytes).

If the file requires an owner name, you must specify it using the /O option. You can specify one of the following:

- Single owner name.
- List of up to eight owner names. Separate the owner names with commas.
- Asterisk (*). The utility prompts you for the owner name. With the rollfwd command, the utility prompts you for a list of owner names separated by commas.

Owner names are case-sensitive. If you enter owner names on the command line, the utility discards leading blanks. If you specify an asterisk, the utility does not discard leading blanks.

Redirecting Error Messages

Be sure that you specify a fully qualified file name (including a drive letter or UNC path) when redirecting error messages.

➢ To redirect error messages to a file

- Use the following command format.

  `butil -`*command commandParameters* `>` *filePath*

ASCII File Format

See Importing and Exporting ASCII File Format in the Interactive Maintenance utility section.

Rules for Specifying File Names on Different Platforms

When you run `butil` on a Windows-based platform or a Linux-based platform, you do not need to specify the name of the path if the data file resides in the same directory as your current directory.

Importing and Exporting Data

This section provides detailed information on importing and exporting data using the following butil commands: Copy, Load, Recover, and Save.

Table 61 Commands to Import and Export Data

Command	Description
Copy	Copies the contents of one data file to another.
Load	Loads the contents of a sequential file into a data file.
Recover	Reads data sequentially from a data file and writes the results to a sequential file.
Save	Reads data along a key path and writes the results to a sequential file.

Copy

The copy command copies the contents of one MicroKernel file to another. Copy retrieves each record in the input data file and inserts it into the output data file. The record size must be the same in both files. After copying the records, copy displays the total number of records inserted into the new data file.

Note Copy performs in a single step the same function as a Recover command followed by a Load command.

Using the copy command, you can create a data file that contains data from an old file, but has new key characteristics.

➢ To copy a MicroKernel data file

1. Use the Create command to create an empty data file with the desired key characteristics (key position, key length, or duplicate key values).

   or

   Use Clone to create an empty data file using the characteristics of an existing file.

2. Use the copy command to copy the contents of the existing data file into the newly created data file.

Format

```
butil -copy sourceFile outputFile [/O< owner1 | *>
    [/O<owner2 | *>]] [/UIDuname /PWDpword [/DBdbname]]
```

sourceFile	The fully qualified name of the data file from which to transfer records. When you run BUTIL for Windows platforms, you do not need to specify the name of the path if the data file resides in the same directory as your current directory.
outputFile	The fully qualified name of the data file into which to insert records. The output data file can contain data or be empty. When you run BUTIL for Windows platforms, you do not need to specify the name of the path if the data file resides in the same directory as your current directory.
/O*owner1*	The owner name of the source data file, if required. If only the output data file requires an owner name, specify **/O** followed by a blank for *owner1* (as illustrated in the example).
/O*owner2*	The owner name of the output data file, if required.
`/UID`<*name*> `/UID`*uname*	Specifies the name of the user authorized to access a database with security enabled.
`/PWD`<*word*> `/PWD`*pword*	Specifies the password for the user who is identified by *uname*. *Pword* must be supplied if *uname* is specified.
`/DB`<*name*> `/DB`*dbname*	Specifies the name of the database on which security is enabled. If omitted, the default database is assumed.

Example

The following command copies the records in COURSE.MKD to NEWCRS.MKD. The COURSE.MKD input file does not require an owner name, but the NEWCRS.MKD output file uses the owner name Pam.

```
butil -copy course.mkd newcrs.mkd /O /OPam
```

If you omit the first /O from this example, the utility assumes that the owner name Pam belongs to the input data file, not the output data file.

Load

The load command inserts records from an input ASCII file into a file. The input ASCII file can be a single file or an extended file (the base file plus several extension files). Load performs no conversion on the data in the input ASCII file. After the utility transfers the records to the data file, it displays the total number of records loaded.

Note The load command opens the output file in Accelerated mode; during a load operation, the database engine does not log the file. If you are using archival logging, back up your data files again after using the load command.

Extended files: If the utility finds the next extension file, it continues the load process. Do not delete any extension file created earlier by the save and recover commands. If the file has three extensions and the user deletes the second one, load stops loading records after processing the first extension file.

If save or recover created three extension files and a fourth one exists from a previous save or recover, load reads the records from the fourth extension and inserts them into the database engine file. If a fourth file exists, then you need to delete it before starting the load process.

Before running the load command, you must create the input ASCII file and the data file. You can create the input ASCII file using a standard text editor or an application; the input ASCII file must have the required file format (see Importing and Exporting ASCII File Format). You can create the data file using either the Create or the Clone command.

Format

```
butil -load unformattedFile outputFile [/O<owner |*>] [/UIDuname
    /PWDpword [/DBdbname]]
```

unformattedFile	The fully qualified name of the ASCII file containing the records to load into a data file. For Windows platforms, you do not need to specify the name of the path if the data file resides in the same directory as your current directory.
outputFile	The fully qualified name of the data file into which to insert the records. When you run BUTIL for Windows platforms, you do not need to specify the name of the path if the data file resides in the same directory as your current directory.
/O*owner*	The owner name for the data file, if required.
`/UID`<*name*> `/UID`*uname*	Specifies the name of the user authorized to access a database with security enabled.
`/PWD`<*word*> `/PWD`*pword*	Specifies the password for the user who is identified by *uname*. *Pword* must be supplied if *uname* is specified.
`/DB`<*name*> `/DB`*dbname*	Specifies the name of the database on which security is enabled. If omitted, the default database is assumed.

Example

The following example loads sequential records from the COURSE.TXT file into the COURSE.MKD file. The owner name of the COURSE.MKD file is Sandy.

```
butil -load course.txt course.mkd /OSandy
```

Recover

The recover command extracts data from a MicroKernel file and places it in an ASCII file that has the same format as the input ASCII file that the load command uses. This is often useful for extracting some or all of the data from a damaged MicroKernel file. The recover command may be able to retrieve many, if not all, of the file's records. You can then use the load command to insert the recovered records into a new, undamaged MicroKernel file.

Note The Maintenance utility performs no conversion on the data in the records. Therefore, if you use a text editor to modify an output file containing binary data, be aware that some text editors may change the binary data, causing the results to be unpredictable.

Format

```
butil -recover sourceFile unformattedFile [/O<owner |*>]
   [/Q] [/J] [/I] [/UIDuname /PWDpword [/DBdbname]]
```

sourceFile	The fully qualified name of the data file from which to recover data. When you run BUTIL for Windows platforms, you do not need to specify the name of the path if the data file resides in the same directory as your current directory.
unformattedFile	The fully qualified name of the ASCII file where the utility should store the recovered records.
/O*owner*	The owner name for the data file, if required.
/Q	Indicates whether to replace an existing unformatted file. By default, the Maintenance utility overwrites the existing files. If you specify this option and a file with the same name exists, the utility returns an error message. The utility also checks whether the database engine file to be recovered is extended. If the file is extended, the utility checks for files with the same name as the potential unformatted extension file. If one of those files exists, the utility returns an error message.
/J	Indicates BACKWARD reading of the file. If you specify this option, the utility recovers data from the database engine file using STEP LAST and PREVIOUS operations. The default is forward reading, using STEP FIRST and NEXT operations.

/I	Indicates FORWARD reading of the file. Although the default is forward reading, you can use this option to indicate FORWARD and BACKWARD reading. This means that if you specify both **/I** and **/J**, respectively, the utility reads the file forward until it fails. Then it starts at the end of the file and reads backwards until it reaches the record that failed previously or encounters another failure. If you specify **/J** first, the utility reads backwards and then reads forward.
`/UID`<*name*> `/UID`*uname*	Specifies the name of the user authorized to access a database with security enabled.
`/PWD`<*word*> `/PWD`*pword*	Specifies the password for the user who is identified by *uname*. *Pword* must be supplied if *uname* is specified.
`/DB`<*name*> `/DB`*dbname*	Specifies the name of the database on which security is enabled. If omitted, the default database is assumed.

For each record in the source file, if the recover command receives a variable page error (Status Code 54), it places all the data it can obtain from the current record in the unformatted file and continues the recovery process.

The utility produces the following messages:

- informs you about the name of the last extension file created
- checks if the next extension file exists, and if so, tells you to delete it
- if you move the extended unformatted files to a different location, you are prompted to move the base file and all of its extension files

Example

The following example extracts records from the COURSE.MKD file and writes them into the COURSE.TXT file.

```
butil -recover course.mkd course.txt
```

Save

The save command retrieves records from a MicroKernel file using a specified index path and places them in an ASCII file that is compatible with the required format for the load command. You can then edit the ASCII file and use the load command to store the edited data in another data file. (See Importing and Exporting ASCII File Format for more information about the ASCII file format.)

Save generates a single record in the output ASCII file for each record in the input data file. Upon completion, save displays the total number of records saved.

Note The Maintenance utility performs no conversion on the data in the records. Therefore, if you use a text editor to modify an output file containing binary data, be aware that some text editors may change the binary data, causing the results to be unpredictable.

Format

```
butil -save sourceFile unformattedFile [Y indexFile | N <keyNumber |
   -1>] [/O<owner1 | *> [/O<owner2 | *>]] [/Q] [/J] [/I]
   [/UIDuname /PWDpword [/DBdbname]]
```

sourceFile	The fully qualified name of the data file containing the records to save. When you run BUTIL for Windows platforms, you do not need to specify the name of the path if the data file resides in the same directory as your current directory.
unformattedFile	The fully qualified name of the ASCII file where you want the utility to store the records.
indexFile	The fully qualified name of an external index file by which to save records *if* you do not want to save records using the default of the lowest key number.
keyNumber	The key number (other than 0) by which to save records *if* you do not want to save records using the default of the lowest key number.
-1	The specification for saving the records in physical order using the Btrieve Step operations.
/O*owner1*	The owner name for the source file, if required. If only the index file requires an owner name, specify **/O** followed by a blank for *owner1*.

/O*owner2*	The owner name for the index file, if required.
/Q	Indicates whether to replace an existing unformatted file. By default, the Maintenance utility overwrites the existing files. If you specify this option and a file with the same name exists, the utility returns an error message. The utility also checks whether the database engine file to be saved is extended. If the file is extended, the utility checks for files with the same name as the potential unformatted extension files. If one of those files exists, the utility returns an error message.
/J	Indicates BACKWARD reading of the file. If you specify this option, the utility recovers data from the database engine file using GET LAST and PREVIOUS operations. The default is forward reading, using GET FIRST and NEXT operations.
/I	Indicates FORWARD reading of the file. Although the default is forward reading, you can use this option to indicate FORWARD and BACKWARD reading. This means that if you specify both **/I** and **/J**, respectively, the utility reads the file forward until it fails. Then it starts at the end of the file and reads backwards until it reaches the record that failed previously or encounters another failure. If you specify **/J** first, the utility reads backwards and then reads forward.
`/UID<`*name*`>` `/UID`*uname*	Specifies the name of the user authorized to access a database with security enabled.
`/PWD<`*word*`>` `/PWD`*pword*	Specifies the password for the user who is identified by *uname*. *Pword* must be supplied if *uname* is specified.
`/DB<`*name*`>` `/DB`*dbname*	Specifies the name of the database on which security is enabled. If omitted, the default database is assumed.

The utility produces the following messages:

- informs you about the name of the last extension file created
- checks if the next extension file exists, and if so, tells you to delete it

- if you move the extended unformatted files to a different location, you are prompted to move the base file and all of its extension files

Examples

The following two examples illustrate how to use the SAVE command to retrieve records from a data file.

This example uses a NEWCRS.IDX external index file to retrieve records from the COURSE.MKD file and store them in an unformatted text file called COURSE.TXT:

```
butil save course.mkd course.txt newcrs.idx
```

The following example retrieves records from the COURSE.MKD file using key number 3 and stores them in an unformatted text file called COURSE.TXT:

```
butil -save course.mkd course.txt n 3
```

Creating and Modifying Data Files

This section includes detailed information on creating and modifying data files using the following BUTIL commands: Clone, Clrowner, Create, Drop, Index, Setowner, and Sindex. This section also includes information about removing unused space in a Btrieve data file, which is discussed in Compacting Btrieve Data Files.

Caution No two files can share the same file name and differ only in their file name extension if both files are in the same directory. For example, do not name a data file Invoice.btr and another one Invoice.mkd in the same directory. This restriction applies because the database engine uses the file name for various areas of functionality while ignoring the file name extension. Since only the file name is used to differentiate files, files that differ only in their file name extension look identical to the database engine.

Table 62 Commands to Create and Modify Data Files

Command	Description
Clone	Creates a new, empty data file using an existing file's specifications.
Clrowner	Clears the owner name of a data file.
Create	Creates a data file.
Drop	Drops an index.
Index	Creates an external index file.
Setowner	Assigns an owner name to a data file.
Sindex	Creates an index.

Clone

The clone command creates a new, empty file with the same file specifications as an existing file (including any supplemental indexes, but excluding the owner name). The new data file includes all the defined key characteristics (such as key position, key length, or duplicate key values) contained in the existing file.

The **clone** command ignores all MicroKernel configuration options that affect file statistics (such as System Data) *except* file version. The **clone** command creates a new file using the database engine file version you specify with the **Create File Version** option.

Format

```
butil -clone outputFile sourceFile [/O<owner | *>] [/
    pagecompresson | /pagecompressoff] [/
    recordcompresson | /recordcompressoff] [/UIDuname /
    PWDpword [/DBdbname]] [/S]
```

outputFile	The fully qualified file name to use for the new, empty data file. When you run BUTIL for Windows platforms, you do not need to specify the name of the path if the data file resides in the same directory as your current directory.
sourceFile	The fully qualified file name of the existing data file to replicate.When you run BUTIL for Windows platforms, you do not need to specify the name of the path if the data file resides in the same directory as your current directory.
/O*owner*	The owner name, if any, for the source data file. The new data file does not have an owner name. See Owner Names for more information.
/pagecompresson	Turns on page compression for *outputFile* provided the following conditions are true: • The version of the Pervasive PSQL database engine is Pervasive PSQL 9.5 or newer. • The setting for Create File Version is 0950 (9.5) or higher. See Create File Version.
/pagecompressoff	Turns off page compression for *outputFile*. This parameter has no effect if *sourceFile* does not contain page compression.
/recordcompresson	Turns on record compression for *outputFile*.
/recordcompressoff	Turns off record compression for *outputFile*. This parameter has no effect if *sourceFile* does not contain record compression.
`/UID<`*name*`>` `/UID`*uname*	Specifies the name of the user authorized to access a database with security enabled.

/PWD<*word*> /PWD*pword*	Specifies the password for the user who is identified by *uname*. *Pword* must be supplied if *uname* is specified.
/DB<*name*> /DB*dbname*	Specifies the name of the database on which security is enabled. If omitted, the default database is assumed.

Remarks

Btrieve 6.0 and later allows a maximum of 23 key segments in a data file with a page size of 1,024 bytes. Therefore, the CLONE command sets the page size in the new data file to 2,048 bytes if the existing data file contains 24 key segments and has a page size of 1,024 bytes. This occurs if the existing data file has a format earlier than 6.0 and the database engine was not loaded with the Create File Version option set to 5.*x* or 6.*x*.

If you are cloning a pre-7.*x* file, ensure that the database engine is configured to create the file format version that you want the new file to be. For example, if you want to clone a 6.15 file in 9.5 format, ensure that the MicroKernel File Format Version option is set to 9.5.

Note If your source file is in 8.x format or later and it does not contain system data, your output file will not contain system data, regardless of the database engine configuration. To add system data to an existing file, refer to *Getting Started With Pervasive PSQL.*

If you are trying to recover from receiving Status Code 30 (The file specified is not a MicroKernel file) and you suspect that the header page of the source file might be damaged, try creating the new MicroKernel file using the Create command with a description file.

Example

The following command creates the NEWCRS.MKD file by cloning the COURSE.MKD file.

```
butil -clone newcrs.mkd course.mkd
```

Clrowner

The clrowner command clears the owner name of a MicroKernel file.

Format

```
butil -clrowner sourceFile </O<owner | *> [/UIDuname /
    PWDpword [/DBdbname]]
```

sourceFile	The fully qualified file name of the data file. When you run BUTIL for Windows platforms, you do not need to specify the name of the path if the data file resides in the same directory as your current directory.
/O*owner*	The owner name to clear. See Owner Names for more information.
`/UID`<*name*> `/UID`*uname*	Specifies the name of the user authorized to access a database with security enabled.
`/PWD`<*word*> `/PWD`*pword*	Specifies the password for the user who is identified by *uname*. *Pword* must be supplied if *uname* is specified.
`/DB`<*name*> `/DB`*dbname*	Specifies the name of the database on which security is enabled. If omitted, the default database is assumed.

Example

The following command clears the owner name for the TUITION.MKD file. The owner name for the file is Sandy.

```
butil -clrowner tuition.mkd /OSandy
```

Create

The create command generates an empty MicroKernel file using the characteristics you specify in a description file. Before you can use the create command, you must create a description file to specify the new key characteristics. For more information, see Description Files.

Format

```
butil -create outputFile descriptionFile [< Y | N >] [/UIDuname
   /PWDpword [/DBdbname]]
```

outputFile	The fully qualified file name of the database engine file to create. If the file name is the name of an existing MicroKernel file, this command creates a new, empty file in place of the existing file. Any data that was stored in the existing file is lost and cannot be recovered. When you run BUTIL for Windows platforms, you do not need to specify the name of the path if the data file resides in the same directory as your current directory.
descriptionFile	The fully qualified name of the description file containing the specifications for the new MicroKernel file.
Y | N	Indicates whether to replace an existing file. If you specify **N** but a MicroKernel file with the same name exists, the utility returns an error message. The default is **Y**.
`/UID`<*name*> `/UID`*uname*	Specifies the name of the user authorized to access a database with security enabled.
`/PWD`<*word*> `/PWD`*pword*	Specifies the password for the user who is identified by *uname*. *Pword* must be supplied if *uname* is specified.
`/DB`<*name*> `/DB`*dbname*	Specifies the name of the database on which security is enabled. If omitted, the default database is assumed.

Example

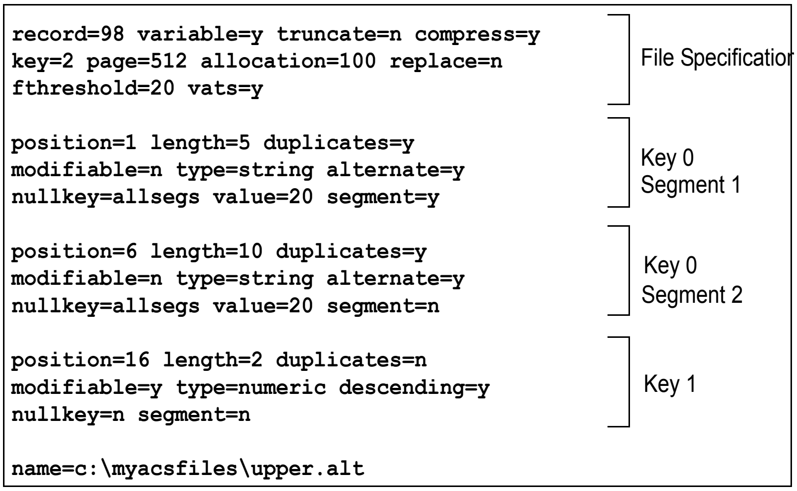
The following command creates a file named COURSE.MKD using the description provided in the CREATE.DES description file.

```
butil -create course.mkd create.des
```

Sample Description File for the CREATE Command

The sample description file shown in Figure 35 creates a MicroKernel formatted file. The file is specified to have a page size of 512 bytes and 2 keys. The fixed-length portion of each record in the file is set to 98 bytes. The file specifies variable-length records with no blank truncation, record compression, and variable-tail allocation tables (VATs). The free space threshold is set to 20 percent. Allocation is set to 100 pages. The MicroKernel preallocates 100 pages, or 51,200 bytes, when it creates the file.

Figure 35 Sample Description File for the CREATE Command



```
record=98 variable=y truncate=n compress=y
key=2 page=512 allocation=100 replace=n
fthreshold=20 vats=y

position=1 length=5 duplicates=y
modifiable=n type=string alternate=y
nullkey=allsegs value=20 segment=y

position=6 length=10 duplicates=y
modifiable=n type=string alternate=y
nullkey=allsegs value=20 segment=n

position=16 length=2 duplicates=n
modifiable=y type=numeric descending=y
nullkey=n segment=n

name=c:\myacsfiles\upper.alt
```

Key 0 is a segmented key with two duplicatable, nonmodifiable string segments and a null value of 20 hexadecimal (space) specified for both segments. Key 0 uses the collating sequence upper.alt.

Key 1 is a numeric, nonsegmented key that does not allow duplicates but permits modification. It is sorted in descending order.

Drop

The drop command removes an index from a file and adjusts the key numbers of any remaining indexes, subtracting 1 from each subsequent key number. If you do not want to renumber the keys, you can add 128 to the key number you specify to be dropped. This renumbering feature is available only for 6.0 and later files.

Format

```
butil -drop sourceFile < keyNumber | SYSKEY >
   [/O<owner | *>] [/UIDuname /PWDpword [/DBdbname]]
```

sourceFile	The fully qualified name of the file from which you are dropping the index. When you run BUTIL for Windows platforms, you do not need to specify the name of the path if the data file resides in the same directory as your current directory.
keyNumber	The number of the key to remove. To preserve the original key numbers, add a 128 bias to the key number you specify.
SYSKEY	Instructs the utility to drop the system-defined log key (also called system data). Dropping the system-defined log key does not delete values from the records; the database engine still assigns unique system-defined log key values to newly inserted records. However, the database engine cannot perform logging for a file from which the system-defined log key is dropped, if no user-defined unique keys exist. For this reason, you should use this option only if you suspect that the system-defined log key is corrupt and you intend to re-add it. The **sindex** command allows you to re-use the system-defined log key once you have dropped it.
/O*owner*	The owner name for the file, if required.
/UID<*name*> /UID*uname*	Specifies the name of the user authorized to access a database with security enabled.
/PWD<*word*> /PWD*pword*	Specifies the password for the user who is identified by *uname*. *Pword* must be supplied if *uname* is specified.
/DB<*name*> /DB*dbname*	Specifies the name of the database on which security is enabled. If omitted, the default database is assumed.

Examples

In both of the following examples, COURSE.MKD has three keys. The original keys in the file are numbered 0, 1, and 2.

In the first example, the **butil -drop** command drops key number 1 from the COURSE.MKD file and renumbers the remaining key numbers as 0 and 1.

```
butil -drop course.mkd 1
```

In the following example, the **butil –drop** command drops key number 1, but does not renumber the keys. The key numbers remain 0 and 2.

```
butil -drop course.mkd 129
```

Index

The **index** command builds an external index file for an existing MicroKernel file, based on a field not previously specified as a key in the existing file. Before you can use the **index** command, you must create a description file to specify the new key characteristics. For more information about description files, see Description Files.

The records in the new file consist of the following:

- The 4-byte address of each record in the existing data file.
- The new key value on which to sort.

Note If the key length you specify in the description file is 10 bytes, the record length of the external index file is 14 bytes (10 plus the 4-byte address).

Format

```
butil -index sourceFile indexFile descriptionFile [/O<owner | *>]
   [/O<owner | *>] [/UIDuname /PWDpword [/DBdbname]]
```

sourceFile	The fully qualified name of the existing file for which to build an external index. When you run BUTIL for Windows platforms, you do not need to specify the name of the path if the data file resides in the same directory as your current directory.
indexFile	The fully qualified name of the index file in which the database engine should store the external index.
descriptionFile	The fully qualified name of the description file you have created containing the new key definition. The description file should contain a definition for each segment of the new key.
/O*owner*	The owner name for the data file, if required.

/UID<*name*> /UID*uname*	Specifies the name of the user authorized to access a database with security enabled.
/PWD<*word*> /PWD*pword*	Specifies the password for the user who is identified by *uname*. *Pword* must be supplied if *uname* is specified.
/DB<*name*> /DB*dbname*	Specifies the name of the database on which security is enabled. If omitted, the default database is assumed.

Remarks

The index command creates the external index file and then displays the number of records that were indexed. To retrieve the data file's records using the external index file, use the Save command.

Sample Description File for the INDEX Command

The description file shown in the following illustration defines a new key with one segment. The key begins at byte 30 of the record and is 10 bytes long. It enables duplicates, is modifiable, is a STRING type, and uses no alternate collating sequence.

Figure 36 Sample Description File for INDEX Command

```
position=30 length=10 duplicates=y modifiable=y
type=string alternate=n segment=n
```

Example

The following command creates an external index file called NEWCRS.IDX using a data file called COURSE.MKD. The COURSE.MKD file does not require an owner name. The description file containing the definition for the new key is called NEWCRS.DES.

```
butil -index course.mkd newcrs.idx newcrs.des
```

Setowner

The setowner command sets an owner name for a data file.

Format

```
butil -setowner sourceFile /O<owner | *> level [/L] [/UIDuname
    /PWDpword [/DBdbname]]
```

sourceFile	The fully qualified name of the data file. When you run BUTIL for Windows platforms, you do not need to specify the name of the path if the data file resides in the same directory as your current directory.
/O*owner*	The owner name to be set
level	The type of access restriction for the data file. The possible values for this parameter are as follows Note that *level* must immediately follow the /O parameter. 0: Requires an owner name for any access mode (no data encryption) 1: Permits read access without an owner name (no data encryption) 2: Requires an owner name for any access mode (with data encryption) 3: Permits read access without an owner name (with data encryption)
/L	Designates a long owner name. Owner names are case sensitive and can be short or long. A “short” owner name can be up to 8 bytes long. A “long” owner name can be up to 24 bytes long. For restrictions pertaining to long owner names, see the section Procedure in *Btrieve API Guide* for Set Owner (29).
`/UID<`*name*`>` `/UID`*uname*	Specifies the name of the user authorized to access a database with security enabled.
`/PWD<`*word*`>` `/PWD`*pword*	Specifies the password for the user who is identified by *uname*. *Pword* must be supplied if *uname* is specified.
`/DB<`*name*`>` `/DB`*dbname*	Specifies the name of the database on which security is enabled. If omitted, the default database is assumed.

Examples

The following example creates a short owner for the course.mkd data file. The owner name is Sandy, and the restriction level is 1.

```
butil -setowner course.mkd /OSandy 1
```

The following example creates a long owner name for the billing.mkd data file, encrypts the owner name and file, and restricts all access modes.

```
butil -setowner billing.mkd /Ohr#Admin$945k7YY%svr 2 /L
```

Sindex

The sindex command creates an additional index for an existing MicroKernel file. By default, the key number of the new index is one higher than the previous highest key number for the data file, or you can instruct the database engine to use a specific key number. An exception is if a **drop** command previously removed an index without renumbering the remaining keys, thus producing an unused key number; in this case, the new index receives the first unused number.

You can instruct the database engine to use a specific key number for the new index with the key number option. The key number you specify must be a valid key number that is not yet used in the file. If you specify an invalid key number, you receive Status Code 6.

If you do not use the SYSKEY option with this command, you must create a description file that defines key specifications for the index before you can use the **sindex** command. For more information about description files, see Description Files.

Format

```
butil -sindex sourceFile <descriptionFile | SYSKEY> [keyNumber]
    [/O<owner | *>] [/O<owner | *>] [/UIDuname /PWDpword [/
    DBdbname]]
```

sourceFile	The fully qualified name of the existing file for which to build an external index. When you run BUTIL for Windows platforms, you do not need to specify the name of the path if the data file resides in the same directory as your current directory.
descriptionFile	The fully qualified name of the description file you have created containing the new key definition. The description file should contain a definition for each segment of the new key.

SYSKEY	Instructs the utility to re-add the system key on a file in which the system key was dropped.
/O*owner*	The owner name for the data file, if required.
`/UID`<*name*> `/UID`*uname*	Specifies the name of the user authorized to access a database with security enabled.
`/PWD`<*word*> `/PWD`*pword*	Specifies the password for the user who is identified by *uname*. *Pword* must be supplied if *uname* is specified.
`/DB`<*name*> `/DB`*dbname*	Specifies the name of the database on which security is enabled. If omitted, the default database is assumed.

Examples

The following example adds an index to the COURSE.MKD file. The name of the description file is NEWIDX.DES.

```
butil -sindex course.mkd newidx.des
```

The following example adds the system-defined key to the COURSE.MKD file. The system-defined key was dropped.

```
butil -sindex course.mkd syskey
```

Compacting Btrieve Data Files

You can use several commands in the BUTIL (Clone, Recover, and Load, respectively) to remove unused space in a data file to decrease its size.

➢ To compact a Btrieve data file

1. Rename your data file and then use the Clone option to create a blank data file using the original file name.
2. Use Recover to save the data from the clone file to an unformatted text file in sequential order.
3. Use Load to load the recovered data into the clone.

   Every record containing data will load into the newly created data file without blank records. (You can also perform this operation in the Btrieve Interactive Maintenance utility.)

Viewing Data File Statistics

This section includes information about generating a report that contains a data file's characteristics and statistics using STAT.

Stat

The stat command generates a report that contains defined characteristics of a data file and statistics about the file's contents. Using the stat command is a good way to determine if a file can be logged by the database engine's transaction durability feature. The stat command reports indexes the same whether they were created by the Create Supplemental Index operation (in Btrieve 6.0 and later) or the Create operation.

Format

```
butil -stat <sourceFile> [/O<owner | *>] [/O<owner | *>] [/
   UIDuname /PWDpword [/DBdbname]]
```

sourceFile	The fully qualified name of the data file for which to report statistics. For Windows platforms, you do not need to specify the name of the path if the data file resides in the same directory as your current directory.
/O*owner*	The owner name for the data file, if required.
/UID<*name*> /UID*uname*	Specifies the name of the user authorized to access a database with security enabled.
/PWD<*word*> /PWD*pword*	Specifies the password for the user who is identified by *uname*. *Pword* must be supplied if *uname* is specified.
/DB<*name*> /DB*dbname*	Specifies the name of the database on which security is enabled. If omitted, the default database is assumed.

Example

The following example reports file statistics for the PATIENTS.DTA file. The data file does not have an owner name.

```
butil -stat patients.dta
```

The following example shows the resulting report:

```
   **************************************************
   File Statistics for PATIENTS.DTA
```

```
File Version = 8.00
Page Size = 2048
Page Preallocation = No
Key Only = No
Extended = No

Total Number of Records = 16
Record Length = 104
Record Compression = No
Variable Records = No

Available Linked Duplicate Keys = 0
Balanced Key = No
Log Key = 1
 System Data = No
Total Number of Keys = 3
Total Number of Segments = 4

Key  Segment Position Length  Type  Flags
Null Values*  Unique  ACS Values
0    1       21       20      String MD
--            16       0
0    2        7       12      String MD
--            16       0
1    1        1        6      String M
--            16       0
2    1       83       10      String MD
--             7       0

Alternate Collating Sequence (ACS) List:
 0 UPPER

Legend:
 < = Descending Order
 D = Duplicates Allowed
 I = Case Insensitive
 M = Modifiable
 R = Repeat Duplicate
 A = Any Segment (Manual)
 L = All Segments (Null)
 * = The values in this column are hexadecimal.
?? = Unknown
-- = Not Specified
```

This example shows that the file called PATIENTS.DTA is an 8.0 file. (The version number indicates the earliest Btrieve version that can read the file format.) The file has a page size of 2,048 bytes and has no preallocated pages. This is not a key-only file, nor is it an extended file.

Sixteen records have been inserted into the file. The file was defined with a record length of 104 bytes, does not use record compression, and does not allow variable-length records.

There are no linked duplicate keys available in the file. The file does not use balanced indexing. The MicroKernel performs logging using Key 1, and the file contains no system-defined data. The file has three keys comprised of four key segments.

Note Indexes created with Sindex are designated with the letter R by default *unless* you specified the Reserved Duplicate Pointer element.

The STAT report also provides information about specific keys. For example, the report shows that Key 0 allows duplicates, is modifiable, and consists of two segments:

- The first segment starts in position 21, is 20 characters long, allows duplicates, is modifiable, and will be sorted as a STRING type. The dashes indicate that a null value was not defined. The Unique Values column indicates that 16 unique values were inserted for this segment. This segment uses the upper.alt alternate collating sequence file.
- The second segment starts in position 7, is 12 characters long, allows duplicates, is modifiable, and will be sorted as a STRING type. Sixteen unique values were inserted for this segment. This segment uses the upper.alt alternate collating sequence file.

Key 1 is the key the database engine uses in logging this file. Key 1 consists of one segment. It starts in position 1, is six characters long, does not allow duplicates, is modifiable, and will be sorted as a STRING type. Sixteen unique values were inserted for this key. This key uses the upper.alt alternate collating sequence file.

Key 2 consists of one segment. It starts in position 83, is 10 characters long, allows duplicates, is modifiable, and will be sorted as a STRING type. Seven unique key values were inserted for this key. This key uses the upper.alt alternate collating sequence file.

File Version Notes

When reporting the file format version for a file, the database engine reports the earliest engine version that can read the specified file. For example, you may have a file that was created in Btrieve 5.x format, but it may be reported as a version 3.x file because it does not use any 4.x or 5.x features. Starting with the 6.x format, the file itself contains a version stamp. Prior to 6.x, the only way to determine the file format version of a file is by inspecting the features that it uses. For version 5.x or earlier files, the next table shows the features which, if used, determine the version that is reported for the file:

Table 63 Version 5.x and Earlier File Format Features

This file format version is reported...	... if one or more of these features are in use:
5.x	Compressed records Key only file
4.x	Extended key types Variable length records Index added with CreateIndex operation
3.x	None of the above

Displaying Btrieve Interface Module Version

This section includes detailed information about displaying the version of the Btrieve Interface module using the ver command.

Ver

The ver command returns the version number of both the database engine and the Btrieve Access Module.

Format

```
butil -ver
```

Remarks

When you run the ver command, the utility displays messages similar to the following:

```
The Btrieve Requester version is 10.00.
The Btrieve Version is 10.00.
```

Unloading the Btrieve Interface and Requester (DOS only)

Stop

Use the stop command to unload the Btrieve Interface and, if applicable, the requester.

Format

```
butil -stop
```

Performing Continuous Operations

The commands pertaining to continuous operations, startbu and endbu, are discussed in the chapter Logging, Backup, and Restore.

Performing Archival Logging

The Maintenance utility (GUI or BUTIL command line) provides a way to roll forward archival log files into the data files. See also the chapter Logging, Backup, and Restore.

The BUTIL **rollfwd** command recovers changes made to a data file between the time of the last backup and a system failure. If a system failure occurs, you can restore the backup copy of your data file and then use the BUTIL **rollfwd** command, which applies all changes stored in the archival log to your restored data files. Do not use this command unless you have restored data files from backup.

Note You cannot take advantage of the **rollfwd** command unless you both enable the MicroKernel's Archival Logging Selected Files option *and* back up your files *before* a system failure occurs.

You can also use the **rollfwd** command to produce an output file of logged operations. The **rollfwd** command can produce the output file either before you roll changes forward or at the same time as the roll forward.

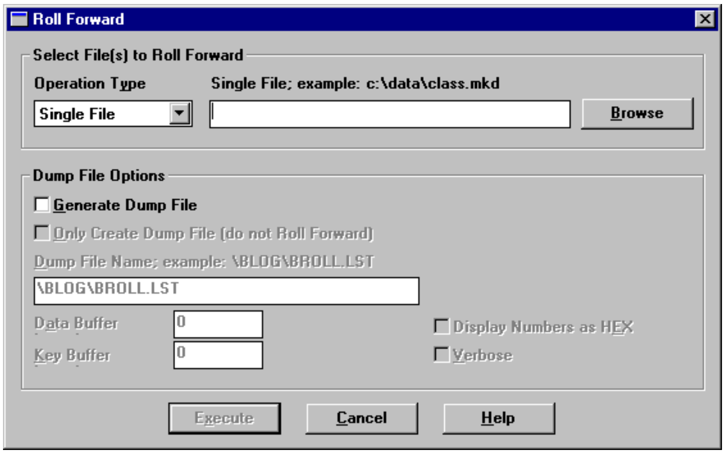
You can roll forward a single file, all data files on a volume, all data files on a drive, or a list of files, volumes, and/or drives.

Using the GUI

1 Access **Maintenance** from the operating system **Start** menu or **Apps** screen or from the **Tools** menu in Pervasive PSQL Control Center.

2 Within the **Maintenance** window, click **Data ▸ Roll Forward** The **Roll Forward** dialog box appears.

Figure 37 Roll Forward Dialog



3 Select the specific operation type: single file, list of files, volume name, or drive letter. When you select either volume name or drive letter, you must insert a back slash (\) or forward slash (/) at the end (for example, \\server\vol1\ or D:\).

4 You can generate a log file, called a dump file, of all the Btrieve operations required to perform the roll forward tasks.

By default, this file is not created. Select the Generate Dump File check box to generate a file. You can also specify the following options.

Table 64 Roll Forward GUI Options

Only Create Dump File	Indicates that only the dump file is to be created, and the roll forward operation is not to be performed.
Dump File Name	Contains the name of the dump file, which must begin with a slash and not contain a drive letter or server/volume name.
Data Buffer Length	Indicates the number of data buffer bytes to write to the dump file for each Btrieve operation.
Key Buffer Length	Indicates the number of key buffer bytes to write to the dump file for each Btrieve operation.

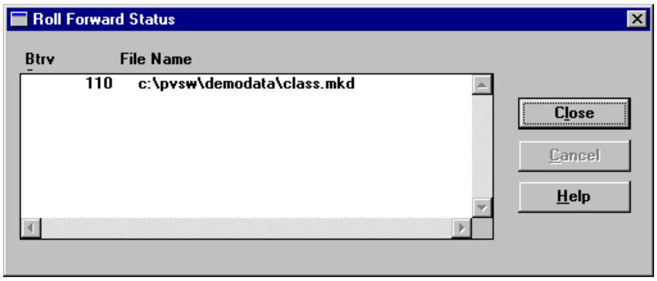
Table 64 Roll Forward GUI Options

Display Numbers as HEX	If you select this option, the numbers in the dump file output are formatted as hexadecimal. If you do not select this check box, the numbers are displayed in decimal format.
Verbose	Includes additional information like user name, network address, and time stamp in the dump file.

Note If the key buffer or the data buffer is not an input parameter for the particular Btrieve operation, nothing is written to the dump file.

5 Click Execute to generate the dump file and/or perform the roll forward operation. If the data is valid, the Roll Forward Status dialog box appears.

Figure 38 Roll Forward Status Dialog Box

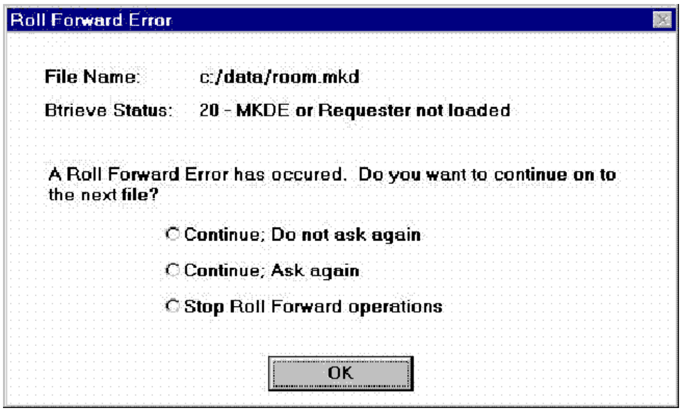


```
110    c:\pvsw\demodata\class.mkd
```

As files are processed, they are added to the scrolling list box which displays the file name and the Pervasive PSQL status code returned from the roll forward operation.

If an error occurs during processing, the Roll Forward Continue on Error dialog box appears. This dialog box allows you to continue without being prompted again, to continue and be prompted again, or to stop processing files.

Figure 39 Roll Forward Continue on Error Dialog Box



File Name: c:/data/room.mkd

Btrieve Status: 20 - MKDE or Requester not loaded

A Roll Forward Error has occured. Do you want to continue on to the next file?

- Continue; Do not ask again
- Continue; Ask again
- Stop Roll Forward operations

Using the Command Line

This section explains the syntax for the command line usage of Roll Forward.

```
butil -rollfwd <sourceFile | drive | @listFile>
    [</L[dumpFile] | /W[dumpFile]> [/T<dataLength>]
    [/E<keyLength>] [/H] [/V] [/O<ownerList | owner>|*]]
    [/A] [/UID<name> <PWD<word>> [DB<name>]]
```

sourceFile	The fully qualified name of a data file for which to roll forward changes. For Windows platforms, you do not need to specify the name of the path if the data file resides in the same directory as your current directory.
drive	A drive letter for which to roll forward changes. End the volume name with a backslash (\) or forward slash (/), as in `F:\` or `F:/` .
listFile	The fully qualified name of a text file containing the paths of files, volumes, or drives for which to roll forward changes. Separate these paths with a carriage return/line feed. If the Maintenance utility encounters an error, the utility stops rolling forward the current file, but does not roll back the changes already made. If you specify the **/A** option, the utility continues rolling forward with the next file.
`/L`*dumpFile*	Produces an output file, but does not roll forward.
`/W`*dumpFile*	Rolls forward and produces an output file.

dumpFile	The file name of the output file to which the Maintenance utility writes a list of logged operations. The default is \BLOG\BROLL.LST, relative to the root of the physical drive. The file name cannot contain a drive letter or volume name and must start with a forward slash (/) or backslash (\). The Maintenance utility places the file on the same volume as the BLOG.CFG file.
/T*dataLength*	Specifies the length of the operation's data buffer to write to the output file. If you do not specify this option, the utility does not include data buffer contents in the output file.
/E*keyLength*	Specifies the length of the operation's key buffer to write to the output file. If you do not specify this option, the utility does not include key buffer contents in the output file.
/H	Instructs the utility to show numbers in the output file in hexadecimal notation. If you do not specify this option, numbers in the output file are in ASCII format. This option affects the format of the **Entry Count**, **Op Code**, **Key Number**, and **Data Length** fields.
/V	Instructs the utility to include additional information (such as the user name, network address, and time stamp) in the output file.
/O	Specifies the owner name of the data file, if required. An owner name is required if you request an output file of logged operations and the backup copy of the data file has an owner name for read-only access. If more than one file has an owner name, the respective owner names must be separated by commas. See Owner Names for more information.
/A	Specifies that if you are rolling back more than one file and the Maintenance utility encounters an error, the utility continues rolling forward with the next file. When you do not specify this option, the utility stops rolling forward if it encounters an error. The utility does not roll back the changes already made. **Note:** When you use the **/A** option, you might want to redirect output to a file, as described in Redirecting Error Messages and Command Files.
/UID<*name*> /UID*uname*	Specifies the name of the user authorized to access a database with security enabled.

`/PWD`<*word*> `/PWD`*pword*	Specifies the password for the user who is identified by *uname*. *Pword* must be supplied if *uname* is specified.
`/DB`<*name*> `/DB`*dbname*	Specifies the name of the database on which security is enabled. If omitted, the default database is assumed.

Note If the key buffer or the data buffer is not an input parameter for the particular Btrieve operation, nothing is written to the dump file.

Examples

Example A The following example recovers changes to the CLASS.MKD file from the default archival log and log location.

```
butil -rollfwd file_path\PSQL\Demodata\class.mkd
```

(For default locations of Pervasive PSQL files, see Where are the Pervasive PSQL files installed? in *Getting Started With Pervasive PSQL*.)

Example B This example recovers changes and outputs them to all files on the d:\ volume with the following options:

- use default dump file
- dump 32 bytes of the data buffer
- dump 4 bytes of the key buffer
- dump in hex mode

```
butil -rollfwd d:\ /W /H /T32 /E4
```

Example C The following example does not perform roll forward but only outputs the changes to the files listed in `files.txt` with the following dump options:

- use d:\temp\files.lst as the dump file
- use verbose mode
- data files have owner names: own123 and own321
- do not dump data or key buffer

```
butil -rollfwd d:\temp\files.txt /L\temp\files.lst /V /
   Oown123,own321
```

chapter

14 Converting Data Files

Maintaining Pervasive PSQL File Compatibility

Pervasive PSQL includes tools that convert Pervasive PSQL files to take advantage of features in the latest versions of the Pervasive PSQL engines. This chapter describes those tools, why you might need to use them and how to do so. This chapter includes the following sections:

Rebuild Utility Concepts

The Rebuild utility allows you to perform the following operations on MicroKernel files (data files and dictionary files):

- convert older file formats to a newer Pervasive PSQL format
- convert newer file formats to a format not older than a 6.x format
- rebuild a file using the same file format (provided the format is 6.x, 7.x, 8.x, or 9.x)
- add file indexes
- change file page size
- rebuild files to include system data and key or system data without key
- specify a location and name of the log file used by Rebuild

If your database uses dictionary files (DDFs), you must rebuild them as well as the data files.

Read further in this section to understand the conceptual aspects of rebuilding data files.

- Platforms Supported
- File Formats
- Command Line Parameters
- Temporary Files
- Optimizing the Rebuild Process
- Log File

For information on using the Rebuild utility, see one of these sections:

- Rebuild Utility GUI Reference
- Rebuild Utility Tasks
- CLI Tasks

Platforms Supported

Rebuild comes in two forms: a 32-bit GUI version for Windows, and command-line versions for Linux and Windows. See Rebuild Utility GUI Reference and CLI Tasks.

Linux CLI Rebuild

Rebuild runs as a program, rbldcli, on Linux. By default, the program is located at `/usr/local/psql/bin`.

Windows CLI Rebuild

Rebuild runs as a program, rbldcli.exe, on Windows. By default, the program is installed in the Program Files directory.

File Formats

The current database engines remain compatible with some older data and dictionary file formats, but you may want to convert files to the current format to take advantage of current features. The following table lists the primary reasons for converting from an older to a newer format.

Table 65 Rebuild Utility Conversions

Original File Format	Converted File Format	Reason for Conversion
9.0	9.5	More than 119 segment keys and files sizes up to 256 GB.
8.x	9.x	Add support for file sizes up to 128 GB.
8.*x*	8.*x*	Remove deleted record space from a file, change the page size, or add system data.
Pre-8.*x*	8.*x*	Take advantage of write (insert, update, delete) performance improvements offered by Turbo Write Accelerator.
7.*x*	7.*x*	Original file does not have a system key.
Pre-7.x	7.*x*	Take advantage of 7.*x* features and improve general performance.
Pre-6.0	6.*x*	Take advantage of 6.*x* features and improve general performance. Use this option only if you are still running the 7.*x* engine with other 6.*x* engines.

The file format that results from using the command-line Rebuild depends on the `-f` parameter. If you omit the `-f` parameter, Rebuild uses the value set for the MicroKernel's Create File Version configuration option. For example, if the Create File Version value is

8.x, then running the Rebuild utility on version 7.x files converts them to 8.x format. See Create File Version and "`-f`" parameter.

It is suggested that you back up all the data files you plan to convert before running Rebuild. This is particularly true if you are rebuilding files to the same location as the source files (in which case the rebuilt files replace the source files). Having backup copies allows you to restore the original files if you so desire. To ensure that the backup is successful, you may perform one or more of the following operations:

- Close all data files before running the backup utility.
- Use continuous operations (only during the backup).

Note You cannot run Rebuild on a file that is in continuous operation mode.

Temporary Files

On Windows, Rebuild creates temporary files in the directory specified by the TMP system environment variable. By default on Linux, Rebuild creates temporary files in the output directory (or in the source directory if the -b parameter is not used). Therefore, you need enough disk space in the temporary file directory (while the Rebuild utility is running) to potentially accommodate both the original file and the new file. You can specify a different directory for storing these files by using the Output Directory option in the Rebuild GUI version or by using the -b parameter with the CLI versions.

Normally, Rebuild deletes temporary files when the conversion is complete. However, if a power failure or other serious interruption occurs, Rebuild may not delete the temporary files. If this occurs, delete the following types of temporary files:

Platform	Temporary File Names
Linux	_rbldxxxxxx, where xxxxxx is six random letters. **Caution**: Ensure that you do not delete the Rebuild executable, rbldcli.
Windows	_rbldx, where x is a number.

Optimizing the Rebuild Process

Rebuild makes Btrieve calls to the database engine. Therefore, the database engine configuration settings and the amount of random access memory (RAM) in your computer affect the performance of the rebuild process. This is particularly evident in the amount of time required to rebuild large data files.

In general, building indexes requires much more time than building data pages. If you have a data file with many indexes, it requires more time to rebuild than would the same file with fewer indexes.

The following items can affect the rebuild processing time:

- CPU Speed and Disk Speed
- Amount of Memory
- Sort Buffer Size
- Max MicroKernel Memory Usage
- Cache Allocation Size
- Index Page Size
- Number of Indexes

CPU Speed and Disk Speed

The speed of the central processing unit (CPU) and access speed of the physical storage disk can affect processing time during a rebuild. In general, the faster the speed for both of these, the faster the rebuild process. Disk speed is more critical for rebuilding files that are too large to fit entirely in memory.

Tip Large files, such as 3 or 4 GB or more, may take several hours to convert. If you have more than one database engine available, you may wish to share the rebuild processing among a number of machine CPUs. For example, you could copy some of your files to each machine that has a database engine installed, then copy the files back after the rebuild process.

Amount of Memory

Rebuild is capable of rebuilding a file using two different methods, a default method and an alternative method. See -m<0 | 2> parameter. The method chosen depends on the amount of memory available.

For the default method (-m2), Rebuild takes the following steps provided available memory exists.

1. Creates a new, empty data file with the same record structure and indexes as defined in the source file.
2. Drops all the indexes from the new file.
3. Copies all the data into the new file, without indexes.
4. Adds the indexes, using the following process.
    a. For a particular key in the source file, reads as many key values as possible into a memory buffer using the Extended Step operation.
    b. Sorts the values in the memory buffer and writes the sorted values to a temporary file.
    c. Repeats steps a and b, processing the key value from every record.

    The temporary file now contains several key value sets, each of which has been individually sorted.
5. Merges the sets into index pages, filling each page to capacity. Each index page is added to the data file at the end, extending the file length.
6. Repeats steps 4 and 5 for each remaining key.

If any failure occurs during this process, such as a failure to open or write the temporary file, Rebuild starts over and uses the alternative method to build the file.

Rebuild uses an alternative method (-m0) when insufficient memory exists to use the default method, or if the default method encounters processing errors.

1. Creates a new, empty data file with the same record structure and indexes as defined in the source file.
2. Drops all the indexes from the new file.
3. Copies all the data into the new file, without indexes.
4. Adds the indexes, using the following process.
    a. For a particular key in the source file, reads one record at a time using the Step Next operation.

   b. Extracts the key value from the record and inserts it into the appropriate place in the index. This necessitates splitting key pages when they get full.
   c. Repeats steps a and b, processing the key value from every record.

5 Repeats step 4 for each remaining key.

The alternative method is typically much slower than the default method. If you have large data files with many indexes, the difference between the two methods can amount to many hours or even days. The only way to ensure that Rebuild uses the default method is to have enough *available* memory. Several Configuration settings affect the amount of available memory.

Formulas For Estimating Memory Requirements

The following formulas estimate the optimal and minimum amount of contiguous free memory required to rebuild file indexes using the fast method. The optimal memory amount is enough memory to store all merge blocks in RAM. The minimum amount of memory is enough to store one merge block in RAM.

```
Key Length = total size of all segments of largest
key in the file.
Key Overhead = 8 if key type is not linked
duplicate. 12 if key type is linked duplicate.
Record Count = number of records in the file.

Optimal Memory Bytes = (((Key Length + Key Overhead)
* Record Count) + 65536) / 0.6

Minimum Memory Bytes = Optimal Memory Bytes / 30
```

For example, if your file has 8 million records, and the longest key is 20 bytes (not linked duplicate), the preferred amount of memory is 373.5 MB, or (((20 + 8) * 8,000,000) + 65536) / 0.6 = 373,442,560 bytes.

The optimal amount of contiguous free memory is 373.5 MB. If you have at least this much free memory available, the Rebuild process takes place entirely in RAM. Because of the 60% allocation limit, the optimal amount of memory is actually the amount required to be free when the rebuild process starts, not the amount that the rebuild process actually uses. Multiply this optimal amount by 0.6 to determine the maximum amount Rebuild actually uses.

The minimum amount of memory is 1/30th of the optimal amount, 12,448,086 bytes, or 12.45 MB.

The divisor 30 is used because the database engine keeps track of no more than 30 merge blocks at once, but only one merge block is required to be in memory at any time. The divisor 0.6 is used because the engine allocates no more than 60% of available physical memory for rebuild processing.

If you do not have the minimum amount of memory available, Rebuild uses the alternative method to rebuild your data file.

Finally, the memory block allocated must meet two additional criteria: blocks required and allocated block size.

Blocks required must be less than or equal to 30, where:

```
Blocks Required = Round Up (Optimal Memory Bytes /
Allocated Block)
```

Allocated block size must be greater than or equal to:

```
((2 * Max Keys + 1) * (Key Length + Key Overhead))
* Blocks Required
```

Assuming a 512-byte page size, and a block of 12.45 MB successfully allocated, the value for blocks required is:

```
Blocks Required = 373,500,000 / 12,450,000 = 30
```

The first criteria is met.

The value for allocated block size is:

```
Max Keys = (512-12) / 28 = 18
(((2 * 18) + 1) * (20 + 8)) * 9 = 9324
```

Is Allocated Block (12.5 million bytes) larger than 9324 bytes? Yes, so the second criteria is met. The index keys will be written to a temporary file in 12.45 MB pieces, sorted in memory, and then written to the index.

Sort Buffer Size

This setting specifies the maximum amount of memory that the MicroKernel dynamically allocates and de-allocates for sorting purposes during run-time creation of indexes. See Sort Buffer Size.

If the setting is zero (the default), Rebuild calculates a value for optimal memory bytes and allocates memory based on that value. If the memory allocation succeeds, the size of the block allocated must be at least as large as the value defined for minimum memory bytes. See Formulas For Estimating Memory Requirements.

If the setting is a non-zero value, and the value is smaller than the calculated minimum memory bytes, Rebuild uses the value to allocate memory.

Finally, Rebuild compares the amount of memory that it should allocate with 60% of the amount that is actually available. It then attempts to allocate the smaller of the two. If the memory allocation fails, Rebuild keeps attempting to allocate 80% of the last attempted amount. If the memory allocation fails completely (which means the amount of memory is less than the minimum memory bytes), Rebuild uses the alternative method to rebuild the file.

Max MicroKernel Memory Usage

This setting specifies the maximum proportion of total physical memory that the MicroKernel is allowed to consume. L1, L2, and all miscellaneous memory usage by the MicroKernel are included (SRDE is not included). See Max MicroKernel Memory Usage.

If you have large files to rebuild, temporarily set Max MicroKernel Memory Usage to a lower percentage than its default setting. Reset it to your preferred percentage after you complete your rebuilding.

Cache Allocation Size

This setting specifies the size of the Level 1 cache that the MicroKernel allocates; the MicroKernel uses this cache when accessing any data files. See Cache Allocation Size.

This setting determines how much memory is available to the database engine for accessing data files, not for use when indexes are built.

Increasing Cache Allocation to a high value does not help indexes build faster. In fact, it may slow the process by taking up crucial memory that is now unavailable to Rebuild. When rebuilding large files, decrease the cache value to a low value, such as 20% of your current value but not less than 5 MB. This leaves as much memory as possible available for index rebuilding.

Index Page Size

The page size in your file also affects the speed of index building. If Rebuild uses the alternative method, smaller key pages dramatically increase the time required to build indexes. Key page size has a lesser effect on building indexes if Rebuild uses the default method.

Rebuild can optimize page size for application performance or for disk storage.

To optimize for performance (your application accessing its data), Rebuild uses a default page size of 4096 bytes. This results in larger page sizes on physical storage and slower rebuilding times.

For a discussion of optimizing page size for disk storage, see Choosing a Page Size in *Pervasive PSQL Programmer's Guide* in the Developer Reference.

Assume that your application has 8 million records, a 20-byte key, and uses a page size of 512 bytes. The MicroKernel places between 8 and 18 key values in each index page. This lessens the amount of physical storage required for each page. However, indexing 8 million records creates a B-tree about seven levels deep, with most of the key pages at the seventh level. Performance will be slower.

If you use a page size of 4096 bytes, the database engine places between 72 and 145 key values in each index page. This B-tree is only about four levels deep and requires many fewer pages to be examined when Rebuild inserts each new key value. Performance is increased but so is the requirement for the amount of physical storage.

Number of Indexes

The number of indexes also affects the speed of index building. Generally, the larger the number of indexes, the longer the rebuild process takes. The time required to build the indexes increases exponentially with increasing depth of the B-tree.

Log File

Information from a rebuild process is appended to a text log file. By default, the log file is placed in the current working directory.

For the CLI Rebuild, the default file name is rbldcli.log on Windows and Linux. You may specify a location and name for the log file instead of using the defaults. See -lfile parameter.

You may examine the log file using a text editor. The information written to the log file includes the following:

- Start time of the rebuild process
- Parameters specified on the command line
- Status code and error description (if an error occurs)
- File being processed
- Information about the processing (such as page size changes)
- Total records processed
- Total indexes rebuilt (if the -m2 processing method is used)
- End time of the rebuild process
- Status of the process (for example, if the file rebuilt successfully)

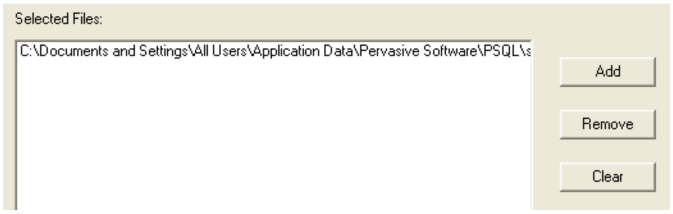
Rebuild Utility GUI Reference

This section describes the objects on the Rebuild utility graphical user interface (GUI).

File Options Screen

This screen allows you to add files to the rebuild list.

Figure 40 Rebuild Utility File Selection

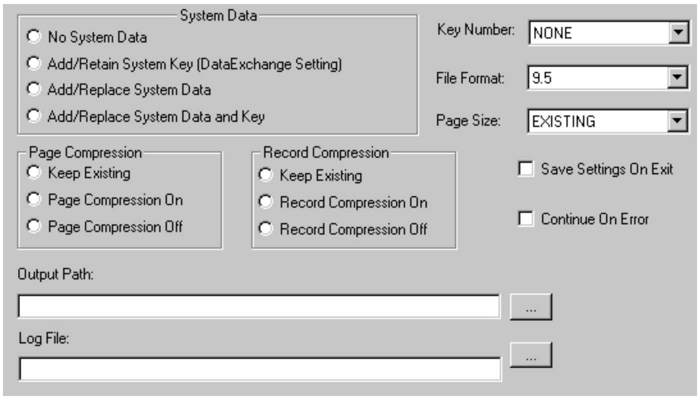

Selected Files:
C:\Documents and Settings\All Users\Application Data\Pervasive Software\PSQL\s
Add
Remove
Clear

GUI Object	Description	Related Information
Selected files	The data and dictionary files listed for rebuilding according to your selections using the Add button.	To rebuild a file or files
Add button	Adds a data or dictionary file to the list of files to be rebuilt.	To rebuild a file or files
Remove button	Removes the selected data or dictionary file in the list.	To rebuild a file or files
Clear button	Clears the entire list of selected data and dictionary files.	To rebuild a file or files

Rebuild Options Screen

This screen allows you to select the options for rebuilding files.

Figure 41 Rebuild Utility File Options


System Data
- No System Data
- Add/Retain System Key (DataExchange Setting)
- Add/Replace System Data
- Add/Replace System Data and Key

Key Number: NONE

File Format: 9.5

Page Size: EXISTING

Page Compression
- Keep Existing
- Page Compression On
- Page Compression Off

Record Compression
- Keep Existing
- Record Compression On
- Record Compression Off

Save Settings On Exit

Continue On Error

Output Path:

Log File:

GUI Object	Description	Related Information
System Data	Specifies whether you want Rebuild to create a System Data key in the file. System data is necessary for transaction durability logging. Specifies whether the file is rebuilt with System Data or System and Key Data. The MicroKernel cannot perform logging for a file without system data when no user-defined unique key exists.	To rebuild a file or files
Page Compression	Specifies if you want page compression for the file. The choices are “on” (yes), “off” (no), and “keep existing.” Keep existing retains whatever page compression the file contains, if any.	Page compression requires a file format of 9.5 or newer. Record and Page Compression
Record Compression	Specifies if you want record compression for the file. The choices are “on” (yes), “off” (no), and “keep existing.” Keep existing retains whatever record compression the file contains, if any.	Record and Page Compression.
Continue on Error	Determines whether the Rebuild utility continues if it encounters an error during the rebuild process. If you select Yes, the utility continues with the next file even if an error occurs. The utility notifies you of non-MicroKernel data files or other errors but continues rebuilding data files. If you select No, the utility halts the rebuild if it encounters an error. This option is useful if you have specified wildcard characters for the rebuilt files.	To rebuild a file or files

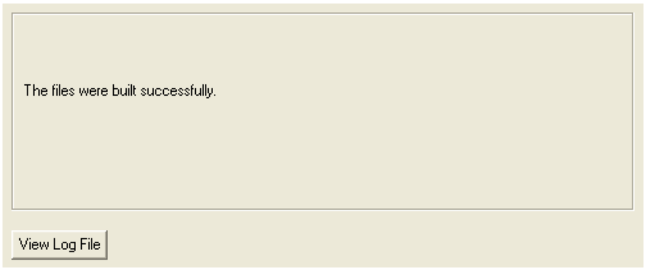
GUI Object	Description	Related Information
Save Settings on Exit	Saves the current values in this dialog box for use in subsequent Rebuild sessions.	To rebuild a file or files
Key Number	Specifies the key by which the utility reads when rebuilding a file. If you specify NONE for this option, the utility clones the files, drops the indexes, copies the records into the new files, and rebuilds the indexes. Because this method is faster and creates smaller files than specifying a key number, use it whenever possible. This method may create a new file in which the records are in a different physical order than in the original file. If you specify a key number, the utility clones and copies the files without dropping and replacing indexes. While this method is slower than specifying NONE, it is available in case you do not want to rebuild your indexes.	• To rebuild a file or files • Key Attributes in *Pervasive PSQL Programmer's Guide*.
File Format	Previous, the Rebuild utility built the file version based on the Create File Version configuration setting. This Rebuild utility allows you to specify the file version type independent of that setting.	To rebuild a file or files
Page Size	Specifies the page size (in bytes) of the new files. Choose either EXISTING, Optimal (disk space), Optimal (data access), or a size in bytes. If you select EXISTING, the utility uses the existing page size. The utility changes the page size if the original size does not work. For example, assume you have a v5.*x* file with a page size of 1,024 and 24 keys. Because Btrieve 6.0 and later supports only 23 keys for a page size of 1,024, the utility automatically selects a new page size for the file and writes an informative message to the status file.	• To rebuild a file or files • For optimizing for data access, see Optimizing the Rebuild Process • For optimizing for disk space, see Choosing a Page Size in *Pervasive PSQL Programmer's Guide*.

GUI Object	Description	Related Information
Output Path	Specifies an alternate location for the rebuilt files. (The default location is the current directory.) You must specify a directory that already exists. This option lets you rebuild large files on a different server. The MicroKernel and its communications components must be loaded on the server that contains the rebuilt files. Do *not* use wildcard characters in the path. If the Output Directory location is different than the original file's location, the original file is not deleted during the rebuild. If the output directory is the same as the original file, the original file is deleted upon completion of the rebuild. DefaultDB w/ DB security: Cannot rebuild outside DB's file locations in Maintain Named Databases	To rebuild a file or files
Log File	Specifies a location for the rebuild log file. (The default location is the current working directory.) Do *not* use wildcard characters in the path.	• To rebuild a file or files • Log File

Rebuild Progress Screen

This screen allows you to see the rebuild progress and to view the log file after the rebuild process completes.

Figure 42 Rebuild Utility Progress Screen


The files were built successfully.

GUI Object	Description	Related Information
Message area	Displays the information about the file being rebuilt, or a summary of the operations if rebuilding has completed.	Log File
View Log File	Allows you to see information about the rebuild process for each file. Click **View Log File** to display the rebuild log using your default text viewer.	Log File

Rebuild Utility Tasks

The following Rebuild tasks are available:

- GUI Rebuild: GUI Tasks
- Command-line Rebuild: CLI Tasks

GUI Tasks

- To start the GUI Rebuild utility
- To obtain help for the Rebuild utility
- To rebuild a file or files

➢ To start the GUI Rebuild utility

Click Tools then Rebuild from the Pervasive PSQL Control Center menu or access Rebuild from the operating system Start menu or Apps screen.

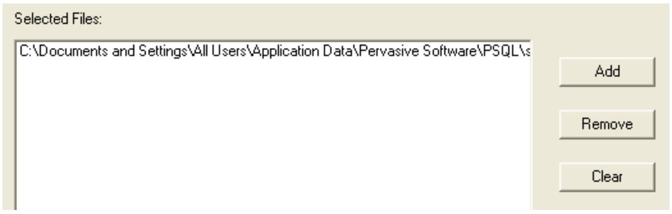
➢ To obtain help for the Rebuild utility

You can access the documentation by clicking Help on the graphical user interface.

➢ To rebuild a file or files

1. After you click Next at the Rebuild welcome screen, the Select Files screen appears.
2. Click Add and select the data or dictionary file you want to rebuild. You can select more than one file to rebuild at a time.

Figure 43 Select Files Dialog Box


Selected Files:
C:\Documents and Settings\All Users\Application Data\Pervasive Software\PSQL\s
Add
Remove
Clear

The Rebuild utility deletes the original file after rebuilding it if the file is being rebuilt in the same directory. If the new file is in a different directory, the original file is not deleted.

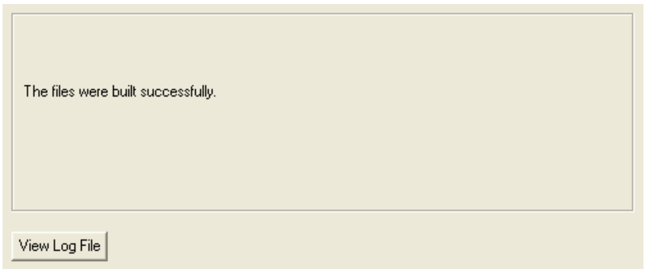
3. Click Next after you have added the desired file or files.

4 Specify the rebuild options. See Rebuild Options Screen.

5 Click **Next** to begin the rebuild process.

The utility reports the processing information. When the rebuild process completes, the success or failure of it displays and **View Log File** is enabled.

Figure 44 Rebuild Process



The files were built successfully.

6 To display the results, click **View Log File**. The contents of the log file display in the default text editor for the operating system.

The Rebuild utility writes to the log file for every file it attempts to convert. If you disabled the **Continue on Error** setting, the log file contains the information up to the point of the error. If the rebuild was not successful, the status file contains error messages explaining why the rebuild failed.

7 Click **Finish** when you have finished rebuilding files and viewing the log file.

CLI Tasks

The Rebuild command-line utility is named rbldcli.exe on Windows and rbldcli on Linux. The following command line Rebuild utility tasks are available:

- To run Rebuild on Linux
- To run Rebuild on Windows
- To see your progress while rebuilding files
- To learn about the command line parameters for the CLI Rebuild utility, see the following section.

Command Line Parameters

The *parameter* option specifies the parameter(s) used with the utility. You may use the parameters in any order. Precede each parameter with a hyphen (**-**). Do not place a space after the hyphen or after the single-letter parameter and the parameter value.

Note On Linux platforms only, the parameters are case sensitive.

Parameter is defined as follows:

-c	Instructs Rebuild to continue with the next data or dictionary file if an error occurs. The utility notifies you of non-MicroKernel data files or errors with MicroKernel files, but continues rebuilding data files. The errors are written to the log file. See Log File. **Tip**: This parameter is particularly useful if you specify wildcard characters (*.*) for a mixed set of files. Mixed set means a combination of MicroKernel files and non-MicroKernel files. Rebuild reports an error for each non-MicroKernel file (or any errors on MicroKernel files), but continues processing.
-d	If you specify -d, Rebuild converts pre-6.0 supplemental indexes (which allow duplicates) to 6.*x*, 7.*x, or 8.x* indexes with linked-duplicatable keys. If you omit this parameter, Rebuild preserves the indexes as repeating-duplicatable keys. If you access your data files only through the transactional interface and your files have a relatively large number of duplicate keys, you can use the -d parameter to enhance the performance of the Get Next and Get Previous operations.
-m<0 | 2>	The “m” parameter stands for “method.” Rebuild selects a processing method whether you specify this parameter or not. If you omit this parameter, Rebuild does the following: • uses -m2 as the default method if sufficient available memory exists • uses an alternative method,-m0, if the amount of available memory is not sufficient. See Amount of Memory for how the amount of memory affects the method chosen.
0	Clones and copies the data or dictionary file without dropping and replacing indexes. This method is slower than the -m2 method. It is available in case you do not want to rebuild your indexes. A file built with the -m0 creates a file where each key page is about 55% to 65% full. The file is more optimized for writing and less for reading. If you can afford the extra rebuild time, which can be considerable depending on the situation, you might want to rebuild a file optimized for writing. See also Optimizing the Rebuild Process.

	2	Clones the data or dictionary file, drops the indexes, copies the records into the new file, and rebuilds the indexes. This method is faster and creates smaller files than the -m0 method. The -m2 method may create a new file in which the records are in a different physical order than in the original file. A file built with the -m2 method has key pages that are 100% full. This allows the file to be optimized for reading.
-p<D | P | *bytes*>		• Optimizes page size for disk storage or processing, or specifies a specific page size to use for the rebuilt file. If you omit this parameter, Rebuild uses the page size from the source file. If the source page size does not work for the current database engine, Rebuild changes the page size and displays an informative message explaining the change. (For example, older file formats, such as 5.x, supported a page size of 1024 with 24 keys. File format 8.x supports only 23 keys for a page size of 1024, so Rebuild would select a different page size if building an 8.x file.) The database engine may ignore the page size specified and automatically upgrade the page size. For example, for the 9.5 file format, the odd page sizes such as 1536 and 3072 are not supported. The database engine automatically upgrades to the next valid page size because the next valid page size is more efficient. For older file formats, the database engine may upgrade the page size based on other conditions. See also Index Page Size.
	D	Optimizes page size for disk storage. See Choosing a Page Size in *Pervasive PSQL Programmer's Guide* in the Developer Reference.
	P	Optimizes for processing (that is, for your application accessing its data). For -pP, Rebuild uses a default page size of 4096 bytes. See Optimizing the Rebuild Process
	bytes	Specifies the page size (in bytes) for the new file. For file versions prior to 9.0, the valid values are 512, 1024, 1536, 2048, 2560, 3072, 3584, and 4096. For file version 9.0, the values are the same with the addition of 8192. For file version 9.5 or newer, the valid values are 1024, 2048, 4096, 8192, and 16384.

-b*directoryname*	Specifies an alternate location for the rebuilt file (which may also be a location on a different server). The default location is the directory where the data file is located. You must specify a location that already exists. Rebuild does not create a directory for you. The directory also must be on a machine that is running the Pervasive PSQL database engine. You may use either a fully qualified path or a relative path. Do *not* use wildcard characters in *directoryname*. On your local server, the MicroKernel Database Engine and the Message Router must be loaded. On a remote server, the MicroKernel Database Engine and communications components must be loaded. If you omit this parameter, the rebuilt file *replaces* the original data file. A copy of the original file is not retained. If you specify this parameter, the rebuilt file is placed in the specified location and the original file is *retained*. An exception to this is if the specified location already contains data files with the same names. Rebuild fails if the alternate location you specify contains files with the same names as the source files. For example, suppose you want to rebuild mydata.mkd, which is in a directory named `folder1`. You want to place the rebuilt file into a directory named `folder2`. If mydata.mkd also exists in `folder2` (perhaps unknown to you), Rebuild fails and informs you to check the log file. **Note:** Ensure that you have create file permission for the location you specify (or for the location of the source file if you omit the parameter).
-k*number*	Specifies the key number that Rebuild reads from the source file and uses to sort the rebuilt file. If you omit this parameter, Rebuild reads the source file in physical order and creates the rebuilt file in physical order. See also Optimizing the Rebuild Process.
-s[D | K]	Retains in the rebuilt file the existing system data and key from the source file. If you omit this parameter, Rebuild does *not* include the system data and key in the rebuilt file. See also System Data.
D	Rebuilds the file to include system data. The system data is not indexed. See also System Data.
K	Rebuilds the file to include system data and key. The system data is indexed. See also System Data.

-l*file*	Specifies a file name, and optionally a path location, for the Rebuild log file. The default file name is rbldcli.log on Windows and Linux. The default location is the current working directory on Windows and Linux. The following conditions apply: • The path location must already exist. Rebuild does not create the path location. • If you specify a path location without a file name, Rebuild ignores this parameter and uses the default file name and location. • If you specify a file name without a path location, Rebuild uses the default location. • You must have read and write file permission for the location you specify. Rebuild uses the default location if it cannot create the log file because of file permission. See also Log File.
-pagecompresson	Turns on page compression for file provided the following conditions are true: • The version of the Pervasive PSQL database engine is Pervasive PSQL 9.5 or newer. • The setting for Create File Version is 0950 (9.5) or higher.
-pagecompressoff	Turns off page compression for file. This parameter has no effect if file does not contain page compression.
-recordcompresson	Turns on record compression for file.
-recordcompressoff	Turns off record compression for file. This parameter has no effect if file does not contain record compression.

-f<6 | 7 | 8 | 9 | 95>	Specifies a file format for the rebuilt data or dictionary file. File formats supported are versions 6.x, 7.x, 8.x, and 9.x. The following example rebuilds a file to the 9.0 format:
	`rbldcli -f9 file_path\class.mkd`
	The following example rebuilds a file to the 9.5 format:
	`rbldcli -f95 file_path\class.mkd`
	If you omit this parameter, Rebuild uses the value set for the MicroKernel's “Create File Version” configuration option. See Create File Version.
	Note1: If you specify a file format newer than the version supported by the current database engine, Rebuild uses the highest supported file format of that engine. Rebuild reports no error or message for this.
	Note2: Rebuild does not convert data types in indexes. If you rebuild a file to an older file format for use with an older database engine, ensure that the engine supports the data types used. You must manually adjust data types as required by your application and by the database engine.
	Example1. Your data file contains index fields that use the WZSTRING data type. If you rebuild the data file to a 6.x file format, the WZSTRING data type is not converted. You would be unable to use the data file with a Btrieve 6.15 engine. That engine does not support the WZSTRING data type.
	Example 2. Your data file contains true NULLs. You rebuild the data file to a 7.x file format. The true NULLs are not converted. You would be unable to use the data file with the Pervasive PSQL 7 engine. That engine does not support true NULLs.

-uid*uname*	Specifies the name of the user authorized to access a database with security enabled.
-pwd*pword*	Specifies the password for the user who is identified by *uname*. *Pword* must be supplied if *uname* is specified.
-db*dbname*	Specifies the name of the database on which security is enabled.

File and *@command_file* are defined as follows:

file	Specifies the data and dictionary file(s) to convert. If the source file is not in the current working directory, include the location, either as a fully qualified path or as a relative path. You may use the asterisk (*) wildcard character in the file name to specify multiple files. **Note**: If the original file contains an owner name, Rebuild applies the owner name and level to the rebuilt file.

@command_file	Specifies a command file for Rebuild to execute. You may include multiple entries in one command file. Each entry in the command file contains the command line parameters (if any) and the set of files to convert, followed by <end> or [end].
	
	When specifying the files to convert, use full directory names. You may use the asterisk (*) wildcard character in the file names.
	
	The following is an example of a Rebuild command file:
	
	`-c d:\mydir\*.* <end>`
	`-c -p1024 e:\dir\*.* <end>`
	`-m0 -k0 d:\ssql\*.* <end>`

➤ To run Rebuild on Linux

1. Ensure that the account under which you are logged in has permission to run Pervasive PSQL utilities.

   By default, you must be logged in as user `psql` to run utilities. User `psql` has no password and can be accessed only through the `root` account by using the `su` command. To use utilities from accounts other than `psql`, you must first make modifications to your `.bash_profile`. See Pervasive PSQL Account Management on Linux in *Getting Started With Pervasive PSQL*.

2. Change directory to `/usr/local/psql/bin` directory.

3. Type one of the following commands at the prompt:

   ```
   rbldcli [-parameter ...] file
   ```

   or

   ```
   rbldcli @command_file
   ```

Parameter, *file*, and *@command_file* are defined in Command Line Parameters.

Example Usage

The following example continues on error, sets a page size of 4096 bytes, and places the rebuilt files in a different directory on the server.

```
rbldcli -c -p4096 -b/usr/local/psql/tmp /usr/local/
   psql/data/DEMODATA/*.mkd
```

➢ To run Rebuild on Windows

1. Open a command prompt on the machine where Pervasive PSQL is installed.
2. Optionally, change to the `\bin` directory where you installed the Program Files. (This is not required if the location is in the Path system variable.)
3. Type one of the following commands at the prompt:

```
rbldcli [-parameter ...] file
```

```
or
```

```
rbldcli @command_file
```

Parameter, *file*, and *@command_file* are defined in Command Line Parameters.

Example Usage

The following example continues on error, sets a page size of 4096 bytes, and places the rebuilt files in a different directory on the server.

```
rbldcli -c -p4096 -bc:\dbtemp c:\datafiles\*.mkd
```

➢ To see your progress while rebuilding files

Rebuild reports on the screen the number of records processed per file, incrementing 50 records at a time. In addition, Rebuild writes information to a text log file. See Log File.

Appendix

A

Description Files

Using Description Files to Store Btrieve File Information

A *description file* is an ASCII text file that contains descriptions of file and key specifications that the Maintenance utility can use to create data files and indexes. Some users employ description files as a vehicle for archiving information about the data files they have created. Description files are not the same as DDFs, or Data Dictionary Files, which are used with the Scalable SQL 4.0 and the ODBC Interface.

Description files contain one or more elements. An element consists of a keyword, followed by an equal sign (=), followed by a value (with no space). Each element in a description file corresponds to a particular characteristic of a data file or key specification.

Note Before using description files, you should be familiar with Btrieve fundamentals. For information about these topics, refer to the *Pervasive PSQL Programmer's Guide*.

This appendix discusses the following topics:

- Rules for Description Files
- Description File Examples
- Description File Elements

Rules for Description Files

Use the following rules when creating a description file.

- Enter elements in either uppercase or lowercase.
- Separate elements from each other with a separator (blank space, tab, or carriage return/line feed), as in the following example:

  ```
  record=4000
  key=24
  ```
- Specify the description file elements in the proper order. Table 66 presents the elements in the appropriate order.
- Address all element dependencies. For example, if you specify `nullkey=allsegs` in your description file, you must also specify a value for the `value= element`.
- Define as many keys as you specify with the Key Count element. For example, if you specify `key=12`, you must define 12 keys in the description file.
- For a key that consists of multiple segments, you must define the following elements for each key segment:
  - Key Position
  - Key Length
  - Duplicate Key Values
  - Modifiable Key Values
  - Key Type

  The Descending Sort Order element is optional for each segment.
- If any key in the file uses an ACS, you must specify an ACS file name, a country ID and code page ID, or an ISR table name. You can include this information as either the last element of the key (applies to current key only) or the last element in the description file (applies to entire data file).
  - You can specify only one ACS per key, and you must provide an ACS file name, country ID and code page ID, or an ISR table name. Different keys in the same file can use different types of ACSs; for example, Key 0 can use an ACS file name, and Key 1 can use a country ID and code page ID.

    - Different segments of the same key cannot have different ACSs.
    - If you specify an ACS at the end of a description file, it is used as the default ACS. That is, if you specify `alternate=y` for a given key but do not include an ACS file name, country ID and code page ID, or an ISR table name for that key, the database engine uses the ACS file name, country ID and code page ID, or ISR table name specified at the end of the file.
    - If you are creating a new key and you specify `alternate=y` but you omit the ACS file name, country ID and code page ID, or ISR table name, the database engine does not create the key.
- If a Description File element is optional, you can omit it.
- Make sure the description file contains no text formatting characters. Some word processors embed formatting characters in a text file.

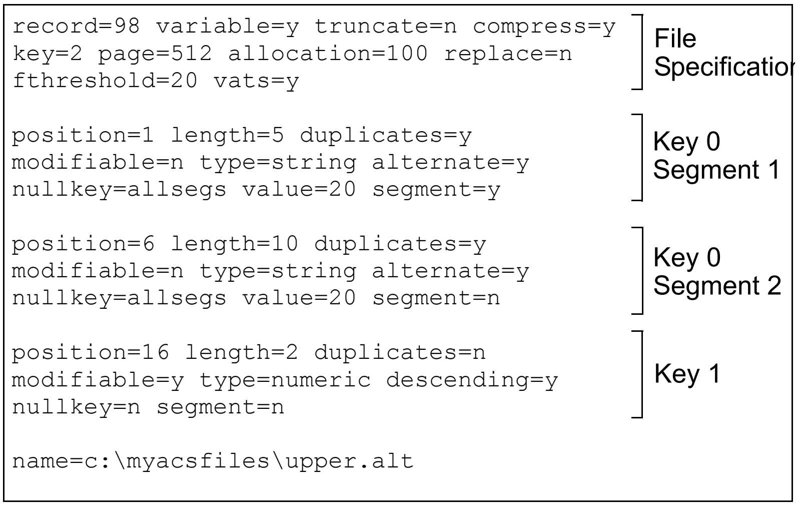
Description File Examples

The sample description files shown in this section describe a data file. This data file has a page size of 512 bytes and 2 keys. The fixed-length portion of the record is 98 bytes long. The file allows variable-length records but does not use blank truncation.

The file uses record compression, allows for Variable-tail Allocation Tables (VATs), and has the free space threshold set to 20 percent. The MicroKernel Database Engine preallocates 100 pages, or 51,200 bytes, when it creates the file. The file has two keys: Key 0 and Key 1. Key 0 is a segmented key with two segments.

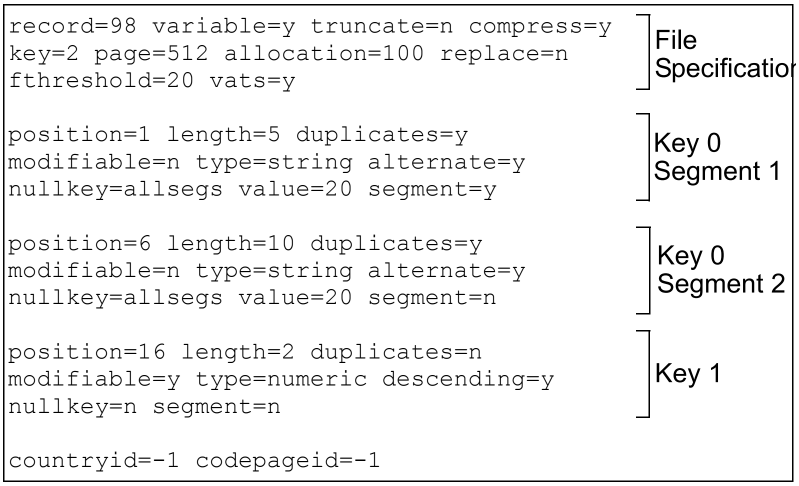
In Figure 45, both keys use the same ACS file name (upper.alt). In Figure 46, both keys use the same country ID (-1) and code page ID (-1). In Figure 47, Key 0 and Key 1 use different ACS file names (lower.alt and upper.alt, respectively). In Figure 48, the file has no keys except the system-defined key used for logging.

Figure 45 Sample Description File Using Alternate Collating Sequence File Name



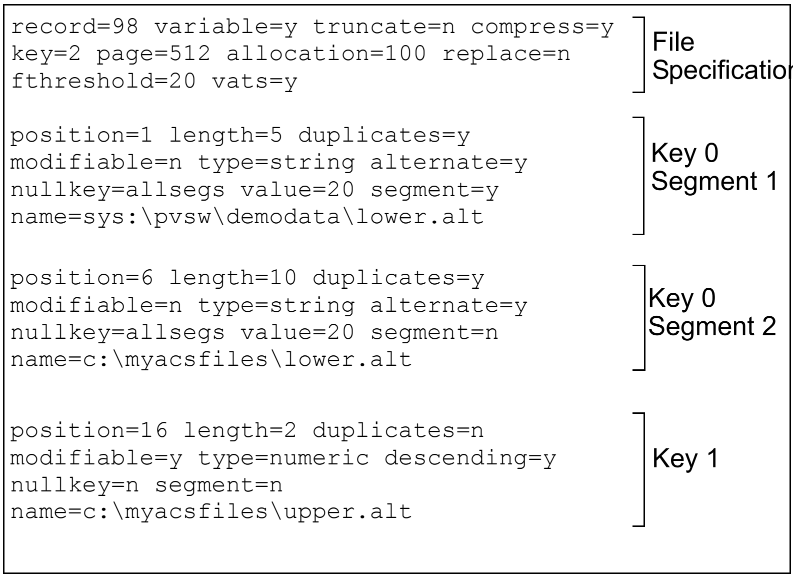
```
record=98 variable=y truncate=n compress=y
key=2 page=512 allocation=100 replace=n
fthreshold=20 vats=y

position=1 length=5 duplicates=y
modifiable=n type=string alternate=y
nullkey=allsegs value=20 segment=y

position=6 length=10 duplicates=y
modifiable=n type=string alternate=y
nullkey=allsegs value=20 segment=n

position=16 length=2 duplicates=n
modifiable=y type=numeric descending=y
nullkey=n segment=n

name=c:\myacsfiles\upper.alt
```

Figure 46 Sample Description File Using Alternate Collating Sequence ID


File
Specificatio
Key 0
Segment 1
Key 0
Segment 2
Key 1

```
record=98 variable=y truncate=n compress=y
key=2 page=512 allocation=100 replace=n
fthreshold=20 vats=y

position=1 length=5 duplicates=y
modifiable=n type=string alternate=y
nullkey=allsegs value=20 segment=y

position=6 length=10 duplicates=y
modifiable=n type=string alternate=y
nullkey=allsegs value=20 segment=n

position=16 length=2 duplicates=n
modifiable=y type=numeric descending=y
nullkey=n segment=n

countryid=-1 codepageid=-1
```

Figure 47 Sample Description File Using Alternate Collating Sequence File Name on a Key Segment


File
Specificatio
Key 0
Segment 1
Key 0
Segment 2
Key 1

```
record=98 variable=y truncate=n compress=y
key=2 page=512 allocation=100 replace=n
fthreshold=20 vats=y

position=1 length=5 duplicates=y
modifiable=n type=string alternate=y
nullkey=allsegs value=20 segment=y
name=sys:\pvsw\demodata\lower.alt

position=6 length=10 duplicates=y
modifiable=n type=string alternate=y
nullkey=allsegs value=20 segment=n
name=c:\myacsfiles\lower.alt


position=16 length=2 duplicates=n
modifiable=y type=numeric descending=y
nullkey=n segment=n
name=c:\myacsfiles\upper.alt
```

Figure 48 Sample Description File Using System-Defined Key for Logging

```
record=98 variable=y truncate=n compress=y
key=2 page=512 allocation=100 replace=n
fthreshold=20 vats=y sysdataonrecord=loggable
```

Description File Elements

Description file elements must appear in a particular order. Table 66 lists the description file elements in the appropriate order. For each element, the table specifies the required format and the range of acceptable values.

- An asterisk (*) indicates that the element is optional.
- A pound sign (#) indicates that it is not applicable in the current MicroKernel version but is retained for backward compatibility with previous MicroKernel versions.
- A percent sign (%) indicates that the element is applicable only to the current MicroKernel version.

Table 66 Summary of Description File Elements

Element	Keyword and Format	Range	Comments
File Specification Information			
Comment Block*	/*. . . . . */	5,120 bytes	None.
Record Length	record=*nnnn*	4 – 8,184	None.
Variable-Length Records	variable=<y|n>	N/A	Not applicable to key-only files.
Reserved Duplicate Pointer*	dupkey=<*nnn*>	0 – 119	Applicable only to files for which you plan to add linked-duplicatable keys.
Blank Truncation*	truncate=<y|n>	N/A	Not applicable for files that use record compression.
Record Compression*	compress=<y | n>	N/A	Not applicable to key-only files. See also Record and Page Compression.
Key Count	key=*nnn*	0 – 119	Specify 0 to create a data-only file. If key count is 0, then Include Data and Use System Data cannot be set to "no."

Table 66 Summary of Description File Elements

Element	Keyword and Format	Range	Comments
Page Size	page=*nnnn*	512 – 4096 bytes for file versions prior to 9.0 (a multiple of 512 bytes up to 4096) 512, 1024, 1536, 2048, 2560, 3072, 3584, 4096, or 8192 bytes for file version 9.0. 1024, 2048, 4096, 8192, or 16384 bytes for file versions 9.5 and newer.	
Page Preallocation*	allocation=*nnnnn*	1 – 65,535	None.
Replace Existing File*#	replace=<y|n>	N/A	None.
Include Data*	data=<y|n>	N/A	Specify *n* to create a key-only file. Cannot create a key-only file that both allows duplicates and uses a system-defined key.
Free Space Threshold*	fthreshold=<5|10|20|30>	N/A	Applicable only for files that have variable-length records. The default is 5.

Variable-Tail Allocation Tables (VATs)	huge=<y|n> #
	vats=<y|n>
		N/A	Applicable only for files that have variable-length records.

Balanced Index*	balance=<y|n>	N/A	None.
Use Key Number *	usekeynum=<y|n>	N/A	Used with the Key Number element.
[1]Use System Data*%	sysdataonrecord=<n|loggable>	N/A	If no element specified, MicroKernel configuration is used. If creating a key-only file, MicroKernel configuration is used and this element is ignored. Also, you cannot create a key-only file that both allows duplicates and uses a system-defined key.
Page Compression*	pagecompress=<y | n>	N/A	See also Record and Page Compression.

Table 66 Summary of Description File Elements

Element	Keyword and Format	Range	Comments
Key Specification Information			
Key Number *	keynum=*nnn*	0 – 118	Must be unique to the file, specified in ascending order, and valid for the file's Page Size. Applicable only when creating a file.
Key Position	position=*nnnn*	1 – 8,184	Cannot exceed the Record Length.
Key Length	length=*nnn*	key type limit	Cannot exceed the limit dictated by the Key Type. For binary keys, the key length must be an even number. The total of the Key Position and Key Length cannot exceed the file's Record Length.
Duplicate Key Values	duplicates=<y|n>	N/A	Cannot create a key-only file that allows duplicates and uses a system-defined key.
Modifiable Key Values	modifiable=<y|n>	N/A	None.
Key Type	type= *validMKDEKeyType*	N/A	Can enter the entire word (as in float) or just the first three letters (as in flo).
Descending Sort Order*	descending=<y|n>	N/A	None.
Alternate Collating Sequence	alternate=<y|n>	N/A	Applicable only for case sensitive STRING, LSTRING, WSTRING, WZSTRING, or ZSTRING keys. When creating an additional index for an existing file, if you want the index to use an ACS other than the first one in the data file, use with `caseinsensitive=y`.
Case-Insensitive Key*	caseinsensitive=<y|n>	N/A	Applicable only for STRING, LSTRING, or ZSTRING keys that do not use an ACS.

Table 66 Summary of Description File Elements

Element	Keyword and Format	Range	Comments
Repeating Duplicates*	repeatdup=<y|n>	N/A	If creating a key-only file, use repeating duplicates. If using this element, you must use duplicates=y.
Null Segments*	nullkey=<allsegs | n | anyseg |>	N/A	None.
Null Key Value	value=*nn*	1-byte hex	Used with the Null Segments element.
Segmented Key	segment=<y|n>	N/A	None.
Alternate Collating Sequence File Name/ ID	name=*sequenceFile* or countryid=*nnn* and codepageid=*nnn* *isr=table name (%)*	valid path *or* values valid to operating system or -1	Used with the Alternate Collating Sequence element.

[1]When the database engine adds a system key, the resulting records may be too large to fit in the file's existing page size. In such cases, the database engine automatically increases the file's page size to the next accommodating size.

Index