VMS Software

VSI ACMS for OpenVMS Writing Server Procedures

Operating System and Version: VSI OpenVMS Alpha Version 8.4-2L1 or higher
VSI OpenVMS IA-64 Version 8.4-1H1 or higher

Software Version: ACMS for OpenVMS Version 5.3-3

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VSI ACMS for OpenVMS Writing Server Procedures

VMS Software

Legal Notice

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Preface

1. About VSI

VMS Software, Inc. (VSI) is an independent software company licensed by Hewlett Packard Enterprise to develop and support the OpenVMS operating system.

2. Intended Audience

This document is intended for those who will:

- Write step procedures for ACMS tasks
- Write ACMS initialization, termination, and cancellation procedures
- Debug ACMS tasks and procedures
- Integrate ACMS with a third-party database

To program the ACMS system, you need a beginner’s knowledge of a programming language that conforms to the OpenVMS Calling Standard – COBOL or BASIC, for example. If you are using Oracle CODASYL DBMS or Oracle Rdb, you also need a beginner's knowledge of database programming. You do not need extensive experience with OpenVMS programming tools or system programming.

3. Document Structure

This manual contains the following chapters and appendixes:

Part I, “User Information”	
Chapter 1, "Introduction to Server Procedures"	Introduces ACMS application programming by explaining procedure server terminology, the kinds of programs you write, the ACMS tools you use to write and debug ACMS application programs, and the programming tools supplied by related products.
Chapter 2, "Writing Initialization, Termination, and Cancel Procedures"	Explains how to write initialization, termination, and cancel procedures for ACMS tasks.
Chapter 3, "Writing Step Procedures"	Presents recommendations for writing step procedures, including naming and structuring step procedures, using workspaces, handling errors in step procedures, and performing terminal I/O from a procedure server.
Chapter 4, "Accessing Resource Managers"	Explains how to write procedures for tasks that use Oracle Rdb databases with SQL, Oracle Rdb with RDO, Oracle CODASYL DBMS databases, and RMS files.
Chapter 5, "Using Message Files with ACMS Tasks and Procedures"	Explains how to create message files for ACMS task groups.

Chapter 6, "Building Procedure Server Images"	Explains how to build procedure server images.
Chapter 7, "Debugging Tasks and Procedures"	Explains how to debug tasks, including tasks called by user-written agent programs, as well as procedures called by tasks.
Chapter 8, "Debugging an Application in an ACMS Run-Time Environment"	Provides guidelines to transition procedures so that they run in the ACMS run-time environment.
Part II, "Reference Material"	
Chapter 9, "ACMS Programming Services"	Provides reference material for the ACMS programming services.
Chapter 10, "ACMS Task Debugger Commands"	Provides reference material for the ACMS Task Debugger commands.
Part III, "Appendixes"	
Appendix A, "Summary of ACMS System Workspaces"	Describes the ACMS system workspaces.
Appendix B, "Libraries Included in AVERTZ Sample Procedures"	Lists the libraries referred to in the AVERTZ procedures that are used as examples in the manual.
Appendix C, "Superseded Features"	Describes superseded features.

4. ACMS Help

ACMS and its components provide extensive online help.

- DCL level help

  Enter **`HELP ACMS`** at the DCL prompt for complete help about the **`ACMS`** command and qualifiers, and for other elements of ACMS for which independent help systems do not exist. DCL level help also provides brief help messages for elements of ACMS that contain independent help systems (such as the ACMS utilities) and for related products used by ACMS (such as DECforms or Oracle CDD/Repository).

- ACMS utilities help

  Each of the following ACMS utilities has an online help system:

  - ACMS Debugger ACMSGEN Utility
  - ACMS Queue Manager (ACMSQUEMGR)
  - Application Definition Utility (ADU)
  - Application Authorization Utility (AAU)
  - Device Definition Utility (DDU)
  - User Definition Utility (UDU)
  - Audit Trail Report Utility (ATR)
  - Software Event Log Utility Program (SWLUP)

The two ways to get utility-specific help are:

- Run the utility and type **HELP** at the utility prompt.
- Use the DCL **HELP** command. At the "Topic?" prompt, type **@** followed by the name of the utility. Use the ACMS prefix, even if the utility does not have an ACMS prefix (except for SWLUP). For example:

  ```
  Topic? @ACMSQUEMGR
  Topic? @ACMSADU
  ```

  However, do not use the ACMS prefix with SWLUP:

  ```
  Topic? @SWLUP
  ```

Note

Note that if you run the ACMS Debugger Utility and then type **HELP**, you must specify a file. If you ask for help from the DCL level with **@**, you do not need to specify a file.

- ACMSPARAM.COM and ACMEXCPAR.COM help

  Help for the command procedures that set parameters and quotas is a subset of the DCL level help. You have access to this help from the DCL prompt, or from within the command procedures.

- LSE help

  ACMS provides ACMS-specific help within the LSE templates that assist in the creation of applications, tasks, task groups, and menus. The ACMS- specific LSE help is a subset of the ADU help system. Within the LSE templates, this help is context-sensitive. Type **HELP/IND (PF1-PF2)** at any placeholder for which you want help.

- Error help

  ACMS and each of its utilities provide error message help. Use **HELP ACMS ERRORS** from the DCL prompt for ACMS error message help. Use **HELP ERRORS** from the individual utility prompts for error message help for that utility.

- Terminal user help

  At each menu within an ACMS application, ACMS provides help about terminal user commands, special key mappings, and general information about menus and how to select tasks from menus.

- Forms help

  For complete help for DECforms or TDMS, use the help systems for these products.

5. Related Documents

Read *VSI ACMS for OpenVMS Getting Started* [https://docs.vmssoftware.com/vsi-acms-get-started-guide/] before using this guide; this book provides an introduction to developing applications with ACMS and DECforms software. It explains the basic concepts and facilities of ACMS and other products needed for developing ACMS applications. The collection of examples in this book shows the development of a complete ACMS application and explains how to install and run the application.

The following table lists the documents in the VSI ACMS for OpenVMS documentation set.

ACMS Information	Description
VSI ACMS Version 5.0 for OpenVMS Installation Guide [https://docs.vmssoftware.com/vsi-acms-installation-guide/]	Description of installation requirements, the installation procedure, and postinstallation tasks.
VSI ACMS for OpenVMS Getting Started [https://docs.vmssoftware.com/vsi-acms-get-started-guide/]	Overview of ACMS software and documentation. Tutorial for developing a simple ACMS application. Description of the AVERTZ sample application.
VSI ACMS for OpenVMS Concepts and Design Guidelines [https://docs.vmssoftware.com/vsi-acms-concepts-and-design-guide/]	Description of how to design an ACMS application.
VSI ACMS for OpenVMS Writing Applications [https://docs.vmssoftware.com/vsi-acms-writing-apps/]	Description of how to write task, task group, application, and menu definitions using the Application Definition Utility. Description of how to write and migrate ACMS applications on an OpenVMS system.
VSI ACMS for OpenVMS Writing Server Procedures [https://docs.vmssoftware.com/vsi-acms-writing-server-proc/]	Description of how to write programs to use with tasks and how to debug tasks and programs.
VSI ACMS for OpenVMS Systems Interface Programming [https://docs.vmssoftware.com/vsi-acms-sys-interface-prog/]	Description of using Systems Interface (SI) Services to submit tasks to an ACMS system.
VSI ACMS for OpenVMS ADU Reference Manual [https://docs.vmssoftware.com/vsi-acms-adu-ref-manual/]	Reference information about the ADU commands, phrases, and clauses.
VSI ACMS for OpenVMS Quick Reference [https://docs.vmssoftware.com/vsi-acms-quick-ref/]	List of ACMS syntax with brief descriptions.
VSI ACMS for OpenVMS Managing Applications [https://docs.vmssoftware.com/vsi-acms-managing-applications/]	Description of authorizing, running, and managing ACMS applications, and controlling the ACMS system.
VSI ACMS for OpenVMS Remote Systems Management Guide [https://docs.vmssoftware.com/vsi-acms-remote-systems-management-guide/]	Description of the features of the Remote Manager for managing ACMS systems, how to use the features, and how to manage the Remote Manager.
Online help	Online help about ACMS and its utilities.

The following documentation is also useful:

- *VSI DECforms Guide to Commands and Utilities* [https://docs.vmssoftware.com/vsi-decforms-for-openvms-guide-to-commands-and-utilities/]

  Explains how to create DECforms forms and design DECforms panels.

- *VSI OpenVMS Debugger Manual* [https://docs.vmssoftware.com/vsi-openvms-debugger-manual] and *VSI OpenVMS Command Definition, Librarian, and Message Utilities* [https://docs.vmssoftware.com/vsi-openvms-command-definition-librarian-and-message-utilities]

Describes how to use the OpenVMS Debugger and the Message Utility.

- *VSI COBOL User Manual* [https://docs.vmssoftware.com/vsi-cobol-for-openvms-user-guide] and *VSI COBOL Reference Manual* [https://docs.vmssoftware.com/vsi-cobol-for-openvms-reference-guide]

  Explains the COBOL statements and compiler used to write ACMS application programs.

- *VSI BASIC User Manual* [https://docs.vmssoftware.com/vsi-basic-for-openvms-user-manual] and *VSI BASIC Reference Manual* [https://docs.vmssoftware.com/vsi-basic-for-openvms-reference-manual]

  Explains the BASIC statements and compiler used to write ACMS application programs.

6. OpenVMS Documentation

The full VSI OpenVMS documentation set can be found on the VMS Software Documentation webpage at https://docs.vmssoftware.com.

7. VSI Encourages Your Comments

You may send comments or suggestions regarding this manual or any VSI document by sending electronic mail to the following Internet address: <docinfo@vmssoftware.com>. Users who have VSI OpenVMS support contracts through VSI can contact <support@vmssoftware.com> for help with this product.

8. Conventions

The following conventions are used in this manual:

Ctrl/*x*	A sequence such as **Ctrl/*x*** indicates that you must press and hold the key labeled Ctrl while you press another key or a pointing device button.
PF1 *x*	A sequence such as **PF1 *x*** indicates that you must first press and release the key labeled PF1 and then press and release another key or a pointing device button.
Return	In the HTML version of this document, this convention appears as brackets rather than a box.
. . .	A horizontal ellipsis in examples indicates one of the following possibilities: • Additional optional arguments in a statement have been omitted. • The preceding item or items can be repeated one or more times. • Additional parameters, values, or other information can be entered.
⋮	A vertical ellipsis indicates the omission of items from a code example or command format; the items are omitted because they are not important to the topic being discussed.
`Monospace text`	Monospace type indicates code examples and interactive screen displays. In the C programming language, monospace type in text identifies the following elements: keywords, the names of

	independently compiled external functions and files, syntax summaries, and references to variables or identifiers introduced in an example. In the HMTL version of this document, this text style may appear as italics.
-	A hyphen at the end of a command format description, command line, or code line indicates that the command or statement continues on the following line.
numbers	All numbers in text are assumed to be decimal unless otherwise noted. Nondecimal radixes—binary, octal, or hexadecimal—are explicitly indicated.
bold text	Bold text represents the introduction of a new term or the name of an argument, an attribute, or a reason. In the HMTL version of this document, this text style may appear as italics.
italic text	Italic text indicates important information, complete titles of manuals, or variables. Variables include information that aries in system output (Internal error *number*), in command lines (**/PRODUCER=*name***), and in command parameters in text (where *dd* represents the predefined code for the device type).
UPPERCASE	Uppercase text indicates the name of a routine, the name of a file, the name of a file protection code, or the abbreviation for a system privilege. In command format descriptions, uppercase text is an optional keyword.
UPPERCASE	In command format descriptions, uppercase text that is underlined is required. You must include it in the statement if the clause is used.
lowercase	In command format descriptions, a lowercase word indicates a required element.
<lowercase>	In command format descriptions, lowercase text in angle brackets indicates a required clause or phrase.
( )	In command format descriptions, parentheses indicate that you must enclose the options in parentheses if you choose more than one.
[| |]	In command format descriptions, vertical bars within square brackets indicate that you can choose any combination of the enclosed options, but you can choose each option only once.
{ | | }	In command format descriptions, vertical bars within braces indicate that you must choose one of the options listed, but you can use each option only once.

9. References to Oracle Products

VSI ACMS documentation set, to which this document belongs, refers to the following Oracle products by their full and abbreviated names:

Full product name	**Shortened product name**
Oracle Common Data Dictionary	CDD
Oracle Rdb	Rdb

Full product name	Shortened product name
Oracle Database/DBMS	DBMS
Oracle Trace	Trace

Part I. User Information

This part contains tutorial information about writing procedures and creating message files for ACMS servers. This part also contains information about building procedure server images, debugging tasks and server procedures, and running tasks in the ACMS run-time environment.

Chapter 1. Introduction to Server Procedures

This chapter defines procedure server terminology, including server procedures, procedure server images, server processes, and procedure server transfer modules. The chapter also explains the similarities and differences between the different types of procedures used in ACMS applications:

- Step procedures
- Specialized procedures: initialization, termination, and cancel procedures

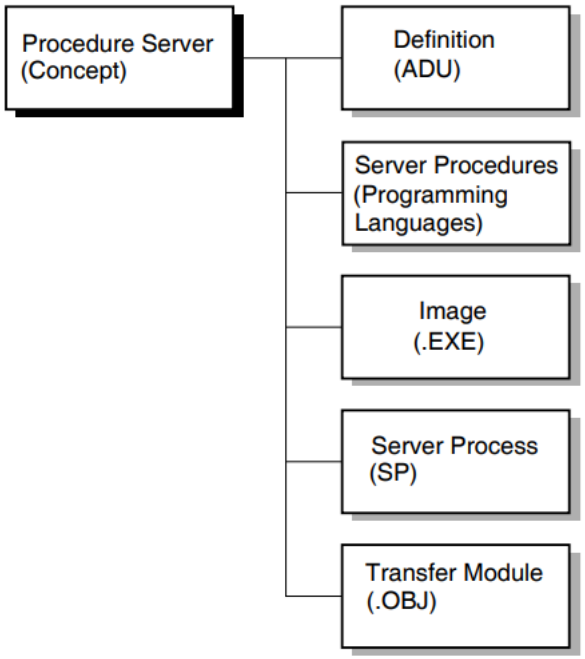
Each section in the chapter includes references to other chapters or manuals where you can find more detailed information about these topics.

1.1. Procedure Server Terminology

A number of terms used in this chapter can be confusing because they all contain the word "server", and they are similar-sounding. Because these terms are used throughout this and other ACMS manuals, it is important to understand the differences among them.

A **procedure server** is a term used in ACMS to describe a number of the specific concepts, which are represented in *Figure 1.1, "Procedure Server Terminology"*.

Figure 1.1. Procedure Server Terminology



To the right of Procedure Server (Concept) in *Figure 1.1, "Procedure Server Terminology"* are five procedure server-related terms:

- A **procedure server definition** is ADU syntax used to describe the server procedures and the server image. A procedure server definition is a part of a task group definition.

- **Server procedures** are programs or subroutines written in 3GL languages that conform to the OpenVMS calling standard. A procedure performs a particular kind of work for an ACMS task. The two kinds of server procedures used in ACMS tasks are the following:

  - Initialization, termination, and cancel procedures
  - Step procedures

  These two types of server procedures are explained in the next section.

- A **procedure server image** (.EXE) is the executable code that actually does the work for an ACMS processing step; it is, in fact, an OpenVMS image. A procedure server image runs in a procedure server process.

- A **procedure server process** (SP) is an OpenVMS process created according to the characteristics defined for a server in ACMS task group and application definitions. Server processes are started and stopped, as needed, by the Application Execution Controller (EXC) process.

  When the EXC starts a procedure server, it creates a server process, activates and loads the procedure server image, and runs any initialization procedure defined for the server.

- A **procedure server transfer module** is an object module created for a procedure server as a result of building an ACMS task group definition. When you build a task group, ADU produces a procedure server transfer module for each server defined in the task group.

Note

The two types of servers in an ACMS environment are procedure servers and DCL servers. See *VSI ACMS for OpenVMS Writing Applications* [https://docs.vmssoftware.com/vsi-acms-writing-apps/] for information about DCL servers.

1.2. Understanding Server Procedures

A server procedure is a program written in a 3GL programming language, such as COBOL, that conforms to the OpenVMS calling standard. A procedure performs a particular kind of work for an ACMS task. The two types of procedures in ACMS are described in the next two sections.

1.2.1. Initialization, Termination, and Cancel Procedures

Initialization, **termination**, and **cancel procedures** make up one type of server procedure. These procedures open files, bind databases, close files, and do cleanup work when an ACMS task is canceled.

Initialization, termination, and cancel procedures do work related to a server process rather than work related to a specific task. The Application Execution Controller (EXC) calls each of them at various times:

- An initialization procedure is called when a server process starts.
- A termination procedure is called when a server process stops.
- A cancel procedure is called when a task is canceled.

Initialization, termination, and cancel procedures for a server are declared in a task group definition. You can have only one initialization, termination, and cancel procedure in each server definition.

Example 1.1, "Declaration of Initialization and Termination Procedures in a Task Group Definition" shows the task group server declaration of the initialization procedure VR_INIT and the termination procedure VR_TERM in the AVERTZ Vehicle Rental Task Group Definition, VR_TASK_GROUP.

Example 1.1. Declaration of Initialization and Termination Procedures in a Task Group Definition

```
REPLACE GROUP VR_TASK_GROUP
  .
  .
  .
SERVER IS VR_SERVER:
     INITIALIZATION PROCEDURE IS VR_INIT;
     TERMINATION PROCEDURE IS VR_TERM;
     PROCEDURES ARE
     .
     .
     .
END SERVER;
END DEFINITION;
```

The declaration of a cancel procedure, if included in the example, would follow the identification of the initialization and termination procedures and would be similar to them.

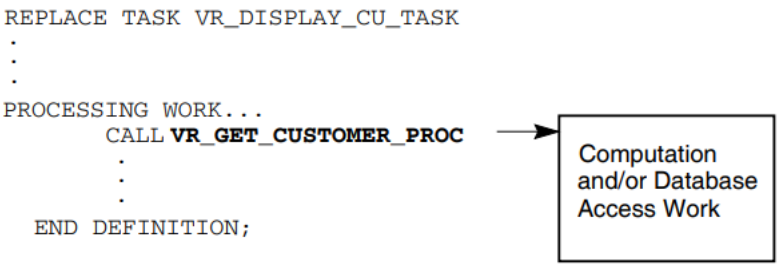
Chapter 2, "Writing Initialization, Termination, and Cancel Procedures" contains more information and examples of initialization, termination, and cancel procedures.

1.2.2. Step Procedures

A **step procedure** is a second type of server procedure. A step procedure is a subroutine that does the computational and database access work for a processing step in an ACMS task. It is invoked by means of a call statement in a processing step, and it returns control to the calling task when it completes.

Figure 1.2, "Call to a Step Procedure in a Task Definition" shows a call to a step procedure in a processing step of a task definition. The step procedure in the example is VR_GET_CUSTOMER_PROC.

Figure 1.2. Call to a Step Procedure in a Task Definition



The names of the step procedures called by the tasks in the task group are declared in the PROCEDURES ARE clause of the SERVER IS statement. *Example 1.2, "Declaration of a Step Procedure in a Task Group Definition"* shows an example of the procedure VR_GET_CUSTOMER_PROC declared in the task group VR_TASK_GROUP.

Example 1.2. Declaration of a Step Procedure in a Task Group Definition

```
REPLACE GROUP VR_TASK_GROUP
```

```
.
.
.
SERVER IS VR_SERVER:
     INITIALIZATION PROCEDURE IS VR_INIT;
     TERMINATION PROCEDURE IS VR_TERM;
     PROCEDURES ARE
                    VR_GET_CUSTOMER_PROC,
     .
     .
     .
END SERVER;
END DEFINITION;
```

1.3. Naming and Structuring a Server Procedure

Two rules apply to naming and structuring a server procedure:

- Assign a unique name to a server procedure.

  The name or entry point used for each procedure must be unique among all procedures in a procedure server. You must use the same name to call the procedure in the processing step in the task definition.

  Example 1.3, "Processing Step in a Task Definition" shows a simplified example of a task definition with a processing step that calls a step procedure.

  Example 1.3. Processing Step in a Task Definition

```
REPLACE TASK VR_DISPLAY_CU_TASK
                .
                .
                .

GET_CUSTOMERS:
  PROCESSING
      CALL VR_GET_CUSTOMER_PROC USING VR_CUSTOMER_WKSP,
                                      VR_CU_ARRAY_WKSP;
                .
                .
                .
```

  The CALL clause shows that you want to run a procedure named VR_GET_CUSTOMER_PROC. The USING keyword names two workspaces that the procedure uses: VR_CUSTOMER_WKSP and VR_CU_ARRAY_WSKP. The task definition does not change regardless of the language you use to write the procedure.

  For a more detailed explanation of the processing step, see *VSI ACMS for OpenVMS Writing Applications* [https://docs.vmssoftware.com/vsi-acms-writing-apps/].

- Structure a step procedure as an externally callable subprogram or function.

  For example, in COBOL you write step procedures as subprograms. Like any other COBOL subprogram, a step procedure begins with an Identification Division that gives the 1- to 31-character

name of the procedure. The name of the procedure corresponding to the GET_CUSTOMERS processing step definition shown in *Example 1.3, "Processing Step in a Task Definition"* is VR_GET_CUSTOMER_PROC. For example:

```
IDENTIFICATION DIVISION.
PROGRAM-ID.  VR_GET_CUSTOMER_PROC.
```

1.4. Programming Services and Tools

ACMS provides programming services and tools to assist you in writing procedures. *Chapter 3, "Writing Step Procedures"* explains how to use programming services in writing step procedures. *Chapter 9, "ACMS Programming Services"* contains reference information about all ACMS programming services.

ACMS tools that you can use to debug tasks and server procedures include the ACMS Task Debugger, online server debugging, and server process dumps. *Chapter 7, "Debugging Tasks and Procedures"* and *Chapter 8, "Debugging an Application in an ACMS Run-Time Environment"* contain information about debugging ACMS tasks and server procedures.

The OpenVMS operating system also provides tools used to create procedure servers: the OpenVMS Message Facility, the OpenVMS Linker, and the OpenVMS Debugger. *Chapter 5, "Using Message Files with ACMS Tasks and Procedures"*, *Chapter 6, "Building Procedure Server Images"*, and *Chapter 7, "Debugging Tasks and Procedures"* explain the use of these tools.

Chapter 2. Writing Initialization, Termination, and Cancel Procedures

The three types of specialized optional ACMS procedures are the following:

- Initialization procedures

  Initialization procedures can open the files and bind to the databases that step procedures in the server use.

- Termination procedures

  Termination procedures can perform application-specific server termination processing, such as unmapping a global section. Note that Rdb, DBMS, and RMS automatically release databases and close files when a process runs down.

- Cancel procedures

  Cancel procedures can perform a variety of functions with ACMS tasks, such as freeing non-transaction-based resources and rolling back active database transactions or recovery units. In most cases, their use is discouraged and can be avoided by following the guidelines that are discussed in *Section 2.4.1, "Guidelines for Avoiding Cancel Procedures"*. However, in some situations they are required; see *Section 2.4.2, "Situations in Which Using Cancel Procedures Is Unavoidable"* for more information.

2.1. Writing Initialization Procedures

Use initialization procedures to open the files or bind to the databases that are subsequently used by the step procedures running in the server. Files and databases are most frequently opened by initialization procedures with shared access so that other processes on the system, including other server processes, can also access the data. However, it is more efficient to use exclusive access in those cases where only a single server process needs to access a file or database.

Binding or attaching to a database in an initialization procedure has the following advantages:

- By forcing the server to bind to the database in the initialization procedure, you ensure that the database is accessible, that is, that the database file or files exist and can be accessed by the application.

- The overhead of binding to a database or opening a file is incurred at initialization time rather than at task execution time.

- Any database recovery can be performed as part of application startup.

  If the application is being restarted after a system crash, the database may need to be recovered because of that crash. By forcing the server to bind to the database in the initialization procedure, you force the database recovery to be performed as part of the application startup processing, rather than as part of the first task that uses that server process.

- The initialization procedure can report any errors encountered while binding to the database.

  If the database is not accessible, or for some reason cannot be recovered after a crash, then you can ensure that the application startup fails because the database is unusable.

The use of an initialization procedure for a server is optional. If you do specify an initialization procedure, ACMS calls the procedure every time it starts a new process for the server. ACMS can start server processes when an application is first started and also while an application is running if additional server processes are required to handle the load placed on the application by the users. If you do not specify an initialization procedure, ACMS starts the server process without performing any application-specific initialization processing.

The processing that is performed in an initialization procedure depends on which database you are using. See the database-specific sections in this chapter for more information.

2.1.1. Guidelines for Writing Initialization Procedures

Initialization procedures do the same kind of work for server processes that use Rdb or DBMS databases or RMS files. Follow these guidelines when writing initialization procedure for databases and files:

- An initialization procedure must return a status value to the server process to indicate whether the initialization procedure completed successfully.

  All languages that follow the OpenVMS calling standard supply a method of returning a status value from a subprogram or function. For example, in COBOL, use the GIVING clause of the Procedure Division header to return a status value to ACMS. Include the status-result definition in the Working Storage Section and in the Procedure Division header:

```
WORKING-STORAGE SECTION.
01  status-result          PIC S9(9) COMP.
PROCEDURE DIVISION GIVING status-result.
```

  With BASIC, specify the data type returned with the FUNCTION statement, and assign a value to the function name. This example shows that the status value returned to ACMS has a longword data type:

```
FUNCTION LONG pers_upd_server_init_proc
```

  If the server initialization procedure completes successfully, return a success status indicating that the server process is ready to use. If the procedure detects an error condition, return a failure status indicating that the server process cannot be used. If you open more than one file or database, return a success value only if the initialization procedure opened all the files and databases successfully.

- In an initialization procedure, signal errors detected during initialization processing.

  When an initialization procedure signals an error, ACMS writes additional information about the error condition to the ACMS audit trail log. Use the following services to signal the error condition:

Resource manager	**Service used to signal error condition**
Rdb with SQL	SQL$SIGNAL
Rdb with RDO	LIB$CALLG and LIB$SIGNAL with the Rdb RDB$MESSAGE_VECTOR array
DBMS	DBM$SIGNAL

Resource manager	Service used to signal error condition
RMS files	LIB$SIGNAL with the RMS STS and STV error codes

If the initialization procedure signals a fatal OpenVMS status, ACMS writes the error to the audit trail log and stops the server process. However, if the procedure signals an error or warning OpenVMS status, then ACMS continues executing the initialization procedure after writing the error to the audit trail log. Therefore, an initialization procedure should always return a failure status when it detects an error, even if it signals the error condition.

- An initialization procedure cannot assign initial values to fields in group or user workspaces.

  Because ACMS does not pass workspaces to initialization procedures, there is no way to assign initial values to fields in workspaces.

2.1.2. Binding or Attaching to Databases

In an initialization procedure, you can bind or attach to a database in three ways. The following sections describe these methods and explain how to decide which of them is appropriate to your application.

To bind to a database, start and end a dummy database transaction in the initialization procedure. The examples below illustrate attaching to an Rdb database using SQL; however, the same techniques also apply when accessing an Rdb database using RDO and when accessing a DBMS database.

The options are:

- Bind to the database

  The following COBOL code extract causes a simple bind to the database:

```
         EXEC SQL
                 WHENEVER SQLERROR GO TO sql-error-handler
         END-EXEC.

         EXEC SQL
                 SET TRANSACTION READ WRITE
         END-EXEC.

         EXEC SQL
                 COMMIT
         END-EXEC.

         SET ret-stat TO SUCCESS.
         EXIT PROGRAM.

 sql-error-handler.
             MOVE Rdb$LU_STATUS TO ret-stat
             CALL "SQL$SIGNAL"
             EXIT PROGRAM.
```

- Start a transaction and, additionally, reserve the relations that will be used by the step procedures in the server.

  Using this method, you also force Rdb to read in the metadata associated with those relations, in addition to just binding to the database. Doing this at application startup time means that this

overhead is incurred once – when the application starts – rather than each time a step procedure in a server process first accesses a relation.

Note

If the procedures in the server perform only read-access transactions against the database, specify READ ONLY access when you start the transaction.

The following code extract causes the process to bind to the database and causes the metadata for the named relations to be read in.

```
        EXEC SQL
                WHENEVER SQLERROR GO TO sql-error-handler
        END-EXEC.

        EXEC SQL
                SET TRANSACTION READ WRITE
                RESERVING
                    reservations, vehicles, vehicle_rental_history
                        FOR SHARED WRITE,
                    sites, regions
                        FOR SHARED READ
        END-EXEC.

        EXEC SQL
                COMMIT
        END-EXEC.

        SET ret-stat TO SUCCESS.
        EXIT PROGRAM.

sql-error-handler.
            MOVE Rdb$LU_STATUS TO ret-stat
            CALL "SQL$SIGNAL"
            EXIT PROGRAM.
```

- Store a dummy record in a relation and then delete it by rolling back the database transaction or recovery unit.

  When you use this method, you force Rdb to create the recovery-unit journal file (.RUJ) during application startup rather than as part of the first task that uses the server process. Furthermore, if the .RUJ file cannot be created for some reason, then the application does not start.

Note

Rdb and DBMS do not use an .RUJ file for read-only transactions. Therefore, this step is not necessary if the procedures in the server perform only read-access transactions against the database.

The following code extract forces Rdb to create the .RUJ file for the process:

```
        EXEC SQL
                WHENEVER SQLERROR GO TO sql-error-handler
        END-EXEC.

        EXEC SQL
                SET TRANSACTION READ WRITE
                RESERVING
```

```
                    reservations, vehicles, vehicle_rental_history
                        FOR SHARED WRITE,
                    sites, regions
                        FOR SHARED READ
        END-EXEC.

        EXEC SQL
                INSERT INTO reservations
                      (
                       reservation_id
                      )
               VALUES (
                       :zero_reservation_id
                      )
        END-EXEC.

        EXEC SQL
                ROLLBACK
        END-EXEC.

        SET ret-stat TO SUCCESS.
        EXIT PROGRAM.

sql-error-handler.
            MOVE Rdb$LU_STATUS TO ret-stat
            CALL "SQL$SIGNAL"
            EXIT PROGRAM.
```

The following sections contain examples of initialization procedures and explanations of how to write code for Rdb and DBMS databases and for RMS files. See the Rdb, DBMS, and RMS documentation for further information on accessing a database or file.

2.1.3. Initialization Procedures for Rdb Databases Using SQL

The initialization procedure for a server that uses an Rdb database attaches to the database by starting and ending a dummy transaction. Note that to attach fully to the database, you must start a transaction, store a dummy record, and roll back the transaction, as explained in *Section 2.1.2, "Binding or Attaching to Databases"*.

The initialization procedure for a server using an Rdb database must declare the database accessed by the step procedures in the server. The database declaration in the initialization procedure must be the same as the database declarations in the step procedures in the server. To declare the database using SQL, use the DECLARE SCHEMA statement. Always use the DECLARE SCHEMA statement to name the database you are using before you use other statements that access the database.

In SQL, you start a transaction using the SET TRANSACTION statement. *Section 2.1.3.1, "Specifying the Access Mode and Relations Used by the Server"* describes how to specify the access mode and relations used by the step procedures in the server. If the database transaction cannot be started, log the failure in the ACMS audit trail log by calling SQL$SIGNAL, and then return the failure status to ensure that ACMS stops the server process.

Section 2.1.3.2, "Using COBOL" illustrates an initialization procedure written in COBOL that uses SQL. See the SQL documentation for more information about using SQL to access Rdb databases.

2.1.3.1. Specifying the Access Mode and Relations Used by the Server

When you start the dummy transaction in the initialization procedure, specify the access mode used by the step procedures in the server. If the procedures in the server perform only read-access transactions against the database, specify READ ONLY access when you start the transaction. Specify READ WRITE access if any step procedures also write or update records in the database.

Name all the relations used by the step procedures in the server to cause Rdb to read in the metadata for those relations when you start the transaction. For each relation, specify READ access if the procedures only read information from the relation. Otherwise, specify WRITE access if any of the procedures write or update records in the relation.

The following example illustrates starting a dummy transaction in an initialization procedure using COBOL and SQL. The step procedures used in the server both read and write information in the database, so the transaction is started using READ WRITE mode. The step procedures in the server access records in the RESERVATIONS, VEHICLES, VEHICLE_RENTAL_HISTORY, SITES, and REGIONS relations. The procedures both read and write records in the RESERVATIONS, VEHICLES and VEHICLE_RENTAL_HISTORY relations, so they are accessed using WRITE mode. However, the procedures only read records in the SITES and REGIONS relations, so they are accessed using READ mode.

```
EXEC SQL
        SET TRANSACTION READ WRITE
        RESERVING
            reservations, vehicles, vehicle_rental_history
                FOR SHARED WRITE,
            sites, regions
                FOR SHARED READ
END-EXEC.
```

The following example illustrates how to start the same dummy transaction using BASIC and RDO.

```
&RDB& START_TRANSACTION READ_WRITE
&RDB&   RESERVING
&RDB&       reservations, vehicles, vehicle_rental_history
&RDB&           FOR SHARED WRITE,
&RDB&       sites, regions
&RDB&           FOR SHARED READ
```

2.1.3.2. Using COBOL

Example 2.1, "SQL Initialization Procedure" shows the initialization procedure for the AVERTZ Vehicle Rental Application Update Server. The procedure names the database used by the server using the DECLARE SCHEMA statement in the Working-Storage Section:

```
DATA DIVISION.
WORKING-STORAGE SECTION.
    .
    .
EXEC SQL
DECLARE EXTERNAL SCHEMA FILENAME AVERTZ_DATABASE:VEHICLE_RENTALS
END-EXEC.
```

The procedure uses the SET TRANSACTION statement to start the dummy transaction. READ WRITE access is used because the server read, writes, and updates records in the VEHICLE_RENTALS database. The procedure names each relation used by the server in the RESERVING clause. A dummy

record is stored in the RESERVATIONS relation using the INSERT statement. Finally, the procedure uses the ROLLBACK statement to end the dummy transaction and delete the dummy record. If an error occurs, the procedure sets the return status to the error status returned by Rdb, logs an error in the ACMS audit trail log by calling SQL$SIGNAL, and then returns.

Example 2.1. SQL Initialization Procedure

```
IDENTIFICATION DIVISION.
*****************************************************************
PROGRAM-ID. VR-UPDATE-INIT.
*                                                               *
*               Version:        01                              *
*               Edit:           00                              *
*               Authors:        00                              *
*                                                               *
*****************************************************************


*****************************************************************
*         F U N C T I O N A L   D E S C R I P T I O N           *
*                                                               *
*  This procedure is the initialization procedure for the       *
*  AVERTZ update server. It is used to the open the             *
*  vehicle rental database.                                     *
*                                                               *
*****************************************************************
ENVIRONMENT DIVISION.
CONFIGURATION SECTION.
*****************************************************************
DATA DIVISION.
*****************************************************************



WORKING-STORAGE SECTION.
*
* Return status to pass to ACMS
*
01 RET-STAT     PIC S9(9) COMP.
01 ZERO_RESERVATION_ID PIC S9(9) VALUE 0.
*
* Define the SQL return status
*
01 SQLCODE      PIC S9(9) COMP.
01 RDB$MESSAGE_VECTOR EXTERNAL.
    03 Rdb$LU_NUM_ARGUMENTS     PIC S9(9) COMP.
    03 Rdb$LU_STATUS            PIC S9(9) COMP.
    03 Rdb$ALU_ARGUMENTS        OCCURS 18 TIMES.
        05 Rdb$LU_ARGUMENTS     PIC S9(9) COMP.


*
* Declare the database.
*
EXEC SQL
DECLARE EXTERNAL SCHEMA FILENAME AVERTZ_DATABASE:VEHICLE_RENTALS
END-EXEC.
```

```
************************************************************
PROCEDURE DIVISION GIVING RET-STAT.
************************************************************
MAIN SECTION.

000-OPEN_DB.


*
* Start a recovery unit to force Rdb to bind to the database and read
* in the metadata for the specified relations used by this server.
*
        EXEC SQL
                SET TRANSACTION READ WRITE
                RESERVING
                    RESERVATIONS, VEHICLES, VEHICLE_RENTAL_HISTORY
                        FOR SHARED WRITE,
                    SITES, REGIONS
                        FOR SHARED READ
        END-EXEC.
        IF SQLCODE < ZERO
        THEN
            MOVE RDB$LU_STATUS TO RET-STAT
            CALL "SQL$SIGNAL"
            GO TO 100-EXIT-PROGRAM
        END-IF.



*
* Force Rdb to create the .RUJ file for this server by inserting a
* dummy record into the reservations relation.
*
        EXEC SQL
                INSERT INTO RESERVATIONS
                      (
                       RESERVATION_ID
                      )
               VALUES (
                       :ZERO_RESERVATION_ID
                      )
        END-EXEC.
        IF SQLCODE < ZERO
        THEN
            MOVE RDB$LU_STATUS TO RET-STAT
            CALL "SQL$SIGNAL"
            GO TO 100-EXIT-PROGRAM
        END-IF.



*
* Roll back the recovery unit, deleting the dummy record.
*
        EXEC SQL
                ROLLBACK
```

```
        END-EXEC.
        IF SQLCODE < ZERO
        THEN
            MOVE RDB$LU_STATUS TO RET-STAT
            CALL "SQL$SIGNAL"
            GO TO 100-EXIT-PROGRAM
        END-IF.

        SET RET-STAT TO SUCCESS.

100-EXIT-PROGRAM.
        EXIT PROGRAM.
```

2.1.4. Initialization Procedures for Rdb Databases Using RDO

The initialization procedure for a server that uses an Rdb database attaches to the database by starting and ending a dummy transaction. Note that to attach fully to the database, you must start a transaction, store a dummy record, and roll back the transaction, as explained in *Section 2.1.2, "Binding or Attaching to Databases"*.

The initialization procedure for a server using an Rdb database must name the database accessed by the step procedures in the server. The database declaration in the initialization procedure must be the same as the database declarations in the step procedures in the server. To declare the database using RDO, use the INVOKE DATABASE statement. For example:

```
&RDB& INVOKE DATABASE FILENAME "avertz_database:vehicle_rentals"
```

Start the dummy database transaction by using the START_TRANSACTION statement, which causes Rdb to attach to the database. See *Section 2.1.3.1, "Specifying the Access Mode and Relations Used by the Server"* for information on how to specify the access mode and relations that are used by the server when you start the transaction. If the step procedures in the server write or modify records in the database, use the STORE statement to write a dummy record to the database to force Rdb to create an .RUJ file. Finally, use the ROLLBACK statement to end the dummy transaction and delete the dummy record.

If an error occurs, log the failure in the ACMS audit trail log by signaling the error information in the RDB$MESSAGE_VECTOR array using the LIB$CALLG and LIB$SIGNAL OpenVMS RTL services; then return the failure status to ensure that ACMS stops the server process. For more information on signaling Rdb errors, refer to the Rdb documentation.

Example 2.2, "BASIC Initialization Procedure for Rdb Server" shows the complete BASIC version of the initialization procedure for a server that uses an Rdb database with RDO. This example also illustrates how storing a dummy record forces RDB to create the .RUJ file for the server process. In this case, the ROLLBACK statement is used to end the database transaction and delete the dummy record.

Example 2.2. BASIC Initialization Procedure for Rdb Server

```
    FUNCTION LONG vr_update_init
    !+
    ! Update server initialization procedure.
    !-



    !+
```

```
! Declare database.
!-
&RDB& INVOKE DATABASE FILENAME "avertz_database:vehicle_rentals"



!+
! Declare OpenVMS RTL routines.
!-
EXTERNAL LONG FUNCTION  LIB$SIGNAL,                          &
                        LIB$CALLG



!+
! Start a database transaction to force Rdb to attach to
! the database and read in the metadata for the specified
! relations used by this server.
!-

&RDB& START_TRANSACTION READ_WRITE
&RDB&   RESERVING
&RDB&       reservations, vehicles, vehicle_rental_history
&RDB&           FOR SHARED WRITE,
&RDB&       sites, regions
&RDB&           FOR SHARED READ
&RDB&   ON ERROR
            CALL LIB$CALLG( Rdb$MESSAGE_VECTOR,              &
                            LOC( LIB$SIGNAL ) BY VALUE )
            EXIT FUNCTION Rdb$LU_STATUS
&RDB&   END_ERROR



!+
! Force Rdb to create the .RUJ file for this server by
! inserting a dummy record into the RESERVATIONS relation.
!-
&RDB& STORE r IN reservations USING
&RDB&   ON ERROR
            CALL LIB$CALLG( Rdb$MESSAGE_VECTOR,              &
                            LOC( LIB$SIGNAL ) BY VALUE )
            EXIT FUNCTION Rdb$LU_STATUS
&RDB&   END_ERROR
&RDB&   r.RESERVATION_ID = "00000000"
&RDB& END_STORE



!+
! Roll back the database transaction, deleting the dummy record.
!-
&RDB& ROLLBACK
&RDB&   ON ERROR
            CALL LIB$CALLG( Rdb$MESSAGE_VECTOR,              &
                            LOC( LIB$SIGNAL ) BY VALUE )
            EXIT FUNCTION Rdb$LU_STATUS
&RDB&   END_ERROR
```

```
!+
! Set return status to success and return.
!-
vr_update_init = 1%
END FUNCTION
```

2.1.5. Initialization Procedures for DBMS Databases

The initialization procedure for a server that uses a DBMS database binds to the database by starting and ending a dummy transaction. Note that to bind fully to the database, you must start a transaction, store a dummy record, and roll back the transaction, as explained in *Section 2.1.2, "Binding or Attaching to Databases"*.

The initialization procedure for a server using a DBMS database must name the database accessed by the step procedures in the server. The database declaration in the initialization procedure must be the same as the database declarations in the step procedures in the server.

Start the dummy database transaction by using the READY statement, which causes DBMS to attach to the database. If the step procedures in the server write or modify records in the database, use the STORE statement to write a dummy record to the database to force DBMS to create an .RUJ file. Finally, use the ROLLBACK statement to end the dummy transaction and delete the dummy record. If an error occurs, log the failure in the ACMS audit trail log by signaling the error information using DBM$SIGNAL; then return the failure status to ensure that ACMS stops the server process.

Note

If you create the database with the **OPEN=MANUAL** attribute, you must open the database manually using the **DBO/OPEN** command before a server process can access it. Opening a database manually may also be more efficient even if you create the database with the **OPEN=AUTOMATIC** attribute. For more information on the **DBO/OPEN** command, refer to the DBMS documentation.

2.1.5.1. Using COBOL

The initialization procedure for a server using a DBMS database must identify the database the server uses. You do this by naming the schema and subschema in the database in the Data Division. For example:

```
DATA DIVISION.

SUB-SCHEMA SECTION.

DB  DEFAULT_SUBSCHEMA
    WITHIN "PERS_CDD.PERSONNEL_SCHEMA"
    FOR "PERS_DB:PERSONNEL".
```

The subschema named – in this case, the default subschema for the PERSONNEL database – must be the same used by the step procedures in the server. You can use more than one database or subschema at a time. However, this manual discusses the use of only one subschema for a server.

If any errors occur in binding to the database, trap the error in the Declaratives section, and use the DBM$SIGNAL routine to return a fatal error status to the server process:

```
WORKING-STORAGE SECTION.

01  status_result               PIC S9(5) COMP.

PROCEDURE DIVISION GIVING status_result.

DECLARATIVES.
DML-FAILURE SECTION.
    USE FOR DB-EXCEPTION.
010-DBM-FAILURE.
    MOVE DB-CONDITION TO status_result.
    CALL "DBM$SIGNAL".
    EXIT PROGRAM.
END DECLARATIVES.
```

Start the dummy database transaction by using the READY statement, which causes DBMS to bind to the database. If the step procedures in the server write or modify records in the database, use the STORE statement to write a dummy record to the database to force DBMS to create an .RUJ file. Finally, use the ROLLBACK statement to end the dummy transaction and delete the dummy record. For example:

```
MAIN SECTION.

000-start.
    SET status_result TO SUCCESS.

    READY CONCURRENT UPDATE.
    MOVE "000000" TO emp_badge_number.
    STORE employee_record.
    ROLLBACK.
```

If you do not end the database transaction in the initialization procedure, the first procedure that uses this server fails with a DBM$_ALLREADY error.

Example 2.3, "COBOL Initialization Procedure for DBMS" shows the complete COBOL version of the initialization procedure for a server that accesses a DBMS database. This example also illustrates how storing a dummy record forces DBMS to create the .RUJ file for the server process. In this case, the ROLLBACK statement is used to end the database transaction and delete the dummy record.

Example 2.3. COBOL Initialization Procedure for DBMS

```
IDENTIFICATION DIVISION.
PROGRAM-ID. pers_upd_server_init_proc.

ENVIRONMENT DIVISION.

DATA DIVISION.
SUB-SCHEMA SECTION.

DB  DEFAULT_SUBSCHEMA
WITHIN "PERS_CDD.PERSONNEL_SCHEMA"
FOR "PERS_DB:PERSONNEL".

WORKING-STORAGE SECTION.

01  status_result               PIC S9(5) COMP.

PROCEDURE DIVISION GIVING status_result.
```

```
DECLARATIVES.
DML-FAILURE SECTION.
USE FOR DB-EXCEPTION.
010-DBM-FAILURE.
MOVE DB-CONDITION TO status_result.
CALL "DBM$SIGNAL".
EXIT PROGRAM.
END DECLARATIVES.



MAIN SECTION.

000-start.
SET status_result TO SUCCESS.

READY CONCURRENT UPDATE.
MOVE "000000" TO emp_badge_number.
STORE employee_record.
ROLLBACK.

999-end.
EXIT PROGRAM.
```

2.1.5.2. Using BASIC

The initialization procedure for a server using a database using DBMS DML must identify the database the server uses. You do this by naming the schema and subschema in the database using the INVOKE statement. For example:

```
# INVOKE DEFAULT_SUBSCHEMA -
         WITHIN PERS_CDD.PERSONNEL_SCHEMA -
         FOR PERS_DB:PERSONNEL -
         ( RECORDS )
```

Start the dummy transaction using the READY statement. Use the STORE statement to write a dummy record to the database, and then end the transaction using a ROLLBACK statement to delete the dummy record. For example:

```
# READY CONCURRENT UPDATE
employee_record::emp_badge_number = "000000"
# STORE employee_record
# ROLLBACK
```

Example 2.4, "BASIC Initialization Procedure for DBMS" illustrates a complete BASIC initialization procedure for a server that accesses a DBMS database. No error handling is necessary in this procedure because DBMS DML always signals a fatal OpenVMS error status when it detects an error condition.

Example 2.4. BASIC Initialization Procedure for DBMS

```
FUNCTION LONG pers_upd_server_init_proc

%INCLUDE "pers_files:pers_common_defns"

# INVOKE DEFAULT_SUBSCHEMA -
         WITHIN PERS_CDD.PERSONNEL_SCHEMA -
         FOR PERS_DB:PERSONNEL -
         ( RECORDS )
```

```
pers_upd_server_init_proc = persmsg_success

# READY CONCURRENT UPDATE
employee_record::emp_badge_number = "000000"
# STORE employee_record
# ROLLBACK

END FUNCTION
```

2.1.6. Initialization Procedures for RMS Files

An initialization procedure for a server process using RMS opens the files used by the step procedures in the server. The file definitions used in the initialization procedure must be the same as the definitions used in other procedures using those files. If you use a language that assigns channels, the channel number must also be the same in the initialization and step procedures.

If the step procedures in the server require only read access to a file, then open the file for read access only. If the step procedures in the server write to a file, then open the file for read/write access. Specify shared access if more than one server process needs access to the file.

If your step procedures need to lock multiple records in a single record stream or retain record locks after writing or updating a record, you must specify explicit lock control when you open a file.

2.1.6.1. Using COBOL

You name the files used by the procedures in the server in the Environment and Data Divisions. For example, the procedures that run in server PERS_UPD_SERVER use the Employee and History files:

```
ENVIRONMENT DIVISION.

INPUT-OUTPUT SECTION.
FILE-CONTROL.
SELECT  emp_file
ORGANIZATION INDEXED
ACCESS RANDOM
ASSIGN TO "emp_file:employee.dat".



SELECT  hist_file
ORGANIZATION INDEXED
ACCESS RANDOM
ASSIGN TO "hist_file:history.dat".

I-O-CONTROL.
APPLY LOCK-HOLDING ON emp_file,
hist_file.



DATA DIVISION.

FILE SECTION.
```

```
FD      emp_file
EXTERNAL
DATA RECORD IS employee_record
RECORD KEY emp_badge_number OF employee_record.
COPY "pers_cdd.employee_record" FROM DICTIONARY.

FD      hist_file
EXTERNAL
DATA RECORD IS history_record
RECORD KEY hist_badge_number OF history_record.
COPY "pers_cdd.history_record" FROM DICTIONARY.
```

The step procedures in the server PERS_UPD_SERVER use explicit record locking; therefore, the initialization procedure specifies the LOCK-HOLDING statement:

```
I-O-CONTROL.
APPLY LOCK-HOLDING ON emp_file,
                      hist_file.
```

If you declare a file-status variable using the FILE-STAT clause in the SELECT statement, define the variable in the Working-Storage Section. For example:

```
WORKING-STORAGE SECTION.
01  file-status                PIC XX IS EXTERNAL.
```

In the following example, the GIVING clause of the Procedure Division header specifies STATUS_RESULT as the procedure's return-status variable. If the initialization procedure traps any errors while trying to open the Employee and History files, it signals the RMS STS and STV error codes, moves the RMS error status into the STATUS_RESULT variable, and exits.

```
WORKING-STORAGE SECTION.

01  status_result              PIC S9(5) COMP.

PROCEDURE DIVISION GIVING status_result.

DECLARATIVES.
employee_file SECTION.
USE AFTER STANDARD ERROR PROCEDURE ON emp_file.
employee_file_handler.
CALL "LIB$SIGNAL" USING BY VALUE RMS-STS OF emp_file,
BY VALUE RMS-STV OF emp_file.
MOVE RMS-STS OF emp_file TO status_result.
EXIT PROGRAM.


history_file SECTION.
USE AFTER STANDARD ERROR PROCEDURE ON hist_file.
history_file_handler.
CALL "LIB$SIGNAL" USING BY VALUE RMS-STS OF hist_file,
BY VALUE RMS-STV OF hist_file.
MOVE RMS-STS OF hist_file TO status_result.
EXIT PROGRAM.
END DECLARATIVES.
```

The initialization procedure initializes the STATUS_RESULT variable to success, and then opens the Employee and History files. Because other processes need to access the files, the procedure specifies the ALLOWING ALL clause.

```
MAIN SECTION.

000-start.
SET status_result TO SUCCESS.

OPEN I-O emp_file ALLOWING ALL.
OPEN I-O hist_file ALLOWING ALL.

999-end.
EXIT PROGRAM.
```

See the COBOL documentation for more information on using RMS files with COBOL.

Example 2.5, "COBOL Initialization Procedure for RMS Server" shows the complete COBOL initialization procedure.

Example 2.5. COBOL Initialization Procedure for RMS Server

```
IDENTIFICATION DIVISION.
PROGRAM-ID. pers_upd_server_init_proc.

ENVIRONMENT DIVISION.


INPUT-OUTPUT SECTION.
FILE-CONTROL.
SELECT  emp_file
ORGANIZATION INDEXED
ACCESS RANDOM
ASSIGN TO "emp_file:employee.dat".


SELECT  hist_file
ORGANIZATION INDEXED
ACCESS RANDOM
ASSIGN TO "hist_file:history.dat".


I-O-CONTROL.
APPLY LOCK-HOLDING ON emp_file,
hist_file.

DATA DIVISION.

FILE SECTION.
FD      emp_file
EXTERNAL
DATA RECORD IS employee_record
RECORD KEY emp_badge_number OF employee_record.
COPY "pers_cdd.employee_record" FROM DICTIONARY.

FD      hist_file
EXTERNAL
DATA RECORD IS history_record
RECORD KEY hist_badge_number OF history_record.
COPY "pers_cdd.history_record" FROM DICTIONARY.
```

```
WORKING-STORAGE SECTION.

01  status_result               PIC S9(5) COMP.

PROCEDURE DIVISION GIVING status_result.


DECLARATIVES.
employee_file SECTION.
USE AFTER STANDARD ERROR PROCEDURE ON emp_file.

employee_file_handler.
CALL "LIB$SIGNAL" USING BY VALUE RMS-STS OF emp_file,
BY VALUE RMS-STV OF emp_file.
MOVE RMS-STS OF emp_file TO status_result.
EXIT PROGRAM.

history_file SECTION.
USE AFTER STANDARD ERROR PROCEDURE ON hist_file.

history_file_handler.
CALL "LIB$SIGNAL" USING BY VALUE RMS-STS OF hist_file,
BY VALUE RMS-STV OF hist_file.
MOVE RMS-STS OF hist_file TO status_result.
EXIT PROGRAM.
END DECLARATIVES.


MAIN SECTION.

000-start.
SET status_result TO SUCCESS.

OPEN I-O emp_file ALLOWING ALL.
OPEN I-O hist_file ALLOWING ALL.

999-end.
EXIT PROGRAM.
```

2.1.6.2. Using BASIC

The examples in this section show a BASIC initialization procedure that opens an Employee file and a History file.

The procedure PERS_UPD_SERVER_INIT_PROC first includes some common definitions used by the Personnel application and the record layouts for the Employee and History files:

```
%INCLUDE "pers_files:pers_common_defns"
%INCLUDE %FROM %CDD "pers_cdd.employee_record"
%INCLUDE %FROM %CDD "pers_cdd.history_record"
```

The PERS_COMMON_DEFNS.BAS file includes definitions for the channel numbers used for the Employee and History files, together with frequently used BASIC errors, error message symbols, system services, and ACMS, OpenVMS, and RMS errors:

```
!+
! Common definitions for the PERSONNEL application.
!-
```

```
!+
! Channel numbers.
!-
DECLARE LONG CONSTANT emp_file = 1%
DECLARE LONG CONSTANT hist_file = 2%


!+
! Frequently used BASIC error codes.
!-
DECLARE LONG CONSTANT basicerr_wait_exhausted = 15%
DECLARE LONG CONSTANT basicerr_duplicate_key = 134%
DECLARE LONG CONSTANT basicerr_record_locked = 154%
DECLARE LONG CONSTANT basicerr_record_not_found = 155%
DECLARE LONG CONSTANT basicerr_deadlock = 193%


!+
! Personnel application messages
!-
EXTERNAL LONG CONSTANT persmsg_success
EXTERNAL LONG CONSTANT persmsg_empexists
EXTERNAL LONG CONSTANT persmsg_empnotfound
EXTERNAL LONG CONSTANT persmsg_emplocked
EXTERNAL LONG CONSTANT persmsg_empchanged
EXTERNAL LONG CONSTANT persmsg_empdeleted


!+
! Frequently used system services
!-
EXTERNAL LONG FUNCTION SYS$GETTIM

!+
! ACMS, OpenVMS system and RMS status codes
!-
EXTERNAL LONG CONSTANT ACMS$_TRANSTIMEDOUT
EXTERNAL LONG CONSTANT RMS$_NRU
EXTERNAL LONG CONSTANT RMS$_DDTM_ERR
```

The initialization procedure then specifies the MAP statements for the Employee and History files:

```
MAP ( emp_map ) employee_record emp_rec
MAP ( hist_map ) history_record hist_rec
```

Next, using an error handler, the procedure initializes the return status to success and opens the Employee and History files. If both files are opened successfully, the procedure returns the success status, indicating that the server process is now ready for use. If an error occurs, the error handler sets the return status to the RMS error status, indicating that the initialization processing failed. The EXIT HANDLER statement causes BASIC to resignal the error, which ACMS then writes to the ACMS audit trail log. Note that the built-in RMSSTATUS function can be used only after BASIC has successfully opened a file.

```
WHEN ERROR IN
    pers_upd_server_init_proc = persmsg_success
    OPEN  "emp_file:employee.dat"                          &
                FOR INPUT AS FILE # emp_file,              &
```

```
                ORGANIZATION INDEXED FIXED,                 &
                ALLOW MODIFY,                               &
                ACCESS MODIFY,                              &
                UNLOCK EXPLICIT,                            &
                MAP emp_map,                                &
                PRIMARY KEY emp_rec::emp_badge_number

    OPEN  "hist_file:history.dat"                           &
                FOR INPUT AS FILE # hist_file,              &
                ORGANIZATION INDEXED FIXED,                 &
                ALLOW MODIFY,                               &
                ACCESS MODIFY,                              &
                UNLOCK EXPLICIT,                            &
                MAP hist_map,                               &
                PRIMARY KEY hist_rec::hist_badge_number
USE
    pers_upd_server_init_proc = VMSSTATUS
    EXIT HANDLER
END WHEN
```

The procedures that run in PERS_UPD_SERVER use explicit lock control to handle record locks to ensure the consistency of the Employee and History files. For this reason, the OPEN statement contains an UNLOCK EXPLICIT clause. Any record accessed by any procedure in the task group remains locked until it is explicitly unlocked with an UNLOCK or FREE statement.

Example 2.6, "BASIC Initialization Procedure for RMS Server" contains a complete BASIC initialization procedure.

Example 2.6. BASIC Initialization Procedure for RMS Server

```
FUNCTION LONG pers_upd_server_init_proc

%INCLUDE "pers_files:pers_common_defns"
%INCLUDE %FROM %CDD "pers_cdd.employee_record"
%INCLUDE %FROM %CDD "pers_cdd.history_record"

MAP ( emp_map ) employee_record emp_rec
MAP ( hist_map ) history_record hist_rec

WHEN ERROR IN
    pers_upd_server_init_proc = persmsg_success
    OPEN  "emp_file:employee.dat"                           &
                FOR INPUT AS FILE # emp_file,               &
                ORGANIZATION INDEXED FIXED,                 &
                ALLOW MODIFY,                               &
                ACCESS MODIFY,                              &
                UNLOCK EXPLICIT,                            &
                MAP emp_map,                                &
                PRIMARY KEY emp_rec::emp_badge_number

    OPEN  "hist_file:history.dat"                           &
                FOR INPUT AS FILE # hist_file,              &
                ORGANIZATION INDEXED FIXED,                 &
                ALLOW MODIFY,                               &
                ACCESS MODIFY,                              &
                UNLOCK EXPLICIT,                            &
                MAP hist_map,                               &
                PRIMARY KEY hist_rec::hist_badge_number
```

```
USE
    pers_upd_server_init_proc = VMSSTATUS
    EXIT HANDLER
END WHEN

END FUNCTION
```

2.2. Writing Termination Procedures

Termination procedures perform application-specific cleanup work for a server process. Note that Rdb, DBMS, and RMS automatically release databases and close files when a process runs down.

The use of a termination procedure for a server is optional. If you do specify a termination procedure for a server, ACMS calls the termination procedure whenever a server process runs down. The only exception is when a server process is forced to run down as the result of a task cancellation; in that case, by default, ACMS does not call the termination procedure. However, by using the ALWAYS EXECUTE TERMINATION PROCEDURE ON CANCEL clause when you define the server in the task group definition, you can force ACMS to call the termination procedure when a server is run down due to a task cancellation. If you do not specify a termination procedure, ACMS runs down the server process without performing any application-specific termination processing.

ACMS runs down server processes when an application is stopped and when more processes than the minimum defined for the server have been started and the extra processes are not needed to handle users' demands. As with initialization procedures, have termination procedures do work specific to the server process rather than task-related work. Termination procedures do the same kind of work for server processes that use Rdb and DBMS databases and RMS files.

Follow these guidelines when writing a termination procedure for files and databases:

- Have termination procedures return a status value to the server process to indicate whether the termination procedure completed successfully.

  If you do not return a status value, the termination continues, but a message that the termination routine has failed is logged in the audit trail log.

- A termination procedure cannot assign values to fields in group or user workspaces.

  Because ACMS does not pass workspaces to termination procedures, there is no way to move data to fields in workspaces.

The following sections contain examples of termination procedures. They describe how to write code for Rdb and DBMS databases, and for RMS files.

2.2.1. Termination Procedures for Rdb Databases Using SQL

You do not need to write a termination procedure for a server that uses an Rdb database. When a server process stops, Rdb automatically releases the database used by the process, rolling back a database transaction if one is still active.

If you decide that you need a termination procedure to perform application-specific processing when the server stops, you must be careful. If you explicitly include a FINISH statement in a server termination

procedure, Rdb commits an outstanding database transaction. However, typically you do not want to commit an outstanding transaction in a termination procedure. For example, you normally want to roll back an existing database transaction if:

- An incorrectly coded step procedure does not perform all necessary updates and does not commit a database transaction.
- There is an outstanding database transaction when a task is canceled and you specify that termination procedures be called for cancels.

In general, if there is a chance that your termination procedure will be called when there is an outstanding database transaction and you are going to use the FINISH verb, include a ROLLBACK verb before the FINISH verb.

Because a transaction is not usually active when the termination procedure runs, the termination procedure should ignore any error from the ROLLBACK verb. Any error returned by the FINISH verb is used as the return status of the termination procedure.

Example 2.7, "SQL Termination Procedure" shows a sample termination procedure for a fictional database.

Example 2.7. SQL Termination Procedure

```
IDENTIFICATION DIVISION.
*****************************************************************
PROGRAM-ID. PERS-TERM-PROC.
*****************************************************************
*         F U N C T I O N A L   D E S C R I P T I O N           *
*                                                               *
*   This procedure is used to close the PERSONNEL database.     *
*                                                               *
*****************************************************************
ENVIRONMENT DIVISION.
CONFIGURATION SECTION.
*****************************************************************
DATA DIVISION.
*****************************************************************


WORKING-STORAGE SECTION.
*
* return status
*
01 RET-STAT     PIC S9(9) COMP.
*
* Define the SQL return status
*
01 SQLCODE      PIC S9(9) COMP.
*
EXEC SQL
DECLARE EXTERNAL SCHEMA FILENAME personnel_database:employees
END-EXEC.


*****************************************************************
PROCEDURE DIVISION GIVING RET-STAT.
```

```
************************************************************
MAIN SECTION.

000-CLOSE_DB.

        SET RET-STAT TO SUCCESS.
*
* <<<<Insert application-specific cleanup here>>>>
*
        EXEC SQL ROLLBACK END-EXEC.
        EXEC SQL FINISH END-EXEC.
        IF SQLCODE < ZERO
        THEN
            MOVE RDB$LU_STATUS TO RET-STAT
            CALL "SQL$SIGNAL"
    END-IF.

100-EXIT-PROGRAM.
        EXIT PROGRAM.
```

For more information about SQL, refer to the SQL documentation.

2.2.2. Termination Procedures for Rdb Databases Using RDO

You do not need to write a termination procedure for a server that uses an Rdb database. When a server process stops, Rdb automatically releases the database used by the process, rolling back a database transaction if one is still active.

If you decide that you need a termination procedure to perform application-specific processing when the server stops, you must be careful. If you explicitly include a FINISH statement in a server termination procedure, Rdb commits an outstanding database transaction. However, typically you do not want to commit an outstanding transaction in a termination procedure. For example, you normally want to roll back an existing database transaction if:

- An incorrectly coded step procedure does not perform all necessary updates and does not commit a database transaction.
- There is an outstanding database transaction when a task is canceled and you specify that termination procedures be called for cancellations.

In general, if there is a chance that your termination procedure will be called when there is an outstanding database transaction, and you are going to use the FINISH verb, include a ROLLBACK verb before the FINISH verb.

Because a transaction is usually not active when the termination procedure runs, any error from the ROLLBACK verb is ignored. Any error returned by the FINISH verb is used as the return status of the termination procedure. For example:

```
!
! <<<<Insert application-specific cleanup here>>>>
!
&RDB&   ROLLBACK
```

```
&RDB&   ON ERROR
            personnel_term_proc = persmsg_success
&RDB&   END_ERROR

&RDB&   FINISH
&RDB&   ON ERROR
            personnel_term_proc = RDB$LU_STATUS
&RDB&   END_ERROR
```

2.2.3. Termination Procedures for DBMS Databases

You do not need to write a termination procedure for a server that uses a DBMS database. When a server process stops, DBMS automatically unbinds the database used by the process, rolling back a database transaction if one is still active. This section illustrates how to unbind from a DBMS database using the DBMS UNBIND embedded DML statement. Note that there is no UNBIND statement in the COBOL language.

The following example illustrates a termination procedure for a DBMS database written in BASIC:

```
FUNCTION LONG pers_upd_server_term_proc

%INCLUDE "pers_files:pers_common_defns"

!
! <<<<Insert application-specific cleanup here>>>>
!
# INVOKE DEFAULT_SUBSCHEMA -
         WITHIN PERS_CDD.PERSONNEL_SCHEMA -
         FOR PERS_DB:PERSONNEL -
         ( RECORDS )

# ROLLBACK ( TRAP ERROR )
# UNBIND

pers_upd_server_term_proc = persmsg_success

END FUNCTION
```

If a database transaction is active when a step procedure explicitly unbinds from a database, DBMS returns an error. Therefore, use the ROLLBACK statement to roll back an outstanding transaction. Because there is not usually a transaction active when a termination procedure is executed, ignore any error returned by the ROLLBACK statement. Finally, use the UNBIND statement to unbind from the database.

2.2.4. Termination Procedures for RMS Files

You do not need to write a termination procedure for a server that uses RMS files. When a server process stops, RMS automatically closes any files that the process has opened. A termination procedure for an RMS server simply closes each open file used by the server, returning a failure status if an error is detected.

2.2.4.1. Using COBOL

The termination procedure in *Example 2.8, "COBOL Termination Procedure for RMS Files"* closes the Employee and History files. Any error is signaled and returned as the procedure's return status.

Example 2.8. COBOL Termination Procedure for RMS Files

```
IDENTIFICATION DIVISION.
PROGRAM-ID. pers_upd_server_term_proc.



ENVIRONMENT DIVISION.



INPUT-OUTPUT SECTION.
FILE-CONTROL.
SELECT  emp_file
        ORGANIZATION INDEXED
        ACCESS RANDOM
        ASSIGN TO "emp_file:employee.dat".

SELECT  hist_file
        ORGANIZATION INDEXED
        ACCESS RANDOM
        ASSIGN TO "hist_file:history.dat".



I-O-CONTROL.
APPLY LOCK-HOLDING ON emp_file,
                      hist_file.

DATA DIVISION.

FILE SECTION.
FD      emp_file
        EXTERNAL
        DATA RECORD IS employee_record
        RECORD KEY emp_badge_number OF employee_record.
COPY "pers_cdd.employee_record" FROM DICTIONARY.



FD      hist_file
        EXTERNAL
        DATA RECORD IS history_record
        RECORD KEY hist_badge_number OF history_record.
COPY "pers_cdd.history_record" FROM DICTIONARY.



WORKING-STORAGE SECTION.

01  status_result               PIC S9(5) COMP.

PROCEDURE DIVISION GIVING status_result.

DECLARATIVES.
employee_file SECTION.
    USE AFTER STANDARD ERROR PROCEDURE ON emp_file.
```

```
employee_file_handler.
        CALL "LIB$SIGNAL" USING BY VALUE RMS-STS OF emp_file,
                                BY VALUE RMS-STV OF emp_file.
        MOVE RMS-STS OF emp_file TO status_result.

history_file SECTION.
    USE AFTER STANDARD ERROR PROCEDURE ON hist_file.

history_file_handler.
        CALL "LIB$SIGNAL" USING BY VALUE RMS-STS OF hist_file,
                                BY VALUE RMS-STV OF hist_file.
        MOVE RMS-STS OF hist_file TO status_result.
END DECLARATIVES.



MAIN SECTION.

000-start.
    SET status_result TO SUCCESS.
*
* <<<<Insert application-specific cleanup here>>>>
*
    CLOSE emp_file.
    CLOSE hist_file.

999-end.
    EXIT PROGRAM.
```

2.2.4.2. Using BASIC

The termination procedure in *Example 2.9, "BASIC Termination Procedure for RMS Files"* closes the Employee and History files. Any error is signaled and returned as the procedure's return status.

Example 2.9. BASIC Termination Procedure for RMS Files

```
    FUNCTION LONG pers_upd_server_term_proc

    %INCLUDE "pers_files:pers_common_defns"


    !
    ! <<<<Insert application-specific cleanup here>>>>
    !

    WHEN ERROR IN
        pers_upd_server_term_proc = persmsg_success
        CLOSE # emp_file
        CLOSE # hist_file
    USE
        pers_upd_server_term_proc = VMSSTATUS
        EXIT HANDLER
    END WHEN

    END FUNCTION
```

2.3. Server Process Rundown

One way to achieve high system performance is to avoid stopping and restarting servers. In addition to the overhead of OpenVMS process creation, starting a server also involves running the server initialization procedure that binds to databases and opens files. Perform these operations as infrequently as possible.

On the other hand, if your server is interrupted and left in an unpredictable state as a result of a task cancellation, it is best to run down the server process and start a new one.

In order to balance these two needs, ACMS allows you to control whether a server process is run down when the execution of a server procedure is interrupted due to a task cancel. ACMS provides the following three options:

- Run down on cancel only if the cancel caused the server to be interrupted

  With this option, ACMS runs down the server process only if the execution of a server procedure was interrupted due to the task cancellation. For example, if a task is retaining context in a server, but the server is not actually executing a procedure at the time of the cancel, ACMS does not run down the server.

- Always run down on cancel

  With this option, ACMS always runs down the server process if the task is canceled while it has context in the server. This option can cause unnecessary server process rundowns. For example, if a task is retaining context in a server when it is canceled, ACMS always runs down the server process, even if the task was not actually executing a server procedure at the time of the cancel. Running down a server in this situation is not necessary because a server procedure was not actually interrupted; therefore, the server is in a predictable state.

- Do not run down on cancel

  With this option, under normal conditions ACMS never runs down the server process if the task is canceled while it has context in the server. However, note that under certain conditions, such as when a server procedure generates a fatal OpenVMS exception, ACMS always runs down a server process. Use this option only when you can guarantee that all context in the server can be cleaned up. Failure to clean up all server context can result in the failure of a subsequent task that uses the server process.

In most cases, the recommended option is to run down down on cancel only if the cancel caused a server procedure to be interrupted. This option balances the need for good performance with the need to run down servers that are in an unpredictable state.

You can specify the rundown option for your servers in the following ways:

- Define the rundown option as a server subclause in your task group definition. The choices of syntax are:

  RUNDOWN ON CANCEL IF INTERRUPTED
  RUNDOWN ON CANCEL
  NO RUNDOWN ON CANCEL

  If you do not specify a rundown attribute, the default is RUNDOWN ON CANCEL.

- Override the rundown attribute that you specified in your task group definition by returning a status from a cancel procedure. In two instances, ACMS overrides the option that you specify. If a fatal error is generated in procedure code, or if a channel is left open to a device when a procedure finishes, ACMS always runs down the server process. See *Section 2.4, "Using Cancel Procedures"* for more information on writing server cancel procedures.

Table 2.1, "Server Rundown" shows whether or not ACMS runs down a server during a cancel operation. The table assumes that a task has context in the server at the time the cancellation occurs. In cancel processing, ACMS never runs down a server if the task does not have context in any servers when the cancellation occurs.

Table 2.1. Server Rundown

Rundown Characteristic	**RUNDOWN ON CANCEL**		**RUNDOWN ON CANCEL IF INTERRUPTED**		**NO RUNDOWN ON CANCEL**	
Server executing during cancel?	**No**	**Yes**	**No**	**Yes**	**No**	**Yes**
ACMS$RAISE_ ... _EXCEPTION	N/A	Run down	N/A	Not run down	N/A	Not run down
ACMSAD$REQ_ CANCEL	N/A	Run down	N/A	Run down	N/A	Not run down
Retain context and cancel task in action step	Run down	N/A	Not run down	N/A	Not run down	N/A
Fatal error generated in procedure code	N/A	Run down	N/A	Run down	N/A	Run down
Channel open to device error created from procedure	N/A	Run down	N/A	Run down	N/A	Run down
All other cancels	Run down	Run down	Not run down	Run down	Not run down	Not run down

2.4. Using Cancel Procedures

This section first discusses the traditional reasons for using cancel procedures. The section then provides guidelines for writing procedures to avoid using cancel procedures, describes situations in which cancel procedures are unavoidable, and explains how to use the $SETAST system service to avoid canceling a task during critical portions of a procedure. This section also describes the conditions under which cancel procedures are called and explains how to write a cancel procedure.

The traditional reasons for using cancel procedures are:

- Cleaning up procedure execution

  This might involve closing a channel that was opened to a terminal or to a temporary work file.

- Freeing non-transaction-based resources

Any transaction-based resources, such as record locks, that a procedure acquires are automatically freed when a transaction ends, whether the transaction commits or aborts. However, if a procedure acquires resources outside a distributed transaction, then the server process must release those resources if the server is to remain active (and not run down) following an exception. Following are examples of situations in which you need to release resources:

- Releasing locks

  For example, if a step procedure takes out a lock on a resource by calling the OpenVMS $ENQ lock manager service directly, then that lock must subsequently be released by a call to the $DEQ service. If a task executes to completion normally, then the step procedure that acquired the lock can release it; if the task retains context in the server, another step procedure called later can release the lock. However, if the task is canceled, then the server cancel procedure must free the lock if the server process is to remain active and if other task instances need to acquire the lock.

- Freeing memory

  Another example is when a step procedure calls LIB$GET_VM to allocate memory for a task instance. Because the memory is required to execute only the current task instance, it must subsequently be freed by a call to LIB$FREE_VM. If a task executes to completion normally, then the step procedure that allocated memory can free memory; if the task retains context in the server, another step procedure called later on can free the allocated memory. However, if the task is canceled, then the server cancel procedure must free memory if the server process is to remain active. Failure to free memory eventually results in the server running out of virtual memory.

- Closing channels

  As a third example, you might need to open a channel to a terminal in a step procedure. Although generally not recommended, some applications require a procedure running in a procedure server to perform terminal I/O. However, if the task is canceled while the procedure has a channel open to the terminal, ACMS cannot close the channel. For this reason, if a task uses a processing step that does terminal I/O from a procedure server, ACMS always runs down the server process if the task is canceled and the server still has channels open to the terminal device.

  To avoid ACMS running down the server, you can use a cancel procedure to close the channel to the terminal. Note that if any channels are left open to the terminal, then ACMS overrides both the return status of the cancel procedure and the NO RUNDOWN clause of the server definition. ACMS also cancels the task and runs down the server if a step procedure ends normally but leaves a channel still open to the terminal.

- Rolling back an active database transaction or a recovery unit

  A cancel procedure is needed to roll back active database transactions or recovery units under the following conditions:

  - If the step procedures in the server directly control Rdb or DBMS database transactions or RMS recovery units

  - If the database transactions or recovery units do not participate in a distributed transaction controlled from the task definition

  - If a task is canceled while retaining context in the server between processing steps

  - If the server is not run down as a result of the task being canceled

A cancel procedure is not necessary if the server is run down as a result of the task being canceled. This is because the database transaction or recovery unit is automatically rolled back as a result of the server process running down. However, it is more efficient to allow a server to remain active if a task is canceled while retaining context but not executing in the server. In this case, it is advantageous to use a cancel procedure to roll back the database transaction or recovery unit so that the server can then be used by another task instance. Note that the recommended option is to allow a server process to run down if ACMS is forced to interrupt a step procedure in order to process a task cancellation.

2.4.1. Guidelines for Avoiding Cancel Procedures

There are two important reasons for avoiding cancel procedures. First, cancel procedures can adversely affect application performance. Also, it is often difficult to write a cancel procedure that performs the necessary cleanup operations, chiefly because an exception can be raised at any time while a task is executing. Therefore, it is recommended that wherever possible you avoid designing and writing tasks and step procedures that require server cancel procedures to clean up server processes following an exception.

To avoid writing cancel procedures, keep the following guidelines in mind as you design and write tasks and step procedures:

- Control database transactions and recovery units with transaction steps in the task definition.

  Resource managers automatically roll back active database transactions and recovery units participating in a distributed transaction if that transaction rolls back. Therefore, you do not need to write a cancel procedure to do this if all database transactions and recovery units participate in distributed transactions that are controlled by the task definition.

  Note

  When using Rdb with RDO, or RMS, you must use a cancel procedure if you allow a server process to remain active after a task cancellation. See *Section 2.4.2, "Situations in Which Using Cancel Procedures Is Unavoidable"* for more information.

- Allow server processes to run down following an exception.

  In most cases, if an exception requires ACMS to interrupt a step procedure while it is executing, allowing the server process to run down as part of the exception-handling sequence has the advantage that OpenVMS automatically performs most, if not all, of the necessary cleanup operations. For example, when a process is run down, OpenVMS automatically closes any channels that are still open. Also, any locks currently owned by the process are freed.

- Avoid operations that require cleanup.

  For example, if you use task workspaces to store data rather than allocate memory using LIB$GET_VM, then you do not need a cancel procedure to free memory allocated in this way.

  However, some applications may require that a step procedure acquire a nondistributed-transaction-based resource. For example, a step procedure may need to acquire an OpenVMS lock using the $ENQ service before performing a critical operation. Using the $DEQ service, the step procedure releases the lock as soon as the operation has been completed.

  When an exception is raised, ACMS immediately interrupts a server process. If the code is interrupted during the time that the server process has acquired the lock, the server may not have

the opportunity to call the $DEQ service. Since the server is using an OpenVMS lock, OpenVMS automatically releases the lock when the server process runs down. However, if the server is using an application-specific mechanism to maintain locks on resources, then running down a server process on an exception does not solve the problem; the resource is still locked.

Section 2.4.3, "Using $SETAST to Prevent Procedure Server Interruption", discusses how to prevent the interruption of a procedure server while it is executing. *Section 2.3, "Server Process Rundown"* explains the conditions under which a procedure is run down.

2.4.2. Situations in Which Using Cancel Procedures Is Unavoidable

As mentioned earlier, whenever possible avoid designing and writing step procedures that require server cancel procedures. However, in certain circumstances, using a cancel procedure is unavoidable.

If you are using RDO in a distributed transaction, use a cancel procedure to roll back the default database transaction that Rdb starts automatically if the distributed transaction aborts between two RDO verbs. For example, the following segment of a BASIC step procedure reads and updates a control record in a database. If the distributed transaction times out and aborts immediately after the GET statement, then Rdb starts a default read-only transaction when it executes the next RDO statement (in this case, the MODIFY statement). See *Chapter 4, "Accessing Resource Managers"* for information on accessing an Rdb database using RDO statements.

```
&RDB& START_TRANSACTION
&RDB&   DISTRIBUTED_TRANSACTION DISTRIBUTED_TID dist_tid
&RDB&   READ_WRITE RESERVING cust_control FOR SHARED WRITE

&RDB& FOR FIRST 1% c IN cust_control
&RDB&   GET
&RDB&       cust_num = c.next_cust_num
&RDB&   END_GET
        next_cust_num = cust_num + 1%
&RDB&   MODIFY c USING
&RDB&       c.next_cust_num = next_cust_num
&RDB&   END_MODIFY
&RDB& END_FOR
```

If you are using RMS in a distributed transaction, use a cancel procedure to unlock any records that a step procedure locks after the distributed transaction aborts. For example, the following segment of a BASIC step procedure reads and updates a control record in a file. If the distributed transaction times out and aborts immediately before the GET statement, then RMS is able to read the record successfully but returns an error when the step procedure executes the UPDATE operation. See *Chapter 4, "Accessing Resource Managers"* for information on accessing RMS files in distributed transactions.

```
GET # emp_file,                                          &
    KEY # 0 EQ emp_wksp::emp_badge_number,               &
    ALLOW NONE
MOVE TO # emp_file, emp_wksp
UPDATE # emp_file
```

You must write a cancel procedure in other situations as well. If you are not using distributed transactions and you allow a server to remain active when a task is canceled between two processing steps while retaining context in a server, then:

- If the first processing step starts a database transaction or a recovery unit that is ended in the second processing step, you must write a cancel procedure to roll back the database transaction or recovery unit before the server can be used by another task.

- If the first processing step locks records in an RMS file outside a recovery unit and those records are unlocked by the second processing step, you must write a cancel procedure to unlock the records before the server can be used by another task.

See *Section 2.4.6, "Writing a Cancel Procedure"* for information on writing server cancel procedures.

2.4.3. Using $SETAST to Prevent Procedure Server Interruption

At times, procedures perform operations that, if interrupted, require cleanup. One way to avoid interrupting procedures (and avoid using cancel procedures) is to prevent ACMS from interrupting a step procedure during a critical section of code. To do this, you can use the $SETAST system service to disable delivery of asynchronous system traps (ASTs) at the beginning of the critical code. You can then reenable the delivery of ASTs at the end of the critical code. By using $SETAST, you can set a window in which ACMS cannot interrupt the step procedure if an exception is raised in the task.

Note

If you call the $SETAST system service to disable AST delivery in order to prevent ACMS from interrupting a step procedure, then you must ensure that you call the $SETAST system service to reenable AST delivery before the end of the step procedure. If you leave AST delivery disabled after the end of a step procedure, the server process can hang.

However, setting this window does not guarantee that an event such as a system crash does not interrupt the critical code. Also, this solution does not apply to programs running in DCL servers because the DCL server process handles all cancel requests in supervisor mode.

You must also be careful to avoid creating a situation in which a task cannot be canceled unless the server process is deleted. For example, if a step procedure disables AST delivery before acquiring an OpenVMS lock using the $ENQ service, ACMS cannot cancel the task until all of the following conditions are met:

- A lock is granted to the server process.

- The step procedure completes the critical operation.

- The $DEQ service releases the lock.

- AST delivery is reenabled.

In this example, if the process is never able to acquire the lock, then the task cancellation sequence can never complete because ACMS can never interrupt the server process. The only way to complete the task cancellation sequence is to delete the server process manually using the DCL **`STOP`** command.

To solve the problem of task cancellation, design the code in the step procedure carefully so that the procedure cannot stall indefinitely. You can, for example, use a timer to control how long the step procedure waits for the OpenVMS lock, as shown in *Example 2.10, "Pseudocode for Using $SETAST"*.

Example 2.10. Pseudocode for Using $SETAST

```
Disable AST delivery
Call $ENQ service in order to acquire an OpenVMS lock using an
event flag and using an IOSB.
If $ENQ returns SS$_NORMAL (we are waiting for the lock to be granted),
then

       Call the $SETIMR service to set a timer.  Pass the same event
       flag that was passed to the $ENQ service.

       Call the $WAITFR service to wait for the event flag passed to
       the two services.  When this service finishes, it means that
       either the $ENQ service has completed or the timer has expired.
       To determine which has occurred, check the IOSB passed to the
       $ENQ service.  If the status in the IOSB is non-zero, the $ENQ
       service completed.

If $ENQ service completed
then
       Cancel the timer
else
       Cancel lock request by calling $DEQ

       Enable ASTs
       Call ACMS$RAISE_NONREC_EXCEPTION to cancel the task

If the $ENQ service completed unsuccessfully,
then

       Enable ASTs

       Call ACMS$RAISE_NONREC_EXCEPTION to cancel the task

else

       Execute the critical code

       Release the locking by calling the $DEQ service

       Enable ASTs
```

2.4.4. Conditions Under Which Cancel Procedures Are Called

Stated simply, ACMS calls the cancel procedure defined for each server in which a task is retaining context if either a transaction exception or a nonrecoverable exception is raised while a task is executing. ACMS does *not* call a server cancel procedure if a step exception is raised while a task is executing and the task handles the exception. If, however, a task does not handle a step exception, and a transaction exception or a nonrecoverable exception is raised as a result, ACMS calls a server cancel procedure, as stated. *VSI ACMS for OpenVMS Writing Applications* [https://docs.vmssoftware.com/vsi-acms-writing-apps/], in its discussion of these conditions as they affect ADU syntax, includes specific examples of task definition syntax.

ACMS cancels procedures under the following conditions:

- A step exception is raised that is not handled by the task.

ACMS does not call cancel procedures if a step exception is raised while a task is executing and the exception is handled by the task. However, if the step exception is not handled by the task, then a transaction or nonrecoverable exception is raised, and ACMS calls server cancel procedures.

- A task is canceled from an action clause in a task definition.

  ACMS conditionally calls cancel procedures if a nonrecoverable exception is raised due to a task executing a CANCEL TASK clause. ACMS calls cancel procedures only if the task is maintaining context in one or more server processes when the nonrecoverable exception is raised.

  ACMS processes the server context action before it processes the CANCEL TASK clause. Therefore, if the server context action in the action clause is RELEASE SERVER CONTEXT [IF ACTIVE SERVER CONTEXT], the task will no longer have context in the server, so ACMS does not call server cancel procedures. However, if the server context action is RETAIN SERVER CONTEXT [IF ACTIVE SERVER CONTEXT] or NO SERVER CONTEXT ACTION, and the task has context in one or more servers, then ACMS calls cancel procedures.

- A distributed transaction fails to prepare successfully.

  This transaction exception can occur only while a task is executing a COMMIT TRANSACTION clause. Because the server context action of a transaction step must be RELEASE SERVER CONTEXT [IF ACTIVE SERVER CONTEXT], ACMS does not call cancel procedures in this case.

- Other transaction or nonrecoverable exceptions are raised.

  Excluding the exception conditions already described, ACMS always calls cancel procedures when a transaction or nonrecoverable exception is raised. For example, ACMS calls cancel procedures in any server in which the task is maintaining context:

  - If the transaction timeout specified for a task expires before a distributed transaction completes and a step procedure does not complete before ACMS interrupts it
  - If a user presses **Ctrl/Y** to cancel a task
  - If an operator uses the **`ACMS/CANCEL TASK`** command to cancel the task

2.4.5. Cancel Procedures in Distributed and Nondistributed Transactions

ACMS calls server cancel procedures in a different order depending on whether a task uses distributed transactions, or a task uses either independent database transactions or RMS recovery units, or both.

- In nondistributed transactions

  The server cancel procedure defined for the server is called *before* executing a database transaction or recovery-unit action, such as COMMIT or ROLLBACK, as specified in the task definition.

- In distributed transactions

  Due to the asynchronous nature of transaction aborts, you cannot predict when cancel procedures are called.

Section 2.3, "Server Process Rundown" discusses the conditions under which ACMS runs down a server process.

2.4.6. Writing a Cancel Procedure

You declare a cancel procedure for a server in the ACMS procedure server definition within a task group. For example:

```
            .
            .
            .
SERVER IS
  pers_upd_server:
      .
      .
    CANCEL PROCEDURE IS pers_upd_server_can_proc;
      .
      .
      .
END SERVER;
```

ACMS calls the cancel procedure PERS_UPD_SERVER_CAN_PROC under the conditions discussed in *Section 2.4.4, "Conditions Under Which Cancel Procedures Are Called"*.

The RUNDOWN ON CANCEL, RUNDOWN ON CANCEL IF INTERRUPTED, or NO RUNDOWN ON CANCEL clause in a server definition determines whether ACMS runs down the server process if a task is canceled while it has context in the server process. The default is RUNDOWN ON CANCEL. If a server definition declares RUNDOWN ON CANCEL, a cancel procedure is usually not necessary. However, if a server definition declares NO RUNDOWN ON CANCEL, then it is often necessary to use a cancel procedure. A cancel procedure may also be necessary if a server definition declares RUNDOWN ON CANCEL IF INTERRUPTED. For example:

```
CANCEL PROCEDURE IS pers_upd_server_can_proc;
NO RUNDOWN ON CANCEL;
```

The server definition initially determines whether or not the server process is run down on cancels. However, the return status of a cancel procedure overrides the server definition. ACMS provides three symbols that a cancel procedure can return:

- ACMS$_RNDWN

  If the cancel procedure returns ACMS$_RNDWN, ACMS runs down the server process even if the server definition declared NO RUNDOWN. If a cancel procedure cannot release the resources allocated to the server, it can return ACMS$_RNDWN to ensure that ACMS runs down the process and releases the resources.

- ACMS$_NRNDWN

  If the cancel procedure returns ACMS$_NRNDWN, under normal conditions ACMS does not run down a server, regardless of whether or not the task is executing in the server process at the time an exception is raised. However, ACMS always runs down a server process if a step procedure signals a fatal OpenVMS exception or leaves channels open to a terminal device.

- ACMS$_RNDWNIFINT

If a cancel procedure returns ACMS$_RNDWNIFINT, ACMS runs down the server process only if the task is executing in the server process at the time an exception is raised. If the task is only maintaining context in the server at the time an exception is raised, then the server process remains active.

Cancel procedures do not have access to workspaces. Store any information that might be needed by the cancel procedure in global variables while a step procedure is executing. The information is then available to the cancel procedure when it executes.

The following sections illustrate cancel procedures for a server accessing an Rdb database using RDO and for a server accessing an RMS file.

2.4.6.1. Cancel Procedure for Rdb with RDO

Write a server cancel procedure when you use Rdb with RDO in the following situations:

- If you access an Rdb database using RDO in a distributed transaction

  If you allow the server to remain active when a task is canceled, you must use a cancel procedure to roll back the default database transaction that Rdb starts if a step procedure accesses the database after a distributed transaction aborts.

- If you write a task that retains context in a server between two processing steps

  If you allow the server to remain active when a task is canceled between two processing steps, you must use a cancel procedure to roll back the database transaction started in the first processing step.

In *Example 2.11, "Server Cancel Procedure in BASIC Using Rdb with RDO"*, the procedure uses the ROLLBACK statement to roll back an active database transaction. Because there might not be a database transaction active every time the cancel procedure is called, the procedure ignores a transaction-not-active (RDB$_BAD_TRANS_HANDLE) error from the ROLLBACK statement. If any other error occurs, the procedure logs the error in the ACMS audit trail log by calling LIB$SIGNAL and returns the ACMS$_RNDWN status to force ACMS to run down the server process. If no errors are detected, the procedure returns the ACMS$_RNDWNIFINT status; in this case, ACMS runs down the server process only if the execution of a step procedure was interrupted due to the cancel.

Example 2.11. Server Cancel Procedure in BASIC Using Rdb with RDO

```
FUNCTION LONG vr_update_cancel
!+
! Invoke database.
!-
&RDB& INVOKE DATABASE FILENAME "avertz_database:vehicle_rentals"

!+
! Cancel procedure return status.
!-
EXTERNAL LONG CONSTANT ACMS$_RNDWNIFINT
EXTERNAL LONG CONSTANT ACMS$_RNDWN


!+
! Rdb error ROLLBACK status code.
!-
EXTERNAL LONG CONSTANT RDB$_BAD_TRANS_HANDLE
```

```
!+
! Error logging routines
!-
EXTERNAL LONG FUNCTION LIB$SIGNAL
EXTERNAL LONG FUNCTION LIB$CALLG


!+
! Assume success.
!-
vr_update_cancel = ACMS$_RNDWNIFINT


!+
! ROLLBACK an outstanding database transaction. Ignore a
! transaction-not-active error. For all other errors, log
! the error and return ACMS$_RNDWN to ensure the server
! runs down.
!-
&RDB& ROLLBACK
&RDB&   ON ERROR
            IF Rdb$LU_STATUS <> RDB$_BAD_TRANS_HANDLE
            THEN
                CALL LIB$CALLG( Rdb$MESSAGE_VECTOR,             &
                                LOC( LIB$SIGNAL ) BY VALUE )
                vr_update_cancel = ACMS$_RNDWN
            END IF
&RDB&   END_ERROR

END FUNCTION
```

2.4.6.2. Cancel Procedure for RMS Files

Write a server cancel procedure when you use RMS in the following situations:

- If you access an RMS file in a distributed transaction

  If you allow the server to remain active when a task is canceled, you must use a cancel procedure to unlock any records that a step procedure locks after a distributed transaction aborts.

- If you write a task that retains context in a server between two processing steps

  If you allow the server to remain active when a task is canceled between two processing steps, you must use a cancel procedure to unlock any records locked by the first processing step.

Example 2.12, "Server Cancel Procedure in COBOL for RMS Files" illustrates a server cancel procedure written in COBOL that uses the UNLOCK statement to release any records locked in the Employee and History files. If an error occurs, the procedure logs the error in the ACMS audit trail log by calling LIB$SIGNAL and returns the ACMS$_RNDWN status to force ACMS to run down the server process. If no errors are detected, the procedure returns the ACMS$_RNDWNIFINT status; in this case, ACMS runs down the server process only if the execution of a step procedure was interrupted due to the cancel.

Example 2.12. Server Cancel Procedure in COBOL for RMS Files

```
 IDENTIFICATION DIVISION.
 PROGRAM-ID. pers_upd_server_can_proc.
```

```
ENVIRONMENT DIVISION.



INPUT-OUTPUT SECTION.
FILE-CONTROL.
SELECT  emp_file
        ORGANIZATION INDEXED
        ACCESS RANDOM
        ASSIGN TO "emp_file:employee_file.dat".



SELECT  hist_file
        ORGANIZATION INDEXED
        ACCESS RANDOM
        ASSIGN TO "hist_file:history_file.dat".

I-O-CONTROL.
APPLY LOCK-HOLDING ON emp_file,
                      hist_file.



DATA DIVISION.

FILE SECTION.
FD      emp_file
        EXTERNAL
        DATA RECORD IS employee_record
        RECORD KEY emp_badge_number OF employee_record.
COPY "pers_cdd.employee_record" FROM DICTIONARY.


FD      hist_file
        EXTERNAL
        DATA RECORD IS history_record
        RECORD KEY hist_badge_number OF history_record.
COPY "pers_cdd.history_record" FROM DICTIONARY.



WORKING-STORAGE SECTION.

01  status_result               PIC S9(5) COMP.

01  ACMS$_RNDWNIFINT            PIC S9(5) COMP
                                VALUE IS EXTERNAL ACMS$_RNDWNIFINT.
01  ACMS$_RNDWN                 PIC S9(5) COMP
                                VALUE IS EXTERNAL ACMS$_RNDWN.

PROCEDURE DIVISION GIVING status_result.



DECLARATIVES.
employee_file SECTION.
    USE AFTER STANDARD ERROR PROCEDURE ON emp_file.
```

```
employee_file_handler.
        CALL "LIB$SIGNAL" USING BY VALUE RMS-STS OF emp_file,
                                BY VALUE RMS-STV OF emp_file
        MOVE ACMS$_RNDWN TO status_result.
        EXIT PROGRAM.
history_file SECTION.
    USE AFTER STANDARD ERROR PROCEDURE ON hist_file.
history_file_handler.
        CALL "LIB$SIGNAL" USING BY VALUE RMS-STS OF hist_file,
                                BY VALUE RMS-STV OF hist_file
        MOVE ACMS$_RNDWN TO status_result.
        EXIT PROGRAM.
END DECLARATIVES.



MAIN SECTION.

000-start.
    UNLOCK emp_file ALL RECORDS.
    UNLOCK hist_file ALL RECORDS.
    MOVE ACMS$_RNDWNIFINT TO status_result.

999-end.
    EXIT PROGRAM.
```

Example 2.13, "Server Cancel Procedure in BASIC" illustrates a server cancel procedure written in BASIC that uses the FREE statement to release any records locked in the Employee and History files. If an error occurs, the procedure returns the ACMS$_RNDWN status to force ACMS to run down the server process. The EXIT HANDLER statement is used to resignal the error so that ACMS writes it to the audit trail log. If no errors are detected, the procedure returns the ACMS$_RNDWNIFINT status; in this case, ACMS runs down the server process only if the execution of a step procedure was interrupted due to the cancel.

Example 2.13. Server Cancel Procedure in BASIC

```
    FUNCTION LONG pers_upd_server_can_proc

    %INCLUDE "pers_files:pers_common_defns"

    EXTERNAL LONG CONSTANT ACMS$_RNDWNIFINT
    EXTERNAL LONG CONSTANT ACMS$_RNDWN



    WHEN ERROR IN
        FREE # emp_file
        FREE # hist_file
        pers_upd_server_can_proc = ACMS$_RNDWNIFINT
    USE
        pers_upd_server_can_proc = ACMS$_RNDWN
        EXIT HANDLER
    END WHEN

    END FUNCTION
```

Chapter 3. Writing Step Procedures

This chapter discusses writing step procedures for ACMS tasks. The suggestions in this chapter apply to users of all languages and all data management systems. The material in this chapter provides a basis for *Chapter 4, "Accessing Resource Managers"*, which contains information and examples specific to Rdb software using SQL, Rdb using RDO, DBMS software, and RMS software.

This chapter discusses the following topics:

- Using workspaces with step procedures

  Explains how tasks use workspaces to pass data between processing steps and exchange steps, and describes the ACMS-supplied system workspaces.

- Using procedures in distributed transactions

  Tells how to write new step procedures and how to migrate existing procedures to participate in distributed transactions.

- Returning status to the task definition

  Discusses how to return status to the task definition using a status return facility or a user-defined workspace.

- Handling error conditions

  Discusses how step procedures handle error conditions by processing error messages and raising recoverable and nonrecoverable exceptions.

- Performing terminal I/O from a procedure server

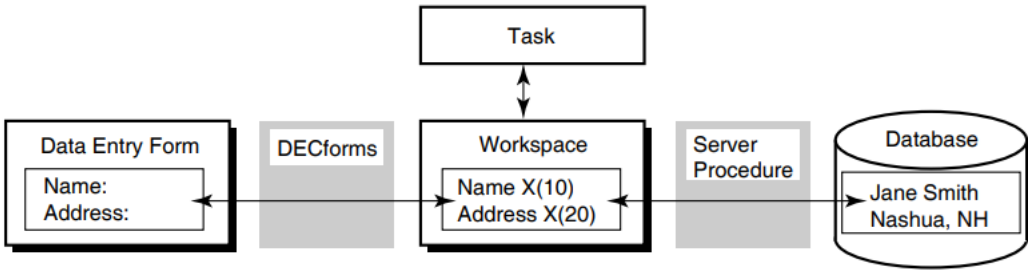
  Explains how programs that run in procedure servers can perform I/O directly to a terminal, which is useful for preexisting programs that you convert to single-step tasks.

3.1. Using Workspaces with Step Procedures

An ACMS task uses workspaces to pass information between the task definition and step procedures and DECforms forms. Workspaces are temporary data storage areas, which are passed to step procedures as parameters. Workspaces are passed by reference (that is, the address is passed), with write access.

Figure 3.1, "How ACMS Applications Use Workspaces " illustrates the way a task uses workspaces to pass data between a form and a step procedure. Once a workspace and its fields have been declared (in CDD, for example), you can use a form to input data and store it in workspace fields. You can then pass that data to a database or RMS file for storage.

Figure 3.1. How ACMS Applications Use Workspaces



3.1.1. Using ACMS-Supplied System Workspaces

ACMS provides special-purpose task workspaces, called **system workspaces**, which contain information about the state of a task. This information might be useful to the step procedures called by the task.

ACMS supplies the following system workspaces:

- ACMS$SELECTION_STRING

  This workspace makes information from an ACMS menu available to the task, forms, and step procedures. You can also use this workspace to pass parameters to DCL command procedures.

  Appendix A, "Summary of ACMS System Workspaces" and *VSI ACMS for OpenVMS Writing Applications* [https://docs.vmssoftware.com/vsi-acms-writing-apps/] contain more information about this workspace.

- ACMS$PROCESSING_STATUS

  A task can use the fields of this workspace to determine the completion status of a step procedure. In addition, ACMS stores information about exceptions in this workspace.

  Section 3.3, "Returning Status to the Task Definition", *Chapter 5, "Using Message Files with ACMS Tasks and Procedures"*, and *Appendix A, "Summary of ACMS System Workspaces"* contain more information about using this workspace.

- ACMS$TASK_INFORMATION

  ACMS stores task execution information such as task ID, sequence number, and task name in this workspace. You can use this workspace, for example, to determine the name of the device from which a task was submitted (for security reasons) or to ascertain whether the task was submitted from a remote node.

  Appendix A, "Summary of ACMS System Workspaces" contains reference information about this workspace.

System workspaces are always available to ACMS tasks. ACMS gives each task its own copy of all three workspaces and initializes each workspace when a task is selected.

Note

Step procedures must not modify the contents of the ACMS$PROCESSING_STATUS or ACMS$TASK_INFORMATION workspaces. Step procedures can, however, modify the contents of the ACMS$SELECTION_STRING workspace.

3.1.2. Identifying Workspaces

You must define record definitions for all the workspaces used by your task. A step procedure reads from or writes to the workspaces using the record names and field names from the record definitions. ACMS takes its workspace definitions from CDD record definitions.

Note

If the programming language you use does not support CDD, you must also define the workspace records in the step procedure.

Example 3.1, "Referencing a Workspace in a Task Definition " shows part of a task definition that declares the VR_CUSTOMERS_WKSP in the USE WORKSPACES clause and passes it to the procedure VR_GET_CUSTOMER_PROC in the CALL statement.

Example 3.1. Referencing a Workspace in a Task Definition

```
REPLACE TASK VR_DISPLAY_CU_TASK

USE WORKSPACES VR_CUSTOMERS_WKSP,


                        .
                        .
                        .
BLOCK WORK WITH FORM I/O IS



GET_CUSTOMERS:
  PROCESSING
      CALL VR_GET_CUSTOMER_PROC USING VR_CUSTOMERS_WKSP,
                  .
                  .
                  .
END DEFINITION;
```

To receive the contents of the workspace named in the task definition, the programming language you use must be able to receive parameters from the calling program. For example, in COBOL, the parameters used to pass information are defined in the Linkage Section and are named in the Procedure Division header.

Example 3.2, "COBOL Procedure that Names a Workspace" shows part of a COBOL procedure that also refers to VR_CUSTOMERS_WKSP.

Example 3.2. COBOL Procedure that Names a Workspace

```
IDENTIFICATION DIVISION.
*********************************************************
PROGRAM-ID. VR-GET-CUSTOMER-PROC IS INITIAL.
.
.
.
```

```
LINKAGE SECTION.
*
* Copy CUSTOMERS record from the CDD
*


EXEC SQL INCLUDE FROM DICTIONARY
            'AVERTZ_CDD_WKSP:VR_CUSTOMERS_WKSP'
END-EXEC.
.
.
.


PROCEDURE DIVISION USING VR_CUSTOMERS_WKSP,
                            .
                            .
                            .
                    GIVING RET-STAT.
```

Example 3.3, "CDD Record Definition for VR_CUSTOMERS_WKSP Workspace" shows part of the CDD record definition of VR_CUSTOMERS_WKSP.

Example 3.3. CDD Record Definition for VR_CUSTOMERS_WKSP Workspace

```
DEFINE RECORD VR_CUSTOMERS_WKSP.
.
.
.
CUSTOMER_ID.
CU_LAST_NAME.
CU_FIRST_NAME.
CU_MIDDLE_INITIAL.
CU_FIRST_ADDRESS_LINE.
.
.
.
END RECORD.
```

Assign an initial value to any non-binary fields for testing in DECforms. For example, set the initial value of each character field in the record definition to blanks, as shown in this CDD field definition:

```
DEFINE FIELD CU_LAST NAME                DATATYPE TEXT SIZE IS 20
        INITIAL VALUE IS "                   ".
```

See the CDD documentation for additional information on assigning initial values.

3.2. Using Procedures in Distributed Transactions

This section discusses the considerations to keep in mind when you write a procedure that accesses a resource manager in a distributed transaction.

A **resource manager** controls shared access to a set of recoverable resources on behalf of application programs. A **resource** is a set of one or more data items in a database or an RMS file. The term

recoverable means that all updates to the resources either can be made permanent or can be undone, and that the integrity of the resources can be recovered after a failure such as a system crash.

The following sections discuss:

- Participation of a procedure in a distributed transaction
- Use of database transactions or recovery units with distributed transactions
- Obtaining the Transaction ID
- Retaining context in distributed transactions
- Migrating existing step procedures to participate in distributed transactions

3.2.1. Determining the Participation of a Procedure in a Distributed Transaction

The following rules determine the participation of a procedure in a distributed transaction:

- When a processing step that executes within a block delimiting a distributed transaction calls a procedure, that procedure automatically participates in the distributed transaction. For example:

```
BLOCK WITH TRANSACTION
    PROCESSING
        CALL    vr_store_cu_proc
        IN      vr_cu_update_server
        USING   vr_control_wksp,
                vr_customers_wksp,
                vr_trans_wksp;
            .
            .
            .
END BLOCK WORK;
       .
       .
       .
```

  Because the processing step executes within the bounds of a distributed transaction, the server automatically participates in the distributed transaction.

- When a processing step that delimits a distributed transaction calls a procedure, that procedure automatically participates in the distributed transaction. For example:

```
PROCESSING WITH TRANSACTION
    CALL    vr_store_cu_proc
    IN      vr_cu_update_server
    USING   vr_control_wksp,
            vr_customers_wksp,
            vr_trans_wksp;
          .
          .
          .
```

  Use this method if a single step procedure needs to update multiple resources. For example, you might choose this method for a procedure that updates an RMS file as well as an Rdb database. You can also use this method if a task has only one step, which is a processing step.

- You can explicitly exclude a procedure server from a distributed transaction by using the WITH NONPARTICIPATING SERVER phrase on the processing step of a task definition:

```
PROCESSING WITH NONPARTICIPATING SERVER
```

See *VSI ACMS for OpenVMS Writing Applications* [https://docs.vmssoftware.com/vsi-acms-writing-apps/] for more information on writing definitions of tasks that use distributed transactions.

In ACMS, you can start a distributed transaction in either an agent program, a task, or a step procedure. *VSI ACMS for OpenVMS Concepts and Design Guidelines* [https://docs.vmssoftware.com/vsi-acms-concepts-and-design-guide/] explains the relative advantages and disadvantages of starting a distributed transaction in each of these locations.

You can also start a distributed transaction in a task and, from that task, call a procedure that acts as an agent. The agent program can call a task on a remote node, and the called task can access databases locally on that node, thus reducing network traffic and increasing the efficiency of the application.

See *VSI ACMS for OpenVMS Concepts and Design Guidelines* [https://docs.vmssoftware.com/vsi-acms-concepts-and-design-guide/] for more information about using a task to update a remote database. See *VSI ACMS for OpenVMS Concepts and Design Guidelines* [https://docs.vmssoftware.com/vsi-acms-concepts-and-design-guide/] for detailed information about using a step procedure as an agent program.

Note

Do not call the $START_TRANS, $END_TRANS, or $ABORT_TRANS system services from a step procedure that is participating in a distributed transaction started by a task or an agent program. If you do call these services under these conditions, they either return an error status or hang until the task is canceled by the terminal user or system operator.

3.2.2. Using Database Transactions or Recovery Units with Distributed Transactions

The unit of interaction with a database that begins with a start-transaction statement is called a database transaction. The Rdb and DBMS documentation refer to this unit as a transaction. A set of RMS recoverable operations is referred to as a recovery unit. To avoid possible confusion with the term distributed transactions, this manual uses the term **database transaction** when referring to this unit for Rdb and DBMS database products and **recovery unit** when referring to this unit for RMS files. The term database transaction is used whether transactions are distributed or nondistributed.

Depending on the database you are using, you start a database transaction with one of the following statements:

Database product	Statement that starts a distributed transaction
Rdb using SQL	SET TRANSACTION
Rdb using RDO	START_TRANSACTION
DBMS	READY

Instructions for starting database transactions are in *Chapter 4, "Accessing Resource Managers"*.

Note that RMS files that are marked for recovery participate automatically in a distributed transaction; in other words, no special syntax is necessary.

The DML verbs COMMIT or ROLLBACK commit or roll back an independent database transaction or a recovery unit that is not participating in a distributed transaction. However, a database transaction that participates in a distributed transaction is automatically committed or rolled back when the distributed transaction ends. Therefore, you cannot use the COMMIT or ROLLBACK DML verbs to end a database transaction that participates in a distributed transaction. The COMMIT and ROLLBACK verbs fail and return an error if you try to use them to end a database transaction that is participating in a distributed transaction.

If a processing step participates in a distributed transaction, you must start the database transaction in the step procedure. You cannot use database-specific or RMS-specific recovery declarations in task definitions in conjunction with distributed transactions. ADU does not allow the use of the WITH SQL/RDB/DBMS/RMS RECOVERY phrase in the definition of a task that is within the bounds of a distributed transaction. These phrases are declining functionality.

Important

Always specify a lock timeout interval when you use Rdb or DBMS in a distributed transaction. This ensures that ACMS can successfully cancel a task that is waiting for a database lock. By specifying a lock timeout interval, you ensure that the task is canceled as soon as the timeout interval expires. If you do not specify a lock timeout interval, ACMS cannot cancel the task until the lock is granted. See *Chapter 4, "Accessing Resource Managers"* for more information on specifying a lock timeout interval.

3.2.3. Obtaining the Transaction ID (TID)

ACMS automatically obtains a transaction ID (TID) when you start a distributed transaction. Whenever a step procedure is called as part of a distributed transaction, ACMS establishes the TID as the default TID of the server process.

For an Rdb or DBMS database transaction to participate in a distributed transaction, you must explicitly pass the TID to Rdb or DBMS when you start the database transaction. In contrast, RMS automatically accesses the TID for files that are marked for recovery-unit journaling. Therefore, no special action is necessary; a step procedure does not need to obtain the TID when using RMS with distributed transactions.

ACMS provides a service, called ACMS$GET_TID, that a step procedure can call to obtain the TID before using the database. For example:

```
CALL "ACMS$GET_TID" USING CS-TID GIVING RET_STAT.
```

See *Chapter 9, "ACMS Programming Services"* for full details on the ACMS$GET_TID service. See *Chapter 4, "Accessing Resource Managers"* for information on how to pass the TID to Rdb and DBMS.

3.2.4. Retaining Server Context in Distributed Transactions

The following rules apply to retaining server context in a distributed transaction:

- Context must be retained in a server that participates in a distributed transaction until the end of the transaction. At the end of the distributed transaction, the task must release context in all the servers that participated in the transaction. ADU automatically supplies default server context actions for transaction steps and steps that participate in distributed transactions. See *VSI ACMS for OpenVMS Writing Applications* [https://docs.vmssoftware.com/vsi-acms-writing-apps/] for more information about server context.

- A task definition can contain multiple processing steps that call one or more server procedures in the same server within a single distributed transaction. Within a single task, a single server process is used for all the processing steps that call step procedures in the same server. In this case, the first step procedure called within a distributed transaction must ready a database for the current procedure and any subsequent step procedures called by the task. For example, if the first step procedure accesses an Rdb database, the procedure must reserve those relations that are required by the current procedure as well as those relations that are required by subsequent step procedures.

  A different situation occurs when a task calls another task as part of a distributed transaction. The called task does not share server context with the parent task; the parent and called tasks use different server processes. Therefore, the first procedure called by the called task must ready a database for the current and any subsequent server procedures used by the called task.

- Both the Rdb and DBMS database products support only a single active database transaction in one process at a time. Therefore, once a server participates in a distributed transaction, the server must remain reserved to the distributed transaction until the transaction ends. See *VSI ACMS for OpenVMS Writing Applications* [https://docs.vmssoftware.com/vsi-acms-writing-apps/] for more information about retaining server context.

3.2.5. Migrating Existing Step Procedures to Participate in Distributed Transactions

If you modify existing step procedures to participate in distributed transactions that start in calling tasks, you must:

- Pass the TID to Rdb or DBMS when you access the database.
- Remove any COMMIT or ROLLBACK syntax in the step procedure.

  The distributed transaction must start and end in the same place, that is, in the action clause of the task step that starts the distributed transaction.

If you perform neither of the above steps, the task appears to execute correctly; however, the end of the distributed transaction is not coordinated with the end of the database transaction. This occurs because Rdb or DBMS does not know that you want the database operation to participate in the transaction if you do not pass the TID. Therefore, the database transaction starts and ends as it did before the task was changed to use distributed transactions.

If you perform the first step but not the second, the COMMIT or ROLLBACK statement returns an error. By specifying the TID, you include your database operation in the distributed transaction. You cannot use the COMMIT or ROLLBACK verbs to end a database transaction that is participating in a distributed transaction.

3.3. Returning Status to the Task Definition

In most situations, a task needs to know whether or not the work done in a processing step is successful so that it can determine what to do next. This means that the step procedure must pass this information back to the task. You can pass this information back to the task in one of two ways:

- Use the status return facility provided for subprograms or functions in the language used. This is the most common method.
- Place status information directly in a user-defined workspace that is passed as a parameter to the procedure.

The following sections describe these methods.

Note

ACMS requires initialization, termination, and cancel procedures to return a status. If they do not return status, results are unpredictable.

3.3.1. Returning Status with a Status Return Facility

All OpenVMS programming languages that follow the OpenVMS calling standard supply a mechanism for returning status from a subprogram or function. For example, in COBOL you can return status by specifying a variable in the GIVING clause of a Procedure Division statement and assigning a status value to this variable:

```
PROCEDURE DIVISION GIVING status-result.
```

The return status from the subprogram or function is automatically returned to the task in the system workspace ACMS$PROCESSING_STATUS. ACMS moves the return status value to the ACMS$L_STATUS field, which is one of four fields in the ACMS$PROCESSING_STATUS workspace. The four fields are the following:

ACMS$L_STATUS
ACMS$T_SEVERITY_LEVEL
ACMS$T_STATUS_TYPE
ACMS$T_STATUS_MESSAGE

ACMS then sets the values of the fields ACMS$T_SEVERITY_LEVEL and ACMS$T_STATUS_TYPE to correspond to the return status value in ACMS$L_STATUS.

*Table 3.1, "Values for ACMS$T_STATUS_TYPE"* show the values of the ACMS$T_STATUS_TYPE field. The binary value in the table refers to the value of the low-order bit in ACMS$L_STATUS.

Table 3.1. Values for ACMS$T_STATUS_TYPE

Status Type	Binary Value	Meaning
G	1	GOOD – Represents successful completion of a step procedure.
B	0	BAD – Represents the failure of a step procedure.

*Table 3.2, "Values for ACMS$T_SEVERITY_LEVEL"* lists the values for the ACMS$T_SEVERITY_LEVEL field. The binary value in the table refers to the value of the three low-order bits in ACMS$L_STATUS.

Table 3.2. Values for ACMS$T_SEVERITY_LEVEL

Severity Level	Binary Value	Meaning
S	001	SUCCESS
I	011	INFORMATION
W	000	WARNING
E	010	ERROR

Severity Level	Binary Value	Meaning
F	100	FATAL
?	Other	Invalid severity level

A task can check the ACMS$T_STATUS_TYPE or the ACMS$T_SEVERITY_LEVEL field to determine what action to take.

ACMS sets initial values for the fields in the ACMS$PROCESSING_STATUS workspace as follows:

Field	Initial value
ACMS$L_STATUS	1 (normal successful completion)
ACMS$T_SEVERITY_LEVEL	S (SUCCESS)
ACMS$T_STATUS_TYPE	G (GOOD)
ACMS$T_STATUS_MESSAGE	Spaces

Note

ACMS puts information into the ACMS$PROCESSING_STATUS workspace whether or not your procedure explicitly returns a status. You must be careful to use this workspace in a task definition only when your procedure returns a status. Otherwise, the results are unpredictable.

3.3.2. Returning Status in User-Defined Workspaces

Returning status to a task in a user-defined workspace is useful if you return a value to DECforms that determines what message DECforms displays.

To return status from a step procedure to a task in a user-defined workspace, define a status field in a workspace used by the task. *Example 3.4, "Record Description for TASK_CONTROL"* shows the CDD definition for a workspace called TASK_CONTROL.

Example 3.4. Record Description for TASK_CONTROL

```
CDO> SHOW RECORD pers_cdd.task_control/FULL
Definition of record TASK_CONTROL
|   Contains field           STEP_STATUS
|   |   Datatype                 text size is 8 characters
    .
    .
    .
```

In *Example 3.4, "Record Description for TASK_CONTROL"*, STEP_STATUS is an 8-character text field into which the step procedure writes a character string indicating whether or not it has completed successfully. The task uses the step status field to determine the completion status of the step procedure. The task uses the contents of the workspace field to determine what to do next.

Example 3.5, "COBOL Procedure for Returning Status in a User-Defined Workspace" and *Example 3.6, "BASIC Procedure for Returning Status in a User-Defined Workspace"* illustrate how to return status in a user-defined workspace. The step procedure first initializes the status field to SUCCESS; it then writes a new record to an employee master file. If a record with the same key already exists, the procedure stores

the error text DUPLICAT in the status field. The task uses the contents of the status field to determine if the step procedure successfully stored the new employee record.

Note

ACMS does not initialize workspaces every time it begins a step procedure. Therefore, you must ensure that a step procedure stores the correct status before it completes. For example, the step procedure illustrated in *Example 3.5, "COBOL Procedure for Returning Status in a User-Defined Workspace"* always initializes the status to SUCCESS at the beginning. This is necessary if a user incorrectly enters a badge number that is already on file for an employee. After the user corrects the mistake, the step procedure is called again, and the WRITE operation succeeds. In this case, the step procedure must return a success status to ensure that the task continues normally when the step procedure completes.

3.3.2.1. COBOL Procedure for Returning Status in a User-Defined Workspace

Example 3.5, "COBOL Procedure for Returning Status in a User-Defined Workspace" illustrates a complete step procedure for a simple data entry task. In this example, the step procedure first initializes the STEP_STATUS field to SUCCESS. If the write operation fails with a duplicate-key error, the step procedure stores DUPLICAT in the STEP_STATUS field using the INVALID KEY clause.

Example 3.5. COBOL Procedure for Returning Status in a User-Defined Workspace

```
IDENTIFICATION DIVISION.
PROGRAM-ID. pers_add_employee_proc.

ENVIRONMENT DIVISION.

INPUT-OUTPUT SECTION.
FILE-CONTROL.
SELECT  emp_file
        ORGANIZATION INDEXED
        ACCESS RANDOM
        ASSIGN TO "emp_file:employee.dat".

I-O-CONTROL.
APPLY LOCK-HOLDING ON emp_file.

DATA DIVISION.

FILE SECTION.
FD      emp_file
        EXTERNAL
        DATA RECORD IS employee_record
        RECORD KEY emp_badge_number OF employee_record.
COPY "pers_cdd.employee_record" FROM DICTIONARY.
WORKING-STORAGE SECTION.

LINKAGE SECTION.
COPY "pers_cdd.task_control" FROM DICTIONARY.
COPY "pers_cdd.employee_record" FROM DICTIONARY
    REPLACING ==employee_record== BY ==emp_wksp_record==.

PROCEDURE DIVISION USING task_control, emp_wksp_record.
MAIN SECTION.
```

```
000-start.
    MOVE "SUCCESS" TO step_status OF task_control.
    WRITE employee_record FROM emp_wksp_record
        ALLOWING NO OTHERS
        INVALID KEY
            MOVE "DUPLICAT" TO step_status OF task_control
        NOT INVALID KEY
            UNLOCK emp_file ALL RECORDS
    END-WRITE.

999-end.
    EXIT PROGRAM.
```

3.3.2.2. BASIC Procedure for Returning Status in a User-Defined Workspace

Example 3.6, "BASIC Procedure for Returning Status in a User-Defined Workspace" illustrates a complete step procedure for a simple data entry task. In this example, the step procedure first initializes the STEP_STATUS field to SUCCESS. If the write operation fails with a duplicate-key error, the step procedure uses an error handler to store DUPLICAT in the STEP_STATUS field.

Example 3.6. BASIC Procedure for Returning Status in a User-Defined Workspace

```
    FUNCTION LONG pers_add_employee_proc(                       &
                                task_control task_ctrl_wksp,    &
                                employee_record emp_wksp )

    %INCLUDE "pers_files:pers_common_defns"

    %INCLUDE %FROM %CDD "pers_cdd.employee_record"
    %INCLUDE %FROM %CDD "pers_cdd.task_control"

    MAP ( emp_map ) employee_record emp_rec

    WHEN ERROR IN
        task_ctrl_wksp::step_status = "SUCCESS"
        MOVE TO # emp_file, emp_wksp
        PUT # emp_file
        UNLOCK # emp_file
    USE
        SELECT ERR
            CASE basicerr_duplicate_key
                task_ctrl_wksp::step_status = "DUPLICAT"
            CASE ELSE
                CALL ACMS$RAISE_NONREC_EXCEPTION( RMSSTATUS( emp_file ) )
                EXIT HANDLER
        END SELECT
    END WHEN

    END FUNCTION
```

3.4. Handling Error Conditions

When you design a task and its components, include logic that checks the status of steps for their successful completion. For example, a task definition for an employee update task includes these steps:

1. Display a form that asks the user for an employee number.
2. Call a procedure to read the data for that employee.

   The step procedure reads the record; it then checks the status of the read operation and performs one of the following:

   - If the read operation succeeds, returns a success status.
   - If a recoverable error occurs, returns a failure status.
   - If a nonrecoverable error occurs, cancels the task.
3. Check the status from the step procedure:

   - If the step procedure succeeds, execute the next exchange step.
   - If the step procedure fails, repeat the first exchange step.
4. Display a form that shows the employee's record and asks the user for changes to the record information.
5. Call a procedure to rewrite the changed employee information.

   The step procedure rewrites the record; it then checks the status of the rewrite operation and performs one of the following:

   - If the rewrite operation succeeds, returns a success status.
   - If a recoverable error occurs, returns a failure status.
   - If a nonrecoverable error occurs, cancels the task.
6. Check the status from step procedure:

   - If the step procedure succeeds, exit the task with a success status.
   - If the step procedure fails, repeat the second exchange step.

See *VSI ACMS for OpenVMS Writing Applications* [https://docs.vmssoftware.com/vsi-acms-writing-apps/] for information about how to write task definitions.

A step procedure can use a number of alternative methods for returning information about recoverable error conditions to the task:

- For recoverable errors that are handled by the action part of the processing step, return a failure status using a status return facility or a status field in a user-defined workspace. See *Section 3.3.1, "Returning Status with a Status Return Facility"* and *Section 3.3.2, "Returning Status in User-Defined Workspaces"* for information on returning status from a step procedure to a task.
- For recoverable errors that are handled by the exception handler part of the processing step or an outer-block step in the task, raise a transaction or step exception.
- For recoverable transaction errors that are handled by an exception handler on the transaction step or an outer-block step in the task, raise a transaction exception.

The following sections discuss processing error messages in step procedures and raising exceptions in step procedures.

3.4.1. Processing Error Messages

If a step procedure detects a recoverable error, you must inform users of the problem. With this information, they can then decide how to continue.

In ACMS, you can choose among several methods of returning error messages to users. These methods are distinguished by where the message text is obtained and processed:

- In the task
- In the form
- In the step procedure

3.4.1.1. Using a Message File in the Task Definition

Using this method, you retrieve the error message text from a message file in the task definition based on the OpenVMS return status from the step procedure. You use a return status facility to return the status from the step procedure to the task, as discussed in section *Section 3.3.1, "Returning Status with a Status Return Facility"*.

ACMS stores the return status in the ACMS$PROCESSING_STATUS workspace, which the task can check and then retrieve error message text from the message file, as explained in *Chapter 5, "Using Message Files with ACMS Tasks and Procedures"*. This is the most common method for returning information about a recoverable error condition from the step procedure to the task.

The advantages of this method are that it is simple to use in both the step procedure and the task definition, and you can change messages without recompiling the procedure. A disadvantage of this method is that you cannot use more informative error messages containing additional information; you can use only simple literal error messages. For example, you cannot include a specific employee number in this message:

```
"Employee ID already exists on file"
```

To use a message file in a task definition, follow these steps:

1. In the step procedure, return the failure status associated with the error condition.

   For example, in COBOL:

   ```
   MOVE persmsg_empexists TO return_status.
   GO TO 999-end.
   ```

   For example, in BASIC:

   ```
   EXIT FUNCTION persmsg_empexists
   ```

2. In the task definition, check the return status from the procedure in the ACMS$PROCESSING_STATUS workspace.

   If the step procedure returns an error status, retrieve the error message text based on the return status and go to an exchange step that displays the error message on the form. For example:

   ```
   PROCESSING
       WORK IS
           CALL pers_add_employee_proc USING
                       task_control,
                       employee_record
   ```

```
ACTION IS
    IF ( ACMS$T_STATUS_TYPE = "B" )
    THEN
        GET ERROR MESSAGE;
        GOTO STEP get_new_employee_data;
    END IF;
```

3.4.1.2. Using a Message File in the Step Procedure

Using this method, you retrieve the error message text from a message file in the step procedure.

Use OpenVMS system services or run-time library (RTL) routines to retrieve and process the error message text in the step procedure. See *VSI OpenVMS System Services Reference Manual* [https://docs.vmssoftware.com/vsi-openvms-system-services-reference-manual-a-getuai/] and *VSI OpenVMS RTL Library (LIB$) Manual* [https://docs.vmssoftware.com/vsi-openvms-rtl-library-lib-manual/] for more information on using the OpenVMS Formatted ASCII Output (FAO) facility.

An advantage to this method is that you can return more informative error messages to the user by including additional information in the error message text. For example:

```
"Employee ID: 123456, last name: SMITH, already exists on file"
```

A disadvantage of this method is that you might have to modify a step procedure if you need to change the error message text. If the order of FAO arguments does not change when you modify the error message, then you do not need to modify the step procedure. However, if the order of the FAO arguments does change, then you must modify and recompile the step procedure, and relink the procedure server image.

To use a message file in a step procedure, follow these steps:

1. Define a field in a user-defined workspace to hold the error message text. For example:

   ```
   task_status_msg       DATATYPE TEXT 80.
   ```

2. In the step procedure, use the SYS$GETMSG and SYS$FAO system services, or the LIB$SYS_GETMSG and LIB$SYS_FAO RTL routines to obtain and process the error message text.

   For example, in COBOL:

   ```
           .
           .
           .
   DATA DIVISION.
   WORKING-STORAGE SECTION.


   01  persmsg_empexists          PIC S9(5) COMP
                                  VALUE IS EXTERNAL persmsg_empexists.
   01  msg_format_string          PIC X(80).
   01  text_only_flag             PIC S9(5) COMP
                                  VALUE IS 1.
   01  sts                        PIC S9(5) COMP.
   01  return_status              PIC S9(5) COMP.


           .
           .
   ```

```
        .


PROCEDURE DIVISION ... GIVING return_status.
        .
        .
        .


*
* Call LIB$SYS_GETMSG to get error message text associated with
* the 'employee already exists' error. Note that we use 1 as the
* message text flag since we want only the message text, not the
* facility code or severity level.
*
    CALL "LIB$SYS_GETMSG" USING
                BY REFERENCE persmsg_empexists
                OMITTED,
                BY DESCRIPTOR msg_format_string,
                BY REFERENCE text_only_flag
            GIVING sts.
    IF sts IS FAILURE
    THEN
        CALL "LIB$STOP" USING BY VALUE sts
    END-IF.



*
* Call LIB$SYS_FAO to format the 'employee already exists' error
* message text to include the employee's badge number and last
* name, using the message text as the FAO control string.
*
    CALL "LIB$SYS_FAO" USING
                BY DESCRIPTOR msg_format_string,
                OMITTED,
                BY DESCRIPTOR task_status_msg,
                BY DESCRIPTOR emp_badge_number,
                BY DESCRIPTOR emp_last_name
            GIVING sts.
    IF sts IS FAILURE
    THEN
        CALL "LIB$STOP" USING BY VALUE sts
    END-IF.



*
* Return failure status to task. Note that the task simply uses
* the return status as a success/failure indicator; it does not
* use the value of the return status to process the message text.
*
    MOVE persmsg_empexists TO return_status.
    GO TO 999-end.
```

For example, in BASIC:

```
    .
    .
    .
EXTERNAL LONG FUNCTION  LIB$SYS_GETMSG,                          &
                        LIB$SYS_FAO

EXTERNAL LONG CONSTANT  persmsg_empexists

DECLARE STRING  msg_format_string,                               &
        LONG    sts
    .
    .
    .


!+
! Call LIB$SYS_MSGMSG to error message text associated with the
! 'employee already exists" error. Note that we use 1 as the
! message text flag since we only want the message text, not the
! facility code or severity level.
!-
sts = LIB$SYS_GETMSG( persmsg_empexists,                         &
                      0% BY VALUE,                               &
                      msg_format_string,                         &
                      1% )


IF ( sts AND 1% ) = 0%
THEN
        CALL LIB$STOP( sts BY VALUE )
END IF

!+
! Call LIB$SYS_FAO to format the 'employee already exists' error
! message text to include the employee's badge number and last
! name, using the message text as the FAO control string.
!-
sts = LIB$SYS_FAO( msg_format_string,                            &
                   0% BY VALUE,                                  &
                   task_ctl_rec::task_status_msg,                &
                   emp_rec::emp_badge_number,                    &
                   TRM$( emp_rec::emp_last_name ) )
IF ( sts AND 1% ) = 0%
THEN
    CALL LIB$STOP( sts BY VALUE )
END IF

!+
! Return failure status indicator to task. Note that the task
! simply uses the return status as a success/failure indicator,
! it does not use the value of the return status to process the
! message text.
!-
EXIT FUNCTION persmsg_empexists
```

3. In the task definition, check the return status from the procedure in the ACMS$PROCESSING_STATUS workspace.

   If the step procedure returns a failure status, then go to an exchange step that displays the error message from the step procedure on the form. For example:

```
PROCESSING
    WORK IS
        CALL pers_add_employee_proc USING
                    task_control,
                    employee_record
    ACTION IS
        IF ( ACMS$T_STATUS_TYPE = "B" )
        THEN
            GOTO STEP get_new_employee_data;
        END IF;
```

3.4.1.3. Using Hard-Coded Messages in the Form

Using this method, you return a status indicator that is processed by the form in a field in a user-defined workspace. See *Section 3.3.2, "Returning Status in User-Defined Workspaces"* for more information on returning status in a field in a user-defined workspace.

The advantage of this method is that you do not need to use message files or OpenVMS system services or RTL routines to return error messages to users. The disadvantage is that you must always modify the form if you need to change the format of an error message.

To use hard-coded messages in the form, follow these steps:

1. Define a field in a user-defined workspace to hold the status indicator. For example:

```
step_status           DATATYPE TEXT 8.
```

2. In the step procedure, return a status indicator in the STEP_STATUS field in the user-defined workspace.

   For example, in COBOL:

```
MOVE "DUPLICAT" TO step_status OF task_control.
GO TO 999-end.
```

   For example, in BASIC:

```
task_ctrl_wksp::step_status = "DUPLICAT"
EXIT FUNCTION
```

3. In the task definition, check the status indicator field in the user-defined workspace.

   If the step procedure returns a failure indicator, then go to an exchange step that uses a form to display an error message based on the status indicator returned by the step procedure. For example:

```
PROCESSING
    WORK IS
        CALL pers_add_employee_proc USING
                    task_control,
                    employee_record
    ACTION IS
```

```
IF ( task_control.step_status <> "SUCCESS" )
THEN
    GOTO STEP get_new_employee_data;
END IF;
```

3.4.1.4. Using Hard-Coded Messages in the Step Procedure

Using this method, you construct the complete error message directly in the step procedure. You use literal message text stored in the procedure, formatting variable error messages, if necessary.

The advantage of this method is that you do not need to use message files or OpenVMS system services or RTL routines to return error messages to users. The disadvantage is that you must always modify and recompile the step procedure and relink the procedure server image if you need to change the format of an error message.

To use hard-coded messages in a step procedure, follow these steps:

1. Define a field in a user-defined workspace to hold the error message text. For example:

   ```
   task_status_msg       DATATYPE TEXT 80.
   ```

2. In the step procedure, construct the error message in the message text field.

   The following example in COBOL formats an error message and then returns a failure status to the task:

   ```
   *
   * Format 'Employee already exists' error message.
   *
       MOVE SPACES TO task_status_msg.
       STRING "Employee ID: " DELIMITED BY SIZE
              emp_badge_number DELIMITED BY " "
              " (last name: " DELIMITED BY SIZE
              emp_last_name DELIMITED BY " "
              ") already exists on file" DELIMITED BY SIZE
       INTO    task_status_msg.
       SET status-result TO FAILURE.
       GO TO 999-end.
   ```

   The following example in BASIC formats an error message and then returns a failure status to the task:

   ```
   !
   ! Format 'Employee already exists' error message.
   !
   task_ctl_rec::task_status_msg =                                    &
           "Employee ID: " +                                          &
           emp_rec::emp_badge_number +                                &
           " (last name: " +                                          &
           TRM$( emp_rec::emp_last_name ) +                           &
           ") already exists on file"
   EXIT FUNCTION 0
   ```

3. In the task definition call to the procedure, test the ACMS$PROCESSING_STATUS workspace, and go to an exchange step that displays the error message on the form if an error occurs. For example:

```
PROCESSING
    WORK IS
        CALL pers_add_employee_proc USING
                    task_control,
                    employee_record
    ACTION IS
        IF ( ACMS$T_STATUS_TYPE = "B" )
        THEN
            GOTO STEP get_new_employee_data;
        END IF;
```

3.4.2. Raising Exceptions in Step Procedures

In some cases, rather than returning errors for the action part of a step to handle, you can let the exception handler part of a step deal with errors. If your task is designed in this way, you need to raise an exception from your step procedure. ACMS supplies three services that raise different kinds of exceptions:

- ACMS$RAISE_STEP_EXCEPTION
- ACMS$RAISE_TRANS_EXCEPTION
- ACMS$RAISE_NONREC_EXCEPTION

The ACMS exception services differ in an important way from the superseded ACMSAD$REQ_CANCEL service. Whereas the ACMSAD$REQ_CANCEL service immediately cancels the current task and does not return control to the step procedure, the ACMS exception services all return control to the step procedure after setting the appropriate exception condition. This allows the step procedure to clean up any context in the server and to complete normally.

Allowing the step procedure to complete before raising the exception in the task means that ACMS does not have to interrupt the server process. Therefore, if a step procedure uses one of the exception services to raise an exception, and you have specified that your server is to be run down on cancel only if it is interrupted, ACMS does not need to run down the server process. See *Section 2.3, "Server Process Rundown"* for details on how to specify when ACMS should run down your server.

Because step exceptions, transaction exceptions, and nonrecoverable exceptions are not raised in the task until the step procedure completes, have the step procedure return as soon as possible after raising an exception.

Note

For all servers, VSI recommends specifying that ACMS run down the server only if it is interrupted. Using this attribute does not, however, change the effect of using the ACMSAD$REQ_CANCEL service. Because the ACMSAD$REQ_CANCEL service causes the server to be interrupted, ACMS runs down the server in this situation. For this reason, use ACMS$RAISE_NONREC_EXCEPTION instead of ACMSAD$REQ_CANCEL.

3.4.2.1. Raising Recoverable Exceptions in Step Procedures

You can handle task execution errors in the exception handler part of a step, as explained in *VSI ACMS for OpenVMS Writing Applications* [https://docs.vmssoftware.com/vsi-acms-writing-apps/]. This manual discusses how to raise exceptions only in step procedures.

Step procedures can raise the following recoverable exceptions:

- Step exception
- Transaction exception

Following are explanations and examples of the two ACMS services that step procedures use to raise recoverable exceptions.

- ACMS$RAISE_STEP_EXCEPTION

  A step procedure raises a step exception by calling this service. You call this service to raise an exception that can be handled by the exception handler part of the processing step or an outer-block step. A step procedure might raise a step exception if, for example, a procedure called from a processing step in a nested block detects an error condition that must be handled by the exception handler on the outer block step.

  The following example shows the COBOL code in the error-handling section of a procedure.

```
CALL "ACMS$RAISE_STEP_EXCEPTION" USING BY REFERENCE RET-STAT.
```

- ACMS$RAISE_TRANS_EXCEPTION

  A step procedure that is participating in a distributed transaction can use the ACMS$RAISE_TRANS_EXCEPTION service to raise a transaction exception if a resource manager returns a recoverable error – for example, a dead-lock error condition. Note that you cannot call the ACMS$RAISE_TRANS_EXCEPTION service in a step procedure that is not participating in a distributed transaction.

  When a step procedure raises a transaction exception, the exception falls under the control of the exception handler part of the transaction step or outer-block step, if one exists. The following example shows the COBOL code in a procedure that raises a transaction exception:

```
SQL_ERROR_HANDLER.

    IF (RDB$LU_STATUS = RDB$_DEADLOCK) OR
       (RDB$LU_STATUS = RDMS$_DEADLOCK) OR
       (RDB$LU_STATUS = RDB$_LOCK_CONFLICT) OR
       (RDB$LU_STATUS = RDMS$_LCKCNFLCT) OR
       (RDB$LU_STATUS = RDMS$_TIMEOUT)
    THEN
        CALL "ACMS$RAISE_TRANS_EXCEPTION" USING
                            BY REFERENCE ACMS$_TRANSTIMEDOUT
    ELSE
        CALL "LIB$CALLG" USING
                    BY REFERENCE Rdb$MESSAGE_VECTOR,
                    BY VALUE LIB$SIGNAL
        CALL "ACMS$RAISE_NONREC_EXCEPTION" USING
                            BY REFERENCE RDB$LU_STATUS
    END-IF.
```

Chapter 9, "ACMS Programming Services" contains reference information regarding recoverable exception services.

3.4.2.2. Raising Nonrecoverable Exceptions in Step Procedures

ACMS raises a nonrecoverable exception under the following conditions:

- A fatal OpenVMS exception condition generated by the procedure

  ACMS raises a nonrecoverable exception if a step procedure generates a fatal exception. For example, if you use the the OpenVMS RTL service LIB$STOP to signal an error, or if an exception is raised by the hardware (perhaps as the result of an access violation), then ACMS raises a nonrecoverable exception and cancels the task.

  Note

  ACMS always runs down a server process if a step procedure generates a fatal OpenVMS exception condition.

- A call to ACMS$RAISE_NONREC_EXCEPTION

  A step procedure calls this programming service when an error occurs from which neither the step procedure nor the task can recover. When a step procedure calls this service, ACMS raises a nonrecoverable exception and unconditionally cancels the current task.

  You call the ACMS$RAISE_NONREC_EXCEPTION service as you do any OpenVMS run-time service, by using a CALL statement in COBOL, for example. No arguments are required in the call. You can, however, include an optional argument describing the reason for the cancellation. The argument is a read-only longword, passed by reference.

  The following example shows the COBOL code in a procedure that raises a nonrecoverable exception.

```
CALL "ACMS$GET_TID" USING CS-TID GIVING ret-stat.
IF ret-stat IS NOT SUCCESS
THEN
    CALL "ACMS$RAISE_NONREC_EXCEPTION" USING ret-stat.
    GO TO 999-end.
```

  Chapter 9, "ACMS Programming Services" contains reference information regarding the nonrecoverable exception service.

3.5. Performing Terminal I/O from a Procedure Server

One of the major advantages of implementing an application with ACMS is that you can easily separate your terminal I/O from your database I/O by performing all terminal I/O in exchange steps and all database I/O in processing steps. Following these guidelines has many advantages; two of the major ones are better performance and the ability to distribute tasks over multiple nodes.

Application developers find, however, that some situations require them to do terminal I/O in a processing step – for example, if they are incorporating an existing program into an application. Sometimes it is simpler to make an existing program a single-step task that does terminal I/O than to convert the program to a multiple-step task, which requires removing the terminal I/O from the program

and placing it in exchange steps. For this reason, although it is not recommended, ACMS supports doing terminal I/O from processing steps. This section describes the limitations and restrictions involved.

ACMS does not automatically associate a terminal channel with the server process. If a procedure is to do terminal I/O, it must open and close the channel it uses each time it is called. The terminal channel cannot be retained across processing steps, even if the task retains server context. If the procedure does not close the channel before it completes, ACMS cancels the task and runs down the server process.

For a server process to perform terminal I/O, the task must pass the terminal to that process. In single-step tasks, the default is to pass the terminal to the server process. In multiple-step tasks, however, the default is not to pass the terminal to the server process, regardless of whether the server is a DCL server or a procedure server.

In multiple-step tasks, therefore, the task definition must use the TERMINAL I/O phrase for any processing step that does terminal I/O. When used as an attribute on a processing step, TERMINAL I/O and REQUEST I/O are equivalent; however, REQUEST I/O as a processing step attribute is a declining feature and is, therefore, discouraged.

Note

Because distributed tasks cannot perform terminal I/O in processing steps, you cannot distribute a task that contains TERMINAL I/O (or REQUEST I/O) syntax in a processing step of the task definition.

Because the procedure must open and close the terminal channel, there are several restrictions on the kinds of statements used for terminal I/O from a procedure server. Keep in mind the following considerations:

- A procedure that does terminal I/O must open the terminal channel it uses; the channel cannot be opened in the initialization procedure.
- You can use any terminal I/O calls that allow you to open a terminal channel explicitly. Two examples of these are the DECforms FORMS$ENABLE and the TDMS TSS$OPEN services.
- Do not use programming statements such as DISPLAY and ACCEPT in COBOL, or INPUT and PRINT in BASIC.
- Do not use the OpenVMS LIB$GET_INPUT and LIB$PUT_OUTPUT services.
- Do not use the RTL screen management services.
- Provide a cancel procedure for the server handling the procedure. It is recommended that the cancel procedure either close any open terminal channel when the task is canceled or allow the server process to run down when the task is canceled.

Chapter 4. Accessing Resource Managers

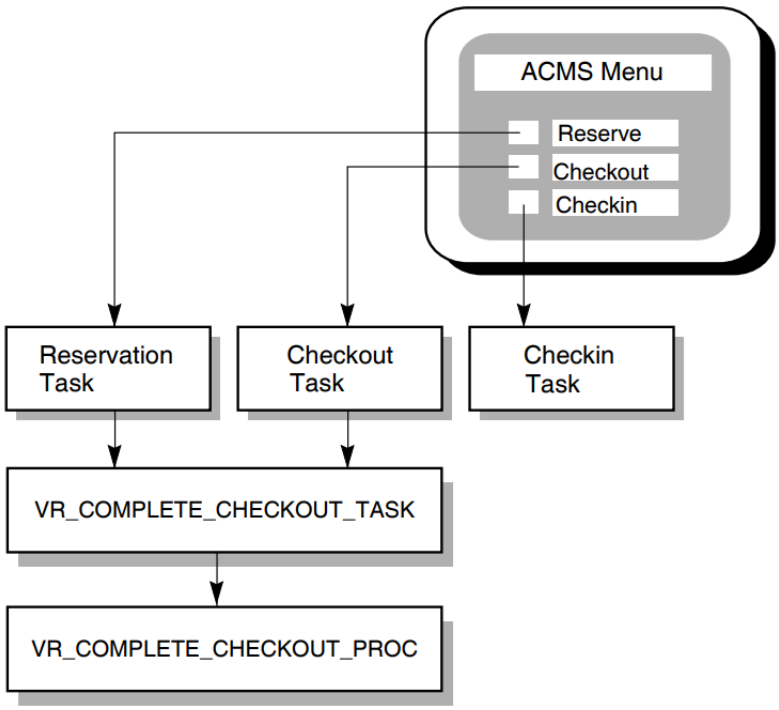
This chapter explains how to write step procedures that access several of the resource managers you can use with ACMS applications: Oracle Rdb using SQL, and Oracle Rdb using RDO, DBMS, and RMS.

The primary example in the chapter shows how to access an Rdb database using SQL with a procedure that participates in a distributed transaction. Examples showing how to access other resource managers supported by ACMS with distributed transactions are partial; they contain only syntax that is different from the SQL example.

The COBOL step procedure that is the principal example in this chapter is part of the AVERTZ Sample Application. The step procedure VR_COMPLETE_CHECKOUT_PROC participates in a distributed transaction that starts and ends in the parent task. *Figure 4.1, "Calling the Procedure VR_COMPLETE_CHECKOUT_PROC"* shows where VR_COMPLETE_CHECKOUT_PROC fits into the AVERTZ Sample Application. The figure shows the ACMS menu, from which users can select the Reservation Task or the Checkout Task as two of three tasks displayed on the menu. Both the Reservation Task and the Checkout Task can call the Complete Checkout Task, which, in turn, calls the procedure VR_COMPLETE_CHECKOUT_PROC.

See *VSI ACMS for OpenVMS Concepts and Design Guidelines* [https://docs.vmssoftware.com/vsi-acms-concepts-and-design-guide/] for a description of the AVERTZ sample application and *VSI ACMS for OpenVMS Writing Applications* [https://docs.vmssoftware.com/vsi-acms-writing-apps/] for a description of VR_COMPLETE_CHECKOUT_TASK. For further explanation of VR_COMPLETE_CHECKOUT_PROC. see *Section 4.1, "Using SQL with Rdb"*.

Figure 4.1. Calling the Procedure VR_COMPLETE_CHECKOUT_PROC



4.1. Using SQL with Rdb

This section describes how to write step procedures using the Structured Query Language (SQL) interface to Rdb. The techniques used with SQL are similar to those used in developing tasks and server procedures using Relational Data Manipulation Language (RDML).

See the SQL documentation for general information regarding SQL.

The main example in this chapter, shown in *Example 4.7, "COBOL Procedure Using SQL with Rdb"*, is a COBOL step procedure called VR_COMPLETE_CHECKOUT_PROC, which accesses an Rdb database using SQL. The procedure is part of the AVERTZ sample application.

Example 4.1, "Task Definition that Calls Server Procedures Using SQL" is part of the Complete Checkout Task, which calls the procedure VR_COMPLETE_CHECKOUT_PROC in the AVERTZ Sample Application. When checking out a car, the customer has the option of canceling the reservation. If the customer chooses to cancel the reservation, the task calls a procedure to perform the cancel processing. Otherwise, the task calls a procedure to complete the reservation. The task definition, in a simplified version, performs the following steps, which are also numbered in the example.

❶ If the customer chooses to check out the car, the task calls the procedure VR_COMPLETE_CHECKOUT_PROC to complete the checkout process.

❷ If the customer cancels the reservation, the task calls the procedure VR_CANCEL_RS_PROC to cancel the reservation.

❸ The task calls another procedure, VR_WRITE_HIST_RECORD_PROC, which writes the completion of the checkout or the cancellation to the database.

Example 4.1. Task Definition that Calls Server Procedures Using SQL

```
REPLACE TASK avertz_cdd_task:vr_complete_checkout_task

USE WORKSPACES vr_control_wksp,
.
.
.
TASK ARGUMENTS ARE vr_sendctrl_wksp     WITH ACCESS READ,
.
.
.
BLOCK WORK WITH TRANSACTION
                     NO I/O


!
perform:
!+
!-
! Perform the checkout process or cancel the reservation depending
! on the user's choice.
!


     PROCESSING
        SELECT FIRST TRUE
                (vr_control_wksp.ctrl_key = "OK"):
```

```
                    ❶ CALL PROCEDURE    vr_complete_checkout_proc
                       IN      vr_update_server
                       USING   vr_reservations_wksp,
                               vr_vehicles_wksp,
                               vr_control_wksp;
                (vr_control_wksp.ctrl_key = "CANCL"):
                    ❷ CALL PROCEDURE     vr_cancel_rs_proc
                       IN      vr_update_server
                       USING   vr_reservations_wksp,
                               vr_control_wksp;
        END SELECT;


   .
   .
   .
! Write to the history record to record the completion of the checkout or
the
! the cancellation of the reservation.
!
     PROCESSING
     ❸ CALL PROCEDURE        vr_write_hist_record_proc
        IN      vr_log_server
        USING   vr_hist_wksp,
                vr_reservations_wksp;


      .
      .
      .
!
END BLOCK;
!
END DEFINITION;
```

4.1.1. Using Embedded SQL Statements in Step Procedures

When using embedded SQL statements in step procedures, follow these guidelines:

- Begin each statement with the EXEC SQL flag.
- Remember that the EXEC SQL flag can occur at the beginning of only the first line of a multiline SQL statement. Follow the rules of the programming language you are using to continue SQL statements from one line to the next.
- Regardless of the rules of the language you are using for parameter names, specify underscores rather than hyphens when entering names of database entities.
- In COBOL, flag the end of an SQL statement with the END-EXEC keyword. Place a period after END-EXEC if a COBOL statement in the same position requires a period.

Example 4.2, "Declaring the Database" contains examples illustrating each of these guidelines.

For other high-level languages, the rules for beginning and ending SQL statements in step procedures vary. See the SQL documentation for more information about beginning and ending SQL statements in step procedures.

Before you can use SQL to access a database, you must declare the database. You do this in each server procedure that accesses the database. If you are using COBOL, name the Rdb database in the Working-Storage Section of the Data Division of your procedure using the DECLARE SCHEMA statement. This must appear in the procedure before you can use other SQL statements to reference data in the database.

Example 4.2, "Declaring the Database" shows the DECLARE SCHEMA statement used in the procedure VR_COMPLETE_CHECKOUT_PROC to declare the database. *Example 4.7, "COBOL Procedure Using SQL with Rdb"* contains the complete procedure.

Example 4.2. Declaring the Database

```
*************************************************************
DATA DIVISION.
*************************************************************
WORKING-STORAGE SECTION.
*
*  Return status to pass to ACMS
*
01 RET-STAT      PIC S9(9) COMP.
01 RSTAT         PIC S9(9) COMP.


.
.
.
*
*  Declare the database schema.
*
EXEC SQL
   DECLARE EXTERNAL SCHEMA FILENAME AVERTZ_DATABASE:VEHICLE_RENTALS
END-EXEC.
```

4.1.2. Using SQL with Distributed Transactions

When you use SQL with a distributed transaction, you must pass the transaction ID (TID) to SQL on each executable DML verb using an SQL context structure.

This section describes how to:

- Define an SQL context structure
- Obtain the TID and store it in the context structure
- Pass the context structure to SQL using embedded SQL and SQL module language.

See *Example 4.7, "COBOL Procedure Using SQL with Rdb"* for a complete example of using precompiled SQL in a distributed transaction using COBOL. See the SQL documentation for information on how to define and use an SQL context structure.

4.1.2.1. Defining an SQL Context Structure

In your procedure, you must define a context structure that holds the TID associated with the distributed transaction.

The following code segment illustrates how to define an SQL context structure using COBOL:

```
     WORKING-STORAGE SECTION.
```

```
           .
           .
           .
01 context-structure.
        02 cs-version           PIC S9(9) COMP VALUE 1.
        02 cs-type              PIC S9(9) COMP VALUE 1.
        02 cs-length            PIC S9(9) COMP VALUE 16.
        02 cs-tid               PIC X(16).
        02 cs-end               PIC S9(9) COMP VALUE 0.
           .
           .
           .
```

Alternatively, you can use a library to hold the context structure and refer to this library in your procedure. For example:

```
WORKING-STORAGE SECTION.
           .
           .
           .
EXEC SQL
    INCLUDE 'AVERTZ_SOURCE:VR_CONTEXT_STRUCTURE_INCLUDE.LIB'
END-EXEC.
           .
           .
           .
```

Appendix B, "Libraries Included in AVERTZ Sample Procedures" contains the contents of the libraries referred to in examples from the AVERTZ sample application in this manual.

The following code segment illustrates how to define an SQL context structure using BASIC:

```
RECORD sql_context_structure
    LONG sqlctx_version
    LONG sqlctx_type
    LONG sqlctx_length
    STRING sqlctx_tid = 16
    LONG sqlctx_end
END RECORD sqlctx_structure



DECLARE sql_context_structure sqlcs

sqlcs::sqlctx_version = 1%
sqlcs::sqlctx_type = 1%
sqlcs::sqlctx_length = 16%
sqlcs::sqlctx_end = 0%
```

Alternatively, you can use a BASIC INCLUDE file to define and initialize the context structure and then include this file in your procedure. For example:

```
%INCLUDE "pers_files:pers_sqlctx"
```

4.1.2.2. Storing the TID in the SQL Context Structure

You must call the ACMS$GET_TID service to obtain the TID and store it in the SQL context structure before you access the database.

The following code segment illustrates how to call the ACMS$GET_TID service to obtain the TID and store it in the SQL context structure using COBOL. If the ACMS$GET_TID service returns an error, the step procedure raises a nonrecoverable exception and exits.

```
CALL "ACMS$GET_TID" USING BY REFERENCE cs-tid
                    GIVING ret-stat.
IF ret-stat IS NOT SUCCESS
THEN
    CALL "ACMS$RAISE_NONREC_EXCEPTION"
                    USING BY REFERENCE ret-stat
    GO TO 999-end
END-IF.
```

The following code segment illustrates how to call the ACMS$GET_TID service to obtain the TID and store it in the SQL context structure using BASIC. If the ACMS$GET_TID service returns an error, the step procedure raises a nonrecoverable exception and exits.

```
sts = ACMS$GET_TID( sqlcs::sqlctx_tid BY REF )
IF ( sts AND 1% ) = 0% THEN
    CALL ACMS$RAISE_NONREC_EXCEPTION( sts )
    EXIT FUNCTION
END IF
```

4.1.2.3. Passing the Context Structure to SQL

You must pass the context structure to SQL whenever you use SQL within a distributed transaction. This section describes how you pass the context structure to SQL when you are using precompiled SQL and SQL module language.

- Using precompiled SQL

  When you use precompiled SQL, the context structure is passed using the CONTEXT parameter on the EXEC SQL phrase.

  The following code segment illustrates how to pass the context structure using precompiled SQL:

  ```
  EXEC SQL USING CONTEXT :context-structure
      SET TRANSACTION READ WRITE
      RESERVING reservations FOR SHARED WRITE,
                rental_classes,sites,regions FOR SHARED READ
  END-EXEC.
  ```

- Using SQL module language

  When you use SQL module language, you must pass the context structure as an argument on the call to the SQL procedure. When you compile the SQL module, you must use the **/CONTEXT** switch to generate an implicit context parameter for each procedure that participates in a distributed transaction. The context argument is always generated as the last argument in the argument list; therefore, always pass the context structure as the last argument when you call the SQL procedure.

  The following code segment illustrates the module header and the first procedure in an SQL module language program for use by a BASIC program:

  ```
  - Header section
  ```

```
MODULE          pers_appl_procs
LANGUAGE        BASIC
AUTHORIZATION   RDB$DBHANDLE
- Declare schema
DECLARE PARTS SCHEMA FOR FILENAME 'pers_db:personnel'
- Start transaction procedure
PROCEDURE start_new_employee_trans
    SQLCODE;
-       Start the transaction
         SET TRANSACTION READ_WRITE
             RESERVING employees FOR SHARED WRITE,
                       history FOR SHARED WRITE;
- Additional procedures
          .
          .
          .
```

The following code segment illustrates how to call the START_NEW_EMPLOYEE_TRANS SQL procedure from a BASIC program. Note that the SQL context structure is passed as the last argument in the call to the SQL procedure.

```
            .
            .
            .
CALL start_new_employee_trans( sqlsts, sqlcs )
            .
            .
            .
```

4.1.3. Starting and Ending SQL Database Transactions

You start an SQL database transaction by using a SET TRANSACTION statement. However, the way in which you start the database transaction depends on whether the database transaction is part of a distributed transaction.

This section describes how to start a database transaction that is part of a distributed transaction and how to start and end an independent database transaction. In addition, this section discusses various access modes that you can specify when starting a database transaction.

4.1.3.1. Starting an SQL Database Transaction that is Part of a Distributed Transaction

You must specify the SQL context structure when you start a database transaction that is part of a distributed transaction. For example:

```
EXEC SQL USING CONTEXT :context-structure
    SET TRANSACTION READ WRITE
    RESERVING reservations FOR SHARED WRITE,
              rental_classes,sites,regions FOR SHARED READ
END-EXEC.
```

Note

You must specify the SQL context structure on every SQL verb that is executed within the distributed transaction. The step procedure does not function correctly if you omit the SQL context structure on an SQL statement.

Because the SQL database transaction is participating in a distributed transaction, Rdb automatically commits or rolls back the database transaction when the distributed transaction ends. Therefore, you must not use the COMMIT or ROLLBACK verbs to end the database transaction.

4.1.3.2. Starting and Ending an Independent SQL Database Transaction

You start an independent database transaction by using a SET TRANSACTION statement. For example:

```
EXEC SQL USING CONTEXT
    SET TRANSACTION READ WRITE
    RESERVING reservations FOR SHARED WRITE,
              rental_classes,sites,regions FOR SHARED READ
END-EXEC.
```

Because the SQL database transaction is not participating in a distributed transaction, you must commit or roll back the database transaction in the procedure. For example:

```
IF step-proc-status IS SUCCESS
THEN
    EXEC SQL
        COMMIT
    END-EXEC
ELSE
    EXEC SQL
        ROLLBACK
    END-EXEC
END-IF.
```

4.1.3.3. Using Rdb Transaction Mode and Lock Mode Specifications

Specify the transaction mode and the lock mode when you start an Rdb database transaction.

The transaction mode specifies how the step procedure accesses the database. If the step procedure only reads records from the database, specify READ ONLY when you start the database transaction. Otherwise, specify READ WRITE in step procedures that read, write, and modify records in the database.

If you do not specify a mode, the SQL default for the SET TRANSACTION statement is READ WRITE, which means that you can both read records from specified tables and write data into them. If you are using RDO, the default is READ ONLY, which means that you can only read records from the database; you cannot update existing records or store new records in the database. Specifying READ ONLY in a procedure that does not write or modify records reduces contention in the database.

Note

When you use an Rdb database, any records you access are not locked until you modify them. Once a record has been modified, it remains locked until the end of the transaction.

The lock mode specifies how the step procedure accesses specific relations in the database. To reduce contention in the database, specify explicitly which relations you access in the database when you start an Rdb transaction. For each relation, specify read or write access to the relation depending on the access the server requires. For example, if the step procedure only reads records, specify READ access. If the server procedure reads, writes, and modifies records in the relation, specify WRITE access.

Refer to the Rdb documentation for an explanation of the Rdb share modes and the defaults for the keywords you use with the SET TRANSACTION statement in SQL and with the START_TRANSACTION statement in RDO and RDML.

Example 4.3, "Lock Specification Example" illustrates how the step procedure VR_COMPLETE_CHECKOUT_PROC starts the database transaction, specifying the transaction mode and the relations it accesses, along with the lock specifications.

Example 4.3. Lock Specification Example

```
EXEC SQL USING CONTEXT :CONTEXT-STRUCTURE
        SET TRANSACTION READ WRITE
          .
          .
          .
        RESERVING  RESERVATIONS,
                   VEHICLES,
                   VEHICLE_RENTAL_HISTORY
        FOR        SHARED WRITE,
                   RENTAL_CLASSES,
                   SITES,
                   REGIONS
        FOR        SHARED READ
END-EXEC.
```

The RESERVATIONS, VEHICLES, and VEHICLE_RENTAL_HISTORY relations are reserved for SHARED WRITE, which means that no other user can modify the records you are updating once they have been modified; other users can, however, read records that you are reading or modifying. Until you commit a modification, other users read the original version of the record.

Also shown in *Example 4.3, "Lock Specification Example"*, the RENTAL_CLASSES, SITES, and REGIONS relations are reserved for SHARED READ; this means that other users can read and modify the same records that you are accessing in the relation.

ACMS tasks typically perform a transaction with SHARED access because the database is shared by more than one server process. You might occasionally need to lock an entire relation when you access it; if you need to do so, refer to the SQL documentation on PROTECTED and EXCLUSIVE access.

4.1.3.4. Using an Rdb Wait Mode Specification

The SQL SET TRANSACTION and RDO START_TRANSACTION statements also allow you to specify a wait mode. Using the wait mode, you specify how Rdb handles the situation if it encounters a locked relation or record while accessing the database. If you specify WAIT, the default, Rdb waits until the lock can be granted before continuing. If you specify NOWAIT, Rdb immediately returns an error if it encounters a lock.

If you choose to wait for locks, you can specify the maximum time you are prepared to wait until a lock is granted. If the lock is not granted in the specified time limit, Rdb returns the RDMS$_TIMEOUT error. Specify the time limit by defining the RDM$BIND_LOCK_TIMEOUT_INTERVAL logical name in a logical name table that is accessible to the server. Define the RDM$BIND_LOCK_TIMEOUT_INTERVAL logical name:

- As a server logical name in the application definition
- In an application-specific logical name table

- In the system logical name table
- In a group logical name table

For example, the following server logical name definition specifies that Rdb should wait no more than 10 seconds for a lock to be granted:

```
LOGICAL NAME IS
     RDM$BIND_LOCK_TIMEOUT_INTERVAL = "10";
```

Important

If you are using distributed transactions, always specify a lock timeout interval to ensure that ACMS can successfully cancel a task that is waiting for a database lock. By specifying a lock timeout interval, you ensure that the task will be canceled as soon as the timeout interval expires. If you do not specify a lock timeout interval, the task cannot be canceled until the lock is granted.

4.1.4. Reading from a Database

The procedure VR_COMPLETE_CHECKOUT_PROC from the AVERTZ Sample Application illustrates the use of SQL statements in reading information from an Rdb database. As part of the processing associated with checking out a car, the procedure must find the current odometer reading for the selected vehicle. It does this by selecting the record with the highest odometer reading from the VEHICLE_RENTAL_HISTORY relation. Because the vehicle history record might contain a null value, the procedure uses an indicator parameter to determine whether or not an odometer reading has been retrieved.

Example 4.4, "Indicator Array for Null Values" illustrates how the procedure VR_COMPLETE_CHECKOUT_PROC declares an indicator array (for a subsequent STORE operation) and an indicator parameter (for the SELECT operation). You need to include this when a read operation on the database might return a null value. *Example 4.4, "Indicator Array for Null Values"* shows one way this can appear in a COBOL program.

For detailed information and information on step procedures written in other high-level languages, see the SQL documentation.

Example 4.4. Indicator Array for Null Values

```
*
* Indicator array for null values
*
01 VR_VRH_IND_ARRAY.
   05 VR_VRH_IND OCCURS 6 TIMES  PIC S9(4) COMP.
01 VR_VRH_IND1                  PIC S9(4) COMP.
```

The section of code in *Example 4.5, "Selecting a Value from a Table"* selects the record with the highest odometer reading from the VEHICLE_RENTAL_HISTORY relation, specifying an indicator parameter (RH_VRH_IND1) that SQL sets when retrieving the data, and places the value in a workspace field.

Example 4.5. Selecting a Value from a Table

```
GET-ODOMETER-READING.
* Get the last return odometer reading for the vehicle being
* checked out from the database.  If not found, ignore it.
        .
        .
        .
```

```
        EXEC SQL USING CONTEXT :CONTEXT-STRUCTURE
           SELECT MAX(RETURN_ODOMETER_READING)INTO
                 :VR_VEHICLE_RENTAL_HISTORY_WKSP.CHECKOUT_ODOMETER_READING
                    INDICATOR :VR_VRH_IND1
              FROM VEHICLE_RENTAL_HISTORY
              WHERE VEHICLE_ID = :VR_VEHICLES_WKSP.VEHICLE_ID
        END-EXEC.
```

4.1.5. Writing to a Database

Example 4.6, "Writing to a Database" illustrates the use of SQL statements in writing to a database. The procedure updates the car reservation record and the vehicle record in the database. The procedure also writes a new vehicle rental history record to the database. The values of the RETURN_ODOMETER_READING and ACTUAL_RETURN_DATE fields are not known at the time the new history record is stored; therefore, the procedure uses an indicator array to store null values in the database for those fields. *Example 4.7, "COBOL Procedure Using SQL with Rdb"* contains the complete procedure.

Example 4.6. Writing to a Database

```
                    .
                    .
                    .
        MOVE NEG-ONE TO VR_VRH_IND(5).
        MOVE NEG-ONE TO VR_VRH_IND(6).
                    .
                    .
                    .


UPDATE-RESERVATION.
*
* Update the reservation in the database
*
        EXEC SQL USING CONTEXT :CONTEXT-STRUCTURE
           UPDATE RESERVATIONS
              SET CREDIT_CARD_NO = :VR_RESERVATIONS_WKSP.CREDIT_CARD_NO,
                  CREDIT_CARD_TYPE_ID =
                     :VR_RESERVATIONS_WKSP.CREDIT_CARD_TYPE_ID,
                  RESERV_STATUS_FLAG = :C-ONE,
                  RESERV_MODIFIC_FLAG =
                     :VR_RESERVATIONS_WKSP.RESERV_MODIFIC_FLAG,
                  BILL_RENTAL_CLASS_ID =
                     :VR_RESERVATIONS_WKSP.BILL_RENTAL_CLASS_ID,
                  VEHICLE_EXPECTED_RETURN_DATE =
                     :VR_RESERVATIONS_WKSP.VEHICLE_EXPECTED_RETURN_DATE
              WHERE RESERVATION_ID = :VR_RESERVATIONS_WKSP.RESERVATION_ID
        END-EXEC.



*
* Update the vehicle record in the database
*
UPDATE-VEHICLES.
        EXEC SQL USING CONTEXT :CONTEXT-STRUCTURE
```

```
            UPDATE VEHICLES
               SET CURRENT_SITE_ID =
                      :VR_RESERVATIONS_WKSP.VEHICLE_CHECKOUT_SITE_ID,
                   AVAILABLE_FLAG = :C-ZERO
               WHERE VEHICLE_ID = :VR_VEHICLES_WKSP.VEHICLE_ID
         END-EXEC.



*
* Write a new vehicle_rental_history record to the database
*
         EXEC SQL USING CONTEXT :CONTEXT-STRUCTURE
            INSERT INTO VEHICLE_RENTAL_HISTORY
               VALUES (:VR_VEHICLE_RENTAL_HISTORY_WKSP:VR_VRH_IND)
         END-EXEC.
```

4.1.6. Handling Errors

You typically write an error handler to process errors returned by Rdb when starting and ending a database transaction and when accessing data in the database. When you use Rdb with SQL, you have normal direct access to the same status values as you do when you use Rdb with RDO. The Rdb return status values are inherently compatible with OpenVMS usage.

Some Rdb errors are expected and are handled by resuming normal program execution. For example, Rdb returns an end-of-stream error when the last record in a record stream has been processed. In this case, the program can resume execution and process the records that have been read. Rdb can also return a number of recoverable errors that the program should check for and handle. For example, if Rdb returns a deadlock error, you might want to roll back the transaction and process the transaction again. Finally, Rdb can return a number of nonrecoverable errors. For example, a disk on which one of the database storage areas resides might fail. In this case, the program cannot continue until the problem has been resolved.

A distributed transaction can abort at any time. If a transaction aborts while a step procedure is executing, Rdb automatically rolls back an active database transaction. However, the step procedure will receive an error the next time it executes an SQL statement in a database transaction that was participating in the distributed transaction. Therefore, an error handler for a step procedure should check for and handle the errors that Rdb returns in this situation.

Typically, you want to retry a transaction automatically in the event of a recoverable error condition such as a deadlock, lock-conflict, lock-timeout, or transaction-timeout error. Rdb returns deadlock, lock-conflict, and lock-timeout errors to your step procedure when you access the database. In contrast, if a distributed transaction times out, the distributed transaction is aborted and ACMS raises a transaction exception in the task. In this case, Rdb returns an error if the step procedure accesses the database after the transaction has aborted.

There is an easy technique, illustrated in examples in this section, that allows you to simplify an exception handler that handles recoverable transaction exceptions in a task definition. The following list indicates how the error handler in the step procedure handles each type of error returned by Rdb:

- Handling recoverable errors

  If an error handler in a step procedure detects a recoverable error condition, such as a deadlock, lock-conflict or lock-timeout error, it calls the ACMS$RAISE_TRANS_EXCEPTION service to raise a transaction exception using the ACMS$_TRANSTIMEDOUT exception code. If a

distributed transaction does not complete within the specified time limit, ACMS also raises a transaction exception using the ACMS$_TRANSTIMEDOUT exception code. Therefore, using ACMS$_TRANSTIMEDOUT as the exception code in the step procedure means that the exception handler in the task definition has to test for only a single exception code in order to handle all recoverable transaction exceptions.

If you detect a recoverable error in a step procedure using an independent database transaction that is not participating in a distributed transaction, you can roll back the database transaction and repeat the transaction in the step procedure.

- Handling transaction aborts

  If a distributed transaction aborts while a step procedure is executing, Rdb returns one of a number of error status values. If a step procedure detects one of these errors, it raises a transaction exception using the error status. If the error was due to a distributed transaction aborting, ACMS overrides the exception in the task. However, if Rdb returns the error due to some other problem, the task is canceled with the specified exception code.

- Handling nonrecoverable errors

  If an unexpected error occurs, the procedure uses the LIB$CALLG RTL routine to call LIB$SIGNAL to signal the error information returned by Rdb. If the procedure signals a fatal OpenVMS status, ACMS writes the error to the audit trail log, cancels the task, and runs down the server process. However, if the procedure signals an error or a warning OpenVMS status, ACMS continues executing the step procedure after writing the error to the audit trail log. The error handler also calls the ACMS$RAISE_NONREC_EXCEPTION service to ensure that the task is canceled.

The procedure VR_COMPLETE_CHECKOUT_PROC handles errors in the following manner:

1. In the Working-Storage Section, the procedure obtains the structure for SQLCODE and RDB$MESSAGE_VECTOR:

```
EXEC SQL INCLUDE SQLCA END-EXEC.
```

2. In the Procedure Division, the step procedure instructs SQL to execute the instructions in the SQL_ERROR_HANDLER paragraph if an error occurs:

```
EXEC SQL
    WHENEVER SQLERROR GO TO SQL-ERROR-HANDLER
END-EXEC.
```

3. In the SQL_ERROR_HANDLER paragraph, the procedure checks the error condition. If a recoverable error occurred, the procedure raises a transaction exception using ACMS$_TRANSTIMEDOUT as the exception code. If the distributed transaction aborted, the procedure raises a transaction exception using the error status returned by Rdb. If any other error occurred, the procedure signals the error information in the Rdb$MESSAGE_VECTOR structure and raises a nonrecoverable exception.

```
SQL-ERROR-HANDLER.

     EVALUATE TRUE
         WHEN ( ( Rdb$LU_STATUS = RDB$_DEADLOCK ) OR
                ( Rdb$LU_STATUS = RDMS$_DEADLOCK ) OR
                ( Rdb$LU_STATUS = RDB$_LOCK_CONFLICT ) OR
                ( Rdb$LU_STATUS = RDMS$_LCKCNFLCT ) OR
                ( Rdb$LU_STATUS = RDMS$_TIMEOUT ) )
```

```
            CALL "ACMS$RAISE_TRANS_EXCEPTION" USING
                        BY REFERENCE ACMS$_TRANSTIMEDOUT


        WHEN ( ( RdB$LU_STATUS = RDB$_SYS_REQUEST_CALL ) OR
               ( Rdb$LU_STATUS = RDB$_BAD_TRANS_HANDLE ) OR
               ( Rdb$LU_STATUS = RDB$_DISTABORT ) OR
               ( Rdb$LU_STATUS = RDB$_REQ_SYNC ) OR
               ( Rdb$LU_STATUS = RDB$_READ_ONLY_TRANS ) )
            CALL "ACMS$RAISE_TRANS_EXCEPTION" USING
                        BY REFERENCE Rdb$LU_STATUS


        WHEN OTHER
            CALL "LIB$CALLG" USING
                        BY REFERENCE Rdb$MESSAGE_VECTOR,
                        BY VALUE LIB$SIGNAL
            CALL "ACMS$RAISE_NONREC_EXCEPTION" USING
                        BY REFERENCE Rdb$LU_STATUS
    END-EVALUATE.
```

4. The task definition uses an exception handler action that repeats the transaction step up to five times if a recoverable transaction error occurs:

```
            .
            .
            .
    EXCEPTION HANDLER
        SELECT FIRST TRUE OF
            ( ACMS$L_STATUS = vr_update_error ):
                MOVE "TRAGN" TO vr_sendctrl_wksp.sendctrl_key;
                GOTO STEP fix_cust_info;
            BOLD
              vr_control_wksp.retry_count < 5 :
                REPEAT STEP;


            NOMATCH:
                GET MESSAGE INTO vr_control_wksp.messagepanel;
                MOVE "ACTWT" TO  vr_sendctrl_wksp.sendctrl_key,
                     "     " TO vr_control_wksp.ctrl_key;
                GOTO STEP disp_stat;
        END SELECT;
            .
            .
            .
```

For detailed information on SQL error handling, see the SQL documentation.

4.1.7. Compiling Procedures that Use SQL

You use the SQL precompiler, SQLPRE, when you compile a procedure containing embedded SQL statements. The SQL precompiler processes the embedded SQL statements in your program, producing an intermediate host-language source file, which it then submits to the host-language compiler to produce an object module.

The SQL precompiler command line includes both precompiler and host-language compiler qualifiers. For the precompiler, include a qualifier to specify in which host language the source is written; you can, optionally, include other qualifiers. On the command line, also include any language compiler qualifiers (such as **LIST** or **DEBUG**) that you want in effect when the precompiler submits the preprocessed source file to the language compiler. For more information on SQL precompiler qualifiers, see the SQL documentation.

You typically define a symbol to invoke the SQL precompiler. For example:

```
$ SCOB == "$SQLPRE/COBOL"
```

The following command line precompiles the procedure VR_COMPLETE_CHECKOUT_PROC:

```
$ SCOB/LIST VR_COMPLETE_CHECKOUT_PROC
```

Note

Do not make changes to the language source module created by the SQL precompiler and then use the language compiler directly to compile that source module. This rule applies even if you want to make source changes that do not affect SQL statements because the next precompilation of the original embedded SQL module overwrites the changes you make to the temporary language source module generated by the precompiler.

Chapter 6, "Building Procedure Server Images" explains how to link procedures that use SQL.

4.1.8. COBOL Step Procedure Using SQL with Rdb

Example 4.7, "COBOL Procedure Using SQL with Rdb" contains a complete COBOL procedure that accesses an Rdb database using SQL.

The Complete Checkout Procedure, VR_COMPLETE_CHECKOUT_PROC, does the following:

- Uses the ACMS$GET_TID service to obtain the TID associated with the transaction
- Starts a database transaction (with the SET TRANSACTION statement)
- For the vehicle being checked out, gets the last odometer reading from the database
- Updates the car rental reservation in the database
- Updates the vehicle record in the database
- Writes a new vehicle rental history record to the database
- Returns a value to the calling task
- Handles any errors encountered in the execution of the procedure

Example 4.7. COBOL Procedure Using SQL with Rdb

```
IDENTIFICATION DIVISION.
*************************************************************
PROGRAM-ID. VR-COMPLETE-CHECKOUT-PROC.
*                                                           *
*               Version:        01                          *
*               Edit:           00                          *
*               Authors:        00                          *
*               Called from:    VR_COMPLETE_CHECKOUT_TASK   *
*                                                           *
```

```
*************************************************************

*************************************************************
*         F U N C T I O N A L   D E S C R I P T I O N       *
*                                                           *
*   This procedure is called from the VR_COMPLETE_CHECKOUT_ *
*   TASK and is used to write a completed reservation record *
*   an updated vehicle record and a new vehicle_rental_his- *
*   tory record to the VEHICLE_RENTALS database.            *
*************************************************************
ENVIRONMENT DIVISION.
*************************************************************
DATA DIVISION.
*************************************************************


WORKING-STORAGE SECTION.
*
* Return status to pass to ACMS
*
01 RET-STAT     PIC S9(9) COMP.
01 RSTAT        PIC S9(9) COMP.


*
* External variables
*
01 RDMS$_DEADLOCK        PIC S9(9) COMP VALUE IS EXTERNAL RDMS$_DEADLOCK.
01 RDB$_DEADLOCK         PIC S9(9) COMP VALUE IS EXTERNAL RDB$_DEADLOCK.
01 RDMS$_LCKCNFLCT       PIC S9(9) COMP VALUE IS EXTERNAL RDMS$_LCKCNFLCT.
01 RDB$_LOCK_CONFLICT    PIC S9(9) COMP VALUE IS EXTERNAL RDB$_LOCK_CONFLICT.
01 RDMS$_TIMEOUT         PIC S9(9) COMP VALUE IS EXTERNAL RDMS$_TIMEOUT.
01 ACMS$_TRANSTIMEDOUT   PIC S9(9) COMP VALUE IS EXTERNAL ACMS$_TRANSTIMEDOUT.
01 RDB$_SYS_REQUEST_CALL PIC S9(9) COMP VALUE IS EXTERNAL RDB$_SYS_REQUEST_CALL.
01 RDB$_BAD_TRANS_HANDLE PIC S9(9) COMP VALUE IS EXTERNAL RDB$_BAD_TRANS_HANDLE.
01 RDB$_DISTABORT        PIC S9(9) COMP VALUE IS EXTERNAL RDB$_DISTABORT.
01 LIB$SIGNAL            PIC S9(5) COMP VALUE IS EXTERNAL LIB$SIGNAL.



*
* Indicator array for null values
*
01 VR_VRH_IND_ARRAY.
   05 VR_VRH_IND OCCURS 6 TIMES PIC S9(4) COMP.
01 VR_VRH_IND1                  PIC S9(4) COMP.
* External status variables for VR messages.
*
EXEC SQL INCLUDE
        'AVERTZ_SOURCE:VR_MESSAGES_INCLUDE.LIB'
END-EXEC.


*
* Literals
*
EXEC SQL INCLUDE
        'AVERTZ_SOURCE:VR_LITERALS_INCLUDE.LIB'
END-EXEC.
*
* Define the SQL return status
*
EXEC SQL INCLUDE
```

```
        'AVERTZ_SOURCE:VR_SQL_STATUS_INCLUDE.LIB'
END-EXEC.


*
* Declare the global transaction context structure. This is required for SQLPRE
*
EXEC SQL INCLUDE
        'AVERTZ_SOURCE:VR_CONTEXT_STRUCTURE_INCLUDE.LIB'
END-EXEC.
*
* Get structure for SQLCODE and RDB$MESSAGE_VECTOR.
*
EXEC SQL INCLUDE SQLCA END-EXEC.


*
* Declare the database schema
*
*
* Copy VEHICLE_RENTAL_HISTORY from the CDD
*
EXEC SQL INCLUDE FROM DICTIONARY
            'AVERTZ_CDD_WKSP:VR_VEHICLE_RENTAL_HISTORY_WKSP'
END-EXEC.


*
EXEC SQL
   DECLARE EXTERNAL SCHEMA FILENAME AVERTZ_DATABASE:VEHICLE_RENTALS
END-EXEC.

*****************************************************************
LINKAGE SECTION.


*
* Copy RESERVATIONS from the CDD
*
EXEC SQL INCLUDE FROM DICTIONARY
            'AVERTZ_CDD_WKSP:VR_RESERVATIONS_WKSP'
END-EXEC.
*
* Copy VEHICLES from the CDD
*
EXEC SQL INCLUDE FROM DICTIONARY
            'AVERTZ_CDD_WKSP:VR_VEHICLES_WKSP'
END-EXEC.
* Copy CONTROL workspace from the CDD - used to handle DDTM timeout
*
EXEC SQL INCLUDE FROM DICTIONARY
            'AVERTZ_CDD_WKSP:VR_CONTROL_WKSP'
END-EXEC.


*****************************************************************
PROCEDURE DIVISION USING VR_RESERVATIONS_WKSP,
                         VR_VEHICLES_WKSP,
                         VR_CONTROL_WKSP
                   GIVING RET-STAT.
*****************************************************************
```

```
MAIN-PROGRAM.

        SET RET-STAT TO SUCCESS.

        IF INCREMENT_RETRY_COUNT OF VR_CONTROL_WKSP = "Y"
        THEN
                ADD 1 TO RETRY_COUNT OF VR_CONTROL_WKSP
        END-IF.

        CALL "ACMS$GET_TID" USING CS-TID GIVING RET-STAT.
        IF RET-STAT IS NOT SUCCESS THEN
                CALL "ACMS$RAISE_NONREC_EXCEPTION" USING BY REFERENCE RET-STAT
                GO TO EXIT-PROGRAM
        END-IF.



*
* Update the required record fields and DECLARE The appropriate null indicators
*
        MOVE VEHICLE_CHECKOUT_SITE_ID OF VR_RESERVATIONS_WKSP TO
           CHECKOUT_SITE_ID OF VR_VEHICLE_RENTAL_HISTORY_WKSP.
        MOVE VEHICLE_ID OF VR_VEHICLES_WKSP TO
           VEHICLE_ID OF VR_VEHICLE_RENTAL_HISTORY_WKSP.
        MOVE RESERVATION_ID OF VR_RESERVATIONS_WKSP TO
           RESERVATION_ID OF VR_VEHICLE_RENTAL_HISTORY_WKSP.
        MOVE NEG-ONE TO VR_VRH_IND(5).
        MOVE NEG-ONE TO VR_VRH_IND(6).



* Set up to trap errors returned by SQL;  the precompiler will generate the
* necessary tests
*
        EXEC SQL
           WHENEVER SQLERROR GO TO SQL-ERROR-HANDLER
        END-EXEC.




* Start the database transaction
*
        EXEC SQL USING CONTEXT: CONTEXT_STRUCTURE
                SET TRANSACTION READ WRITE
                EVALUATING RS_VALID_BILL_RENTAL_CLASS AT VERB TIME,
                RS_VALID_VEHICL_CHKOUT_SITE_ID AT VERB TIME,
                VE_VALID_CURRENT_SITE_ID AT VERB TIME,
                VRH_VALID_VEHICLE_ID AT VERB TIME,
                VRH_VALID_PRIMARY_KEY AT VERB TIME
                RESERVING RESERVATIONS,VEHICLES,VEHICLE_RENTAL_HISTORY
                   FOR SHARED WRITE,
                RENTAL_CLASSES,SITES,REGIONS FOR SHARED READ
        END-EXEC.


*
*
GET-ODOMETER-READING.
* Get the last return odometer reading for the vehicle being checked out
* from the database.  If not found, ignore it.
        EXEC SQL WHENEVER NOT FOUND CONTINUE END-EXEC.
```

```
        EXEC SQL USING CONTEXT :CONTEXT-STRUCTURE
           SELECT MAX(RETURN_ODOMETER_READING)INTO
                 :VR_VEHICLE_RENTAL_HISTORY_WKSP.CHECKOUT_ODOMETER_READING
                    INDICATOR :VR_VRH_IND1
              FROM VEHICLE_RENTAL_HISTORY
              WHERE VEHICLE_ID = :VR_VEHICLES_WKSP.VEHICLE_ID
        END-EXEC.



UPDATE-RESERVATION.
* Update the reservation in the database
*
        EXEC SQL USING CONTEXT :CONTEXT-STRUCTURE
           UPDATE RESERVATIONS
              SET CREDIT_CARD_NO = :VR_RESERVATIONS_WKSP.CREDIT_CARD_NO,
                  CREDIT_CARD_TYPE_ID =
                     :VR_RESERVATIONS_WKSP.CREDIT_CARD_TYPE_ID,
                  RESERV_STATUS_FLAG = :C-ONE,
                  RESERV_MODIFIC_FLAG =
                     :VR_RESERVATIONS_WKSP.RESERV_MODIFIC_FLAG,
                  BILL_RENTAL_CLASS_ID =
                     :VR_RESERVATIONS_WKSP.BILL_RENTAL_CLASS_ID,
                  VEHICLE_EXPECTED_RETURN_DATE =
                     :VR_RESERVATIONS_WKSP.VEHICLE_EXPECTED_RETURN_DATE
              WHERE RESERVATION_ID = :VR_RESERVATIONS_WKSP.RESERVATION_ID
        END-EXEC.



* Update the vehicle record in the database
*
UPDATE-VEHICLES.
*
        EXEC SQL USING CONTEXT :CONTEXT-STRUCTURE
           UPDATE VEHICLES
              SET CURRENT_SITE_ID =
                     :VR_RESERVATIONS_WKSP.VEHICLE_CHECKOUT_SITE_ID,
                  AVAILABLE_FLAG = :C-ZERO
              WHERE VEHICLE_ID = :VR_VEHICLES_WKSP.VEHICLE_ID
        END-EXEC.



* Write a new vehicle_rental_history record to the database
*
        EXEC SQL USING CONTEXT :CONTEXT-STRUCTURE
           INSERT INTO VEHICLE_RENTAL_HISTORY
              VALUES (:VR_VEHICLE_RENTAL_HISTORY_WKSP:VR_VRH_IND)
        END-EXEC.

* All database activity was successful; commit the transaction in the task
*

        MOVE CHKOUTCOM TO RET-STAT.

        GO TO EXIT-PROGRAM.

* Error handling



SQL-ERROR-HANDLER.
```

```
    EVALUATE TRUE
        WHEN ( ( Rdb$LU_STATUS = RDB$_DEADLOCK ) OR
               ( Rdb$LU_STATUS = RDMS$_DEADLOCK ) OR
               ( Rdb$LU_STATUS = RDB$_LOCK_CONFLICT ) OR
               ( Rdb$LU_STATUS = RDMS$_LCKCNFLCT ) OR
               ( Rdb$LU_STATUS = RDMS$_TIMEOUT ) )
            CALL "ACMS$RAISE_TRANS_EXCEPTION" USING
                        BY REFERENCE ACMS$_TRANSTIMEDOUT



        WHEN ( ( RdB$LU_STATUS = RDB$_SYS_REQUEST_CALL ) OR
               ( Rdb$LU_STATUS = RDB$_BAD_TRANS_HANDLE ) OR
               ( Rdb$LU_STATUS = RDB$_DISTABORT ) OR
               ( Rdb$LU_STATUS = RDB$_REQ_SYNC ) OR
               ( Rdb$LU_STATUS = RDB$_READ_ONLY_TRANS ) )
            CALL "ACMS$RAISE_TRANS_EXCEPTION" USING
                        BY REFERENCE Rdb$LU_STATUS



        WHEN OTHER
            CALL "LIB$CALLG" USING
                        BY REFERENCE Rdb$MESSAGE_VECTOR,
                        BY VALUE LIB$SIGNAL
            CALL "ACMS$RAISE_NONREC_EXCEPTION" USING
                        BY REFERENCE Rdb$LU_STATUS
    END-EVALUATE.



EXIT-PROGRAM.
        EXIT PROGRAM.
```

4.2. Using Precompiled RDO or RDML with Rdb

This section describes how to write step procedures that access an Rdb database using precompiled RDO or RDML.

A step procedure that accesses an Rdb database on behalf of an ACMS task is similar to any Rdb program that accesses a database. This section explains how to start an Rdb database transaction and how to access data in an Rdb database using RDO.

4.2.1. Using RDO Statements in Step Procedures

You use the *&RDB&* flag to distinguish Rdb RDO statements from host language statements. See the Rdb documentation for more information on using RDO and RDML statements in a host language program. You name the Rdb database that your step procedure accesses using the INVOKE DATABASE statement. You must use the INVOKE DATABASE statement before you can use other RDO statements to access data in the database. For example:

```
   &RDB&  INVOKE DATABASE FILENAME "avertz_database:vehicle_rentals"
```

The database you name must be the same in all the step procedures, and in the initialization and termination procedures and cancel procedures in the server.

4.2.2. Starting and Ending RDO Database Transactions

You start an RDO database transaction by using a START_TRANSACTION statement. However, the way in which you start the database transaction depends on whether the database transaction is part of a distributed transaction.

This section describes how to start a database transaction that is part of a distributed transaction and how to start and end an independent database transaction. When you start an Rdb database transaction, you can also specify transaction, lock, and wait modes.

Important

See *Section 4.1.3.3, "Using Rdb Transaction Mode and Lock Mode Specifications"* for information on transaction and lock mode specifications. See *Section 4.1.3.4, "Using an Rdb Wait Mode Specification"* for important information on transaction wait modes.

4.2.2.1. Starting an RDO Database Transaction that is Part of a Distributed Transaction

For an RDO database transaction to participate in a distributed transaction, you must specify the Transaction ID (TID) on the START_TRANSACTION statement.

Note

For a procedure that accesses an Rdb database to participate in a distributed transaction, the database transaction must start in the procedure, not in the task definition.

The following code segment in COBOL illustrates how to start an RDO database transaction that is part of a distributed transaction. The procedure allocates a structure to hold the TID in the Working-Storage Section. In the Procedure Division, the procedure calls ACMS$GET_TID to retrieve the TID. If an error occurs, the procedure raises a nonrecoverable exception and exits. If there is no error, the procedure starts the database transaction, specifying the TID using the DISTRIBUTED_TID phrase. A common error handler, described in *Section 4.2.5, "Handling Errors"*, is used to check the status from the START_TRANSACTION statement.

```
            .
            .
            .
WORKING-STORAGE SECTION.



&RDB& INVOKE DATABASE FILENAME "avertz_database:vehicle_rentals"

01 dist_tid.
   03 tid_data                  PIC X(16).
01 sts                          PIC S9(5) COMP.
      .
      .
      .
```

```
PROCEDURE DIVISION.
MAIN SECTION.
      .
      .
      .
    CALL "ACMS$GET_TID" USING BY REFERENCE dist_tid
                        GIVING sts.
    IF sts IS FAILURE
    THEN
        CALL "ACMS$RAISE_NONREC_EXCEPTION" USING BY REFERENCE sts
        GO TO 999_end
    END-IF.



    &RDB& START_TRANSACTION DISTRIBUTED_TRANSACTION
    &RDB&   DISTRIBUTED_TID dist_tid READ_WRITE
    &RDB&   RESERVING reservations FOR SHARED WRITE,
    &RDB&             rental_classes,sites,regions FOR SHARED READ
    &RDB&   ON ERROR
                GO TO 900-rdb-error
    &RDB&   END_ERROR.
          .
          .
          .
```

The following code segment in BASIC illustrates how to start an RDO database transaction that is part of a distributed transaction. The procedure first defines and allocates a structure to hold the TID. The procedure next calls ACMS$GET_TID to retrieve the TID. If an error occurs, the procedure raises a nonrecoverable exception and exits. If there is no error, the procedure starts the database transaction, specifying the TID using the DISTRIBUTED_TID phrase. A common error handler is used to check the status from the START_TRANSACTION statement.

```
.
.
.
&RDB& INVOKE DATABASE FILENAME "avertz_database:vehicle_rentals"

RECORD dist_tid_structure
    STRING tid_data = 16
END RECORD



DECLARE dist_tid_structure dist_tid

sts = ACMS$GET_TID( dist_tid )
IF ( sts AND 1% ) = 0%
THEN
    CALL ACMS$RAISE_NONREC_EXCEPTION( sts )
    EXIT FUNCTION sts
END IF



&RDB& START_TRANSACTION DISTRIBUTED_TRANSACTION
&RDB&   DISTRIBUTED_TID dist_tid READ_WRITE
```

```
&RDB&   RESERVING reservations FOR SHARED WRITE,
&RDB&             rental_classes,sites,regions FOR SHARED READ
&RDB&   ON ERROR
            GOSUB check_rdb_error
            EXIT FUNCTION Rdb$LU_STATUS
&RDB&   END_ERROR
      .
      .
      .
```

Because the RDO database transaction is participating in a distributed transaction, Rdb automatically commits or rolls back the database transaction when the distributed transaction ends. Therefore, you must not use the COMMIT or ROLLBACK verbs to end the database transaction in the step procedure.

4.2.2.2. Starting and Ending an Independent RDO Database Transaction

You start an independent database transaction by using the START_TRANSACTION statement. For example:

```
&RDB& START_TRANSACTION
&RDB&   RESERVING reservations FOR SHARED WRITE,
&RDB&             rental_classes,sites,regions FOR SHARED READ
&RDB&   ON ERROR
            .
            .
            .
&RDB&   END_ERROR
```

Because the RDO database transaction is not participating in a distributed transaction, you must commit or roll back the database transaction in the procedure. For example:

```
IF sts IS SUCCESS
THEN
    &RDB& COMMIT
ELSE
    &RDB& ROLLBACK
END-IF.
```

4.2.3. Reading from a Database

The examples in this section illustrate how to read a record from a database and retrieve the data from the record.

Each example shows how to read a record from the SITES relation in the AVERTZ database. The procedure first initializes the return status to a failure status; it next uses a FOR statement to locate the target record and a GET statement to retrieve the data from the record. If a record is successfully located, a success value is stored in the procedure's return status. If the record is not found, the return status remains set to the failure status, indicating that the record does not exist. For example, in COBOL:

```
            .
            .
            .
```

```
MOVE vr_sirecnotfnd TO return_status.
&RDB& FOR s IN sites WITH s.site_id = site_id
&RDB&   ON ERROR
            GO TO 900-rdb-error
&RDB&   END_ERROR
&RDB&   GET
&RDB&       ON ERROR
                GO TO 900-rdb-error
&RDB&       END_ERROR
&RDB&       vr_sites_wksp = s.*
&RDB&   END_GET
        SET return_status TO SUCCESS
&RDB& END_FOR.
        .
        .
        .
```

For example, in BASIC:

```
        .
        .
        .
vr_find_site_proc = vr_sirecnotfnd
&RDB& FOR s IN sites WITH s.site_id = sites::site_id


&RDB&   ON ERROR
            GOSUB check_rdb_error
            EXIT FUNCTION Rdb$LU_STATUS
&RDB&   END_ERROR


&RDB&   GET
&RDB&       ON ERROR
                GOSUB check_rdb_error
                EXIT FUNCTION Rdb$LU_STATUS
&RDB&       END_ERROR
&RDB&       sites = s.*


&RDB&   END_GET
        vr_find_site_proc = 1%
&RDB& END_FOR
        .
        .
        .
```

The error handlers used in these examples are shown in *Section 4.2.5, "Handling Errors"*.

4.2.4. Writing to a Database

The examples in this section illustrate how to modify an existing record in a database using the MODIFY statement and how to store a new record in a database using the STORE statement.

When new customers are added to the AVERTZ database, each one must be allocated a customer ID number and a new record stored in the CUSTOMERS relation. A relation called

CU_ID_INC_CONTROL contains a single control record that holds the next available customer ID number. Each example in this section:

- Reads the customer ID control record
- Saves the next available customer ID number
- Increments the ID number and updates the control record
- Stores the new record in the CUSTOMERS relation

The following code segment shows how a new customer is added to the database using COBOL:

```
                .
                .
                .
*
* Obtain new customer ID number
*
    &RDB& FOR i IN cu_id_inc_control
    &RDB&   ON ERROR
                GO TO 900-rdb-error
    &RDB&   END_ERROR
*
* Retrieve next available ID number from control record
*
    &RDB&   GET
    &RDB&       ON ERROR
                    GO TO 900-rdb-error
    &RDB&       END_ERROR
    &RDB&       customer_id = i.max_customer_id
    &RDB&   END_GET


*
* Increment next available ID number and update control record
*
    &RDB&   MODIFY i USING
    &RDB&       ON ERROR
                    GO TO 900-rdb-error
    &RDB&       END_ERROR
    &RDB&       i.max_customer_id = i.max_customer_id + 1
    &RDB&   END_MODIFY
    &RDB& END_FOR



*
* Store new customer record
*
    &RDB& STORE c IN customers USING
    &RDB&   ON ERROR
                GO TO 900-rdb-error
    &RDB&   END_ERROR
    &RDB&   c.last_name = cu_last_name;
    &RDB&   c.first_name = cu_first_name;
```

```
                    .
                    .
                    .
&RDB&   c.driver_license_region_id =
&RDB&                       cu_driver_license_region_id;
&RDB&   c.driver_license_country_id =
&RDB&                       cu_driver_license_country_id
&RDB& END_STORE
          .
          .
          .
```

The following code segment illustrates how a new customer is added to the database using BASIC:

```
             .
             .
             .
!
! Obtain new customer ID number
!
&RDB& FOR i IN cu_id_inc_control
&RDB&   ON ERROR
            GOSUB check_rdb_error
            EXIT FUNCTION Rdb$LU_STATUS
&RDB&   END_ERROR


        !
        ! Retrieve next available ID number from control record
        !
&RDB&   GET
&RDB&       ON ERROR
                GOSUB check_rdb_error
                EXIT FUNCTION Rdb$LU_STATUS
&RDB&       END_ERROR
&RDB&       cust::customer_id = i.max_customer_id
&RDB&   END_GET


        !
        ! Increment next available ID number and update record
        !
&RDB&   MODIFY i USING
&RDB&       ON ERROR
                GOSUB check_rdb_error
                EXIT FUNCTION Rdb$LU_STATUS
&RDB&       END_ERROR
&RDB&       i.max_customer_id = i.max_customer_id + 1%
&RDB&   END_MODIFY
&RDB& END_FOR



!
! Store new customer record
!
&RDB& STORE c IN customers USING
```

```
&RDB&   ON ERROR
            GOSUB check_rdb_error
            EXIT FUNCTION Rdb$LU_STATUS
&RDB&   END_ERROR


&RDB&   c.last_name = cust::cu_last_name;
&RDB&   c.first_name = cust::cu_first_name;
                    .
                    .
                    .


&RDB&   c.driver_license_region_id =
&rdb&                   cust::cu_driver_license_region_id;
&RDB&   c.driver_license_country_id =
&rdb&                   cust::cu_driver_license_country_id
&RDB& END_STORE
```

4.2.5. Handling Errors

You typically write an error handler to process errors returned by Rdb when starting and ending a database transaction and when accessing data in the database. Handling error conditions using RDO with Rdb is very similar to using SQL with Rdb. This section describes the differences between RDO and SQL when using distributed transactions. See *Section 4.1.6, "Handling Errors"* for information on handling errors using SQL.

A distributed transaction can abort at any time. If a transaction aborts while a step procedure is executing, Rdb automatically rolls back an active database transaction. The next time the step procedure executes an RDO statement, Rdb starts a new, default database transaction with read-only access to the database. The RDO statement completes successfully only if it retrieves information from the database. However, Rdb returns an error if the RDO statement writes to the database. Therefore, the error handler in a procedure using RDO must check for additional Rdb error codes.

Note

Chapter 2, "Writing Initialization, Termination, and Cancel Procedures" discusses how to write a server cancel procedure that is used to roll back the default database transaction that Rdb starts if a procedure executes an RDO statement after a distributed transaction has aborted.

The following example shows how to write an error handler in BASIC for use in a procedure using RDO:

```
EXTERNAL LONG CONSTANT RDB$_LOCK_CONFLICT
                    .
                    .
                    .
EXTERNAL LONG FUNCTION LIB$SIGNAL
                    .
                    .
                    .


check_rdb_error:
```

```
SELECT Rdb$LU_STATUS
    CASE    RDB$_DEADLOCK,                                  &
            RDMS$_DEADLOCK,                                 &
            RDB$_LOCK_CONFLICT,                             &
            RDMS$_LCKCNFLCT,                                &
            RDMS$_TIMEOUT
        CALL ACMS$RAISE_TRANS_EXCEPTION( ACMS$_TRANSTIMEDOUT )



    CASE    RDB$_SYS_REQUEST_CALL,                          &
            RDB$_BAD_TRANS_HANDLE,                          &
            RDB$_DISTABORT,                                 &
            RDB$_READ_ONLY_TRANS,                           &
            RDB$_REQ_SYNC
        CALL ACMS$RAISE_TRANS_EXCEPTION( Rdb$LU_STATUS )

    CASE    ELSE
        CALL LIB$CALLG( Rdb$MESSAGE_VECTOR,                 &
                        LOC( LIB$SIGNAL ) BY VALUE )
        CALL ACMS$RAISE_NONREC_EXCEPTION( Rdb$LU_STATUS )
END SELECT
RETURN
    .
    .
    .
```

4.2.6. Compiling Rdb Procedures that Use RDO

You use the RDO precompiler, RDBPRE, when you compile a procedure containing embedded RDO statements. The RDO precompiler processes the embedded RDO statements in your program, producing an intermediate host language source file, which it then submits to the host language compiler to produce an object module.

The RDO precompiler command line includes both precompiler and host language compiler qualifiers. For the precompiler, include a qualifier to specify in which host language the source is written; you can, optionally, include other qualifiers. On the command line, also include any language compiler qualifiers (such as **LIST** or **DEBUG**) that you want in effect when the precompiler submits the preprocessed source file to the language compiler. For more information on RDO precompiler qualifiers, see the Rdb documentation.

You typically define a symbol to invoke the RDO precompiler. For example:

```
$ RCOB == "$RDBPRE/COBOL"
```

The following command line precompiles a procedure called VR_FIND_SITE_RDO_PROC:

```
$ RCOB/LIST VR_FIND_SITE_RDO_PROC
```

Note

Do not make changes to the language source module created by the RDO precompiler and then use the language compiler directly to compile that source module. This rule applies even if you want to make source changes that do not affect RDO statements because the next precompilation of the original

embedded RDO module overwrites the changes you make to the temporary language source module generated by the precompiler.

Chapter 6, "Building Procedure Server Images" explains how to link procedures that use RDO.

4.3. Using DBMS

A procedure for an ACMS task that accesses a DBMS database is similar to any DBMS program that accesses a database. For example, the procedure uses the same DBMS DML (Data Manipulation Language) statements, such as MOVE and STORE. It handles errors by testing against DBMS error conditions.

4.3.1. Using DBMS DML Statements in Step Procedures

COBOL supports DBMS DML statements as part of the COBOL language. However, if you are using DBMS with another language, such as BASIC, you use the DBMS DML precompiler to process the DML statements in your program in much the same way as you do when you use SQL or RDO with Rdb.

The DBMS DML precompiler uses a prefix character to distinguish DML statements from host language statements. The default prefix character is the pound-sign (#) character. For information on DML statements, refer to the DBMS documentation.

In COBOL, you name the database that your step procedure accesses in the SUBSCHEMA section in the Data Division. The subschema name is required, even if you are using the default subschema. The schema name is also required. For example:

```
DB  DEFAULT_SUBSCHEMA
    WITHIN "PERS_CDD.PERS_DBMS_SCHEMA"
    FOR "PERS_DB:PERS_DBMS".
```

In other languages, you name the database that your step procedure accesses using the INVOKE statement. In this BASIC example, the procedure uses record-type structures in the user work area:

```
    # INVOKE DEFAULT_SUBSCHEMA -
             WITHIN PERS_CDD.PERS_DBMS_SCHEMA -
             FOR PERS_DB:PERSONNEL -
             ( RECORDS )
```

The database and subschema you name must be the same in all the procedures linked into the server.

4.3.2. Starting and Ending a DBMS Database Transaction

You start a DBMS database transaction by using a READY statement. However, the way in which you start the database transaction depends on whether the database transaction is part of a distributed transaction. In the READY statement, you can specify the realms the step procedure accesses in the database. If you do not specify one or more realms, DBMS readies all the realms in the subschema.

This section describes how to start a database transaction that is part of a distributed transaction and how to start and end an independent database transaction. In addition, it discusses various access modes that you can specify when starting a database transaction.

4.3.2.1. Starting a DBMS Database Transaction that Is Part of a Distributed Transaction

For a DBMS database transaction to participate in a distributed transaction, you must specify the transaction ID (TID) on the READY statement.

Note

For a procedure that accesses a DBMS database to participate in a distributed transaction, the database transaction must start in the procedure, not in the task definition.

The following code segment illustrates how to start a DBMS database transaction that is part of a distributed transaction in COBOL. In the Working-Storage Section, the procedure allocates a structure to hold the TID. In the Procedure Division, the procedure calls ACMS$GET_TID to retrieve the TID. If an error occurs, the procedure raises a nonrecoverable exception and exits. If there is no error, the procedure starts the database transaction by calling DBQ$INTERPRET. It specifies the FOR TRANSACTION phrase in the READY statement and passes the TID as an argument to DBQ$INTERPRET.

```
CALL "DBQ$INTERPRET" USING
        BY DESCRIPTOR "READY CONCURRENT UPDATE FOR TRANSACTION",
        BY REFERENCE dist_tid
        GIVING return_status.
IF return_status IS FAILURE
THEN
    CALL "DBM$SIGNAL"
END-IF
```

See the COBOL and DBMS documentation for more information on starting a database transaction in COBOL.

The following code segment illustrates how to start a DBMS database transaction that is part of a distributed transaction in BASIC. The procedure first defines and allocates a structure to hold the TID. It next calls ACMS$GET_TID to retrieve the TID. If an error occurs, the procedure raises a nonrecoverable exception and exits. If there is no error, the procedure starts the database transaction, specifying the TID using the FOR TRANSACTION phrase on the READY statement.

```
            .
            .
            .
RECORD dist_tid_structure
    STRING tid_data = 16
END RECORD
DECLARE dist_tid_structure dist_tid
            .
            .
            .
sts = ACMS$GET_TID( dist_tid BY REF )

IF ( sts AND 1% ) = 0%                                          &
THEN
    CALL ACMS$RAISE_NONREC_EXCEPTION( sts )
END IF

# READY CONCURRENT UPDATE FOR TRANSACTION dist_tid
```

```
.
.
.
```

Because the DBMS database transaction is participating in a distributed transaction, DBMS automatically commits or rolls back the database transaction when the distributed transaction ends. Therefore, you must not use the COMMIT or ROLLBACK verbs to end the database transaction in the step procedure.

Important

For a DBMS database transaction to participate in a distributed transaction, you must specify the TID in the READY verb. If you omit it, the task does not function correctly.

4.3.2.2. Starting and Ending an Independent DBMS Database Transaction

You start an independent database transaction by using the READY statement. For example, in COBOL:

```
READY CONCURRENT RETRIEVAL.
```

The following example starts an independent, read-only database transaction using BASIC:

```
# READY CONCURRENT RETRIEVAL
```

Because the DBMS database transaction is not participating in a distributed transaction, you must commit or roll back the database transaction in the procedure. For example, in COBOL:

```
  .
  .
  .
IF sts IS SUCCESS
THEN
    COMMIT
ELSE
    ROLLBACK
END-IF.
  .
  .
  .
```

For example, in BASIC:

```
   .
   .
   .
IF ( sts AND 1% ) = 1%
THEN
    # COMMIT
ELSE
    # ROLLBACK
END IF
   .
   .
   .
```

4.3.2.3. Using DBMS Access and Allow Mode Specifications

You can specify the access mode and allow mode when you start a DBMS database transaction. The access mode specifies how the step procedure accesses the database. If the step procedure only reads records from the database, specify RETRIEVAL when you start the database transaction. Specify UPDATE in step procedures that read, write, and modify records in the database. If you do not specify an access mode, the default is RETRIEVAL access, which means that you can only read records from the database. Using RETRIEVAL mode in a procedure that does not update records reduces database contention.

The allow mode specifies how you will allow other processes to access the database. The default is PROTECTED, which means that other processes can read records from the database, but they cannot modify existing records or store new records in the database. Specify PROTECTED if a single process only needs write-access to the database. If multiple processes need write-access to the database, specify CONCURRENT mode. DBMS also supports BATCH and EXCLUSIVE allow modes.

Refer to the DBMS documentation for more information on database access and allow modes.

4.3.2.4. Using a DBMS Wait Mode Specification

When you create or modify a database, you can specify how DBMS handles the situation if it encounters a locked record while accessing the database. If you use the **/WAIT_RECORD_LOCKS** qualifier on the **DBO/CREATE** or **DBO/MODIFY** command, DBMS waits until the lock can be granted before continuing. If you use the **/NOWAIT_RECORD_LOCKS** qualifier, DBMS immediately returns an error if it encounters a lock. You can override the wait-mode specification at run time by using the DBM$BIND_WAIT_RECORD_LOCKS logical name.

If you choose to wait for locks, you can specify the maximum time you are prepared to wait until a lock is granted. If the lock is not granted in the specified time limit, DBMS returns the DBM$_LCKCNFLCT or DBM$_TIMEOUT errors. Specify the time limit by defining the DBM$BIND_LOCK_TIMEOUT_INTERVAL logical name in a logical name table that is accessible to the server. Define the DBM$BIND_LOCK_TIMEOUT_INTERVAL logical name in one of the following ways:

- As a server logical name in the application definition
- In an application-specific logical name table
- In the system logical name table
- In a group logical name table

For example, the following server logical name definition specifies that DBMS should wait no more than 10 seconds for a lock to be granted:

```
LOGICAL NAME IS
     DBM$BIND_LOCK_TIMEOUT_INTERVAL = "10";
```

See the DBMS documentation for more information on specifying the wait mode and lock timeout interval.

Important

If you are using distributed transactions, always specify a lock timeout interval to ensure that ACMS can successfully cancel a task that is waiting for a database lock. By specifying a lock timeout interval,

you ensure that the task is canceled as soon as the timeout interval expires. If you do not specify a lock timeout interval, the task cannot be canceled until the lock is granted.

4.3.3. Reading from a Database

The examples in this section illustrate how to read a record from a DBMS database and return the data to the task in a workspace.

Example 4.8, "Step Procedure in COBOL that Reads a DBMS Record" illustrates a simple step procedure written in COBOL that reads a record from a personnel database. The procedure first moves the record key from the task workspace into the user work area (UWA). It next starts a database transaction and reads the record from the database. If the employee's record does not exist or is locked, the procedure returns a failure status. If any other error occurs, the procedure calls DBM$SIGNAL to signal the error and then calls ACMS$RAISE_NONREC_EXCEPTION to ensure that the task is canceled. If the record is read successfully, the procedure moves the data from the UWA into the task workspaces and returns a success status. Finally, the procedure ends the transaction.

Example 4.8. Step Procedure in COBOL that Reads a DBMS Record

```
IDENTIFICATION DIVISION.
PROGRAM-ID. pers_find_employee_proc.


ENVIRONMENT DIVISION.



DATA DIVISION.
SUB-SCHEMA SECTION.


DB  DEFAULT_SUBSCHEMA
    WITHIN "PERS_CDD.PERS_DBMS_SCHEMA"
    FOR "PERS_DB:PERS_DBMS".


WORKING-STORAGE SECTION.

01 return_status               PIC S9(5) COMP.
01 error_cond                  PIC S9(5) COMP.

COPY "pers_files:pers_common_defns".



LINKAGE SECTION.
COPY "pers_cdd.employee_record" FROM DICTIONARY
    REPLACING ==employee_record== BY ==emp_wksp_record==.

PROCEDURE DIVISION USING emp_wksp_record GIVING return_status.



MAIN SECTION.

000-start.
```

```
    MOVE emp_badge_number OF emp_wksp_record TO
         emp_badge_number OF employee_record.

    READY CONCURRENT RETRIEVAL.

    FETCH FIRST WITHIN ALL_EMPLOYEES
                USING emp_badge_number OF employee_record


    ON ERROR
        CALL "LIB$MATCH_COND" USING
                BY REFERENCE DB-CONDITION,
                BY REFERENCE DBM$_END,
                BY REFERENCE DBM$_DEADLOCK,
                BY REFERENCE DBM$_LCKCNFLCT,
                BY REFERENCE DBM$_TIMEOUT
                GIVING error_cond


        EVALUATE error_cond
            WHEN 1
                MOVE persmsg_empnotfound TO return_status
            WHEN 2 THRU 4
                MOVE persmsg_emplocked TO return_status
            WHEN OTHER
                CALL "DBM$SIGNAL"
                CALL "ACMS$RAISE_NONREC_EXCEPTION" USING
                            BY REFERENCE DB-CONDITION
        END-EVALUATE


    NOT ON ERROR
        MOVE employee_record TO emp_wksp_record
        MOVE persmsg_success TO return_status
    END-FETCH.

    COMMIT.

999-end.
    EXIT PROGRAM.
```

Example 4.9, "Step Procedure in BASIC that Reads a DBMS Record" illustrates a simple step procedure written in BASIC that reads a record from a personnel database. The procedure extends the previous COBOL example by including logic to retry the transaction automatically if the employee's record is locked. The procedure first initializes a transaction retry-counter and moves the record key from the task workspace into the user work area (UWA). It then starts a database transaction, reads the record from the database, and ends the transaction. Finally, the procedure moves the employee's record from the UWA into the task workspaces and returns a success status.

The procedure uses an error handler to trap errors signaled by DBMS. Because DBMS always signals severe OpenVMS status codes, the procedure uses the HANDLE=SEVERE option to trap the errors in the handler. If the employee's record does not exist, the error handler returns a failure status. If the error handler detects a record-locked or lock-timeout error, it retries the transaction up to 5 times before return a failure status. If any other error occurs, the error handler uses the EXIT HANDLER statement to resignal the error condition. Finally, the error handler ends the current transaction, trapping and ignoring all errors.

Example 4.9. Step Procedure in BASIC that Reads a DBMS Record

```
    FUNCTION LONG pers_find_employee_proc( employee_record emp_wksp )

    OPTION HANDLE=SEVERE

    %INCLUDE "pers_files:pers_common_defns"
    %INCLUDE %FROM %CDD "pers_cdd.employee_record"



    DECLARE LONG retry_count

    # INVOKE DEFAULT_SUBSCHEMA -
             WITHIN PERS_CDD.PERS_DBMS_SCHEMA -
             FOR PERS_DB:PERS_DBMS -
             ( RECORDS )



    WHEN ERROR IN
        retry_count = 0%
        employee_record::emp_badge_number = emp_wksp::emp_badge_number



start_db_trans:
        # READY CONCURRENT RETRIEVAL
        # FETCH FIRST WITHIN ALL_EMPLOYEES USING emp_badge_number
        # COMMIT

        emp_wksp = employee_record
        pers_find_employee_proc = persmsg_success


    USE
        SELECT LIB$MATCH_COND( DBM_COND, DBM$_END,                      &
                                         DBM$_DEADLOCK,                 &
                                         DBM$_LCKCNFLCT,                &
                                         DBM$_TIMEOUT )
            CASE 1          ! DBM$_END
                pers_find_employee_proc = persmsg_empnotfound



            CASE 2, 3, 4    ! DBM$_DEADLOCK, DBM$_LCKCNFLCT, DBM$_TIMEOUT
                IF retry_count < 5%                                     &
                THEN
                    retry_count = retry_count + 1%
                    # ROLLBACK ( TRAP ERROR )
                    CONTINUE start_db_trans
                ELSE
                    pers_find_employee_proc = persmsg_emplocked
                END IF



            CASE ELSE
```

```
                EXIT HANDLER
        END SELECT
        # ROLLBACK ( TRAP ERROR )
    END WHEN

    END FUNCTION
```

4.3.4. Writing to a Database

This section illustrates how to store a new record in a DBMS database and how to update a record in a DBMS database.

Example 4.10, "Step Procedure in COBOL that Updates a DBMS Record" explains how to store a new record in a DBMS database. The PERS_ADD_EMPLOYEE_PROC procedure stores a new record in the employee set using the information that is entered by the user and passed to the procedure in a task workspace.

The procedure first calls ACMS$GET_TID to obtain the current transaction ID (TID). The procedure next calls DBQ$INTERPRET to start the database transaction. If successful, it copies the new employee record data from the task workspace to the user work area (UWA) and stores the current time in the employee record; the time-stamp field is used for consistency-checking by the update procedure. The procedure then stores the record in the database. If all is successful, the procedure returns a success status to the task. The error handler for this procedure is described in *Section 4.3.5, "Handling Errors"*.

Example 4.10. Step Procedure in COBOL that Updates a DBMS Record

```
IDENTIFICATION DIVISION.
PROGRAM-ID. pers_add_employee_proc.

ENVIRONMENT DIVISION.

DATA DIVISION.
SUB-SCHEMA SECTION.



DB  DEFAULT_SUBSCHEMA
    WITHIN "PERS_CDD.PERS_DBMS_SCHEMA"
    FOR "PERS_DB:PERS_DBMS".



WORKING-STORAGE SECTION.

01 return_status                PIC S9(5) COMP.
01 error_cond                   PIC S9(5) COMP.
01 dist_tid.
   03 tid_data                  PIC X(16).



COPY "pers_files:pers_common_defns".

LINKAGE SECTION.
COPY "pers_cdd.employee_record" FROM DICTIONARY
    REPLACING ==employee_record== BY ==emp_wksp_record==.
```

```
PROCEDURE DIVISION USING emp_wksp_record GIVING return_status.

DECLARATIVES.
dml-failure SECTION.
    USE FOR DB-EXCEPTION.
010-dbm-failure.
        .
        .
        .
    EXIT PROGRAM.
END DECLARATIVES.



MAIN SECTION.

000-start.
    CALL "ACMS$GET_TID" USING
                BY REFERENCE dist_tid
                GIVING return_status.
    IF return_status IS FAILURE
    THEN
        CALL "ACMS$RAISE_NONREC_EXCEPTION" USING
                BY REFERENCE return_status
        EXIT PROGRAM
    END-IF.



    CALL "DBQ$INTERPRET" USING
            BY DESCRIPTOR "READY CONCURRENT UPDATE FOR TRANSACTION",
            BY REFERENCE dist_tid
            GIVING return_status.
    IF return_status IS FAILURE
    THEN
        CALL "DBM$SIGNAL"
    END-IF



    MOVE emp_wksp_record TO employee_record.
    CALL "SYS$GETTIM" USING
            BY REFERENCE emp_last_update OF employee_record
            GIVING return_status.
    IF return_status IS FAILURE
    THEN
        CALL "LIB$STOP" USING BY VALUE return_status
    END-IF.

    STORE employee_record.

    MOVE persmsg_success TO return_status.

999-end.
    EXIT PROGRAM.
```

Example 4.11, "Step Procedure in BASIC that Updates a DBMS Record" illustrates how to update a record in a DBMS database. The PERS_CHANGE_EMPLOYEE_PROC procedure updates a record in the employee set using the information that is entered by the user and passed to the procedure in a task workspace. To conserve resources, the task does not retain server context while the user is modifying the employee's information. Therefore, the procedure must ensure that the information in the record has not changed while the user was updating the information on the screen.

The procedure first rereads the original record in the file and then uses a time stamp stored in the record to ensure that the version read in this procedure is the same as the version read previously by the PERS_FIND_EMPLOYEE_PROC procedure. If the record has been updated, the procedure returns an error and unlocks the record. If the record has not been changed, the procedure copies the data from the task workspace record to the user workspace area (UWA), calls SYS$GETTIM to retrieve the current system time, and updates the current record. The error handling in this procedure is described in *Section 4.3.5, "Handling Errors"*.

Example 4.11. Step Procedure in BASIC that Updates a DBMS Record

```
FUNCTION LONG pers_change_employee_proc( employee_record emp_wksp )

OPTION HANDLE=SEVERE

%INCLUDE "pers_files:pers_common_defns"
%INCLUDE %FROM %CDD "pers_cdd.employee_record"



RECORD dist_tid_structure
    STRING tid_data = 16
END RECORD
DECLARE dist_tid_structure dist_tid

DECLARE LONG sts



# INVOKE DEFAULT_SUBSCHEMA -
         WITHIN PERS_CDD.PERS_DBMS_SCHEMA -
         FOR PERS_DB:PERS_DBMS -
         ( RECORDS )



sts = ACMS$GET_TID( dist_tid BY REF )
IF ( sts AND 1% ) = 0%                                              &
THEN
    CALL ACMS$RAISE_NONREC_EXCEPTION( sts )
END IF



WHEN ERROR IN
    employee_record::emp_badge_number = emp_wksp::emp_badge_number
    # READY CONCURRENT UPDATE FOR TRANSACTION dist_tid
    # FETCH FIRST WITHIN ALL_EMPLOYEES -
                  USING emp_badge_number
```

```
        IF employee_record::emp_last_update =                              &
           emp_wksp::emp_last_update                                       &
        THEN
            employee_record = emp_wksp
            sts = SYS$GETTIM( employee_record::emp_last_update BY REF )
            IF ( sts AND 1% ) = 0%                                         &
            THEN
                CALL LIB$STOP( sts )
            END IF
            # MODIFY employee_record
            pers_change_employee_proc = persmsg_success
        ELSE
            pers_change_employee_proc = persmsg_empchanged
        END IF


    USE
        .
        .
        .
    END WHEN

    END FUNCTION
```

4.3.5. Handling Errors

You typically write an error handler to process errors returned by DBMS when accessing records in a database. The examples in *Section 4.3.3, "Reading from a Database"* and *Section 4.3.4, "Writing to a Database"* illustrate how to handle some of the standard errors, such as record-not-found, that DBMS can return when you read, write, or update a record in a database. In addition, also be aware of the error conditions that can occur when you are using DBMS in distributed transactions.

Some DBMS errors are expected and are handled by resuming normal program execution. For example, DBMS returns an end-of-collection error if a procedure reads past the last record in a set. In this case, the program can resume execution and process the records that have been read. DBMS can also return a number of recoverable errors that the program should check for and handle. For example, if DBMS returns a deadlock error, you might want to roll back the transaction and process the transaction again. Finally, DBMS can return a number of nonrecoverable errors. For example, a disk on which one of the database storage areas resides might fail. In this case, the program cannot continue until the problem has been resolved.

A distributed transaction can abort at any time. If a transaction aborts while a step procedure is executing, DBMS automatically rolls back an active database transaction. However, the step procedure will receive an error the next time it executes a DML statement in a database transaction that was participating in the distributed transaction. Therefore, an error handler for a step procedure should check for and handle the errors that DBMS returns in this situation.

Typically, you want to retry a transaction automatically in the event of a recoverable error condition such as a deadlock, lock-timeout or transaction timeout error. If DBMS detects deadlock or lock-timeout error conditions, it returns an error to your step procedure when you access the database. In contrast, if a distributed transaction times out, the distributed transaction is aborted, and ACMS raises a transaction exception in the task. In this case, DBMS returns an error if the step procedure accesses the file after the transaction has aborted.

There is an easy technique, illustrated in examples in this section, that allows you to simplify an exception handler that handles recoverable transaction exceptions in a task definition. The following list indicates how the error handler in the step procedure handles each type of error returned by DBMS:

- Handling recoverable errors

  If an error handler in a step procedure detects a recoverable error condition, such as a deadlock or lock-timeout error, it calls the ACMS$RAISE_TRANS_EXCEPTION service to raise a transaction exception using the ACMS$_TRANSTIMEDOUT exception code. If a distributed transaction does not complete within the specified time limit, ACMS also raises a transaction exception using the ACMS$_TRANSTIMEDOUT exception code. Therefore, using ACMS$_TRANSTIMEDOUT as the exception code in the step procedure means that the exception handler in the task definition has to test for only a single exception code in order to handle all recoverable transaction exceptions.

  If you detect a recoverable error in a step procedure that is using an independent database transaction that is not participating in a distributed transaction, you can roll back the database transaction and repeat the transaction in the step procedure.

- Handling transaction aborts

  If a distributed transaction aborts while a step procedure is executing, DBMS returns one of a number of error status values. If a step procedure detects one of these errors, it raises a transaction exception using the error status. If the error was due to a distributed transaction aborting, ACMS overrides the exception in the task. However, if DBMS returns the error due to some other problem, the task is canceled with the specified exception code.

- Handling nonrecoverable errors

  If an unexpected error occurs, the procedure signals the error information returned by DBMS. If the procedure signals a fatal OpenVMS exception, ACMS writes the error to the audit trail log, cancels the task, and runs down the server process. However, if the procedure signals an error or a warning OpenVMS status, ACMS continues executing the step procedure after writing the error to the audit trail log. The error handler also calls the ACMS$RAISE_NONREC_EXCEPTION service to ensure that the task is canceled.

The following example illustrates the error handler for the COBOL example in *Section 4.3.4, "Writing to a Database"*. If a record with the same badge number already exists in the database, the procedure returns a failure status. If the employee record set is locked, it raises a transaction exception using ACMS$_TRANSTIMEDOUT as the exception code. If the distributed transaction has aborted, it raises a transaction exception using the DBMS error status as the exception code. If any other error condition occurred, the procedure calls DBM$SIGNAL to signal the error and then raises a nonrecoverable exception.

```
        .
        .
        .
WORKING-STORAGE SECTION.

01 return_status                PIC S9(5) COMP.
01 error_cond                   PIC S9(5) COMP.
01 dist_tid.
   03 tid_data                  PIC X(16).
        .
        .
        .
PROCEDURE DIVISION USING emp_wksp_record GIVING return_status.
```

```
DECLARATIVES.
dml-failure SECTION.
    USE FOR DB-EXCEPTION.


010-dbm-failure.
    CALL "LIB$MATCH_COND" USING
                BY REFERENCE DB-CONDITION,
                BY REFERENCE DBM$_DUPNOTALL,
                BY REFERENCE DBM$_DEADLOCK,
                BY REFERENCE DBM$_LCKCNFLCT,
                BY REFERENCE DBM$_TIMEOUT,
                BY REFERENCE DBM$_PARTDTXNERR,
                BY REFERENCE DBM$_NOTIP,
                BY REFERENCE DBM$_DTXNABORTED
                GIVING error_cond


    EVALUATE error_cond
        WHEN 1
            MOVE persmsg_empexists TO return_status
        WHEN 2 THRU 4
            CALL "ACMS$RAISE_TRANS_EXCEPTION" USING
                            BY REFERENCE ACMS$_TRANSTIMEDOUT
        WHEN 5 THRU 7
            CALL "ACMS$RAISE_TRANS_EXCEPTION" USING
                            BY REFERENCE DB-CONDITION
        WHEN OTHER
            CALL "DBM$SIGNAL"
            CALL "ACMS$RAISE_NONREC_EXCEPTION" USING
                            BY REFERENCE DB-CONDITION


    END-EVALUATE
    EXIT PROGRAM.
END DECLARATIVES.
       .
       .
       .
```

The following example illustrates the error handler for the BASIC example in *Section 4.3.4, "Writing to a Database"*. If the employee's record has been deleted, the procedure returns a failure status. If the record is locked by another user, it raises a transaction exception using ACMS$_TRANSTIMEDOUT as the exception code. If the distributed transaction has aborted, it raises a transaction exception using the DBMS error status as the exception code. If any other error condition occurred, the procedure uses the EXIT HANDLER statement to resignal the error.

```
       .
       .
       .
    WHEN ERROR IN
        employee_record::emp_badge_number = emp_wksp::emp_badge_number
        # READY CONCURRENT UPDATE FOR TRANSACTION dist_tid
        # FETCH FIRST WITHIN ALL_EMPLOYEES -
```

```
                    USING emp_badge_number


    IF employee_record::emp_last_update =                              &
       emp_wksp::emp_last_update                                       &
    THEN
        employee_record = emp_wksp
        sts = SYS$GETTIM( employee_record::emp_last_update BY REF )
        IF ( sts AND 1% ) = 0%                                         &
        THEN
            CALL LIB$STOP( sts )
        END IF
        # MODIFY employee_record
        pers_change_employee_proc = persmsg_success


    ELSE
        pers_change_employee_proc = persmsg_empchanged
    END IF


USE
    SELECT LIB$MATCH_COND( DBM_COND, DBM$_END,                         &
                                     DBM$_DEADLOCK,                    &
                                     DBM$_LCKCNFLCT,                   &
                                     DBM$_TIMEOUT,                     &
                                     DBM$_PARTDTXNERR,                 &
                                     DBM$_NOTIP,                       &
                                     DBM$_DTXNABORTED )


        CASE 1          ! DBM$_END
            pers_change_employee_proc = persmsg_empdeleted

        CASE 2, 3, 4    ! DBM$_DEADLOCK, DBM$_LCKCNFLCT, DBM$_TIMEOUT
            CALL ACMS$RAISE_TRANS_EXCEPTION( ACMS$_TRANSTIMEDOUT )

        CASE 5, 6, 7    ! DBM$_PARTDTXNERR, DBM$_NOTIP, DBM$_DTXNABORTED
            CALL ACMS$RAISE_TRANS_EXCEPTION( VMSSTATUS  )



        CASE ELSE
            EXIT HANDLER
    END SELECT
END WHEN
   .
   .
   .
```

4.3.6. Compiling DBMS Procedures

If you are using COBOL, use the COBOL compiler to compile your procedure. However, if you are using another programming language, such as BASIC, use the DBMS DML precompiler when you compile a procedure containing embedded DML statements. The DML precompiler processes the embedded DML statements in your program, producing an intermediate host language source file, which it then submits to the host language compiler to produce an object module.

The DML precompiler command line includes both precompiler and host language compiler qualifiers. For the precompiler, use the **/LANGUAGE** qualifier to specify in which host language the source is written; you can, optionally, include other qualifiers. On the command line, include any language compiler qualifiers (such as **LIST** or **DEBUG**) that you want in effect when the precompiler submits the preprocessed source file to the language compiler using the **/OPTION** qualifier. For more information on DML precompiler qualifiers, see the DBMS documentation.

The following command line precompiles a procedure called PERS_CHANGE_EMPLOYEE_PROC:

```
$ DML/LANGUAGE=BASIC/OPTION="/LIST" PERS_CHANGE_EMPLOYEE_PROC
```

Note

Do not make changes to the language source module created by the DML precompiler and then use the language compiler directly to compile that source module. This rule applies even if you want to make source changes that do not affect DML statements because the next precompilation of the original embedded DML module overwrites the changes you make to the temporary language source module generated by the precompiler.

Chapter 6, "Building Procedure Server Images" explains how to link procedures that use DML.

4.4. Using RMS

This section describes how to write step procedures that access RMS files. A step procedure that accesses an RMS file on behalf of an ACMS task is similar to any other program that uses RMS to access a file.

The RMS Journaling layered product provides recovery-unit journaling, after-image journaling, and before-image journaling for RMS sequential, relative, and Prologue 3 indexed files. If you have installed the RMS Journaling product, you can use recovery-unit journaling and distributed transactions to coordinate modifications to records in RMS files with modifications to records in Rdb and DBMS databases. If you do not have the RMS Journaling product, modifications to RMS files will not be coordinated with modifications to Rdb and DBMS databases. See *RMS Journaling for OpenVMS Manual* [https://docs.vmssoftware.com/rms-journaling-for-openvms-manual/] for more information on RMS journaling.

This section first discusses how to access RMS files that are marked for recovery-unit journaling. The section then illustrates how to read, write, and modify records in an RMS file. Note that there are no special considerations for using RMS files that are marked for after-image journaling or before-image journaling or for using files that are not journaled.

4.4.1. Using Files Marked for RMS Recovery-Unit Journaling

There are no special considerations for using RMS recovery-unit journaling in a distributed transaction started by a task or an agent program. If an RMS file that is marked for recovery-unit journaling is accessed by a step procedure that is participating in a distributed transaction, RMS automatically associates the record stream with the default transaction established by ACMS for the server process. See *Chapter 3, "Writing Step Procedures"* for more information on the participation of a step procedure in a distributed transaction.

Note

Processing steps that participate in a distributed transaction must not make calls to the RMS Recovery Unit services ($START_RU, $PREPARE_RU, $COMMIT_RU, $END_RU, and $ABORT_RU). Any attempt to intermix these services with distributed transactions leads to unpredictable results.

In contrast, if you access an RMS file marked for recovery-unit journaling outside a distributed transaction, you must start a transaction in the step procedure. Use the OpenVMS transactions services $START_TRANS, $END_TRANS, and $ABORT_TRANS to start and end a transaction in a step procedure. Note that the OpenVMS transaction services have superseded the RMS Recovery Unit services. See *RMS Journaling for OpenVMS Manual* [https://docs.vmssoftware.com/rms-journaling-for-openvms-manual/] for more information on using the OpenVMS transaction services and RMS recovery-unit journaling.

4.4.2. Reading RMS Records

The examples in this section illustrate how to read a record from an RMS file and return the data to the task in a workspace.

Each example reads a record from a file containing employee records using a key from a field in a workspace. If the record exists, the procedure returns a success status to the task. If the record does not exist, the procedure returns a failure status. Because the PERS_FIND_EMPLOYEE_PROC procedure executes in a server that opens the employee file for read-only access, there is no need to use manual locking statements.

Example 4.12, "Step Procedure in COBOL that Reads an RMS Record" is a step procedure in COBOL that reads an RMS record.

Example 4.12. Step Procedure in COBOL that Reads an RMS Record

```
IDENTIFICATION DIVISION.
PROGRAM-ID. pers_find_employee_proc.
       .
       .
       .
DATA DIVISION.


FILE SECTION.
FD      emp_file
        EXTERNAL
        DATA RECORD IS employee_record
        RECORD KEY emp_badge_number OF employee_record.
COPY "pers_cdd.employee_record" FROM DICTIONARY.
       .
       .
       .


LINKAGE SECTION.
COPY "pers_cdd.employee_record" FROM DICTIONARY
    REPLACING ==employee_record== BY ==emp_wksp_record==.

PROCEDURE DIVISION USING emp_wksp_record GIVING return_status.
```

```
MAIN SECTION.



000-start.
    MOVE persmsg_success TO return_status.
    MOVE emp_badge_number OF emp_wksp_record TO
         emp_badge_number OF employee_record.
    READ emp_file RECORD INTO emp_wksp_record
        KEY IS emp_badge_number OF employee_record
        INVALID KEY
            MOVE persmsg_empnotfound TO return_status
            GO TO 999-end
    END-READ.


        .
        .
        .
999-end.
    EXIT PROGRAM.
```

Example 4.13, "Step Procedure in BASIC that Reads an RMS Record" is a step procedure in BASIC that reads an RMS record.

Example 4.13. Step Procedure in BASIC that Reads an RMS Record

```
    FUNCTION LONG pers_find_employee_proc( employee_record emp_wksp )

    %INCLUDE "pers_files:pers_common_defns"
    %INCLUDE %FROM %CDD "pers_cdd.employee_record"



    MAP ( emp_map ) employee_record emp_rec


    WHEN ERROR IN
        GET # emp_file,                                          &
            KEY # 0 EQ emp_wksp::emp_badge_number
        MOVE FROM # emp_file, emp_wksp
        pers_find_employee_proc = persmsg_success


    USE
        SELECT ERR
            CASE basicerr_record_not_found
                pers_find_employee_proc = persmsg_empnotfound
            CASE ELSE
                CALL ACMS$RAISE_NONREC_EXCEPTION( RMSSTATUS( emp_file ) )
                EXIT HANDLER
        END SELECT
    END WHEN

    END FUNCTION
```

4.4.3. Writing and Updating RMS Records

This section explains how to write a new record into an RMS file and how to update a record in an RMS file.

Example 4.14, "Step Procedure in COBOL that Writes an RMS Record" illustrates how to write a new record to a file. The PERS_ADD_EMPLOYEE_PROC procedure is used to store a new record in an employee file using the information entered by the user and passed to the procedure in a task workspace. The procedure first stores the current time in the employee record; the time-stamp field is used for consistency checking by the update procedure. It then initializes the return status to success and writes the new record to the file. Because this procedure is executing in a server that opens the file for read and write access with explicit lock control, the procedure must unlock the record if the write operation completes successfully. If the write operation fails with a duplicate key, the procedure returns an error status to the task.

Example 4.14. Step Procedure in COBOL that Writes an RMS Record

```
IDENTIFICATION DIVISION.
PROGRAM-ID. pers_add_employee_proc.

       .
       .
       .
DATA DIVISION.


FILE SECTION.
FD      emp_file
        EXTERNAL
        DATA RECORD IS employee_record
        RECORD KEY emp_badge_number OF employee_record.


COPY "pers_cdd.employee_record" FROM DICTIONARY.
       .
       .
       .


LINKAGE SECTION.
COPY "pers_cdd.employee_record" FROM DICTIONARY
    REPLACING ==employee_record== BY ==emp_wksp_record==.



PROCEDURE DIVISION USING emp_wksp_record GIVING return_status.
MAIN SECTION.



000-start.
    CALL "SYS$GETTIM" USING
            BY REFERENCE emp_last_update OF emp_wksp_record
            GIVING return_status.
    IF return_status IS FAILURE
    THEN
```

```
        CALL "LIB$STOP" USING BY VALUE return_status
    END-IF.


    MOVE persmsg_success TO return_status.
    WRITE employee_record FROM emp_wksp_record
        ALLOWING NO
        INVALID KEY
            MOVE persmsg_empexists TO return_status
        NOT INVALID KEY
            UNLOCK emp_file ALL RECORDS
    END-WRITE.
       .
       .
       .
999-end.
    EXIT PROGRAM.
```

Example 4.15, "Step Procedure in BASIC that Updates an RMS Record" illustrates how to update a record in an RMS file. The PERS_CHANGE_EMPLOYEE_PROC procedure updates a record in an employee file using the information that is entered by the user and passed to the procedure in a task workspace. To conserve resources, the task does not retain server context while the user is modifying the employee's information. Therefore, the procedure must ensure that the information in the record has not changed while the user was updating the information on the screen.

The procedure first rereads the original record in the file and then uses a time-stamp stored in the record to ensure that the version read in this procedure is the same as the version read previously by the PERS_FIND_EMPLOYEE_PROC procedure. If the record has been updated, the procedure returns an error and unlocks the record. If the record has not been changed, the procedure copies the data from the task workspace record to the file record, calls SYS$GETTIM to retrieve the current system time, and updates the current record.

Because the employee file was opened using explicit lock control, the procedure must unlock the record after updating it. The error handling in this procedure checks for record-locked and record-lock timeout errors in case another user is trying to update the employee's record at the same time. In addition, it also checks for a record-not-found error in case the employee's record was deleted while the user was modifying the information. In both cases, the procedure returns an error status so the task can retrieve the error message text and inform the user of the problem.

Example 4.15. Step Procedure in BASIC that Updates an RMS Record

```
    FUNCTION LONG pers_change_employee_proc( employee_record emp_wksp )

    %INCLUDE "pers_files:pers_common_defns"
    %INCLUDE %FROM %CDD "pers_cdd.employee_record"



    DECLARE LONG sts

    MAP ( emp_map ) employee_record emp_rec



    WHEN ERROR IN
```

```
        GET # emp_file,                                             &
            KEY # 0 EQ emp_wksp::emp_badge_number,                  &
            ALLOW NONE,                                             &
            WAIT 20
        IF emp_rec::emp_last_update = emp_wksp::emp_last_update &


        THEN
            MOVE TO # emp_file, emp_wksp
            sts = SYS$GETTIM( emp_rec::emp_last_update BY REF )
            IF ( sts AND 1% ) = 0%                                  &
            THEN
                CALL LIB$STOP( sts )
            END IF
            UPDATE # emp_file
            pers_change_employee_proc = persmsg_success


        ELSE
            pers_change_employee_proc = persmsg_empchanged
        END IF
        UNLOCK # emp_file


    USE
        SELECT ERR
            CASE    basicerr_record_not_found
                pers_change_employee_proc = persmsg_empdeleted
            CASE    basicerr_record_locked,                                 &
                    basicerr_deadlock,                                      &
                    basicerr_wait_exhausted
                pers_change_employee_proc = persmsg_emplocked
            CASE    ELSE
                CALL ACMS$RAISE_NONREC_EXCEPTION( RMSSTATUS( emp_file ) )
                EXIT HANDLER
        END SELECT
    END WHEN

    END FUNCTION
```

4.4.4. Handling Errors

You typically write an error handler to process errors returned by RMS when accessing records in a file. The examples in *Section 4.4.2, "Reading RMS Records"* and *Section 4.4.3, "Writing and Updating RMS Records"* illustrate how to handle some standard errors, such as record-not-found, that RMS can return when you read, write, or update a record in an RMS file. In addition, also be aware of the error conditions that can occur when you use RMS files in distributed transactions.

Some RMS errors are expected and are handled by resuming normal program execution. For example, RMS returns an end-of-file error if a procedure reads past the last record in a file. In this case, the program can resume execution and process the records that have been read. RMS can also return a number of recoverable errors that the program should check for and handle. For example, if RMS returns a deadlock error, you might want to roll back the transaction and process the transaction again. Finally, RMS can return a number of nonrecoverable errors. For example, a disk on which a file resides might fail. In this case, the program cannot continue until the problem has been resolved.

A distributed transaction can abort at any time. For example, if the PERS_CHANGE_EMPLOYEE_PROC procedure shown in *Section 4.4.3, "Writing and Updating RMS Records"* participates in a distributed transaction, the transaction could time out while the procedure is reading the original copy of the employee's record or while updating the record with the new information. If a transaction aborts while a step procedure is executing, RMS automatically rolls back an active recovery unit. If a step procedure reads a record from the file after a distributed transaction has aborted, RMS completes the operation successfully if the record exists and is not locked by another process. However, the step procedure receives an error if it executes a recoverable operation, such as a write or update operation, on the file. Therefore, an error handler for a step procedure should check for and handle the errors that RMS returns in this situation.

If you use RMS in a distributed transaction, you must write a server cancel procedure to release any records that might be read and locked by a step procedure after a distributed transaction aborts. See *Chapter 2, "Writing Initialization, Termination, and Cancel Procedures"* for more information on writing server cancel procedures.

Typically, you want to retry a transaction automatically in the event of a recoverable error condition such as a deadlock, lock-timeout or transaction timeout error. RMS returns deadlock and lock-timeout errors to your step procedure when you access the file. In contrast, if a distributed transaction times out, the distributed transaction is aborted, and ACMS raises a transaction exception in the task. In this case, RMS returns an error if the step procedure accesses the file after the transaction has aborted.

There is an easy technique, illustrated in examples in this section, that allows you to simplify an exception handler that handles recoverable transaction exceptions in a task definition. The following list indicates how the error handler in the step procedure handles each type of error returned by RMS:

- Handling recoverable errors

  If an error handler in a step procedure detects a recoverable error condition, such as a deadlock or lock-timeout error, it calls the ACMS$RAISE_TRANS_EXCEPTION service to raise a transaction exception using the ACMS$_TRANSTIMEDOUT exception code. If a distributed transaction does not complete within the specified time limit, ACMS also raises a transaction exception using the ACMS$_TRANSTIMEDOUT exception code. Therefore, using ACMS$_TRANSTIMEDOUT as the exception code in the step procedure means that the exception handler in the task definition has to test for only a single exception code in order to handle all recoverable transaction exceptions.

- Handling transaction aborts

  If a distributed transaction aborts while a step procedure is executing, RMS returns one of a number of error status values. If a step procedure detects one of these errors, it raises a transaction exception using the error status. If the error was due to a distributed transaction aborting, ACMS overrides the exception in the task. However, if RMS returns the error due to some other problem, the task is canceled with the specified exception code.

  If you detect a recoverable error in a step procedure that is using an independent recovery unit that is not participating in a distributed transaction, you can roll back the recovery unit and repeat the recovery unit in the step procedure.

- Handling nonrecoverable errors

  If an unexpected error occurs, the procedure signals the error information returned by RMS. If the procedure signals a fatal OpenVMS exception, ACMS writes the error to the audit trail log, cancels the task, and runs down the server process. However, if the procedure signals an error or warning OpenVMS status, ACMS continues executing the step procedure after writing the error to the audit

trail log. The error handler also calls the ACMS$RAISE_NONREC_EXCEPTION service to ensure that the task is canceled.

The following example illustrates how to handle RMS errors using COBOL. In this example, the error-handling code in the Declaratives section uses the RMS error status when checking for record locks because COBOL returns error 30 for all but the record-locked error.

```
    .
    .
    .
PROCEDURE DIVISION USING emp_wksp_record GIVING return_status.



DECLARATIVES.
employee_file SECTION.
    USE AFTER STANDARD ERROR PROCEDURE ON emp_file.


employee_file_handler.
    EVALUATE TRUE
        WHEN    ( ( RMS-STS OF emp_file = RMS$_RLK ) OR
                  ( RMS-STS OF emp_file = RMS$_DEADLOCK ) )
            CALL "ACMS$RAISE_TRANS_EXCEPTION" USING
                        BY REFERENCE ACMS$_TRANSTIMEDOUT
        WHEN    ( ( RMS-STS OF emp_file = RMS$_NRU ) OR
                  ( RMS-STS OF emp_file = RMS$_DDTM_ERR ) )
            CALL "ACMS$RAISE_TRANS_EXCEPTION" USING
                        BY REFERENCE RMS-STS OF emp_file


        WHEN    OTHER
            CALL "LIB$SIGNAL" USING
                        BY REFERENCE RMS-STS OF emp_file,
                        BY REFERENCE RMS-STV OF emp_file
            CALL "ACMS$RAISE_NONREC_EXCEPTION" USING
                        BY REFERENCE RMS-STS OF emp_file
    END-EVALUATE.
END DECLARATIVES.



MAIN SECTION.
000-start.
    MOVE persmsg_success TO return_status.



    MOVE emp_badge_number OF emp_wksp_record TO
         emp_badge_number OF employee_record.
    READ emp_file RECORD
        ALLOWING NO OTHERS
        KEY IS emp_badge_number OF employee_record
        INVALID KEY
            MOVE persmsg_empdeleted TO return_status
            GO TO 999-end
    END-READ.
```

```
    IF emp_last_update OF employee_record = emp_last_update OF
emp_wksp_record
    THEN
        CALL "SYS$GETTIM" USING
                BY REFERENCE emp_last_update OF emp_wksp_record
                GIVING return_status
        IF return_status IS FAILURE
        THEN
            CALL "LIB$STOP" USING BY VALUE return_status
        END-IF


        REWRITE employee_record FROM emp_wksp_record
            ALLOWING NO OTHERS
            INVALID KEY
                CALL "ACMS$RAISE_NONREC_EXCEPTION"
                            USING RMS-STS OF emp_file
        END-REWRITE


    ELSE
        MOVE persmsg_empchanged TO return_status
    END-IF.

    UNLOCK emp_file ALL RECORDS.

999-end.
    EXIT PROGRAM.
```

The following example illustrates how to handle RMS errors using BASIC. Note that the EXIT HANDLER statement is used to resignal the error and exit the error handler in BASIC.

```
    FUNCTION LONG pers_change_employee_proc( employee_record emp_wksp )

    %INCLUDE "pers_files:pers_common_defns"
    %INCLUDE %FROM %CDD "pers_cdd.employee_record"



    DECLARE LONG sts

    MAP ( emp_map ) employee_record emp_rec



    WHEN ERROR IN
        GET # emp_file,                                          &
            KEY # 0 EQ emp_wksp::emp_badge_number,               &
            ALLOW NONE,                                          &
            WAIT 20
        IF emp_rec::emp_last_update = emp_wksp::emp_last_update &
        THEN
            MOVE TO # emp_file, emp_wksp
            sts = SYS$GETTIM( emp_rec::emp_last_update BY REF )
            IF ( sts AND 1% ) = 0%                               &
            THEN
```

```
                CALL LIB$STOP( sts )
            END IF
            UPDATE # emp_file
            pers_change_employee_proc = persmsg_success


        ELSE
            pers_change_employee_proc = persmsg_empchanged
        END IF
        UNLOCK # emp_file


    USE
        SELECT ERR
            CASE    basicerr_record_not_found
                pers_change_employee_proc = persmsg_empdeleted
            CASE    basicerr_record_locked,                              &
                    basicerr_deadlock,                                   &
                    basicerr_wait_exhausted
                CALL ACMS$RAISE_TRANS_EXCEPTION( ACMS$_TRANSTIMEDOUT )


            CASE    ELSE
                IF ( RMSSTATUS( emp_file ) = RMS$_NRU ) OR               &
                   ( RMSSTATUS( emp_file ) = RMS$_DDTM_ERR )             &
                THEN
                    CALL ACMS
$RAISE_TRANS_EXCEPTION( RMSSTATUS( emp_file ) )
                ELSE
                    CALL ACMS
$RAISE_NONREC_EXCEPTION( RMSSTATUS( emp_file ) )
                    EXIT HANDLER
                END IF
        END SELECT
    END WHEN

    END FUNCTION
```

Chapter 5. Using Message Files with ACMS Tasks and Procedures

At times, tasks and procedures need to return messages to users telling them, for example, that information they requested is locked by another user, that information they typed is not valid for the file the task is using, or that other errors have occurred. You can simplify returning messages to users by setting up a message file that contains the text of messages you want to display. If you set up a message file, you can change the text of messages without having to recompile and relink the procedures and definitions in the application.

This chapter discusses the following topics:

- Creating a source file of messages, including setting up message file characteristics and writing messages
- Using the **MESSAGE** command to create two output files from your input message file
- Displaying user-defined messages by returning message names from procedures and using the GET MESSAGE clause to retrieve messages from the message file and display messages to users

For more information on creating message files than is in this chapter, see *VSI OpenVMS Command Definition, Librarian, and Message Utilities Manual* [https://docs.vmssoftware.com/vsi-openvms-command-definition-librarian-and-message-utilities/].

5.1. Creating Source Files of Messages

A message source file has two main parts:

- Statements that apply to the entire message source file; they define characteristics of the message file. These statements are in the first two lines of the following example.
- Error messages, grouped by the facility to which they apply. These are in the remaining lines of the following example.

```
.TITLE VRMSG Messages for AVERTZ
.IDENT /Version 1.0/

.FACILITY VR,1 / PREFIX=VR_

.SEVERITY INFORMATION

MULCURECFND <Multiple customer records found>
MULRSRECFND <Multiple reservation records found>

.END
```

The following sections explain how to write each part of a message source file. *Example 5.1, "Source File of Messages"* contains a complete message source file.

5.1.1. Setting Up Message File Characteristics

Three kinds of information can appear in the first part of a message source file, which contains statements that apply to the entire message file:

- Module name
- Listing title
- Comments

The .TITLE statement defines the object module name, which is assigned to the object module when you compile the source file using the Message Utility. The object module does not need to have the same name as the source file or the file containing the object module, but it is common practice to do so. The maximum length of the module name is 31 characters.

In the .TITLE statement, include a module name and a listing title. For example:

```
.TITLE VRMSG Messages for AVERTZ
```

After the module name (here, VRMSG) is a listing title. If you use the **/LIST** qualifier when compiling the source file, the listing title (in this case, Messages for AVERTZ), appears at the top of each page of the .LIS file. The maximum length of a listing title is 28 characters.

Optionally, you can use an .IDENT statement after a .TITLE statement to include additional information (beyond that supplied by the .TITLE statement) in the object module and the listing file. For example, you can use .IDENT to identify the version of the file:

```
.IDENT /Version 1.0/
```

The Message Utility includes the literal string from the .IDENT statement in the object module name.

To include comment text in your source file, use an exclamation mark (!). For example:

```
! History:
!           V1.0    Created 12-May-91.
```

Comment text helps others understand the message file and documents the history of the file.

5.1.2. Writing Messages

The main part of a message source file includes the following:

- A .FACILITY statement
- .SEVERITY statements
- A list of message names and their accompanying text

The following sections explain how to write these.

5.1.2.1. .FACILITY Statement

You must have at least one .FACILITY statement and one .END statement in a message file.

The following example illustrates how to use the .FACILITY statement:

```
.FACILITY VR,1
   .
   .
```

```
   .
.END
```

Always include both a 1- to 9-character facility name and a facility number in each .FACILITY statement. In the example, VR is the facility name. Separate the facility name and the facility number with either a comma, one or more spaces, or tabs. The name used in a .FACILITY statement does not need to be unique in the message file.

The number in the .FACILITY statement must be a decimal value in the range of 1 to 2047. The facility number used must be unique for the facility name. In the example, 1 is the facility number. For a list of the qualifiers that you can use with the .FACILITY statement, see *VSI OpenVMS Command Definition, Librarian, and Message Utilities Manual* [https://docs.vmssoftware.com/vsi-openvms-command-definition-librarian-and-message-utilities/].

The .END statement has no parameters or qualifiers. Always end the file with an .END statement.

5.1.2.2. .SEVERITY Statements

In each block of messages, group messages by their OpenVMS severity levels. The five severity level keywords are:

- SUCCESS
- INFORMATION
- WARNING
- ERROR
- FATAL (or SEVERE)

Use these keywords to mark the beginning of a subgroup of messages in the .SEVERITY statement. For example:

```
.FACILITY VR,1
.SEVERITY INFORMATION
   .
   .
   .
.END
```

In message files for ACMS tasks, application developers can write the text of severity messages. In the AVERTZ sample application, most messages are either INFORMATION level or WARNING level messages. The messages for recoverable errors, for example, indicate that an error prevented the procedure from completing but that the user can recover from the error.

Chapter 3, "Writing Step Procedures" and *VSI OpenVMS RTL Library (LIB$) Manual* [https://docs.vmssoftware.com/vsi-openvms-rtl-library-lib-manual/] contain more information about severity levels.

5.1.2.3. Message Names and Text

Messages contain the following:

- Message name

A message name is part of a message symbol, which ACMS uses to retrieve messages from a message file. An explanation of message symbols follows.

- Message text

  Message text is the 1- to 255-byte text displayed on the screen for the terminal user. Enclose message text in angle brackets (< >) or in quotation marks (" "). For example:

```
.FACILITY VR,1

.SEVERITY INFORMATION

MULCURECFND <Multiple customer records found>
MULRSRECFND <Multiple reservation records found>

.END
```

Note

Never include $FAO directives in message text accessed by the GET MESSAGE clause. However, message text accessed directly by step procedures can include $FAO directives. See *Chapter 3, "Writing Step Procedures"* for details.

In the previous example, each message text follows a message name (MULCURECFND, for example). ACMS uses message symbols (rather than message names) to retrieve message text from the message file. The linker also uses message symbols to resolve the message symbols in step procedures.

When you compile a message source file, the Message Utility creates a symbol for each message by putting the facility code and an underscore (_) in front of each message name.

Follow these guidelines when creating and using message symbols:

- You can define a shorter facility prefix in a message symbol by using a **/PREFIX** qualifier with the .FACILITY statement. For example:

```
.FACILITY VEHICLE,1 / PREFIX=VR_
```

  If you define a prefix, the Message Utility then uses the prefix instead of the facility name when it creates the message symbol. For example:

```
VR_MULCURECFND
VR_MULRSRECFND
```

- Message symbols must be unique in each message file and in all files used by an ACMS task group. If an ACMS application uses more than one task group, each message symbol must be unique in all files used by all task groups in that application.

- If you use message files, make sure that the symbols created by the Message Utility when you compile the message source file are the same as the message symbols you define in your procedures. For example:

```
01  MULCURECFND              PIC S9(11) COMP
                              VALUE IS EXTERNAL VR_MULCURECFND.
```

Example 5.1, "Source File of Messages" shows a complete message source file.

Example 5.1. Source File of Messages

```
.TITLE VRMSG Messages for AVERTZ
.IDENT /Version 1.0/

.FACILITY VR,1 /PREFIX=VR_


.SEVERITY INFORMATION
MULCURECFND <Multiple customer records found>
MULRSRECFND <Multiple reservation records found>
VEUPGPRF    <Vehicle upgrade performed - no charge>
VEDNGPRF    <Vehicle downgrade performed - rates adjusted>
CURECUPD    <Customer record has been updated in database-hit RETURN to
continue>
CURECINS    <Customer record has been inserted in database>
CHKINCOMP   <Vehicle Checking-in completed successfully - hit RETURN to
continue>
CHKOUTCOM   <Vehicle Checkout completed successfully - hit RETURN to continue>
RESVCOMP    <Vehicle reservation completed successfully - hit RETURN to
continue>
VERECFND    <Vehicles/vehicles found in class requested, choose one>
RESSUCCNCLD <Reservation successfully canceled - hit RETURN to continue>


.SEVERITY WARNING
CURECNOTFND  <Customer record not found>
RCRECNOTFND  <Rental class record not found>
RERECNOTFND  <Invalid state/country-reenter valid state/country names>
RSRECNOTFND  <Reservation record not found >
SIRECNOTFND  <Site record not found, press PF1 S for a list of sites>
VERECNOTFND  <No vehicles available for checkout - hit RETURN to continue>
VRHRECNOTFND <Vehicle rental history record not found>
NOTCHKOUT    <Vehicle not checked out>
RESCNCLD     <Reservation was canceled - reenter data or PF1 Q to quit>
CARCHKIN     <Reservation archived,car checked in,paid in full>
CARCHKOUT    <Vehicle has already been checked out - reenter data or PF1 Q to
quit>
RESCLOSED    <Reservation archived,car checked in,payment pending>
DLRENOTFND   <Invalid Driver's license state/country>
NOCANCEL     <Reservation cannot be canceled at this stage>
INACTIVE     <Please enter data or task will be canceled due to inactivity>
DDTM_TIMEOUT <The distributed transaction timed out --- please retry>


.SEVERITY ERROR
NO_DUP           <Duplicate database key>
DEADLOCK         <Database deadlock>
INTEG_FAIL       <Database integrity failure>
LOCK_CONFLICT    <Database lock conflict>
CAR_UNAVAILABLE  <Vehicle unavailable - hit RETURN to continue>
CHK_CANCL_ERR    <Error in checkout or cancel reservation>
HIST_WRITE_ERR   <Error in writing to history file>
UPDATE_ERROR     <Error updating file>


.SEVERITY FATAL
BILLERR          <Bill computation error - canceling transaction>
DB_FATAL         <Fatal database error - check audit log>
ICRECNOTFND      <ID increment control record not found>

.END
```

Example 5.1, "Source File of Messages" lists the messages available to tasks in the AVERTZ Vehicle Rental task group. For example, the example lists both CURECNOTFND and RCRECNOTFND under a .SEVERITY WARNING statement. When you compile the file, the Message Utility sets the low three bits of the longwords representing the message symbols to the binary value corresponding to WARNING level (000).

Regardless of what the error level was when the procedure trapped the error, if you return CURECNOTFND or RCRECNOTFND as status values of your procedure, the error level of the return status is WARNING. For information on returning status values, see *Chapter 3, "Writing Step Procedures"*.

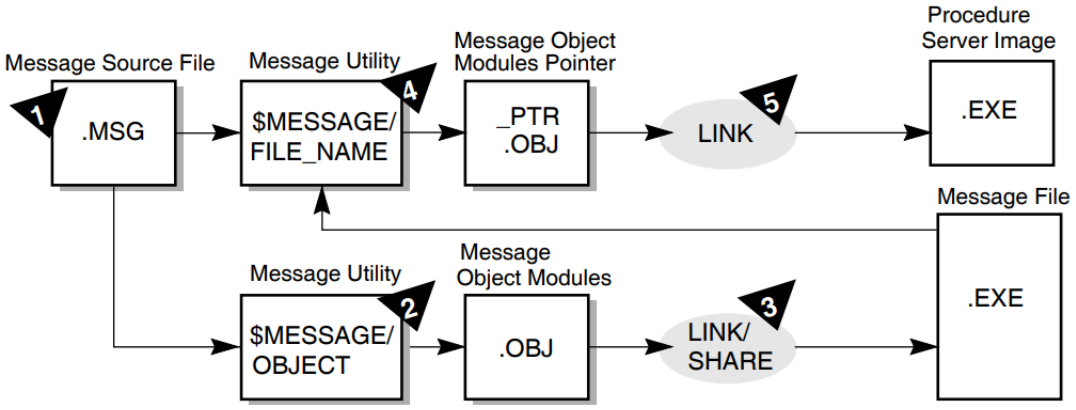
5.2. Compiling Message Files

To use message files with ACMS applications, create two output files from your source file:

- The image (.EXE) file containing the message texts and their corresponding symbols. This file is a shared image.
- Object module containing pointers to the .EXE message file.

Figure 5.1, "Creating Message Files" shows the steps you take and the files you create when you compile message files. Following the figure are numbered instructions that correspond to the numbers in the figure.

Figure 5.1. Creating Message Files



1. Edit a message file (.MSG) with an editor.

   Follow the instructions in *Section 5.1, "Creating Source Files of Messages"* to create a source file containing the text of messages.

2. Create the object module (.OBJ) containing the message text from the message file by running the Message Utility with the **/OBJECT** qualifier. For example:

   ```
   $ MESSAGE /OBJECT=VRMSG.OBJ VRMSG.MSG
   ```

   The optional **/OBJECT** qualifier defines the name of the object module. If you omit the qualifier (and do not use **/NOOBJECT**), the utility assigns the file name of the input file to the object module with a file type of .OBJ. The default file type for the input file is .MSG.

3. Create an .EXE message file by using the **LINK** command with the **/SHARE** qualifier. For example:

   ```
   $ LINK /SHARE=VRMSG.EXE VRMSG.OBJ
   ```

The **/SHARE** qualifier defines the name of the shareable image to be created by the Linker. If you omit the file name from the **/SHARE** qualifier, the Linker assigns the file name of the input file to the object module output file, giving the output file a file type of .EXE. The default file type for the input file is .OBJ.

4. Create an object module that points to the .EXE message file containing the message text by running the Message Utility again, using the **/FILE_NAME** qualifier with the **MESSAGE** command. For example:

```
$ MESSAGE /FILE_NAME=ACMS$EXAMPLES:VRMSG.EXE/OBJ=VRMSG_PTR  VRMSG
```

When you use this command, the Message Utility creates an object module named VRMSG_PTR.OBJ. This object module contains the message symbols from the source file, but points to VRMSG.EXE for the text corresponding to those symbols. The default file name for the text message file is the same file name as the source file; the default file type is .EXE.

Always include the device and directory specification for the text message file. Otherwise, ACMS looks for the text message file in the same directory as the ACMS software. Make sure that the name you use in the **/FILE_NAME** qualifier is the same as the name of the file you created with the **LINK** command.

5. After creating the pointer object module, link it into the procedure server images for all servers that handle tasks using that message file. The procedure server image contains all the modules for the procedure server, including step, initialization, and termination procedures; the message object module; and the server control object module created by the **BUILD** command of the Application Definition Utility. For example:

```
$ LINK /DEBUG /EXE=VR_SERVER.EXE VR_SERVER.OBJ, -
_$ ...,VRMSG_PTR
```

This example is an abbreviated version of the **LINK** command. See *Chapter 6, "Building Procedure Server Images"* for instructions and examples of full **LINK** commands.

Do not link the text message file into the server image. The .EXE file created with the **MESSAGE** command is separate from the server image, in the same way that a run-time library is separate from a program.

If you need to change the wording of a message, change the message source file; then use the **MESSAGE** and **LINK** commands to create a new text message file (.EXE). You do not need to relink the procedure server image. For example:

```
$ MESSAGE /OBJ=VRMSG.OBJ VRMSG.MSG
$ LINK/SHARE=VRMSG.EXE VRMSG.OBJ
```

If you change only the message text, you do not need to create a new object module pointer file. However, if you add a new message, delete a message, change the order of messages in the file, or change a message symbol, you must create a new object module pointer file and relink the server image to include that new module (steps 4 and 5). Otherwise, the symbols in the message file and in the server image do not correspond to one another.

5.3. Displaying User-Defined Messages

After you define error messages in a message file, you can return message names from a server procedure and have the task calling the procedure trap for errors. Follow these steps for returning and displaying user-defined messages:

1. Define all symbols that you want a procedure to return as external to the program. In COBOL, use the VALUE IS EXTERNAL clause in the procedure. For example:

```
01  CURECNOTFND                PIC S9(11) COMP
                                VALUE IS EXTERNAL VR_CURECNOTFND.
```

   In the previous example, the message name is CURECNOTFND; the message symbol is VR_CURECNOTFND.

   In BASIC, use the EXTERNAL CONSTANT statement to define the message symbol in the procedure. For example:

```
        EXTERNAL LONG CONSTANT VR_CURECNOTFND
```

   You can define return values either in the program or in a library file of values.

2. In the procedure, move the message name into the return-status workspace. For example:

```
SQL-NOT-FOUND.
* If no customer record was found, return warning status.
        IF CTRL_KEY = "CUSID" THEN
                MOVE CURECNOTFND TO RET-STAT
        . . .
        END-IF.
```

   When a procedure returns a value in a return status field, ACMS does the following:

   - Stores the return status values in ACMS$L_STATUS field of the ACMS$PROCESSING_STATUS workspace.
   - Sets the value of the ACMS$T_SEVERITY_LEVEL field; here, the value is set to W (warning).
   - Also sets the value of the ACMS$T_STATUS_TYPE field; here, the value is set to B (bad).

   Chapter 3, "Writing Step Procedures" explains fields in the ACMS$PROCESSING_STATUS workspace.

3. Have the task definition check the ACMS$T_STATUS_TYPE field of the ACMS$PROCESSING_STATUS workspace.

   Include the GET MESSAGE clause in the task definition to direct ACMS to store the error message associated with the message symbol in the ACMS$T_STATUS_MESSAGE workspace. For example:

```
ACTION IS
   IF (ACMS$T_STATUS_TYPE = "B") THEN
       GET MESSAGE INTO vr_control_wksp.messagepanel;
       GOTO PREVIOUS EXCHANGE;
   END IF;
```

   According to the previous instructions, ACMS checks the ACMS$T_STATUS_TYPE field. If it is B (bad), ACMS retrieves the error message. ACMS then goes to the previous exchange step in the task definition to display the error message.

Chapter 6. Building Procedure Server Images

After writing procedures for ACMS tasks, you must compile and link those procedures. You compile procedures as you do any other program. However, you do not link and run ACMS procedures as you do an OpenVMS image, because ACMS procedures are not independent programs.

The first section of this chapter contains the steps necessary to build a procedure server image, including compiling and linking commands that you use to debug procedures later. The chapter also explains the run-time operation of server processes and describes the files that you need to create to debug an ACMS application. Finally, the chapter tells how to use a procedure object library.

6.1. Steps in Building a Procedure Server Image

Procedures that you write for ACMS tasks run under the control of ACMS. Each performs only part of the processing for a task; the task definition takes care of the rest of the processing. Before you can debug tasks and the procedures that run in those tasks, you need to link the object code of procedures together with the procedure server transfer module and the message object module. You link all of these into a procedure server image (.EXE).

A simplified list of the order of operations for building a procedure server image follows.

1. Write the source code of the procedure.

2. Compile the source code into a procedure object module.

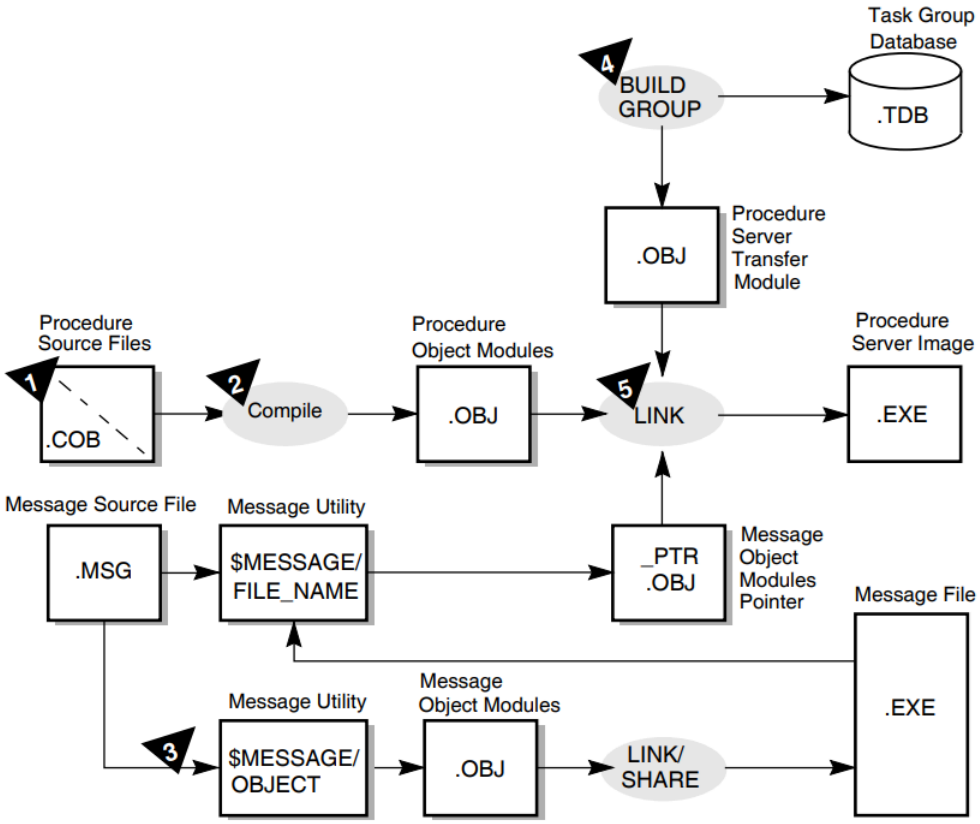
3. Create any message files you want to use; compile and link them.

4. Build the task group, which creates both a task group database (.TDB) and a procedure server transfer module (.OBJ).

5. Link the procedure server transfer module, server procedure object modules, and message pointer object modules to create a procedure server image.

Figure 6.1, "Creating a Procedure Server Image" shows the steps that you need to take and the files that you use when you create a procedure server image. The steps are labeled 1 through 5 in the diagram. The example in the figure is a procedure that is a COBOL program.

Figure 6.1. Creating a Procedure Server Image



The following sections explain the steps for creating a procedure server image. The sections correspond to the steps in *Figure 6.1, "Creating a Procedure Server Image"*.

6.1.1. Writing the Source Code of the Procedure

Follow the instructions in *Chapter 3, "Writing Step Procedures"* for writing step procedures. Follow the instructions in *Chapter 2, "Writing Initialization, Termination, and Cancel Procedures"* for writing initialization, termination, and cancel procedures.

6.1.2. Compiling the Source Code into a Procedure Object Module

Compiling step, initialization, termination, and cancel procedures is similar to compiling any program. You use the same commands, create the same output files, and expect the same kinds of errors, such as missing periods in COBOL or missing ampersands in BASIC. For information on compiling source programs and correcting compile-time errors, see the reference manual and user's guide for the language you are using.

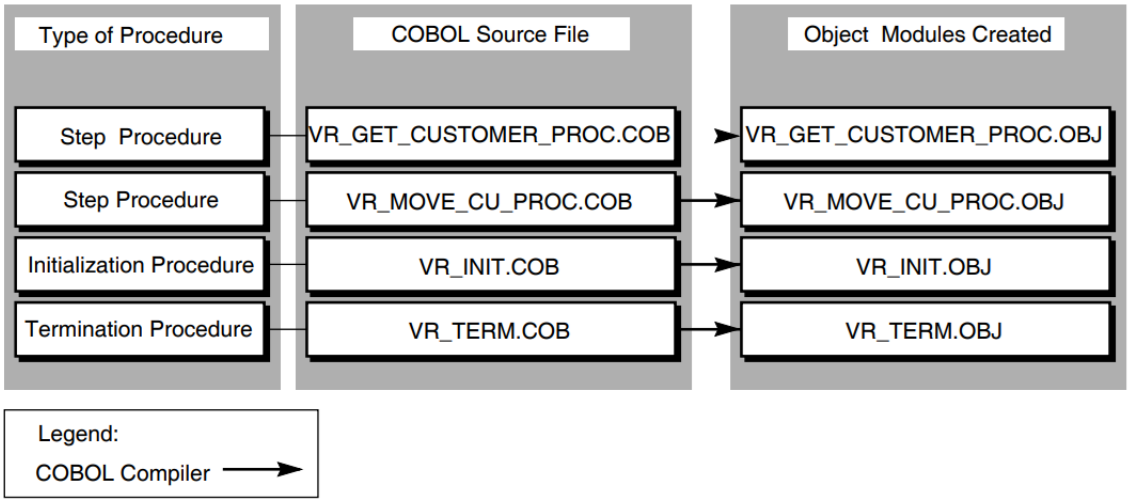
If you plan to debug a high-level language procedure later, you might want to include the OpenVMS debug symbol table in the procedure when you compile it. For example, if you use the **COBOL** command to compile a procedure, use the **/DEBUG** qualifier in the command line:

```
$ COBOL/DEBUG VR_FIND_SI_PROC
```

The file name of the procedure in the example is VR_FIND_SI_PROC.

Figure 6.2, "Compiling Source Code into Object Modules" shows the relationship between procedure source files and their file names when they are compiled to create object modules. These are the file names that you use when you link object modules in step 5. The example uses COBOL step, initialization, and termination procedures from the AVERTZ application.

Figure 6.2. Compiling Source Code into Object Modules



6.1.3. Creating, Compiling, and Linking Message Files

Chapter 5, "Using Message Files with ACMS Tasks and Procedures" explains how to create, compile, and link message files. When you use the Message Utility a second time, you create a pointer object module, which is a file that you link into the procedure server image in step 5.

6.1.4. Building the Task Group

When you build a task group, you create both a task group database (.TDB) and a procedure server transfer module (.OBJ). For example:

```
ADU> BUILD GROUP VR_TASK_GROUP
```

VSI ACMS for OpenVMS Writing Applications [https://docs.vmssoftware.com/vsi-acms-writing-apps/] contains detailed instructions for building a task group.

To use the ACMS Task Debugger **EXAMINE** and **DEPOSIT** commands, include the **/DEBUG** qualifier with the **BUILD GROUP** command. For example:

```
ADU> BUILD GROUP VR_TASK_GROUP/DEBUG
```

Chapter 7, "Debugging Tasks and Procedures" contains instructions for debugging tasks.

6.1.5. Linking the Object Code of Procedures

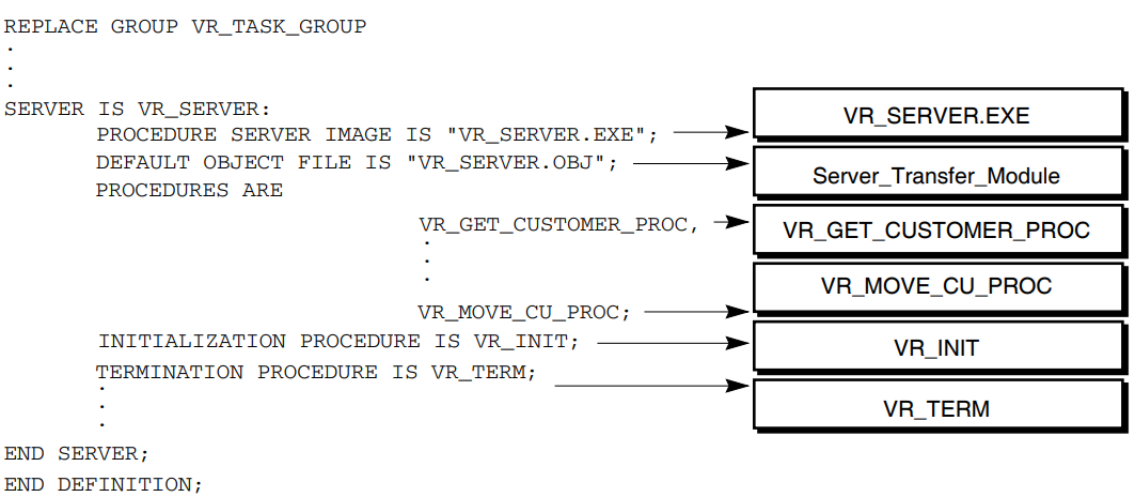
Link the object code of procedures with the procedure server transfer module into a procedure server image. Before linking, you can place files in a procedure object library. Doing so allows you to track insertion into the library and simplifies the job of creating a server image. Using procedure object libraries also reduces linking time. See *Section 6.2, "Using an Object Library for Procedures"* for more information about using an object library.

You use the **LINK** DCL command to combine the following object modules into an executable (.EXE) file:

- Procedure server transfer module created for that server by the **BUILD** command of ADU
- All step procedures for all tasks in the task group that use that server
- Initialization, termination, and cancel procedures (if any) for the server
- Any procedures called as cancel actions by tasks using the server

Figure 6.3, "Linking Object Modules into a Procedure Server Image" shows the relationship between the task group definition and object modules when they are linked to create a procedure server image.

Figure 6.3. Linking Object Modules into a Procedure Server Image



Follow these guidelines when using the **LINK** command:

- In the **LINK** command, include all of the procedures that are named in the server definition in the task group.

  The **LINK** command creates a server image named from the first module named in the command line, and places it in your default directory. Use the optional **/EXE** qualifier to explicitly assign a name to the server image. For example:

  ```
  $ LINK/DEBUG/EXE=VR_SERVER.EXE ...
  ```

  In the example, the name assigned to the executable file is VR_SERVER.EXE. If you do not use the qualifier, the Linker uses the file name of the first object module in the **LINK** command as the name of the server image. The default file type is .EXE.

- Include the **/DEBUG** qualifier in the **LINK** command if you want to debug the procedures in the server.

- Use the same name for the server image in the **LINK** command as you do in the IMAGE clause of the task group definition. For example:

  ```
  REPLACE GROUP VR_TASK_GROUP
          .
          .
  ```

```
SERVER IS
        PROCEDURE SERVER IMAGE IS "VR_SERVER.EXE";
```

In the **LINK** command, the first object module that you name is the procedure server transfer module; in the example, it is called VR_SERVER.OBJ. You can assign a name to the procedure server transfer module in the task group definition, in the SERVER IS statement. For example:

```
SERVER IS
        PROCEDURE SERVER IMAGE IS "VR_SERVER.EXE";
          .
          .
          .
        DEFAULT OBJECT FILE IS "VR_SERVER.OBJ";
```

You might also prefer to include a logical with file names. For example:

```
PROCEDURE SERVER IMAGE IS "PRODUCTION:VR_SERVER.EXE";
```

- If you plan to debug a server image later, do not use the **/NOTRACEBACK** qualifier on the **LINK** command. You can still start the server with the Task Debugger if you link the server with **/NOTRACEBACK**. However, you cannot debug it because the OpenVMS Debugger cannot be invoked while a program linked without traceback information is running. Also, if you use the **INTERRUPT** command to access the OpenVMS Debugger in that server, the server stops.

Example 6.1, "LINK Command for a Procedure that Uses SQL" shows a **LINK** command example for a server that uses SQL.

Example 6.1. LINK Command for a Procedure that Uses SQL

```
$ LINK/DEBUG/EXE=VR_SERVER.EXE VR_SERVER.OBJ,-
_$ ACMS$SAMPLES:VR_TERM,-
_$ ACMS$SAMPLES:VR_GET_CUSTOMER_PROC,-
_$ ACMS$SAMPLES:VR_MOVE_CU_PROC,-
_$ ACMS$SAMPLES:VR_INIT,-
_$ SYS$LIBRARY:SQL$USER/LIB
```

When linking a server image containing procedures called by tasks that use the WITH SQL RECOVERY phrase, you must reference the ACMS SQL library in SYS$LIBRARY immediately after the transfer vector object module name. As the last item, link the SQL library file that is found in SYS$LIBRARY. When you use the WITH SQL RECOVERY phrase in the task definition, if you do not reference the correct libraries *in the correct order*, you can receive unpredictable run-time errors.

Example 6.2, "LINK Command for Servers Called by Tasks that Use the SQL RECOVERY Phrase" shows a complete **LINK** command for a server image containing procedures called by tasks that use the WITH SQL RECOVERY phrase.

Example 6.2. LINK Command for Servers Called by Tasks that Use the SQL RECOVERY Phrase

```
$ LINK/DEBUG/EXE=VR_SERVER.EXE VR_SERVER.OBJ,-
_$ SYS$LIBRARY:ACMSSQL/LIB,-
_$ ACMS$SAMPLES:VR_GET_CUSTOMER_PROC,-
_$ ACMS$SAMPLES:VR_MOVE_CU_PROC,-
_$ ACMS$SAMPLES:VR_INIT,-
_$ SYS$LIBRARY:SQL$USER/LIB
```

The ACMSSQL library is *not* required if the SQL database transactions are started by the step procedures in the server, not in the task definition.

When linking procedure server code, if the task definition uses Rdb recovery, then include the following two statements in your link option file:

```
PSECT_ATTR=RDB$TRANSACTION_HANDLE,LCL,NOSHR
PSECT_ATTR=RDB$DBHANDLE,LCL,NOSHR
```

Because of an Rdb restriction, the link is not upward compatible; therefore, you need to relink the server for each new version of Rdb.

6.2. Using an Object Library for Procedures

In many cases, it is more convenient to place all the object modules for your procedures in a procedure object library before linking the server image. A procedure object library allows you to track insertion into the library by using the following command:

```
$ LIBRARY/LIST/FULL library_name
```

Using a library also simplifies the job of creating a server image. Finally, using object libraries also reduces link time.

After compiling the procedures for a server and correcting the compilation errors, use the OpenVMS **LIBRARY** command to put the object modules in your procedure object library. If the library does not exist, create it. For example:

```
$ LIBRARY VR_PROC.OLB /CREATE
```

To place modules in the library, use the **/INSERT** qualifier in the **LIBRARY** command. For example:

```
$ LIBRARY/INSERT VR_PROC.OLB VR_FIND_SI_PROC.OBJ
```

The first name used in the **LIBRARY** command is the procedure object library; its default file type is .OLB. The second name is the file containing the object module to be placed in the library. In this case, the name of the file is VR_FIND_SI_PROC.OBJ in the default device and directory.

If you use an object library for your procedures, use the **/LIBRARY** qualifier to identify the object library when you link the server image. For example:

```
$ LINK/DEBUG  VR_SERVER, VR_PROC/LIBRARY
```

In this example, VR_SERVER is the name of the procedure server transfer module (.OBJ) created by building the task group containing that server. The procedure object library is identified as VR_PROC.OLB. By using the **/LIBRARY** qualifier, you indicate that all modules referenced by VR_SERVER.OBJ are to be taken from the VR_PROC.OLB library and included in the server image.

For more information on using a procedure object library, see *VSI OpenVMS Command Definition, Librarian, and Message Utilities Manual* [https://docs.vmssoftware.com/vsi-openvms-command-definition-librarian-and-message-utilities/].

Chapter 7. Debugging Tasks and Procedures

After writing server procedures for tasks, you need to test procedures for errors. You compile procedures as you would any other program, but, because ACMS procedures are not independent programs, you do not link, run, and debug server procedures as you would an OpenVMS image.

Server procedures run under the control of ACMS and perform only part of the processing for a task. The task definition takes care of the rest of the processing. You need to debug tasks and the procedures that are called by tasks at the same time to be sure that tasks and procedures work together as they should.

This chapter discusses the following topics:

- Using debugging tools
- Preparing to use the ACMS Task Debugger
- Using the ACMS Task Debugger to step through the execution of individual tasks
- Using the OpenVMS Debugger to step through the execution of server procedures
- Returning to the `ACMSDBG>` prompt
- Debugging tasks that are called by user-written agent programs

7.1. Using Debugging Tools

You use several tools to debug ACMS tasks and procedures:

- ACMS Task Debugger

  The ACMS Task Debugger provides an environment for testing tasks and server procedures without building an entire ACMS application. The Task Debugger lets you control a task while the task is running. You can set breakpoints at the beginning of the task, at the beginning of any step in the task, at the action part of any step, and at the end of any step. Once you reach a breakpoint in the task, you can examine and deposit values in workspaces and then resume the execution of the task.

- OpenVMS Debugger

  The OpenVMS Debugger lets you control the procedures called by the task. You use the OpenVMS Debugger in the same way as you use it with any program. For example, you can use the OpenVMS Debugger to set a breakpoint in the procedure after the procedure reads a record; when you reach the breakpoint, you can examine and deposit data in variables and then resume execution of the procedure. You also use the OpenVMS Debugger to check whether your procedures perform properly or not and to debug DECforms escape routines.

- DECforms Trace Facility

  In addition to ACMS and OpenVMS facilities for debugging tasks, you can also use the DECforms trace facility. This facility logs processing information at run time to help you debug both

your applications and your form. The trace facility uses the logical names FORMS$TRACE and FORMS$TRACE_FILE. See *VSI DECforms Guide to Commands and Utilities* [https://docs.vmssoftware.com/vsi-decforms-for-openvms-guide-to-commands-and-utilities/] for more information about the DECforms trace facility.

Chapter 10, "ACMS Task Debugger Commands" contains reference information on all of the ACMS Task Debugger commands. In general, you use Task Debugger commands to do the following:

- Start, stop, and assign logical names for the servers you are going to use
- Start, stop, and step through a task
- Display and change workspace contents while a task is running

When you select a task to debug, the ACMS Task Debugger starts the task. When the task reaches a breakpoint, you can enter commands to continue running the task, display the contents of workspaces, change the contents of workspaces, or display information about ACMS Task Debugger commands.

By examining and changing workspace contents, variable assignments, and other values, you can find most of the errors in the definitions or procedures for your tasks. You can look for inconsistencies between workspaces in form definitions, task definitions, and procedures. You can also check that logical names in procedures or definitions point to the correct files and that files have correct protection codes. Finally, you can check for error conditions that are not handled by the server procedures or the task definition.

7.2. Preparing to Use the ACMS Task Debugger

Before you can debug ACMS tasks, you need to:

- Prepare definitions and build a task group.
- Prepare procedures by compiling and linking them.
- Check to make sure that all the files you need are complete.
- Define logical names and prepare DECforms escape routines for debugging, if necessary.

Before you debug, you need to check a number of quotas to make sure that the ACMS Task Debugger can be run. If you plan to debug using two terminals, you also need to complete additional preparatory steps. Finally, to debug a task called from a user-written agent program, you must complete additional preparatory steps, which are explained in *Section 7.6, "Debugging Tasks Called from a User-Written Agent Program"*.

7.2.1. Preparing Definitions

Before debugging a task, be sure to complete the following steps:

1. Use the Common Dictionary Operator (CDO) Utility to define all fields, records, and workspaces used by the task.
2. Use DECforms to define all forms for the task.

3. Use the Application Definition Utility (ADU) to define the task and the task group.

   Because tasks involve both code and definitions, it is important to understand all parts of the task to debug it. The primary definition you must understand is the task definition. For a detailed explanation of task definitions, see *VSI ACMS for OpenVMS Writing Applications* [https://docs.vmssoftware.com/vsi-acms-writing-apps/].

4. Use the ADU **BUILD** command to create a task group database from the task group definition. To use the ACMS Task Debugger **EXAMINE** and **DEPOSIT** commands, include the **/DEBUG** qualifier with the **BUILD GROUP** command. For example:

   ```
   ADU> BUILD GROUP/DEBUG VR_TASK_GROUP
   ```

   You can use the **EXAMINE** and **DEPOSIT** commands to examine or deposit data into the workspaces when you debug the task.

7.2.2. Preparing Procedures

It is easier to debug procedures if you compile and link them with the **/DEBUG** qualifier. Using the **/DEBUG** qualifier makes more information available to the OpenVMS Debugger. For example:

```
$ COBOL/DEBUG VR_FIND_SI_PROC
 $ LINK/DEBUG/EXE=VR_SERVER.EXE VR_SERVER.OBJ,-
 .
 .
 .
```

After you compile and link the procedures called by a task, you can run the task in the ACMS Task Debugger. The task you run is a real one; when the task is in daily use, ACMS runs the same definitions and code as the ones you test.

To protect business data, you can set up test files to run against the task. For example, if your procedures use logical names to identify files, create a set of data files in another directory, and temporarily redefine the logical names to point to that directory. See *Section 7.2.3, "Defining Logical Names"* for an explanation of the two methods of defining logical names.

While debugging, keep in mind the relationship between a server procedure, a task, and a task group:

- If you make a change in a server procedure, you must compile the server procedure and relink the server image to include the new object module.
- If you revise a task or task group definition, you must rebuild the task group using ADU.

One of the difficult parts of debugging a task is making sure that all the files you need are complete. *Chapter 6, "Building Procedure Server Images"* explains the steps you take to build a procedure server image. After completing those steps, check that all the files are ready. *Figure 7.1, "Files Needed for Debugging"* shows the files needed for debugging and depicts how you produce those files from CDD definitions, source programs, and message source files.

Figure 7.1. Files Needed for Debugging

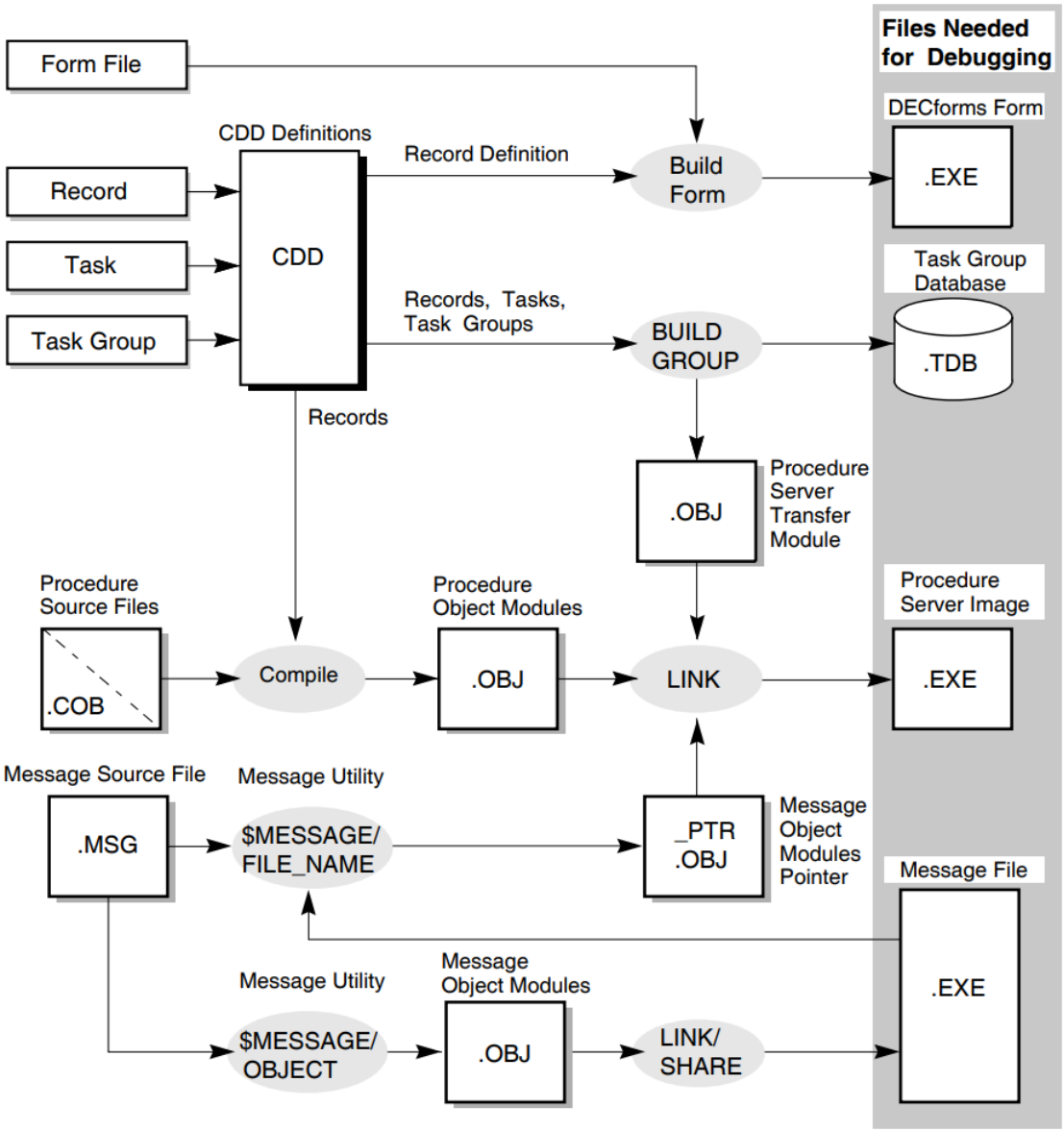


Table 7.1, "Files Needed for Debugging" explains how to produce the files needed to run a task with the ACMS Task Debugger.

Table 7.1. Files Needed for Debugging

Files	Description
DECforms form files	Created using DECforms.
Data files or database files for the task group	Created and populated using either RMS, DBMS, or Rdb.
Message files for the task group	Created with the OpenVMS Message Utility. You need these files if your tasks use the GET MESSAGE clause.
Procedure server images	Created with the DCL **LINK** command. These files contain executable images of the procedure

Files	Description
	server transfer module, message file module, and all procedures for the task group.
Task group database (.TDB)	Created with the **BUILD GROUP** command of the ACMS Application Definition Utility (ADU). This file contains information used by ACMS to run tasks.

7.2.3. Defining Logical Names

Most task groups and server procedures use OpenVMS logical names. If this is the case in your ACMS application, you must define these logical names before you start a debugging session. For example, the AVERTZ task group definition specifies that it uses the message file AVERTZ_DEFAULT:VRMSG.EXE. If the logical name AVERTZ_DEFAULT is not defined when you attempt to start the debugging session, the Task Debugger cannot find the message file, and therefore cannot start.

Some of the logical names used by your task group and server procedures might have already been defined. In the previous example, the AVERTZ application might be installed on your system in such a way that the necessary logical names are available to everyone on the system. In this case, you do not need to define any logical names in order to run the application. However, if the logical names are not defined, or if you want to test your own private copy of a file, you must define the logical names that point to that file. Also, be sure to define logical names in a way that does not affect other users on the system.

To define logical names, you need some information about the processes that are used in a debugging session. When you use the **ACMS/DEBUG** task-group command, you run the ACMS Task Debugger image in your process. For this reason, any logical names that are available to your process are also available to the Task Debugger.

However, when the Task Debugger starts a server, it creates the server as a subprocess of your process. When this server process is created, it has access to the same logical name tables as the Task Debugger process, with the exception of the Task Debugger's process logical name table. Instead of using the Task Debugger process logical name table, each server is created with its own process logical name table.

The logical names that must be available to the Task Debugger process include the logical names pointing to:

- Form files
- Message files
- Request library files

The logical names that the server process must have access to are:

- Logical names pointing to the procedure server image
- Logical names used in server procedures

With this information, you can decide which logical name tables to use in different situations. Generally, if you want the Task Debugger and the server process to use the same definition of a logical name, define the logical in a logical name table that is shared by the Task Debugger process and the server subprocess. You can do this in one of two ways:

- To do this in a way that does not affect anyone else on the system, define the logical as a job logical name. For example:

  ```
  $ DEFINE/JOB AVERTZ_DEFAULT DSK$:[AVERTZ.PUBLIC]
  ```

- Alternatively, define logical names in a user-defined logical name table. If the application uses a user-defined logical name table at run time, there is one less difference between the debugging environment and the run-time environment, which makes the transition between the two easier. Follow these steps:

  1. Create the logical name table.

     If a logical name table does not already exist, create it. To make the table shareable, specify the system directory as the parent table. For example:

     ```
     $ CREATE/NAME_TABLE -
     _$ /PARENT_TABLE=LNM$SYSTEM_DIRECTORY my_name_table
     ```

     This command requires the SYSPRV privilege. If you do not have this privilege, ask your system manager to create the table for you.

  2. Define the logical name in the logical name table.

     If the logical name is not defined in the table, define it:

     ```
     $ DEFINE/TABLE=my_name_table AVERTZ_DEFAULT DSK$:[AVERTZ.PUBLIC]
     ```

  3. Include the logical name table in the list that the system searches.

     If the logical name table is not included in the system default logical name table list, include it in the logical name table list for your process. For example:

     ```
     $ DEFINE/TABLE=LNM$PROCESS_DIRECTORY LNM$FILE_DEV -
     _$ LNM$PROCESS, LNM$JOB, my_name_table, LNM$GROUP, LNM$SYSTEM
     ```

     List the logical name tables in the same order as the name tables will be defined in the application definition.

See *VSI OpenVMS User's Manual* [https://docs.vmssoftware.com/vsi-openvms-user-s-manual/] for more information on logical names and logical name tables.

In some situations, you might not want to share logical names between the Task Debugger and the server:

- If you want the logical name to be used only by the Task Debugger process, define the logical name as a process logical name.

- If you want the logical name to be used only by the server process, define the logical name as a process logical name for the server subprocess. The only way to do this is to use the Task Debugger **ASSIGN** command. See *Section 7.3.2, "Using the Task Debugger ASSIGN Command"* for details.

7.2.4. Preparing to Debug DECforms Escape Routines

If exchange steps in your tasks call DECforms, and DECforms, in turn, calls procedural escapes, you need to debug escape routines. Because DECforms escape routines are written in an OpenVMS programming language, you use the OpenVMS Debugger to debug escape routines. To have more

information available to you while you are debugging, compile escape routines using the **/DEBUG** qualifier.

You must complete several preparatory steps before you debug DECforms escape routines. First, you must tell DECforms that you want to debug escape routines by defining the logical name FORMS$DEBUG_ESCAPE_ROUTINES to be true. This definition tells DECforms to activate the OpenVMS Debugger when it activates the escape routine image for the first time. Because DECforms invokes the OpenVMS Debugger only one time for each image, you must set breakpoints in your escape routines in order to debug them. See the DECforms documentation for more details on the FORMS$DEBUG_ESCAPE_ROUTINES logical name.

The next step depends on whether the escape routine you are debugging is linked into a separate image or linked into the forms image.

Note

Debugging escape routines is much easier if you link the routines into a separate image.

- For an escape routine linked into a separate image:

  Specify the location of the escape routine image. Do this by defining FORMS$IMAGE to point to the shared image that contains the escape routine. If you have more than one escape routine image, you can make FORMS$IMAGE a search list. Refer to the DECforms documentation for more information about defining this logical name.

  ACMS uses the ACMS$ESC_RTN_*node_application* logical name at run time to avoid naming conflicts that can occur with multiple applications. However, the ACMS Task Debugger does not recognize this logical name because the task group that the Task Debugger uses does not have an application name. Instead, use the FORMS$IMAGE logical name.

- For escape routines linked directly into the form image:

  You must modify your escape routine code to debug it. The escape routine must initiate the debugging process by invoking the OpenVMS Debugger. Do this by signaling SS$_DEBUG from the escape routine. For example:

```
01 debug_symbol      pic S9(9) COMP VALUE EXTERNAL SS$_DEBUG
 .
 .
 .
CALL 'LIB$SIGNAL' USING BY VALUE debug_symbol.
```

  Remember to remove the signal of SS$_DEBUG when you finish debugging. If you do not define FORMS$DEBUG_ESCAPE_ROUTINES to be true, and you do not remove the code that signals SS$_DEBUG, your escape routine will hang.

7.2.5. Setting Up for Debugging with Two Terminals

When debugging ACMS tasks, you control two input/output (I/O) streams:

- Task I/O stream

  The task I/O stream handles the terminal I/O defined for the task. For example, in an inquiry task that reviews car rental reservations, the task I/O stream handles the form that displays information about the reservations.

- Debugger I/O stream

  The debugger I/O stream handles the debugger commands and the information the debugger displays in response to those commands. For example, the debugger I/O stream handles the `ACMSDBG>` Task Debugger prompt.

By default, both the task I/O stream and the debugger I/O are attached to the same terminal. This is necessary if you have only one terminal to use. However, if two terminals are available to you, you might want to use a separate terminal for each I/O stream. This is useful when you want to see the task output without having debugger prompts overwrite it.

The OpenVMS operating system supplies the following logical names that connect a terminal with the I/O streams:

- SYS$INPUT – Where ACMS looks for task input
- SYS$OUTPUT – Where ACMS sends task output
- DBG$INPUT – Where the debugger looks for input
- DBG$OUTPUT – Where the debugger sends output

OpenVMS defines the logical names SYS$INPUT and SYS$OUTPUT to be the name of your terminal when you log in (TTA1, for example). The logical names DBG$INPUT and DBG$OUTPUT default to SYS$INPUT and SYS$OUTPUT. If you do not reassign DBG$INPUT and DBG$OUTPUT, both I/O streams are attached to your terminal.

To use a second terminal for the debug stream, assign DBG$INPUT and DBG$OUTPUT to the second terminal. For example:

```
$ DEFINE DBG$INPUT TTA6:
$ DEFINE DBG$OUTPUT TTA6:
```

In this example, the debug streams are assigned to terminal TTA6.

After setting up your I/O streams for two terminals, follow the instructions in the next section. The breakpoints you set, the commands you use, and the problems to look for are the same as when you debug from a single terminal. The only difference is that the terminal I/O and the debugger I/O display at different terminals. Before starting the debugger, make sure that no one is logged in at the other terminal. If anyone is logged in at the second terminal, the debugger cannot allocate and use that terminal.

7.2.6. Verifying that the ACMS Task Debugger Can Be Run

Before starting the ACMS Task Debugger, you need to check that quotas and system parameters are set correctly:

- Quotas

  For each of these, use the DCL command **`SHOW PROCESS/QUOTA`**. Make sure that:

  - The buffered I/O byte count quota (BYTLM) is at least 50,000.
  - The enqueue quota (ENQLM) is at least 2,000.

- The open file quota (FILLM) is at least 96.
- The subprocess quota (PRCLM) is adequate.

  The workspace looker process (that is, the process activated if you use the **/WORKSPACE** qualifier) and server processes are implemented as subprocesses. Make sure that your PRCLM is large enough to handle this.
- The AST limit (ASTLM) is at least 24.
- The timer queue entry limit (TQELM) is at least 10.

See your system manager if you need higher quotas.

- System parameters

  Check with your system manager to make sure that the following system parameters have values equal to or greater than the ones indicated here:

  PQL_DASTLM = 24
  PQL_DDIOLM = 20
  PQL_DBIOLM = 18
  PQL_MDIOLM = 20

7.3. Using the ACMS Task Debugger

When you have completed all of the preparations for debugging ACMS tasks and procedures, you are ready to debug a task. After you start the ACMS Task Debugger, assign any additional logical names that you need. Then you can start the servers needed by a task.

Before running a task in the Task Debugger, however, you usually set breakpoints so that you can check that information that should be in a workspace is actually there. You might also want to set breakpoints in procedures to debug them using the OpenVMS Debugger.

The following sections explain how to start the ACMS Task Debugger; use the Task Debugger **ASSIGN** command; start, stop, and interrupt servers; set and remove breakpoints in tasks; check values in workspaces; and debug transaction timeout codes. Debugging procedures with the OpenVMS Debugger is described in *Section 7.4, "Using the OpenVMS Debugger"*.

You can use two control characters when running the Task Debugger. *Table 7.2, "Control Characters for the ACMS Task Debugger"* lists these control characters and explains how to use them.

Table 7.2. Control Characters for the ACMS Task Debugger

Control Character	Function
Ctrl/G	Interrupts the current task (if any) and the current Task Debugger or OpenVMS Debugger command, and returns to the Task Debugger prompt (ACMSDBG>). Typing **GO** continues a task interrupted with **Ctrl/G**.
Ctrl/Z	Equivalent to the **EXIT** command. If you press **Ctrl/Z** when you are at the Task Debugger prompt, the Task Debugger stops all servers, cleans up all the subprocesses it

Control Character	Function
	has allocated, and returns to the DCL command-level prompt ($). If you press **Ctrl/Z** at an OpenVMS Debugger prompt, the debugger stops the server process you are running in and returns to the Task Debugger prompt. Any active tasks using that server are canceled.

7.3.1. Starting the Task Debugger

To start the ACMS Task Debugger, you use the **ACMS/DEBUG** command. For example:

```
$ ACMS/DEBUG VR_TASK_GROUP/WORKSPACE
```

In the command, include the name of the task group database file (.TDB) containing the task or tasks you want to debug; in the example, the task group is VR_TASK_GROUP. You cannot debug more than one task group at a time. If the file is not in your default device and directory, include the device and directory specifications. The default file type is .TDB.

Use the **/WORKSPACE** qualifier with the **ACMS/DEBUG** command to examine and deposit data in workspaces using the Task Debugger. If you do not include the **/WORKSPACE** qualifier, you can still look at workspaces when a task is running in a server. However, you must use **/WORKSPACE** if you want to look at workspaces during exchange steps, during the action part of processing steps, or at the beginning or end of the task.

Once the Task Debugger starts, it displays the ACMSDBG> prompt. You can then enter any of the Task Debugger commands. Reference information on all the ACMS Task Debugger commands is in *Chapter 10, "ACMS Task Debugger Commands"*.

7.3.2. Using the Task Debugger ASSIGN Command

ACMS defines process logical names for a server based on logical names that you define using the Task Debugger **ASSIGN** command. A logical name that you assign in the Task Debugger takes effect only when the server starts. Therefore, if you assign a logical name after a server starts, that name does not take effect.

The following example assigns a logical name for the VR_UPDATE_SERVER to point to a different directory from the one defined with the **DEFINE** DCL command:

```
ACMSDBG> ASSIGN /SERVER=VR_UPDATE_SERVER [AVERTZ.UNAME] AVERTZ_DEFAULT
ACMSDBG> START VR_UPDATE_SERVER
```

Note that, unlike the **DEFINE** DCL command, the directory name precedes the logical name in the Task Debugger **ASSIGN** command. The ACMS Task Debugger **ASSIGN** command is patterned after the **ASSIGN** DCL command.

The **ASSIGN** command defines the logical name AVERTZ_DEFAULT to point to the [AVERTZ.UNAME] directory rather than to the [AVERTZ.PUBLIC] directory. The **/SERVER** qualifier names the server that can use this logical name: VR_UPDATE_SERVER.

If you are assigning many logical names for a server, use the **SET SERVER** command to indicate the server to which the **ASSIGN** commands apply. If you use **SET SERVER** before the **ASSIGN** command, you do not need the **/SERVER** qualifier. For example:

```
ACMSDBG> SET SERVER VR_UPDATE_SERVER
ACMSDBG> ASSIGN [AVERTZ.UNAME] AVERTZ_DEFAULT
```

The name included in the **SET SERVER** command or the **/SERVER** qualifier must be the same name used for the server in the task group definition.

7.3.3. Starting, Stopping, and Interrupting Servers

After starting the ACMS Task Debugger, the next step is to start the servers that handle the tasks you want to debug. The following sections explain how to start, stop, and interrupt servers.

7.3.3.1. Starting Servers

You can start servers in two ways from the Task Debugger:

- The ACMS Task Debugger automatically starts a server if it is needed to run a procedure called by the task.
- Alternatively, you can start servers for tasks yourself. You might, for example, want to debug an initialization procedure without starting a task.

You might need multiple instances of a server when you use distributed transactions and the task-call-task feature. When you use distributed transactions, a called task that participates in a distributed transaction started by a parent task might need to use the same server as the parent task. Different server processes are started and allocated to the parent and to the called tasks.

The number of active servers allowed for a debugging session is limited. A user is allowed up to four times the number of servers defined in the task group that is being debugged. You can, however, allocate the total number of servers allowed to server instances in any manner you like. For example, if a task group has two servers, you can start eight server instances. You can, if you like, have eight instances of one server and none of the other.

Use the **START** ***server-name*** command to start one or more instances of one or more servers. The following examples show three alternative ways to use the **START** command:

- If both a parent and a called task use the same server (in this case, VR_SERVER), issue a command like the following one to start two instances of that server:

  ```
  ACMSDBG> START VR_SERVER, VR_SERVER
  ```

- If you will use only one of the servers defined for the task group, include that server name in the **START** command:

  ```
  ACMSDBG> START VR_SERVER
  ```

- If the tasks you are debugging use all the servers in a task group or if only one server is defined for a group, use the **/ALL** qualifier in the **START** command to start any servers that have not been started:

  ```
  ACMSDBG> START /ALL
  ```

  You cannot use both the **/ALL** qualifier and a server name in the same **START** command.

When you start a server with the ACMS Task Debugger, ACMS creates the server process. If the server is a procedure server, the OpenVMS Debugger prompt is displayed. For example:

```
ACMSDBG> START VR_SERVER
Terminal is in SERVER VR_SERVER

                  VAX DEBUG Version V5.4-019
%DEBUG-I-INITIAL - language is COBOL, module set to 'VR_SERVER'
DBG>
```

The first line after the **START** server command indicates that the ACMS Task Debugger has transferred control of the debugging session to the server process. The OpenVMS Debugger software displays an identifying line showing the version number. On a separate line, the OpenVMS Debugger names the language it is using and the module where the program is beginning. The program begins in the server transfer module, which is produced by building the task group. Therefore, the language displayed comes from the server transfer module rather than from your server procedure. The default language for the server transfer module is COBOL. Following these messages, the OpenVMS Debugger displays the DBG> prompt.

At this point, you can set breakpoints in the server using the OpenVMS Debugger. You might, for example, want to set a break at the server's initialization procedure. Instructions for using the OpenVMS Debugger are in *Section 7.4, "Using the OpenVMS Debugger"*.

To complete the operation of starting the server and return to the ACMS Task Debugger, enter the **GO** command:

```
DBG> GO
Server VR_SERVER has been started
ACMSDBG>
```

7.3.3.2. Stopping Servers

Once a server starts, it remains available for other tasks until one of the following occurs:

- You use the Task Debugger **STOP** command.
- You use the OpenVMS Debugger **EXIT** command.
- ACMS runs down a server due to a task cancellation.

One way to stop a server is to use the **STOP** command. For example:

```
ACMSDBG> STOP VR_SERVER
Terminal is in SERVER VR_SERVER
Server VR_SERVER stopped
ACMSDBG>
```

If there are multiple instances of a server started when you use the **STOP** command, only one instance is stopped. For example:

```
ACMSDBG> STOP VR_SERVER
Stopping only one instance of server VR_SERVER
Terminal is in SERVER VR_SERVER
Server VR_SERVER stopped
ACMSDBG>
```

You can stop all instances of all servers with the **STOP/ALL** command. For example:

```
ACMSDBG> STOP/ALL
Terminal is in SERVER VR_SERVER
```

```
Server VR_SERVER stopped
Terminal is in SERVER VR_SERVER
Server VR_SERVER stopped
Terminal is in SERVER DCL_SERVER
Server DCL_SERVER stopped
ACMSDBG>
```

If you use the **STOP** command, the termination procedure is run for the server. If you want to debug the termination procedure, you must set a breakpoint at the termination procedure. If you forget to do this when the server is first started or while you are debugging step procedures, you can use the **INTERRUPT** command to bring the OpenVMS Debugger up in the server.

You cannot issue a **STOP** command while a task is active. If you want to stop the server while a task is active, you can interrupt the server and use the **EXIT** command at the OpenVMS Debugger prompt. Exiting the server while an active task has context in the server causes the task to be canceled. For example:

```
ACMSDBG> INTERRUPT VR_SERVER
Task is in SERVER VR_SERVER
DBG> EXIT
Task is in the task debugger
%ACMSDBG-I-SPDIED, Server VR_SERVER stopped unexpectedly
Processing non-recoverable exception from step $STEP_1 in task
 VR_RESERVE_TASK
Exception code text:
%ACMS-E-TASK_SP_DIED, Cancel results from the server process dying
Exception code value: 16632498 (decimal), %X00FDCAB2 (hex)
Task was canceled.
ACMSDBG>
```

The previous example shows that the task is canceled due to a nonrecoverable error. The nonrecoverable error is that a server that the task was using stopped unexpectedly. The message also gives the decimal and hexadecimal values of the exception code.

Another reason a server stops is that a task is canceled while the task has context in the server, and the server is to run down as a result of a cancel. In this situation, the termination procedure is called only if you use the ALWAYS EXECUTE TERMINATION PROCEDURE clause in your server definition. See *Chapter 2, "Writing Initialization, Termination, and Cancel Procedures"* for details on how to determine if a server is run down on a cancel.

7.3.3.3. Interrupting Servers

You can use the **INTERRUPT** command to interrupt a server and transfer control to the OpenVMS Debugger. After you enter this command, the OpenVMS Debugger displays the `DBG>` prompt. You can then set breakpoints, examine addresses, or change values in a server that has already been started. Beginning with ACMS Version 3.2, you can specify an instance of a server that is allocated to a specific task. Reference information about this command is in *Chapter 10, "ACMS Task Debugger Commands"*.

If you do not specify a task with the **INTERRUPT** command, ACMS interrupts the named server if the current task instance has context in that server. If the task is not retaining context in the named server, or if no task is active, then ACMS interrupts the first free server process belonging to the named server. This process is allocated to the first task or first called task that calls a procedure in the named server.

In a distributed transaction, both parent and called tasks might use the same server. As explained in *Section 7.3.3.1, "Starting Servers"*, you can start separate instances of a server. To interrupt a specific server process when both tasks have started, specify a task name after the **INTERRUPT** command.

Following is an example of setting breakpoints for a procedure after a Task Debugger **INTERRUPT** command.

```
ACMSDBG> INTERRUPT VR_SERVER/ TASK=VR_RESERVE_CAR_TASK
Terminal is in server VR_SERVER
DBG> SET BREAK VR_FIND_SI_PROCMAINMAIN-SECTION
DBG> GO

ACMSDBG>
```

When you specify a task name, ACMS interrupts the process currently owned by that task. In the previous example, ACMS interrupts the VR_SERVER owned by the called task, VR_RESERVE_CAR_TASK. If the named task (in this case, VR_RESERVE_CAR_TASK) is not currently retaining context in the named server (in this case, VR_SERVER), then the command returns an error. The example also illustrates using **Ctrl/G** to return to the ACMS Task Debugger prompt, ACMSDBG>.

If you are debugging a recursive task, supplying a task name does not have any effect; ACMS ignores the **/TASK** qualifier and follows the rules for interrupting a server when no task name is supplied.

Note

If you use the **INTERRUPT** command, do not link the server image with **/NOTRACEBACK**. If the server image was linked with **/NOTRACEBACK**, and you try to access the server process with an **INTERRUPT** command, the server process returns a fatal error and exits. The debugger returns the Task Debugger prompt, ACMSDBG>. You must then use the **START** command to restart the server.

You cannot use the **INTERRUPT** command to interrupt servers that are in the process of starting or stopping. If you do, ACMS displays the following error message:

```
%ACMSDBG-E-SRVNOTUP, Server ... is not started
```

If there is a bug in your initialization procedure that causes it not to return, you cannot stop the server. To debug the initialization procedure, you must use **Ctrl/G** to display the ACMSDBG> prompt, and then exit from the Task Debugger. When you start the Task Debugger again and attempt to start the server, set a breakpoint at the initialization procedure so that you can debug it. Do the same for termination procedures.

7.3.4. Setting and Removing Breakpoints in a Task

After you start the servers needed by a task for debugging, you are ready to start the task. However, you might want to set breakpoints before selecting the task.

A **breakpoint** is a selected place where the debugger stops a task. For example, the first time through a task, you might want to stop the task at the beginning of the action part of each exchange step. You can then check that the information that should be in a workspace is actually there.

You use the **SET BREAK** command to set breakpoints in a task. For example:

```
ACMSDBG> SET BREAK VR_RESERVE_TASK
```

In this example, a breakpoint is set in the VR_RESERVE_TASK.

After you have used ACMS Task Debugger commands to examine and deposit data in workspaces, set breakpoints, and so on, enter **GO** to continue processing from that breakpoint in the task. Otherwise, the step or task cannot complete, and you cannot select another task.

The following sections explain how to:

- Set breakpoints in a task
- Debug a task called by another task
- Remove breakpoints from tasks

If there are breakpoints that you often use, you can create a command file containing **SET BREAK** commands. Then use the at-sign (@) command to run the command (.COM) file. For example:

```
ACMSDBG> @RESERVE_CAR_DBG.COM
```

Setting up a command file of common commands can make a debugging session much easier.

7.3.4.1. Setting Location and Event Breakpoints

With the ACMS Task Debugger, you can use a breakpoint to cause the Task Debugger to break either at a particular location in a task or when a particular event occurs:

- Location breakpoints

  Use the following format to define a location breakpoint:

  task-name\step-name\location

  In the format above:

  - Task-name is required.
  - Step-name is optional.

    The default is the root step of the task.
  - Location is optional.

    The default is the beginning of the step.

  The step-name can be the one you define in the task definition. If you do not define a label for a step, ACMS assigns one. The label that ACMS assigns always has the format $STEP_*n*, where *n* is the number of the step. For example:

  ```
  $STEP_1
  ```

  Step numbering continues sequentially from step to step rather than just for steps that do not have labels. A label supplied in a task definition replaces the ACMS label. ACMS assigns the name $TASK to the block step of a multiple-step task and to the only step in a single-step task.

  Note

  To see a listing of step label names, use the ADU **DUMP** command to obtain a dump of the task group database. *Example 7.2, "Sample Task Group Dump File"* contains part of a dump file.

  You can use four symbols for location breakpoints: $BEGIN, $ACTION, $HANDLER, and $END. *Table 7.3, "Location Breakpoint Symbols"* lists location symbols and explains the effect of using each of them.

Table 7.3. Location Breakpoint Symbols

Symbol	Explanation
$BEGIN	Breakpoint occurs at the start of the step.
$ACTION	Breakpoint occurs at the start of the action of the step. At this breakpoint, none of the actions for the step have been performed.
$HANDLER	Breakpoint occurs at the start of the exception handler action for the step. At this breakpoint, none of the exception handler actions for the step have been performed. The exception reason, however, has been moved to the ACMS $PROCESSING_STATUS workspace.
$END	Breakpoint occurs at the end of the step. At this breakpoint, the action clauses (if any) have been performed.

- Event breakpoints

  Use the following format to define an event breakpoint:

  ```
  task-name\event
  ```

  In the format above:

  - Task-name is required.
  - Event is required.

  You can use two symbols for event breakpoints: $EXCEPTION and $CANCEL. *Table 7.4, "Event Breakpoint Symbols"* lists event symbols and explains the effect of using each of them.

Table 7.4. Event Breakpoint Symbols

Symbol	Explanation
$EXCEPTION	Breakpoint occurs as soon as an exception is raised in the task. At this breakpoint, the exception reason has not been moved to the ACMS$L_STATUS field in the workspace. ACMS displays information about the exception (type, reason code, and so on).
$CANCEL	Breakpoint occurs just before ACMS cancels the task. At this time, ACMS has called server cancel procedures but has not yet performed a task cancel action, if supplied.

At the $EXCEPTION breakpoint, ACMS has not yet updated the ACMS$PROCESSING_STATUS workspace with information about the exception. This allows you to examine the contents of the ACMS$PROCESSING_STATUS workspace at the time the exception occurred. Once you reach the $HANDLER breakpoint, ACMS has filled in the ACMS$PROCESSING_STATUS workspace with

information about the exception. This enables you to examine the workspace before you execute the exception handler action.

Server cancel procedures are called after a task stops at the $EXCEPTION breakpoint and before a task stops at the $CANCEL breakpoint. Therefore, you must set a break at the $EXCEPTION breakpoint if you want to interrupt a server process in order to set a breakpoint in a server cancel procedure. Alternatively, you can use the OpenVMS Debugger to set a breakpoint in a server cancel procedure when you start the server process. *Section 7.4, "Using the OpenVMS Debugger"* contains instructions for using the OpenVMS Debugger.

The breakpoints you set depend on the task you are debugging. Breakpoints are often useful at the beginning of a task, at the action part of each step, and at the block action for a task. Setting breakpoints at these places helps you make sure that the work part of each step has put the right values into the workspaces it used.

In setting breakpoints, be sure to include backslashes (\) to separate task name, step label, and symbol. Use the **SHOW BREAK** command to check the breakpoints set.

Example 7.1, "Task Definition with Breakpoint Symbols" contains part of a task definition that is annotated to show the use of breakpoint symbols.

Example 7.1. Task Definition with Breakpoint Symbols

```
                                        REPLACE TASK sample_task
                                          .
                                          .
                                          .
  sample_task\$BEGIN ----------->         BLOCK WITH DISTRIBUTED
TRANSACTION

                                          get_number:
 -------------------------                  EXCHANGE
| sample_task\$EXCEPTION  |                      .
| When exception occurs   |                      .
 -------------------------                      .
 -------------------------
| sample_task\$CANCEL     |
| When cancellation occurs|
 -------------------------

                                          get_data:

  sample_task\get_data\$BEGIN ->           PROCESSING WORK IS
                                               CALL    sample_procedure
                                               .
                                               .
                                               .
  sample_task\get_data\$ACTION ->            ACTION IS
                                                  SELECT FIRST TRUE OF
                                                  .
                                           .
                                                  .
  sample_task\get_data\$END ------>               END SELECT;

                                          display_data;
                                             EXCHANGE
                                             .
                                             .
                                             .
```

```
                                        END BLOCK;

   sample_task\$ACTION ------------->    ACTION IS
                                           REPEAT STEP;

   sample_task\$HANDLER ------------>    EXCEPTION HANDLER ACTION
                                           .
                                           .
                                           .
   sample_task\$END ----------------->    END DEFINITION;
```

7.3.4.2. Using a Dump File

Using an ADU task-group dump file can simplify the job of debugging ACMS tasks because a dump file of a task group lists, in one place, all of the following:

- Names of servers
- Tasks
- Workspaces
- Steps (in tasks)

Rather than searching through directories and listings, in the dump file you can find the names of all the elements that you need to know for debugging. To obtain a dump file, enter **ADU** and use the **DUMP GROUP** command. For example:

```
ADU> DUMP GROUP VR_TASK_GROUP /OUTPUT=VR_TASK_GROUP.DMP
```

Examples of how you can use a dump file in debugging are bolded and numbered in *Example 7.2, "Sample Task Group Dump File"*. The numbers correspond to the numbered explanations following the example.

Example 7.2. Sample Task Group Dump File

```
❶ Task group file : UDISK:[UNAME]VR_TASK_GROUP.TDB;5
    Creation time   :  6-MAR-1991 15:08:29.07
    File size       : 107 BLOCKS
  ================================================================================

                CDD node name : AVERTZ_CDD_GROUP:VR_TASK_GROUP

  ================================================================================
    GROUP workspace count  : 0                              Server count    : 4
    TASK workspace count   : 21                             Task count      : 5
    USER workspace count   : 0

    Message file list -
        1. "AVERTZ_DEFAULT:VRMSG.EXE"

    No request library

    Forms list -
        1. Form: VR_FORM                    File: AVERTZ_DEFAULT:VR_FORM.FORM


  ================================================================================
                                    WORKSPACES
  ================================================================================
```

```
  GROUP workspace list -
  USER workspace list -
  TASK workspace list -
      VR_CONTROL_WKSP                                          0
      VR_TRANS_WKSP                                            1
      .
      .
      .
      ACMS$PROCESSING_STATUS                                   18
      ACMS$TASK_INFORMATION                                    19
      ACMS$SELECTION_STRING                                    20


 ------------------------------------------------------------------------------
  Workspace name  : VR_CONTROL_WKSP                  Workspace index : 0
  Workspace size  : 127 BYTES                        Workspace type  : TASK
  Owner node name : AVERTZ_CDD_GROUP:VR_TASK_GROUP   Owner type      : GROUP
  Initial content -
      00000000 00000000 00000000 00000000         "................"
        The above line is repeated 6 times (96 BYTES).
      00000000 00000000 00000000 00000000         "................"
  .
  .
  .


 ==============================================================================
                                  SERVERS
 ==============================================================================
 ------------------------------------------------------------------------------
❷ Group server name  : VR_UPDATE_SERVER              Server index : 1
   Server username    : USERNAME OF APPLICATION      Server type  : PROCEDURE
   Rundown on cancel  : YES, IF INTERRUPTED          Reusable     : YES
   Username attribute : NOT EXPLICITLY SPECIFIED
   Server image file  : "AVERTZ_DEFAULT:VR_UPDATE_SERVER.EXE"
   Execute termination procedure: ALL RUNDOWNS
 .
 .
 .


 ==============================================================================
                                  TASKS
 .
 .
 .
 ------------------------------------------------------------------------------
❸              Task name : VR_COMPLETE_CHECKOUT_TASK
 ------------------------------------------------------------------------------
   Task type            : GLOBAL
   Composable           : YES
   Wait/delay specified : NONE                        Task index    : 4

   The following is a list of 5 workspaces that are arguments to this task -
      1.  Workspace name : VR_SENDCTRL_WKSP           Access mode:  READ
      2.  Workspace name : VR_CONTROL_WKSP            Access mode:  MODIFY
      3.  Workspace name : VR_RESERVATIONS_WKSP       Access mode:  MODIFY
      4.  Workspace name : VR_TRANS_WKSP              Access mode:  READ
      5.  Workspace name : VR_VEHICLES_WKSP           Access mode:  READ
```

```
   The following is a list of 9 workspaces referenced by this task -

      1.  Workspace name : ACMS$PROCESSING_STATUS      Workspace index : 18
          Access type    : UPDATE NO LOCK
          .
          .
          .
   000
-------------------------------------------------------------------------------
   000     Step name: $TASK             Step type: BLOCK
   000
-------------------------------------------------------------------------------
   000 BLOCK STEP CHARACTERISTICS -
   000     Server context   : RETAINED
   000     I/O method       : REQUEST
   000     Recovery unit    : NOT ACTIVE
   000     Transaction state: STARTING



   000 BLOCK WORK -
   001
-------------------------------------------------------------------------
❹ 001         Step name : PERFORM
   001
-------------------------------------------------------------------------
   001     STEP CHARACTERISTICS -

   001         Step type        : PROCESSING     Step index    : 0
          .
          .
          .
   001     STEP WORK -

   001     1.  Conditional      : YES
          .
          .
          .
   001         Processing server: VR_UPDATE_SERVER             Server index : 1
   001             The procedure vector index in the server image is 3
   001         2 workspaces passed to the server -
   001             Wksp. name: VR_RESERVATIONS_WKSP            Wksp. index: 5
   001             Wksp. size: 140
   001             Wksp. name: VR_VEHICLES_WKSP                Wksp. index: 7
   001             Wksp. size: 71

❺ 001     STEP ACTION -

   001     1.  Conditional      : YES
   001         Comparison type  : EQUAL
   001         Data type        : TEXT STRING
   001         Source field information -
   001             Source type  : WORKSPACE FIELD
   001             Wksp. name   : ACMS$PROCESSING_STATUS
              .
              .
              .
   001         Recovery action  : NO RECOVERY ACTION
   001         Transaction action: NO TRANSACTION ACTION
   001         Context action   : RETAIN SERVER CONTEXT IF ACTIVE
   001         Sequencing action: RAISE EXCEPTION
   001             Returning    : A MESSAGE NUMBER
```

```
001             Message no.  : 08018122
              .
              .
              .
001             Error message will be put into the following workspace :
001                 Wksp. name   : VR_CONTROL_WKSP
001                 Wksp. index  : 0
001                 Field offset : 11
001                 Field size   : 80
001          Move Action      : NONE SPECIFIED
 .
 .
 .
```

Following are explanations of how you can use a task group dump file to help you in debugging a task. The numbers correspond to those in *Example 7.2, "Sample Task Group Dump File"*.

❶ Use the task group name when you start the ACMS Task Debugger:

```
$ ACMS/DEBUG VR_TASK_GROUP/WORKSPACE
```

❷ Use the server name to start the server in ADU:

```
ADU> START VR_UPDATE_SERVER
```

❸ Use the task name to select the task:

```
ADU> SELECT VR_COMPLETE_CHECKOUT_TASK
```

❹ Use the task name, the step name, and $BEGIN to set a breakpoint at the beginning of a task:

```
ACMSDBG> SET BREAK VR_COMPLETE_CHECKOUT_TASK  PERFORM  $BEGIN
```

❺ Use the task name, step name, and $ACTION to set a breakpoint at the action part of a step:

```
ACMSDBG> SET BREAK VR_COMPLETE_CHECKOUT_TASK  PERFORM  $ACTION
```

7.3.4.3. Debugging a Task Called by Another Task

When debugging a task that is called by another task (parent task), use the **SET BREAK** command to pause execution of the called task just as you do when you debug any ACMS task. If you do not define breakpoints in the called task, then the task runs to completion and returns control to the parent task.

If you use a **STEP** command at the point in the parent task where the parent task calls another task, the Task Debugger steps *into* the called task. Then use the **STEP** command to execute one exchange or processing step at a time. The Task Debugger executes one step in the called task for each **STEP** command issued.

To avoid stepping all the way through the called task, set a breakpoint at the end of the called task to have it run to completion without pausing at each exchange or processing step:

```
ACMSDBG> SET BREAK called_task$END
ACMSDBG> GO
```

The commands in this example cause the Task Debugger to execute all the steps in the task CALLED_TASK without waiting for you to issue the **STEP** command. After reaching the breakpoint at the end of the called task, enter the **STEP** command to have the Task Debugger resume stepping through the parent task.

7.3.4.4. Removing Breakpoints

You can remove breakpoints at any time during a debugging session with the **CANCEL BREAK** command. For example:

```
ACMSDBG> CANCEL BREAK VR_RESERVE_CAR_TASK$BEGIN
```

To remove all breakpoints in a task or in all tasks for the task group that you are debugging, use the **/ALL** qualifier. For example:

```
ACMSDBG> CANCEL BREAK /ALL=VR_RESERVE_CAR_TASK
```

This command removes all breakpoints in VR_RESERVE_CAR_TASK. If you do not include a task name in the **/ALL** qualifier, the command removes all breakpoints in all tasks.

7.3.5. Running a Task in the ACMS Task Debugger

To start a task you want to run, use the **SELECT** command. For example:

```
ACMSDBG> SELECT VR_RESERVE_CAR_TASK
```

The name you use in the **SELECT** command must be the name of the task in the task definition. For example:

```
REPLACE GROUP VR_TASK_GROUP
  .
  .
  .
   TASKS ARE
     RESERVE_CAR   :    TASK IS VR_RESERVE_CAR_TASK;
```

If a task uses information entered as part of the selection string, you can include this information as part of the **SELECT** command. For example:

```
ACMSDBG> SELECT DISPLAY_EMPLOYEE JONES
```

In this example, the Display Employee task expects an employee name to be passed to it in the ACMS$SELECTION_STRING workspace. If you enter a name after the task name, ACMS moves the name into the ACMS$SELECTION_STRING workspace and passes it to the task. For further explanation of the use of selection strings, see *VSI ACMS for OpenVMS Writing Applications* [https://docs.vmssoftware.com/vsi-acms-writing-apps/].

When you use the **SELECT** command, select only one task at a time. If you have selected a task and it is still running, use the **CANCEL TASK** command to stop the current task before starting another one:

```
ACMSDBG> CANCEL TASK
```

The **CANCEL TASK** command does not take any parameters or qualifiers. It always stops the current task, if there is one. If the task has context in a server when it is canceled, and if there is a cancel procedure defined for the server, the cancel procedure runs. If there is a cancel action defined for the task, that action is performed after the server cancel procedure, if any, runs.

When you select a task, the ACMS Task Debugger starts the task. Once the task reaches the first breakpoint, you can enter commands to continue running the task, display the contents of workspaces, change the contents of workspaces, or display information about ACMS Task Debugger commands.

7.3.6. Checking Values in Workspaces

You can use both the ACMS Task Debugger and the OpenVMS Debugger to check values in workspaces.

Use the ACMS Task Debugger to check the following workspace values:

- Initial values
- Entered values
- Values in ACMS$PROCESSING_STATUS

The following sections explain how to check the workspace values listed above.

7.3.6.1. Checking Initial Values

Use the **EXAMINE** command to check the initial value of a workspace field. For example:

```
ACMSDBG> EXAMINE CHECKOUT_SITE_ID OF VR_VEHICLE_RENTAL_HISTORY_WKSP
CHECKOUT_SITE_ID of VR_CHECKIN_TASK\VR_VEHICLE_RENTAL_HISTORY_WKSP:   0
```

In this example, the initial value of the CHECKOUT_SITE_ID field is 0.

You can also examine the initial contents of an entire workspace. For example:

```
ACMSDBG> EXAMINE VR_VEHICLE_RENTAL_HISTORY_WKSP
VR_CHECKIN_TASK\VR_VEHICLE_RENTAL_HISTORY_WKSP
VEHICLE_ID: +0
CHECKOUT_SITE_ID:   +0
RESERVATION_ID:     +0
          .
          .
          .
```

To continue running the task after you check an initial workspace value, enter **GO** after the ACMSDBG> prompt. The **GO** command tells the Task Debugger to run the task until it reaches the next breakpoint.

7.3.6.2. Checking Entered Values

As you debug a task, exchange and processing steps store new data in workspace fields. At breakpoints in the task, you can use the **EXAMINE** command to examine the contents of workspaces to determine whether the task is functioning correctly. For example:

```
ACMSDBG> EXAMINE CHECKOUT_SITE_ID OF VR_VEHICLE_RENTAL_HISTORY_WKSP
CHECKOUT_SITE_ID of VR_CHECKIN_TASK\VR_VEHICLE_RENTAL_HISTORY_WKSP:   1
```

You can also examine the contents of an entire workspace. For example:

```
ACMSDBG> EXAMINE VR_VEHICLE_RENTAL_HISTORY_WKSP
VR_CHECKIN_TASK\VR_VEHICLE_RENTAL_HISTORY_WKSP
VEHICLE_ID: +2
CHECKOUT_SITE_ID:   +1
RESERVATION_ID:     +26
          .
          .
          .
```

In this example, reservation 26 was correctly retrieved from the VEHICLE_RENTAL_HISTORY relation in the AVERTZ database. In this case, the car was rented from site number 1.

While debugging a task, you might find that a workspace does not contain the data you expect. When you encounter such a problem, check that:

- The order of the workspaces in the form definition and step procedures is the same as the order specified in the task definition.
- The workspace definition is the same in the form definitions, the step procedures, and the task definition; if you have modified a workspace definition, be sure to rebuild all the components that reference the workspace.
- The forms used by the task correctly return the necessary data in a RECEIVE or TRANSCEIVE operation.
- The step procedures called by the task read the correct records from a database or a file.

7.3.6.3. Checking Values in the ACMS$PROCESSING_STATUS Workspace

You can check the contents of the ACMS$PROCESSING_STATUS workspace by using the **EXAMINE** command. Using the **EXAMINE** command, you can make sure that the workspace message field contains the correct message and that the correct error codes are loaded into ACMS$T_STATUS_TYPE.

You can use the **EXAMINE** command to check that a procedure did what was expected. For example, if a read was successful, a workspace should contain a value, and the ACMS$T_SEVERITY_LEVEL field of the system workspace should contain the value S, showing that the process was successful:

```
ACMSDBG> EXAMINE ACMS$T_SEVERITY_LEVEL
ACMS$T_SEVERITY_LEVEL OF VR_RESERVE_CAR_TASK:  S
```

For a detailed discussion of the ACMS$PROCESSING_STATUS workspace, see *VSI ACMS for OpenVMS Writing Applications* [https://docs.vmssoftware.com/vsi-acms-writing-apps/].

7.3.7. Debugging Transaction Timeout Code

In an ACMS application definition, you can specify a time limit within which a distributed transaction must complete. If the transaction does not end within the specified number of seconds, ACMS rolls back the transaction.

You can use the following commands to test that a task handles transaction timeout errors correctly:

- **SET TRANSACTION_TIMEOUT** ***seconds***

  After you set a transaction timeout limit using this command, ACMS raises a transaction exception if a transaction does not complete in the specified amount of time.

- **CANCEL TRANSACTION_TIMEOUT**

  When you have finished testing the task definition logic to handle transaction timeouts, you can use this command to cancel the transaction timeout period you set previously.

- **SHOW TRANSACTION_TIMEOUT**

  You can use this command to determine the current transaction timeout value.

By default, there is no transaction time limit. *Chapter 10, "ACMS Task Debugger Commands"* contains reference information about these commands.

7.3.8. Stopping the Task Debugger

Use the **EXIT** command or **Ctrl/Z** at the ACMSDBG> prompt to exit the Task Debugger and return to the DCL command-level prompt:

```
ACMSDBG> EXIT
$
```

If you exit the Task Debugger while server processes are still active, these servers are stopped. If the server has a termination procedure defined for it, the termination procedure is executed.

If there is some reason that you do not want the server's termination procedure to run, you can set a breakpoint at the termination procedure. When you reach the breakpoint, use the **EXIT** command at the OpenVMS Debugger prompt to cause the server process to exit without executing the termination procedure.

7.4. Using the OpenVMS Debugger

Section 7.3, "Using the ACMS Task Debugger" explains how to use the ACMS Task Debugger to debug the steps in a task. This section explains how to use the OpenVMS Debugger to debug server procedures. Transfer control to the OpenVMS Debugger in a server process in one of the following ways:

- Start a server.

  When a server is started, the server comes up under the control of the OpenVMS Debugger. See *Section 7.3.3.1, "Starting Servers"* for information on starting servers.

- Issue the **INTERRUPT** command.

  When the server is already started, you can use the ACMS Task Debugger **INTERRUPT** command to transfer control to the OpenVMS Debugger in the server. See *Section 7.3.3.3, "Interrupting Servers "* for details.

- Set a breakpoint in the procedure code.

  If you set a breakpoint in your procedure code at a time when the server is under the control of the OpenVMS Debugger, you return to the server when you reach this breakpoint.

Once you display the DBG> prompt, you can debug your procedure as you debug procedures in any standalone program. You can enter any of the OpenVMS Debugger commands that are valid for the language used. There are, however, situations in which the OpenVMS Debugger behaves differently when you use it in an ACMS environment.

Following are details that are specific to using the OpenVMS Debugger in an ACMS environment:

- Using **SET BREAK/EXCEPTION**

  You might want to use the **SET BREAK/EXCEPTION** command so that the debugger stops the program at any line where an error occurs. However, be sure to cancel the exception break before canceling a task. Otherwise, a breakpoint occurs in the ACMS code controlling the server process, with confusing messages from the Task Debugger.

- Using **SET WATCH** and defining symbols

  Because workspace addresses can change during a task, be careful when using the OpenVMS Debugger **SET WATCH** command. When you use **SET WATCH**, the debugger sets a watchpoint at a location in the workspace to watch an entity and to notify you if the value changes. Because the workspace can be in a different location for each task instance, the field you look at might be in a different location each time, and you might never get a watchpoint.

  A task can exit from a server process and later use the same server again with different workspace addresses. When a task reenters a server process, redefine symbols and reset watchpoints. Also, changing the contents of a workspace from the ACMSDBG> prompt when the task is not using the server, or when it is using a different server, does not trigger a watchpoint set in the server.

For more information on how to set, display, and change breakpoints, see the *VSI OpenVMS Debugger Manual* [https://docs.vmssoftware.com/vsi-openvms-debugger-manual/]. For features specific to a language, see the user's guide for that language.

7.5. Returning to the ACMSDBG> Prompt

In the process of debugging a task definition and server procedures, you might want to use an ACMS Task Debugger command, but you cannot because you are not at the ACMSDBG> prompt. Following are situations in which you might want to display the ACMSDBG> prompt:

- As you step through server code, you decide that you want to set a breakpoint in your task.

  You must transfer control to the ACMS Task Debugger to set your task breakpoint.

- As you step through a task, you might want to interrupt a server to set a breakpoint.

  Once you set your breakpoint, you need to return control to the ACMS Task Debugger to continue stepping through the task.

- Your server is in an infinite loop.

  You need to transfer control to the ACMS Task Debugger so that you can use the **INTERRUPT SERVER** command to get control of your server. Once you finish with your server code, you might need to return control to the ACMS Task Debugger again to cancel the task.

Use **Ctrl/G** to display the ACMDBG> prompt in all of these situations.

Note

In versions of ACMS prior to Version 3.2, you use **Ctrl/C** to display the ACMSDBG> prompt.

7.6. Debugging Tasks Called from a User-Written Agent Program

Users who have written their own command process, called an **agent program**, must not only debug their ACMS task definitions and the high-level language step procedures called from the task definition, but also debug the flow of control between an agent program and an ACMS task.

When you debug a conventional ACMS task, the task and the task submitter both execute in the same Task Debugger process, and you have your choice of debugging using one or two terminals. However,

when you debug a task called by a user-written agent program, you must debug both the task and the agent program at the same time. Because an additional process is running, you must allocate a terminal to each process. One process runs the agent program, whose only job is to select ACMS tasks. The other process runs the ACMS Task Debugger and performs the usual debugging functions, including:

- Starting and stopping servers
- Setting breakpoints
- Examining and depositing data in workspaces
- Assigning logical names for servers
- Executing tasks

These task debugging functions are described in *Section 7.2.5, "Setting Up for Debugging with Two Terminals"* and *Section 7.3, "Using the ACMS Task Debugger"*.

Important

The agent program and the ACMS Task Debugger must run on the same node.

The processes running the agent program and the Task Debugger require special consideration during debugging. Before debugging, set up so that the agent program selects the task in the ACMS Task Debugger rather than in an ACMS application. Follow these steps to debug tasks that are submitted by agent programs:

1. Use the ACMS$SIGN_IN service in the agent program.

   Do not use the default submitter when debugging tasks submitted by agent programs. The agent program must execute the ACMS$SIGN_IN service to obtain a submitter ID.

2. Set protection for remote terminals.

   Set WORLD protection for remote terminals to read/write access. Check the protection set for remote terminals using the DCL **SHOW DEVICE** command:

   ```
   $ SHOW DEV/FULL TT
   ```

   If the terminal does not have WORLD:RW protection, then set the appropriate protection. For example:

   ```
   $ SET PROT=W:RW/DEV TT
   ```

3. Check quotas, parameters, and logical names.

   Make sure that system quotas and parameters are set using the values specified in *Section 7.2.6, "Verifying that the ACMS Task Debugger Can Be Run"*. Also, make sure that any logical names used by the ACMS Task Debugger are defined. See *Section 7.2.3, "Defining Logical Names"*.

4. Start the ACMS Task Debugger.

   Use the **ACMS/DEBUG** command to start the ACMS Task Debugger. With the command, include the **/AGENT_HANDLE** qualifier and a handle name (for the agent program) that is unique to the system on which you are debugging the task.

The handle name must be a maximum of 39 characters. To ensure that the agent handle name is unique to the system, you can choose to include the PID of the task debugger or the user name of the person doing the debugging in the **/AGENT_HANDLE** name.

The following example shows how to start the Task Debugger using an agent handle named VR_26200E49 and a task group database called VR_TASK_GROUP:

```
$ ACMS/DEBUG/AGENT_HANDLE=VR_26200E49 VR_TASK_GROUP
ACMSDBG>
```

When you start the Task Debugger and include the **/AGENT_HANDLE** qualifier, you can select tasks from within the Task Debugger as well as submitting calls to ACMS tasks from an agent program. Select or submit only one task at a time.

You can run more than one agent program consecutively or simultaneously with the Task Debugger, but only one agent program can select a task at one time. Also, you cannot use the ACMS Task Debugger **CANCEL TASK** command to cancel tasks that are called by agent programs.

5. Set up the ACMS Task Debugger environment.

   After you start the ACMS Task Debugger, it returns its ACMSDBG> prompt. You can then start servers (described in *Section 7.3.3, "Starting, Stopping, and Interrupting Servers"*) and define the debugging environment to include items such as breakpoints (described in *Section 7.3.4, "Setting and Removing Breakpoints in a Task"*).

6. Accept calls to ACMS tasks from agent programs.

   Use the ACMS Task Debugger **ACCEPT** command to have the ACMS Task Debugger accept calls from the agent program:

   ```
   ACMSDBG> ACCEPT
   ```

   After this command, the ACMS Task Debugger waits until the agent program selects a task. After the agent program selects a task, the task executes in the ACMS Task Debugger. *Chapter 10, "ACMS Task Debugger Commands"* describes all the ACMS Task Debugger commands.

   You can use **Ctrl/G** to return to the ACMSDBG> prompt to set more breakpoints, for example, or to exit from the debugger. To resume waiting for the task call, enter the **GO** command.

   The **ACCEPT** command accepts one task selection at a time from an agent program. To allow the ACMS Task Debugger to accept subsequent calls to tasks without reentering the **ACCEPT** command for each task selection, use the **/CONTINUOUS** qualifier on the **ACCEPT** command:

   ```
   ACMSDBG> ACCEPT/CONTINUOUS
   ```

   This allows the ACMS Task Debugger to accept task selections from an agent program without entering the **ACCEPT** command at the agent program's terminal each time.

7. Define logical names for the application names used in the agent program.

   To make tasks selected by the agent program run in the Task Debugger, define two process logical names before running the agent program.

   - Define the logical name ACMS$DEBUG_AGENT_TASK to be either TRUE (T or t), YES (Y or y), or an ASCII number with an odd value:

```
$ DEFINE ACMS$DEBUG_AGENT_TASK Y
```

- Assign a logical name for the application name used in the agent program. The agent program code contains actual application and task names that are defined in the application definition. However, because the agent program selects tasks in the ACMS Task Debugger, you can use logical names (rather than changing the names in the agent program) to associate the application name used in the agent program and the handle name for the debugger. The following example illustrates how to define the application name as a logical name that equates to the agent handle that you specified when you started the Task Debugger.

  ```
  $ DEFINE VR_APPL VR_26200E49
  ```

  In this case, VR_APPL is the application name used in the agent program, and VR_26200E49 is the agent handle name included on the **ACMS/DEBUG** command when the debugger was started (see the example in step 4).

  The logical name is optional; if the application name is not defined as a logical name, then the application name in the agent program is used as the **/AGENT_HANDLE** name. If the agent program cannot find a Task Debugger process with the appropriate handle name, the agent program returns an ACMS-E-SRVNOTFOUND error.

8. Do any preparation work necessary for DECforms.

   Because DECforms runs in the agent process, do all DECforms setup in the agent process. *Section 7.2.4, "Preparing to Debug DECforms Escape Routines"* contains instructions for preparing to debug DECforms escape routines.

9. Run the agent program.

   Remember that the agent program can select tasks in only one application. If the agent program's ACMS$GET_PROCEDURE_INFO service selects a task from a second application, the ACMS Task Debugger returns the ACMS-E-DBGMULTIPKGS error message.

Chapter 8. Debugging an Application in an ACMS Run-Time Environment

After debugging the tasks in a task group, you include the task group in an application definition and make the tasks available from a menu. Then you need to test the application as a single, working unit before releasing it for use in the ACMS run-time environment.

Because the ACMS Task Debugger runs in a different environment from an ACMS application, even the best-designed and best-developed application can encounter problems during the transition from one environment to another. To help you overcome this potential problem, ACMS allows you to debug servers executing in an active ACMS application. You can also request an OpenVMS process dump for a server that aborts execution due to system or programming errors and then analyze the output from the dump file.

Sections in this chapter explain the following:

- Moving to an ACMS run-time environment
- Checking files that you need to run tasks under ACMS
- Debugging procedure servers in a run-time environment
- Determining why a server stops unexpectedly

8.1. Moving from Debugging to a Run-Time Environment

When you make the transition from testing a task running under the ACMS Task Debugger to running the task in the ACMS run-time environment, check that logical names, server quotas and privileges, and file or database protections are set adequately for the run-time environment.

Avoid run-time problems by ensuring that:

- Logical names that were available to the server subprocess running under the ACMS Task Debugger are available to the ACMS run-time server process.

  The server runs as a subprocess under the ACMS Task Debugger, but it runs as a detached process under the ACMS run-time environment. Therefore, logical names that were available to the server through logical name tables when it runs as a subprocess may not be available to the server when it runs as a detached process.

  The Application Execution Controller and servers can run under user names different from each other and different from the one you used while debugging the task group. Because of this, determine the best way to define the logical names so that all processes that need them have access to them. You can define them:

  - As system logical names

  - In a logical name table to which the server and application have access
  - As server logical names in the application definition for the server

- Server quotas and privileges are adequate for the operations that the run-time server performs.

  As discussed previously, the ACMS run-time server may run under a different user name than in the ACMS Task Debugger. Therefore, an operation that was performed successfully under the ACMS Task Debugger may not work at run time. This happens if the server user name does not have the quotas or privileges (if any) required for the operation.

  If the user names are different, the quotas may be insufficient. Make sure that the quotas of the user name in the run-time environment are high enough.

- Protection on files and databases allow access by the run-time server.

  If the run-time server uses a different user name than the server that it ran under in the ACMS Task Debugger, files and databases that can be read and written to during debugging may not be available at run time.

- Servers that perform terminal I/O during processing steps must explicitly open and close the terminal channel.

  During debugging, the ACMS Task Debugger always makes the terminal available to the server subprocess. Therefore, procedures that successfully do terminal I/O during processing steps under the ACMS Task Debugger may not work when they are run under the ACMS run-time system. The task definition must explicitly make the terminal available to the server using the TERMINAL I/O phrase.

- Logical names that translate to specific devices or files under the ACMS Task Debugger must translate to the appropriate devices or files when used during run time with the ACMS Application Execution Controller.

  When a task uses logical names to determine which of several files or devices to access, take care that the logical names translate to the file or device you intend to access. Under the ACMS Task Debugger, for example, if you want to print or generate a hard copy of a DECforms form, the form listing goes to the device pointed to by the programmer's translation of the FORMS$PRINT_FILE logical name. Tasks running under the ACMS run-time environment, however, send their output to the device pointed to by the agent process's translation of the FORMS$PRINT_FILE logical name (for example, the CP process).

  In addition, if the task is accessed remotely (such as when the submitter and the application are on different nodes), the output goes to the device pointed to by the remote agent process's translation of FORMS$PRINT_FILE (for example, the CP process).

- Step procedures that open channels to the terminal must close them before ending.

  In the run-time environment, if a step procedure opens a channel to the terminal but returns without closing it, ACMS cancels the task. However, ACMS cannot do this when you are using the Task Debugger because open channels could be due to debugging. Therefore, if you do not correctly close all channels to the terminal that you open in a step procedure, the task works in the Task Debugger but will be canceled at run time.

8.2. Checking Files Needed to Run Tasks Under ACMS

A task under the control of ACMS at run time uses all the files needed to run the task under the ACMS Task Debugger plus two additional files, the application database (.ADB) and the menu database (.MDB):

- Application database

  You create application database files with the ADU command **BUILD APPLICATION**. These files contain information used by ACMS in running tasks.

- Menu database

  You create menu database files when you use the ADU command **BUILD MENU**. These files contain binary versions of menu definitions.

For a list of the files you need when you use the ACMS Task Debugger, see *Table 7.1, "Files Needed for Debugging"* and *Figure 7.1, "Files Needed for Debugging"*.

8.3. Debugging Procedure Servers in the Run-Time Environment

Even though a task executes successfully in the ACMS Task Debugger environment, it may contain errors that do not show up until the task runs in a server in the ACMS run-time environment. For example, the server may go into an infinite loop, give incorrect output, or terminate prematurely.

ACMS provides the **ACMS/DEBUG/SERVER** operator command so that you can debug servers as they execute in the ACMS run-time environment. Using this command, you can observe the server process execution through the OpenVMS Debugger. This feature provides a way for you to use OpenVMS Debugger commands to locate run-time programming or logic errors and other bugs. If a server is looping, for example, you can step through a procedure and isolate bugs in the live server just as though the server were running in the ACMS Task Debugger.

Once you have identified and corrected an error in a server, ACMS also provides the **ACMS/REPLACE SERVER** operator command to replace the faulty server without interrupting the live application.

The following sections describe how to debug running servers. *Section 8.3.2, "Using the ACMS/DEBUG/SERVER Command"* describes the **ACMS/DEBUG/SERVER** command. *VSI ACMS for OpenVMS Managing Applications* [https://docs.vmssoftware.com/vsi-acms-managing-applications/] describes the syntax for the **ACMS/REPLACE SERVER** operator commands.

Note

Use **ACMS/DEBUG/SERVER** to debug only procedure servers. Do not use this command to debug DCL servers.

8.3.1. Controlling Which Users Can Debug Servers

Because the **ACMS/DEBUG/SERVER** command allows users to stop a server or change the way it operates, you must provide a means of controlling which users can debug servers. You provide

this security by using logical names. For each user who can debug servers, define the logical name ACMS$DEBUG_SERVER_*vmsusername* as either TRUE or YES.

Note

The logical name ACMS$DEBUG_SERVER_*vmsusername* must be an executive mode logical.

The following example shows how to define an executive mode logical name to allow the user SMITH to debug any server on the system:

```
$ DEFINE/SYSTEM/EXEC ACMS$DEBUG_SERVER_SMITH YES
```

This example uses the **/SYSTEM** qualifier to define the logical name as a system logical so that the user named SMITH can debug any server on the system.

Define the ACMS$DEBUG_SERVER_*vmsusername* logical at DCL level as shown in the previous example, using the **/SYSTEM**, **/GROUP**, or **/TABLE** qualifier. A user can debug any server on the system if ACMS$DEBUG_SERVER_*vmsusername* is defined as an executive mode system logical.

By using the **/GROUP** qualifier, you can restrict users to debugging only servers in a particular group. You can also define the logical in a server logical name table and point to it from the ACMS application definition. Use the **/TABLE** qualifier on the **DEFINE ACMS$DEBUG_SERVER_*vmsusername*** command if you define the logical in a server logical name table.

You do not need to define the ACMS$DEBUG_SERVER_*vmsusername* logical if the user has the CMKRNL privilege. ACMS allows any user with the CMKRNL privilege to debug any server.

Although you can authorize several users to debug a server or servers, only one user can debug a server at a time.

8.3.2. Using the ACMS/DEBUG/SERVER Command

To debug a running server, you must link the server to include traceback information. This is required for the OpenVMS Debugger to interrupt the server. By default, the OpenVMS Linker links images with traceback. If the server was linked without traceback (that is, the **/NOTRACEBACK** qualifier was used on the **LINK** command), you must relink the server before you can debug it. Then you must replace the server in the running application before continuing.

If the server is linked with **/TRACEBACK** (the default), and you have either defined the ACMS$DEBUG_SERVER_*vmsusername* logical name or provided the CMKRNL privilege for the users who can debug the server, follow these steps to debug the server:

1. Use the **ACMS/SHOW SERVER** command to get the server process name and process identification (PID). Use the process name or the server's PID when you start debugging the server.

2. Invoke the debugger by issuing the **ACMS/DEBUG/SERVER** command, including either the server process name or the process ID. The following example starts the debugger for VR_SERVER, whose server process name is ACMS021SP001000:

   ```
   $ ACMS/DEBUG/SERVER ACMS021SP001000
   DBG>
   ```

   Include the PID number with this command by specifying the PID number with the **/PID=*PID_number*** qualifier. For example:

```
$ ACMS/DEBUG/PID=26000049
DBG>
```

3. Issue OpenVMS Debugger commands to debug the server code.

   See *VSI OpenVMS Debugger Manual* [https://docs.vmssoftware.com/vsi-openvms-debugger-manual/] for more information on using the OpenVMS Debugger commands.

4. Press **Ctrl/G** while debugging a server to interrupt the server and return control to the OpenVMS Debugger.

   Using **Ctrl/G** is a handy way to interrupt the debugger, if you forgot to set a breakpoint and want to do it before continuing, for example. Use the **GO** command or **STEP** command to continue debugging the server.

5. Use **Ctrl/Z** or the **EXIT** command to stop the debugging session from the DBG> prompt. When you complete a debugging session, you stop the server that you are debugging.

8.3.3. Replacing a Faulty Server

After you find an error in a server, you need to complete several steps to correct the situation:

1. Correct the code.

2. Rebuild the server image.

3. Place the server image in the location specified in the SERVER IMAGE IS statement in the task group definition.

4. Use the **ACMS/REPLACE SERVER** operator command to run down the server processes that are executing the faulty server code and create new processes running the corrected image. You can do this without interrupting the live application. For example:

   ```
   $ ACMS/REPLACE SERVER VR_SERVER /CONFIRM
   ```

If a task has context in a server that you are replacing at the time the **REPLACE** command is issued, the server does not run down until context is released.

You must have OPER privilege to issue the **ACMS/REPLACE SERVER** command. *VSI ACMS for OpenVMS Managing Applications* [https://docs.vmssoftware.com/vsi-acms-managing-applications/] contains more information on replacing servers in a live application.

8.4. Determining Why Servers Stop Unexpectedly

Sometimes servers executing in a production environment stop unexpectedly. If you suspect that the server stopped as a result of system errors or errors in the step procedure, you need a way to trace the location of the error.

You can request ACMS to generate an OpenVMS process dump if a server stops unexpectedly. This produces a dump file that contains the context of the process when the server stopped. You can then analyze the contents of the dump file for clues as to why the server stopped.

To get a server process dump, you can include the SERVER PROCESS DUMP clause in the ACMS application definition or use the **ACMS/MODIFY APPLICATION** command. These two methods are explained in the next section.

8.4.1. Collecting Server Information in a Dump File

The following occurrences can cause a server to stop executing while running in an application:

- The initialization procedure, termination procedure, or a step procedure signals a FATAL (F) error.
- The initialization procedure returns a bad status with a severity level of FATAL (F), ERROR (E), or WARNING (W).
- Channels to the terminal are left open after the procedure returns control to the task definition.

If you have problems with a particular server, set up the server to provide server process dumps. Then run the task and try to reproduce the situation that causes the server to stop, so that ACMS generates a dump file for analyzing the problem.

First, enable or disable server process dumps in the application definition by using the SERVER PROCESS DUMP clause. You can enable server process dumps in the running application by using the **ACMS/MODIFY APPLICATION** operator command in an active application. This command temporarily modifies the application definition parameters for the current active application. If you stop and restart the application, the application parameters are reset to their original values.

VSI ACMS for OpenVMS Managing Applications [https://docs.vmssoftware.com/vsi-acms-managing-applications/] describes the **ACMS/MODIFY APPLICATION** command and its qualifiers.

Another method of enabling server process dumps is to stop the application, replace the application definition with one that includes the SERVER PROCESS DUMP clause, rebuild the application, and then restart the application. This method permanently enables server process dumps for the server in the application definition.

Example 8.1, "Using the SERVER PROCESS DUMP Clause in an Application Definition" shows an application definition that specifies server process dumps.

Example 8.1. Using the SERVER PROCESS DUMP Clause in an Application Definition

```
.
.
.
SERVER ATTRIBUTES ARE
  UPDATE_SERVER:
    SERVER PROCESS DUMP;
END SERVER ATTRIBUTES;
.
.
.
```

When the server terminates abnormally, ACMS writes the context for the server to a dump file located in the default directory for the server. The dump file has the same name as the server. At the same time that ACMS generates the dump file, it also writes a record to the ACMS audit trail log.

If, for some reason, ACMS is unable to generate a server process dump, ACMS writes an audit record to explain the failure. For example, there may be insufficient privileges for ACMS to write the dump file to the server's default directory.

See *VSI ACMS for OpenVMS ADU Reference Manual* [https://docs.vmssoftware.com/vsi-acms-adu-ref-manual/] for more information about including the server process dump qualifier in an application definition.

8.4.2. Analyzing Server Process Dumps

You use the DCL command **ANALYZE/PROCESS_DUMP** to analyze the contents of a server process dump file. For example:

```
$ ANALYZE/PROCESS_DUMP/IMAGE=avertz_default:vr_update_server_.exe -
_$ vr_update_server.dmp
```

In some cases, the **ANALYZE/PROCESS_DUMP** returns an error if the server process dump file and procedure server image are not located in the same directory. If you encounter this problem, simply copy the procedure server image to the same directory as the server process dump file, and reissue the **ANALYZE/PROCESS_DUMP** command. For example:

```
$ ANALYZE/PROCESS_DUMP/IMAGE=vr_update_server_.exe -
_$ vr_update_server.dmp
```

Be sure the dump file allows read (R) access before invoking the analyzer. For a complete description of the debugger, see *VSI OpenVMS Debugger Manual* [https://docs.vmssoftware.com/vsi-openvms-debugger-manual/]. *VSI OpenVMS DCL Dictionary* [https://docs.vmssoftware.com/vsi-openvms-dcl-dictionary-a-m/] discusses using the **ANALYZE/PROCESS_DUMP** DCL command.

Part II. Reference Material

This part of the manual contains reference materials on writing procedures and debugging ACMS tasks and procedures: ACMS programming services and ACMS Task Debugger commands.

Chapter 9. ACMS Programming Services

This chapter contains reference material for the programming services supplied by ACMS. *Table 9.1, "Summary of the ACMS Programming Services"* summarizes these services. The sections following the table list the services and provide detailed information about how to use each service.

ACMS queuing services are discussed in *VSI ACMS for OpenVMS Writing Applications* [https://docs.vmssoftware.com/vsi-acms-writing-apps/].

Table 9.1. Summary of the ACMS Programming Services

Service	Description
ACMS$GET_TID	Used by a server procedure to obtain the transaction ID currently associated with an executing task.
ACMS$RAISE_NONREC_EXCEPTION	Raises a nonrecoverable exception. This service is called if a step procedure detects an error from which it cannot recover. ACMS cancels the task when a step procedure raises a nonrecoverable exception.
ACMS$RAISE_STEP_EXCEPTION	Raises a step exception. This service is called if a step procedure detects an error from which it cannot recover, but which the task definition may be able to handle.
ACMS$RAISE_TRANS_EXCEPTION	Raises a transaction exception. This service is called if a step procedure detects an error from which it cannot recover, but which the task definition may be able to handle.

Note

The raise-exception programming services differ in an important way from the superseded ACMSAD$REQ_CANCEL service; if a step procedure calls the ACMSAD$REQ_CANCEL service, the service immediately cancels the current task and does not return control to the step procedure.

In contrast, after storing the appropriate exception information, the raise-exception services all return control to the step procedure. Once the step procedure completes, the exception is raised in the task.

The format descriptions for the services use OpenVMS procedure parameter notation. Each parameter can have four characteristics, represented by two groups of symbols following the parameter. The characteristics definable for each parameter are:

```
<name>.<access type><data type>.<pass mech>
```

The characteristics are always listed in this order. A period (.) separates access and data types from passing mechanism and parameter form. For example:

```
comp_status.wl.r
```

Table 9.2, "Procedure Parameter Notation" defines the symbols used for procedure parameter notation.

Table 9.2. Procedure Parameter Notation

Notation	Symbol	Meaning
Access type	r	Read access only
	w	Write and read access
Data type	l	Longword integer (signed)
	o	Octaword integer (signed)
Passing mechanism	r	By reference

For a complete explanation of all the OpenVMS data structures, data types, access mechanisms and passing mechanisms, see *Guide to Creating OpenVMS Modular Procedures*.

ACMS$GET_TID

ACMS$GET_TID — Used by a server procedure to obtain the transaction ID (TID) currently associated with an executing task.

Format

ACMS$GET_TID (*tid.wo.r*)

Parameter

tid

Address of a 16-byte data structure into which ACMS writes the TID.

Return Status

The ACMS$GET_TID service can return the following status values:

Status	Severity Level	Description
ACMS$_NORMAL	Success	Normal successful completion.
ACMS$_TRANSNOTACT	Error	A distributed transaction is not active at this time.
ACMS$_INSUFPRM	Error	Insufficient number of arguments supplied to this routine. You must specify a TID argument when you call ACMS$GET_TID.
ACMS$_INVNUMARGS	Error	Too many arguments supplied to this service. Check the procedure and remove any extraneous arguments.
ACMS$_NOGETTIDCANPROC	Error	Cannot obtain the transaction ID from a server cancel procedure.
ACMS$_TASKNOTACTGT	Fatal	ACMS$GET_TID service may not be called when no task is active.

Note

This service cannot be called by initialization, termination, or cancel procedures.

Examples

1.
```
IDENTIFICATION DIVISION.
    PROGRAM-ID. VR-COMPLETE-CHECKOUT-PROC.
    ...
    DATA DIVISION.
    ...
    WORKING-STORAGE SECTION.
    *
    * Return status to pass to ACMS
    *
    01 RET-STAT         PIC S9(9) COMP.
    .
    .
    .
    *
    * Declare the global transaction context structure.  This is
    * required for SQLPRE
    *
    EXEC SQL INCLUDE
            'AVERTZ_SOURCE:VR_CONTEXT_STRUCTURE_INCLUDE.LIB'
    END-EXEC.
    .
    .
    .
    PROCEDURE DIVISION USING VR_RESERVATIONS_WKSP,
                             VR_VEHICLES_WKSP
                       GIVING RET-STAT.

    MAIN-PROGRAM.
         CALL "ACMS$GET_TID" USING CS-TID GIVING RET-STAT.
        .
        .
        .
```

In this example from the AVERTZ sample application, the context structure is defined in the library VR_CONTEXT_STRUCTURE_INCLUDE.LIB.CS-TID is one field in that structure:

2.
```
01 CONTEXT-STRUCTURE.
  02 CS-VERSION          PIC S9(9) COMP VALUE 1.
  02 CS-TYPE             PIC S9(9) COMP VALUE 1.
  02 CS-LENGTH           PIC S9(9) COMP VALUE 16.
  02 CS-TID              PIC X(16).
  02 CS-END              PIC S9(9) COMP VALUE 0.
```

ACMS$RAISE_NONREC_EXCEPTION

ACMS$RAISE_NONREC_EXCEPTION — Raises a nonrecoverable exception if a step procedure detects an error from which it cannot recover. ACMS cancels the current task when a nonrecoverable exception is raised.

Format

ACMS$RAISE_NONREC_EXCEPTION ([*exception_code.rl.r*])

Parameter

exception_code

Optional address of a longword containing the exception code.

Return Status

The ACMS$RAISE_NONREC_EXCEPTION service can return the following status values:

Status	Severity Level	Description
ACMS$_NORMAL	Success	Normal successful operation; the nonrecoverable exception is raised and the task is canceled as soon as the step procedure completes.
ACMS$_EXCPTNACTIVE	Error	An exception of the same or higher level has already been raised. The existing exception is raised in the task as soon as the step procedure completes.
ACMS$_INVNONRECEXCCODE	Error	An invalid nonrecoverable exception code was passed to the service. A nonrecoverable exception is raised, and the task is canceled with the ACMS$_INVNONRECEXCCODE failure status as soon as the step procedure completes.
ACMS$_NOEXCPTNCANPROC	Error	Cannot raise an exception from a server cancel procedure.
ACMS$_TSKCANINVARGS	Error	Too many arguments were supplied to this service. A nonrecoverable exception is raised, and the task is canceled with the ACMS$_TSKCANINVARGS failure status as soon as the step procedure completes.
ACMS$_TASKNOTACTNRE	Fatal	ACMS$RAISE_NONREC_EXCEPTION service may not be called when no task is active.

Notes

If an exception code is not supplied, ACMS uses ACMS$_NONRECEXCPTN_PROCSVR; ACMS-E-NONRECEXCPTN_PROCSVR, "Exception resulted from a procedure server calling ACMS $RAISE_NONREC_EXCEPTION." If an exception code is supplied, it must be a failure status.

If an exception code is supplied that is not a failure status, then ACMS cancels the task with a status of ACMSEXC-E-INVNONRECEXCCODE, "Task canceled: invalid exception code passed to ACMS$RAISE_NONREC_EXCEPTION."

ACMS sets the appropriate exception information when this service is called; however, the exception is not raised in the task until the step procedure completes. Therefore, a step procedure should return as soon as possible after calling the ACMS$RAISE_NONREC_EXCEPTION service.

This service cannot be called from a cancel procedure or from an initialization or a termination procedure.

Example

```
IF RET-STAT NOT SUCCESS THEN
        CALL "ACMS$RAISE_NONREC_EXCEPTION" GIVING RSTAT
```

In this example, if the return status is not success, then the procedure raises a nonrecoverable exception in the task.

ACMS$RAISE_STEP_EXCEPTION

ACMS$RAISE_STEP_EXCEPTION — Raises a step exception if a step procedure detects an error from which it cannot recover but which the task definition may be able to handle. When a step procedure raises a step exception, the exception falls under the control of the exception handler defined for the processing step or outer-block step, if one exists.

Format

ACMS$RAISE_STEP_EXCEPTION ([*exception_code.rl.r*])

Parameter

exception_code

Optional address of a longword containing the exception code.

Return Status

The ACMS$RAISE_STEP_EXCEPTION can return the following status values:

Status	Severity Level	Description
ACMS$_NORMAL	Success	Normal successful operation; the step exception is raised in the task as soon as the step procedure completes.
ACMS$_EXCPTNACTIVE	Error	An exception of the same or higher level has already been raised. The existing exception is raised in the task as soon as the step procedure completes.
ACMS$_INVSTPEXCCODE	Error	An invalid step exception code was passed to the service. A nonrecoverable exception is raised, and the task is canceled with the ACMS$_INVSTPEXCCODE failure

Status	Severity Level	Description
		status as soon as the step procedure completes.
ACMS$_NOEXCPTNCANPROC	Error	Cannot raise an exception from a server cancel procedure.
ACMS$_TSKCANINVARGS	Error	Too many arguments were supplied to this service. A nonrecoverable exception has been raised, and the task is canceled with the ACMS$_TSKCANINVARGS failure status as soon as the step procedure completes.
ACMS$_TASKNOTACTSE	Fatal	ACMS$RAISE_STEP_EXCEPTION service may not be called when not task is active.

Notes

If an exception code is not supplied, ACMS uses ACMS$_STPEXCPTN_PROCSVR; ACMS-E-STPEXCPTN_PROCSVR, "Exception resulted from a procedure server calling ACMS$RAISE_STEP_EXCEPTION." If an exception code is supplied, it must be a failure status.

If an exception code is supplied that is not a failure status, then ACMS cancels the task with a status of ACMSEXC-E-INVSTPEXCPTNCODE, "Task canceled: invalid step exception code passed to ACMS$RAISE_STEP_EXCEPTION."

ACMS stores the appropriate exception information when this service is called; however, the exception is not raised in the task until the step procedure completes. Therefore, a step procedure should return as soon as possible after calling the ACMS$RAISE_STEP_EXCEPTION service.

This service cannot be called from a cancel procedure or from an initialization or a termination procedure.

Example

```
SQL-ERROR-HANDLER.
         CALL "ACMS$RAISE_STEP_EXCEPTION" USING
                     BY REFERENCE RET-STAT.
```

In this example, the SQL error handler raises a step exception that is handled in the task.

ACMS$RAISE_TRANS_EXCEPTION

ACMS$RAISE_TRANS_EXCEPTION — Raises a transaction exception if a step procedure detects an error from which it cannot recover but which the task definition may be able to handle. When a step procedure raises a transaction exception, the exception falls under the control of the exception handler defined for the transaction step or outer-block step, if one exists.

Format

ACMS$RAISE_TRANS_EXCEPTION ([*exception_code.rl.r*])

Parameter

exception_code

Optional address of a longword containing the exception code.

Return Status

The ACMS$RAISE_TRANS_EXCEPTION service can return the following status values:

Status	Severity Level	Description
ACMS$_NORMAL	Success	Normal successful operation; the transaction exception is raised in the task as soon as the step procedure completes.
ACMS$_INVTRANSEXCCODE	Error	An invalid transaction exception code was passed to the service. A nonrecoverable exception has been raised, and the task is canceled with the ACMS$_INVTRANSEXCCODE failure status as soon as the step procedure completes.
ACMS$_EXCPTNACTIVE	Error	An exception of the same or higher level has already been raised. The existing exception is raised in the task as soon as the step procedure completes.
ACMS$_NOEXCPTNCANPROC	Error	Cannot raise an exception from a server cancel procedure.
ACMS$_TRANSEXCNOTACT	Error	The ACMS$RAISE_TRANS_EXCEPTION service was called by a step procedure, but a transaction was not active. A nonrecoverable exception has been raised, and the task is canceled with the ACMS$_TRANSEXCNOTACT failure status as soon as the step procedure completes.
ACMS$_TSKCANINVARGS	Error	Too many arguments were supplied to this service. A nonrecoverable exception has been raised, and the task is canceled with the ACMS$_TSKCANINVARGS failure status as soon as the step procedure completes.
ACMS$_TASKNOTACTTE	Fatal	ACMS$RAISE_TRANS_EXCEPTION service may not be called when no task is active.

Notes

If an exception code is not supplied, ACMS uses ACMS$_TRANSEXCPTN_PROCSVR; ACMS-E-TRANSEXCPTN_PROCSVR, "Exception resulted from a procedure server calling ACMS$RAISE_TRANS_EXCEPTION." If an exception code is supplied, it must be a failure status.

If an exception code is supplied that is not a failure status, then ACMS cancels the task with a status of ACMSEXC-E-INVTRANSEXCCODE, "Task canceled: invalid step exception code passed to ACMS$RAISE_TRANS_EXCEPTION."

If a step procedure calls the ACMS$RAISE_TRANS_EXCEPTION service when a transaction is not active, then ACMS cancels the task with a status of ACMS$_TRANSEXCNOTACT; ACMS-E-TRANSEXCNOTACT, "Task canceled: ACMS$RAISE_TRANS_EXCEPTION called when no transaction active."

ACMS sets the appropriate exception information when this service is called; however, the exception is not raised in the task until the step procedure completes. Therefore, a step procedure should return as soon as possible after calling the ACMS$RAISE_TRANS_EXCEPTION service.

This service cannot be called from a cancel procedure or from an initialization or a termination procedure.

Example

```
SQL-ERROR-HANDLER.

         CALL "ACMS$RAISE_TRANS_EXCEPTION" USING
                     BY REFERENCE RDB$LU_STATUS.

 EXIT PROGRAM.
```

The previous example shows how to raise a transaction exception in the error-handling section of a COBOL procedure.

Chapter 10. ACMS Task Debugger Commands

This chapter lists the commands available with the ACMS Task Debugger. You can use these commands to run an ACMS task without starting an application, to control the task, and to examine and change the contents of the workspaces the task uses as it runs.

@ (At sign)

@ (At sign) — Runs the debugger commands contained in the named file. The file can contain any ACMS Task Debugger command, including another at-sign command. When the ACMS Task Debugger reaches an **EXIT** command or the end of the file, it returns control to the terminal or command procedure that issued the at-sign command.

Format

@ ***file-spec***

Parameter

file-spec

The OpenVMS file specification of the command procedure to be run. The default device and directory are your current default device and directory. The default file type is .COM. Do not enclose the file specification in single or double quotation marks.

Notes

The ACMS Task Debugger does not recognize a **SET VERIFY** command. When the command procedure runs, the commands in the file are not displayed on the terminal screen.

Include comments in the command file by preceding them with an exclamation mark (!).

Examples

1. ```
   ACMSDBG> @VRDBG.COM
   ```

   This example shows how to run the command procedure whose file specification is VRDBG.COM; it is in the current default directory. The following example is a command procedure.

2. ```
   ! Command procedure for debugging tasks using the VR_SERVER.
   !
   ASSIGN /SERVER=VR_SERVER SYS$SAMPLE:VRFILE.DAT VR_FILE
   START VR_SERVER
   ```

   In this example, the equivalence name SYS$SAMPLE:VRFILE.DAT is assigned to the process logical name VR_FILE for the server named VR_SERVER. The command file VRDBG.COM specifies this assignment.

ACCEPT

ACCEPT — Accepts calls from an agent program.

Format

ACCEPT [/*qualifier*]

Command Qualifier	Default
/CONTINUOUS	None

Qualifier

/CONTINUOUS

Specifies that the Task Debugger can accept multiple consecutive task selections from agent programs.

Notes

One or more agent programs can call tasks, but the **ACCEPT** command accepts only one task selection at a time. You must type the **ACCEPT** command each time you want the Task Debugger to accept another call from an agent program unless you specify the **/CONTINUOUS** qualifier. The **/CONTINUOUS** qualifier allows the Task Debugger to accept subsequent task calls without entering the **ACCEPT** command each time. After you type the **ACCEPT** or **ACCEPT/CONTINUOUS** command, the Task Debugger waits until the agent program calls a task. Then the task executes in the Task Debugger.

Before the agent program calls a task, use **Ctrl/G** to return to the ACMSDBG> prompt if you want to enter more Task Debugger commands before executing the task. This discontinues the effect of the **/CONTINUOUS** qualifier. To resume waiting for the task call, enter the **GO** command.

Tasks selected by agent programs cannot be canceled using the **CANCEL TASK** command.

Example

```
ACMSDBG> ACCEPT/CONTINUOUS
```

This example allows the Task Debugger to accept consecutive calls to tasks without reentering the **ACCEPT** command for each task selection.

ASSIGN

ASSIGN — Assigns a process logical name for a server.

Format

ASSIGN [/*qualifier*] *equivalence-name logical-name*

Command Qualifier	Default
/SERVER=*server-name*	/SERVER=*current-server*

Parameters

equivalence-name

The OpenVMS file specification or other string assigned to the logical name. The string must conform to the standards for equivalence names, which are explained in *VSI OpenVMS DCL Dictionary* [https://docs.vmssoftware.com/vsi-openvms-dcl-dictionary-a-m/].

logical-name

The 1- to 63-character process logical name assigned. The logical name must conform to the standards for logical names as explained in *VSI OpenVMS DCL Dictionary* [https://docs.vmssoftware.com/vsi-openvms-dcl-dictionary-a-m/].

Qualifier

/SERVER=*server-name*

Names the server for which the logical name is assigned. The server name must be the same as the name used in a Task Debugger **START** command; that is, it must be the name assigned to the server in the task group definition. The default server name is the one named in the most recent **SET SERVER** command.

Note

When ACMS starts a server, it creates the server with all the logical names specified up to that point. Therefore, to assign logical names for a server, assign them before starting the server.

Examples

1. `ACMSDBG> ASSIGN SYS$SAMPLE:VRFILE.DAT VR_FILE`

   In this example, the equivalence name SYS$SAMPLE:VRFILE.DAT is assigned to the process logical name VR_FILE for the current server.

2. `ACMSDBG> ASSIGN /SERVER=VR_SERVER SYS$SAMPLE:VRFILE.DAT VR_FILE`

   In this example, the equivalence name SYS$SAMPLE:VRFILE.DAT is assigned to the process logical name VR_FILE for the server named VR_SERVER.

CANCEL BREAK

CANCEL BREAK — Removes one or more breakpoints from a task or from all tasks.

Format

CANCEL BREAK [/*qualifiers*] [*breakpoint*]

Command Qualifier	Default
/ALL[=*task-name*]	None

Parameter

breakpoint

Names a breakpoint to cancel in the current task. See the entry for the **SET BREAK** command for the format of this parameter.

Qualifier

/ALL

Declares that all breakpoints in all tasks or in one task are to be canceled. If you include an equal sign (=) and task name in the **/ALL** qualifier, the task name must be the name of the task in the task group definition.

Note

You must include either the **/ALL** qualifier or the *breakpoint* parameter in the **CANCEL BREAK** command.

Examples

1. ACMSDBG> **CANCEL BREAK VR_RESERVE_TASK$STEP_1$BEGIN**

   This example shows how to cancel the breakpoint at the beginning of the first step of the Vehicle Rental Reserve Car Task, VR_RESERVE_TASK.

2. ACMSDBG> **CANCEL BREAK /ALL=VR_RESERVE_TASK**

   This example shows how to cancel all task-level breakpoints in the task VR_RESERVE_TASK.

CANCEL TASK

CANCEL TASK — Cancels the current task.

Format

CANCEL TASK

Notes

You can use the **CANCEL TASK** command at the ACMSDBG> prompt when there is an active task that was started with the **ACMSDBG SELECT** command. However, you cannot use this command to cancel a task that was submitted by an agent program.

To display the ACMSDBG> prompt when you are not at a breakpoint or when you are at an OpenVMS Debugger prompt, press **Ctrl/G**.

When you use this command, the OpenVMS Debugger runs the cancel action if any is defined for the task. If the task has context in a server when it is canceled, the cancel procedure (if any) for that server is also run.

Example

```
ACMSDBG> CANCEL TASK
```

This example shows how to cancel the current task.

CANCEL TRANSACTION_TIMEOUT

CANCEL TRANSACTION_TIMEOUT — Cancels any transaction timeout period previously set.

Format

CANCEL TRANSACTION_TIMEOUT

Notes

You can use the **CANCEL TRANSACTION_TIMEOUT** command at the ACMSDBG> prompt when you have already set a transaction timeout period. Use the command when you have finished testing your transaction timeout handling.

Example

```
ACMSDBG> CANCEL TRANSACTION_TIMEOUT
```

This example shows how to cancel the current transaction timeout.

DEPOSIT

DEPOSIT — Puts a value into a workspace field.

Format

DEPOSIT [/*qualifiers*] *workspace-field-name=value*

Parameters

workspace-field-name

The name of a field in a workspace defined for the task. The value parameter is put into this field. Use the symbol for current location (.) to indicate that the field named in the last **DEPOSIT** or **EXAMINE** command is the field in which to put a value.

value

The data put into the workspace field. The qualifiers used with the **DEPOSIT** command define the length and data type of the value.

Qualifiers

When the Task Debugger receives a **DEPOSIT** command, it passes that command directly to the OpenVMS Debugger. The qualifiers for the **DEPOSIT** command are the same qualifiers available for the **DEPOSIT** command for the OpenVMS Debugger. These qualifiers determine the data type

used to display the information in the workspace field. See *VSI OpenVMS Debugger Manual* [https://docs.vmssoftware.com/vsi-openvms-debugger-manual/] for a list of available qualifiers.

Notes

You can use the **DEPOSIT** command only if a task is active.

Both the Task Debugger and the OpenVMS Debugger look at the same copy of the workspace. If you change a workspace value from the Task Debugger (`ACMSDBG>`), you see the changes in the OpenVMS Debugger; if you change a workspace value from the OpenVMS Debugger (`DBG>`), you see the changes in the Task Debugger.

Example

```
ACMSDBG> DEPOSIT RESERVATION_NUMBER = "000121"
```

This example shows how to deposit the 6-byte ASCII value 000121 in the RESERVATION_NUMBER field.

EXAMINE

EXAMINE — Displays the contents of a workspace field.

Format

EXAMINE [*/qualifiers*] *workspace-field-name* [OF *workspace-record-name*]

Parameters

workspace-field-name

The workspace field to be read by the **EXAMINE** command. Use the symbol for current location (.) to indicate that the field named in the last **DEPOSIT** or **EXAMINE** command is the field you want to examine.

workspace-record-name

If the `workspace-field-name` is not unique, use the `workspace-record-name` to specify the name of the workspace that contains the field you want to examine.

Qualifiers

When the ACMS Task Debugger receives an **EXAMINE** command, it passes that command directly to the OpenVMS Debugger. The qualifiers for the **EXAMINE** command are the same qualifiers as for the **EXAMINE** command for the OpenVMS Debugger. These qualifiers determine the data type used to display information in the workspace field. See *VSI OpenVMS Debugger Manual* [https://docs.vmssoftware.com/vsi-openvms-debugger-manual/] for a list of available qualifiers.

Notes

You can use the **EXAMINE** command only if a task is active.

Both the ACMS Task Debugger and the OpenVMS Debugger look at the task's copy of a workspace.

Example

```
ACMSDBG> EXAMINE RESERVATION_NUMBER OF VR_RECORD
RESERVATION_NUMBER OF VR_RECORD: +121
```

This example shows how to display the contents of the RESERVATION_NUMBER field of the VR_RECORD workspace.

EXIT

EXIT — Ends the debugging session or ends the execution of commands in a command procedure. If typed after the ACMSDBG> prompt, the **EXIT** command stops all subprocesses started by the Task Debugger and returns to DCL command level. If included in a command procedure, the **EXIT** command returns control to the command stream that started the command procedure.

Format

EXIT

Example

```
ACMSDBG> EXIT
```

This example shows how to end the current Task Debugger session.

GO

GO — Continues a task after a breakpoint. Also returns you to a server process from which you have exited with **Ctrl/G** and continues any command after an **INTERRUPT** command.

Format

GO

Note

The **GO** command always restarts the task at the breakpoint where it stopped.

Examples

1. ```
   ACMSDBG> SELECT VR_RESERVE_TASK
   Task breakpoint at VR_RESERVE_TASK$TASK$BEGIN
   ACMSDBG> GO
   ```

   This example shows how to start the task VR_RESERVE_TASK, which breaks at $BEGIN on the root step. The **GO** command restarts the task VR_RESERVE_TASK at that breakpoint.

2. ```
   ACMSDBG> INTERRUPT VR_SERVER
   Task is in server VR_SERVER
   ```

```
DBG> SET BREAK UPDATE_RECORD
DBG> GO
```

Ctrl/G

```
ACMSDBG> GO
```

This example shows how to return to the OpenVMS Debugger prompt (DBG>) so that you can set breakpoints or use other OpenVMS Debugger commands in the server VR_SERVER. The example then shows how to return to the ACMSDBG> prompt and resume task execution.

HELP

HELP — Displays information about ACMS Task Debugger commands, step points, control characters, and symbols.

Format

HELP [*topic*] [...]

Parameter

topic

A Task Debugger command, step point, or symbol about which information is available. Topics can have subtopics about which additional information is available.

Examples

1. ACMSDBG> **HELP**

   This example shows how to display general information about the Task Debugger.

2. ACMSDBG> **HELP EXAMINE**

   This example shows how to display information about how to use the Task Debugger **EXAMINE** command.

INTERRUPT

INTERRUPT — Interrupts a server and gives control to the OpenVMS Debugger in that server process. Use this command to get the DBG> prompt in order to set breakpoints, examine addresses, or change values in a server that has already been started.

Format

INTERRUPT *server-name* [/*qualifiers*]

Command Qualifier	Default
/[TASK=*task-name*]	None

Parameter

server-name

The name of a server in the task group definition. This parameter is required.

Qualifier

/TASK

A called task that participates in a distributed transaction started by a parent task might need to use the same server as the parent task. In a distributed transaction, different server processes are started and allocated to the parent and to the called tasks. The **/TASK** qualifier allows you to specify the server process that you want to interrupt.

If you do not specify a task name, ACMS checks for an active task:

- If there is an active task, and the task has context in an instance of the specified server, ACMS interrupts that instance of the server.
- If no task is active, or if the active task does not have context in the specified server, ACMS interrupts the first free instance of the specified server. The first free server instance is the process that ACMS uses the next time a task calls a procedure in this server.

If you specify a task name, then ACMS interrupts the server process currently owned by that task. If the named task is not currently retaining context in the named server, this command returns an error.

If you debug a recursive task, supplying a task name does not have any effect; the **/TASK** qualifier is ignored and the rules for interrupting a server when no task name is supplied are followed.

Notes

The **START** server command must be completed before interrupting the server. If you use **Ctrl/G** to return to the ACMSDBG> prompt before the server is completely started, you will not be able to complete the server startup and will experience unpredictable results.

When you finish with your debugging commands, type **GO** to resume the execution of the server. Then press **Ctrl/G** to end the **INTERRUPT** command and return to the Task Debugger ACMSDBG> prompt.

When linking server images that you are going to debug, take the default of **/TRACEBACK**. If you link a server with **/NOTRACEBACK**, you cannot interrupt the server because the **INTERRUPT** command causes a fatal error in the server. Instead, use the **STOP** command to stop the server and return to the ACMSDBG> prompt. You can then relink and restart the server.

Example

```
ACMSDBG> INTERRUPT VR_SERVER
Task is in server VR_SERVER
DBG> SET BREAK UPDATE_RECORD
DBG> GO
```

Ctrl/G

```
ACMSDBG>
```

This example shows how to return to the OpenVMS Debugger prompt (DBG>) so that you can set breakpoints or use other OpenVMS Debugger commands in the server VR_SERVER. The example also shows how to return to the ACMSDBG> prompt in order to resume task execution.

SELECT

SELECT — Selects and starts a task.

Format

SELECT *task-name* [*selection-string*]

Parameters

task-name

The name of the task selected, which is assigned in the task group definition. This parameter is required.

selection-string

Additional information the Task Debugger passes to the task in the ACMS$SELECTION_STRING workspace. Enclose the selection string in quotation marks if the data has embedded spaces.

Note

Select only one task at a time. If a selected task has not completed yet, use **CANCEL TASK** to end that task before selecting another.

Examples

1. ACMSDBG> **SELECT VR_RESERVE_TASK**

   This example shows how to select and start the VR_RESERVE_TASK.

2. ACMSDBG> **SELECT VR_RESERVE_TASK 000121**

   This example shows how to start the VR_RESERVE_TASK. It also shows how to pass the decimal number 000121 to the ACMS$SELECTION_STRING workspace.

SET BREAK

SET BREAK — Sets a breakpoint in a task. Breakpoints can be set at specific locations or at specific events. *Table 7.3, "Location Breakpoint Symbols"* contains location breakpoint symbols. *Table 7.4, "Event Breakpoint Symbols"* contains event breakpoint symbols.

Format

SET BREAK *task-namestep-name**location***

SET BREAK *task-nameevent***

Parameters

task-name

Always include a task name in the **SET BREAK** command.

step-name

The step in the task at which a breakpoint is set.

If you omit the step-name in a location breakpoint, the break is set at the root step.

location

Location breakpoint symbols are $BEGIN, $ACTION, $HANDLER, and $END.

If you omit the location, the breakpoint is set at the beginning of the step.

event

Event breakpoint symbols are $EXCEPTION and $CANCEL.

Notes

You can use the **SET BREAK** command from the ACMSDBG> prompt only to set breakpoints in the task definition. Use the **SET BREAK** command from the DBG> prompt to set breakpoints in user procedure code.

You can set breakpoints for tasks that are not active.

Examples

1. ACMSDBG> **SET BREAK VR_RESERVE_TASK**

   In this example, a breakpoint is set at the beginning of the VR_RESERVE_TASK.

2. ACMSDBG> **SET BREAK VR_RESERVE_TASK\$STEP_1\$BEGIN**

   In this example, a location breakpoint is set at the beginning of the first step in VR_RESERVE_TASK.

3. ACMSDBG> **SET BREAK VR_RESERVE_TASK\$CANCEL**

   In this example, a **CANCEL** event breakpoint is set. This breakpoint is reached when any event that causes a task cancellation occurs.

SET SERVER

SET SERVER — Names the server used as the default for the **ASSIGN** command.

Format

SET SERVER *server-name*

Parameter

server-name

The name of the server, taken from the task group definition, to set as the current server for **ASSIGN** commands. This parameter is required.

Notes

The **SET SERVER** command does not affect which servers the **START** and **STOP** commands handle.

The **SET SERVER** command has no default.

If you do not use the **SET SERVER** command, you must use the **/SERVER** qualifier on the **ASSIGN** command.

Example

```
ACMSDBG> SET SERVER VR_SERVER
```

This example shows how to establish VR_SERVER as the current server for **ASSIGN** commands.

SET TRANSACTION_TIMEOUT

SET TRANSACTION_TIMEOUT — Sets the current transaction timeout period. This allows you to verify that your task correctly handles a transaction timeout.

Format

SET TRANSACTION_TIMEOUT *seconds*

Parameter

seconds

The number of seconds to set as the current transaction timeout limit. This parameter is required.

Notes

If you do not set a transaction timeout, your transactions will never time out.

Once a transaction timeout limit is set using this command, if a transaction does not complete in the specified amount of time, the Task Debugger raises a transaction exception.

Example

```
ACMSDBG> SET TRANSACTION_TIMEOUT 60
```

This example shows how to establish 60 seconds as the transaction timeout limit.

SHOW BREAK

SHOW BREAK — Displays breakpoints that have been set in the task.

Format

SHOW BREAK

Example

```
ACMSDBG> SHOW BREAK
```

This example shows how to display all breakpoints that you have set (and not yet canceled) in the task during the current Task Debugger session.

SHOW SERVERS

SHOW SERVERS — Displays all servers that have started (and not stopped) in the current Task Debugger session.

Format

SHOW SERVERS

Example

```
ACMSDBG> SHOW SERVERS
VR_SERVER
```

This example shows that VR_SERVER is the only server currently running in this Task Debugger session.

SHOW TRANSACTION_TIMEOUT

SHOW TRANSACTION_TIMEOUT — Displays the value of the current transaction timeout.

Format

SHOW TRANSACTION_TIMEOUT

EXAMPLE

```
ACMSDBG> SHOW TRANSACTION_TIMEOUT
Transaction timeout value is 60 seconds
```

This example shows how to display the transaction timeout currently set.

SHOW VERSION

SHOW VERSION — Displays the version number of the Task Debugger.

Format

SHOW VERSION

EXAMPLE

```
ACMSDBG> SHOW VERSION
ACMS Task Debugger V5.0
```

This example shows how to display the version number of the Task Debugger image that the user is running.

START

START — Starts one or more instances of one or more servers.

Format

START [/*qualifier*] [*server-name*] [,...]

Command Qualifier	Default
/ALL	None

Parameter

server-name

The name of one or more servers, from the task group definition. Separate multiple server names with commas.

In most cases, you need only one instance of a server to be active. The instance that is started is used by each task that uses that server.

In a distributed transaction, however, a called task that participates in a distributed transaction started by a parent task might need to use the same server as the parent task. Different server processes are started and allocated to the parent and the called task. You can use the **START** command to start multiple instances of the same server.

Qualifier

/ALL

Starts all reusable servers defined in the task group database (.TDB) being used for the current debugger session.

Notes

Always include either a server name or **/ALL** in the **START** command.

The servers named in the **START** command go through startup as if you were starting them with the **ACMS/START APPLICATION** command. The Task Debugger runs all initialization procedures and allocates group workspaces. If the server image was linked with **/DEBUG**, the **START** server command gives control to the OpenVMS Debugger in the server process.

The number of active server processes allowed for the debugging session is limited. A user is allowed up to four times the number of servers defined in the task group that is being debugged. The number of

server instances allowed per server, however, is unlimited. If a task group has two servers, for example, you have can eight server instances started. If need be, you can have eight instances of one server and none of the other.

Examples

1. ACMSDBG> **START VR_SERVER,VR_SERVER**

   This example shows how to start two processes for the server VR_SERVER.

2. ACMSDBG> **START/ALL**

   This example shows how to start one instance of all servers defined in the task group database file (.TDB) used in the current debugger session.

STEP

STEP — Runs the task from the current breakpoint to the next task-level breakpoint. When stepping through a task that was called by another task, the Task Debugger proceeds through all the steps in the called task until the task completes. Control then returns to the parent task; continue to enter the **STEP** command for the Task Debugger to step through the parent task.

Format

STEP

Note

This command is valid only when you select a task using the **SELECT** or **ACCEPT** commands.

Example

ACMSDBG> **STEP**

This example shows how to move the current task to the next task-level breakpoint.

STOP

STOP — Stops one or more servers.

Format

STOP [/*qualifier*] [*server-name*][,...]

Command Qualifier	Default
/ALL	None

Parameter

server-name

The name of the server to stop. The name of the server comes from the task group definition. Separate multiple server names with commas.

Qualifier

/ALL

Stops all instances of all servers included in the task group database file (.TDB) used in the current debugger session.

Notes

Use either the server-name parameter or the **/ALL** qualifier. If you use the server-name parameter, ACMS stops a single server process and displays a message if other server processes remain active for the same server.

The servers named in the **STOP** command go through shutdown as if you were stopping them with the **ACMS/STOP APPLICATION** command. All termination procedures are run.

Examples

1. `ACMSDBG>` **`STOP VR_SERVER,VR_UPDATE_SERVER`**

   This example shows how to stop the servers VR_SERVER and VR_UPDATE_SERVER.

2. `ACMSDBG>` **`STOP /ALL`**

   This example shows how to stop all servers defined in the task group database file (.TDB) used in the current debugger session.

Part III. Appendixes

This part of the manual contains supplemental information that may be useful when writing server procedures for ACMS applications.

Appendix A, "Summary of ACMS System Workspaces" contains a summary of ACMS system workspaces. *Appendix B, "Libraries Included in AVERTZ Sample Procedures"* lists the libraries included in the AVERTZ sample procedures. *Appendix C, "Superseded Features"* describes superseded features of ACMS.

Appendix A. Summary of ACMS System Workspaces

The three ACMS system workspaces are:

- ACMS$PROCESSING_STATUS
- ACMS$SELECTION_STRING
- ACMS$TASK_INFORMATION

Each ACMS system workspace has a different purpose. All of the Common Data Definition Language (CDDL) record definitions for these workspaces are stored in the CDD$TOP.ACMS$DIR.ACMS$WORKSPACES directory in the CDD. This appendix lists these workspaces and explains the uses of each.

A.1. ACMS$PROCESSING_STATUS System Workspace

The ACMS$PROCESSING_STATUS workspace handles processing status information. It has four fields, each for a different part of that information. The CDD location of the CDDL record definition for this workspace is CDD$TOP.ACMS$DIR.ACMS$WORKSPACES.ACMS$PROCESSING_STATUS.

*Table A.1, "Fields in the ACMS$PROCESSING_STATUS Workspace"* describes the fields in the ACMS$PROCESSING_STATUS workspace.

Table A.1. Fields in the ACMS$PROCESSING_STATUS Workspace

ACMS$L_STATUS	
Type	Signed longword
Description	Contains the return status from the last processing step. The initial value of the ACMS$L_STATUS field is set to 1 (SUCCESS) when a task is started.
ACMS$T_SEVERITY_LEVEL	
Type	Text
Size	1 character
Description	Contains a single-character severity level code representing the return status in the ACMS$L_STATUS field. The characters this field can contain are: S (SUCCESS), I (INFORMATION), W (WARNING), E (ERROR), F (FATAL), or ? (OTHER). The initial value of ACMS$T_SEVERITY_LEVEL is S.
ACMS$T_STATUS_TYPE	
Type	Text

Size	1 character
Description	Contains a single-character severity level code representing the return status in the ACMS$L_STATUS field. G indicates the low bit in the ACMS$L_STATUS field is set to 1. B indicates the low bit is clear. The initial value of the ACMS$T_STATUS_TYPE field is G.
ACMS$T_STATUS_MESSAGE/ACMS$T_STATUS_MESSAGE_LONG	
Type	Text
Size	80/132 characters
Description	ACMS$T_STATUS_MESSAGE is an 80-character variant of the 132 character ACMS$T_STATUS_MESSAGE_LONG field. When you use the GET ERROR MESSAGE clause, this field contains the error message associated with the return status code in ACMS$L_STATUS. The ACMS$T_STATUS_MESSAGE_LONG field is set initially to spaces.

A.2. ACMS$SELECTION_STRING System Workspace

The ACMS$SELECTION_STRING workspace handles strings passed by a task submitter (terminal user) at task selection time. This workspace has a single field. The CDD location of the CDDL record definition for this workspace is CDD$TOP.ACMS$DIR.ACMS$WORKSPACES.ACMS$SELECTION_STRING.

Table A.2, "Field in the ACMS$SELECTION_STRING Workspace" describes the field in the ACMS $SELECTION_STRING workspace.

Table A.2. Field in the ACMS$SELECTION_STRING Workspace

ACMS$T_SELECTION_STRING	
Type	Text
Size	255 characters
Description	Contains the selection string provided by a terminal user at task selection time. If the user does not provide a selection string, ACMS sets the field to spaces. If the task is queued, the first 32 bytes of the selection string contain the queued task element ID.

A.3. ACMS$TASK_INFORMATION System Workspace

The ACMS$TASK_INFORMATION workspace handles task execution information. It has ten fields, each for a different part of that information. The CDD location of the CDDL record definition for this workspace is CDD$TOP.ACMS$DIR.ACMS$WORKSPACES.ACMS$TASK_INFORMATION.

*Table A.3, "Fields in the ACMS$TASK_INFORMATION Workspace"* describes the fields in the ACMS$TASK_INFORMATION workspace.

Table A.3. Fields in the ACMS$TASK_INFORMATION Workspace

ACMS$AL_TASK_ID	
Type	Signed longword array
Size	4 longwords
Description	Contains the task ID in binary format for the current task instance; the ACMS$AL_TASK_ID field is a four-element longword array. It is possible for two task instances to have the same value if the tasks are selected on two different nodes. To ensure a unique task identifier, use both the ACMS$AL_TASK_ID field and the ACMS$T_SUBMITTER_NODE field.
ACMS$L_TASK_SEQUENCE_NUMBER	
Type	Signed longword
Description	Contains the number of the current task instance within the current task. This field always contains 1 when the task is initially selected from a menu. ACMS increments this number each time the user repeats the task or chains to another task, thus starting a new task instance without returning to the menu.
ACMS$T_TASK_NAME	
Type	Text
Size	31 characters
Description	Contains the task name as defined in the application under which the task is running. ACMS does not update this field when one task chains to another.
ACMS$T_TASK_IO_DEVICE	
Type	Text
Size	8 characters
Description	Contains the device name for the task submitter. For remote users, the device name is always

	NL:. For local request I/O or terminal I/O users, this field includes the terminal device name. For stream I/O or no I/O, this field is set to spaces. If this field contains a device name (not spaces or NL:), then the device can be used by the task to perform I/O from a processing step.
ACMS$AL_TASK_SUBMITTER_ID	
Type	Signed longword array
Size	4 longwords
Description	Contains the current terminal user's identification code for the user who started the current task instance. This field is a four-element longword array.
ACMS$T_TASK_USERNAME	
Type	Text
Size	12 characters
Description	Contains the OpenVMS user name for the terminal user who started the current task instance. For remote tasks, this is the name of the proxy.
ACMS$T_SUBMITTER_NODE_NAME	
Type	Text
Size	15 characters
Description	Contains the DECnet node name for the task submitter.
ACMS$L_CALL_SEQUENCE_NUMBER	
Type	Signed longword
Description	Contains the call sequence number of the currently called task. ACMS increments this number each time a task calls another task.
ACMS$T_SIGN_IN_USERNAME	
Type	Text
Size	12 characters
Description	Contains the OpenVMS user name of the user on the submitter node. If a submitter selects a remote task, then the user name under which that task runs may be different from the user name under which the submitter signed in. The contents of the ACMS$T_TASK_USERNAME are based on the proxy lookup and user name

	defaulting mechanism and may differ from the ACMS$T_SIGN_IN_USERNAME field. If a submitter selects a local task, the ACMS$T_SIGN_IN_USERNAME field is the same as the ACMS$T_TASK_USERNAME field. To distinguish between users that have the same name but reside on different nodes, use the ACMS$T_SIGN_IN_USERNAME field with the ACMS$T_SUBMITTER_NODE_NAME field to log the user name and the node location.
ACMS$T_SIGN_IN_DEVICE	
Type	Text
Size	8 characters
Description	Contains the name of the device that was supplied to ACMS when the submitter signed in. For applications using the ACMS command process, this field contains a terminal device name. For applications using a user-written command process (agent), this field can contain a terminal device name, the name of a nonterminal device that the agent is handling, or the NL: device specification. Use the ACMS$T_SIGN_IN_DEVICE field in conjunction with the ACMS$T_SUBMITTER_NODE_NAME field to log the device name and its node location. Use both fields to distinguish between devices that have the same name but reside on different nodes.

Appendix B. Libraries Included in AVERTZ Sample Procedures

This appendix lists the contents of the libraries referred to in procedures that are part of the AVERTZ sample application.

B.1. VR_MESSAGES_INCLUDE.LIB

```
*
* AVERTZ messages
*
*
* Informational
*
01 MULCURECFND          PIC S9(9) COMP VALUE IS EXTERNAL VR_MULCURECFND.
01 MULRSRECFND          PIC S9(9) COMP VALUE IS EXTERNAL VR_MULRSRECFND.
01 VEUPGPRF             PIC S9(9) COMP VALUE IS EXTERNAL VR_VEUPGPRF.
01 VEDNGPRF             PIC S9(9) COMP VALUE IS EXTERNAL VR_VEDNGPRF.
01 CURECUPD             PIC S9(9) COMP VALUE IS EXTERNAL VR_CURECUPD.
01 CURECINS             PIC S9(9) COMP VALUE IS EXTERNAL VR_CURECINS.
01 CHKINCOMP            PIC S9(9) COMP VALUE IS EXTERNAL VR_CHKINCOMP.
01 CHKOUTCOM            PIC S9(9) COMP VALUE IS EXTERNAL VR_CHKOUTCOM.
01 RESVCOMP             PIC S9(9) COMP VALUE IS EXTERNAL VR_RESVCOMP.
01 VERECFND             PIC S9(9) COMP VALUE IS EXTERNAL VR_VERECFND.
01 RESSUCCNCLD          PIC S9(9) COMP VALUE IS EXTERNAL VR_RESSUCCNCLD.
*
* Warning
*
01 CURECNOTFND          PIC S9(9) COMP VALUE IS EXTERNAL VR_CURECNOTFND.
01 RCRECNOTFND          PIC S9(9) COMP VALUE IS EXTERNAL VR_RCRECNOTFND.
01 RERECNOTFND          PIC S9(9) COMP VALUE IS EXTERNAL VR_RERECNOTFND.
01 RSRECNOTFND          PIC S9(9) COMP VALUE IS EXTERNAL VR_RSRECNOTFND.
01 SIRECNOTFND          PIC S9(9) COMP VALUE IS EXTERNAL VR_SIRECNOTFND.
01 VERECNOTFND          PIC S9(9) COMP VALUE IS EXTERNAL VR_VERECNOTFND.
01 VRHRECNOTFND         PIC S9(9) COMP VALUE IS EXTERNAL VR_VRHRECNOTFND.
01 NOTCHKOUT            PIC S9(9) COMP VALUE IS EXTERNAL VR_NOTCHKOUT.
01 RESCNCLD             PIC S9(9) COMP VALUE IS EXTERNAL VR_RESCNCLD.
01 CARCHKIN             PIC S9(9) COMP VALUE IS EXTERNAL VR_CARCHKIN.
01 CARCHKOUT            PIC S9(9) COMP VALUE IS EXTERNAL VR_CARCHKOUT.
01 RESCLOSED            PIC S9(9) COMP VALUE IS EXTERNAL VR_RESCLOSED.
01 DLRENOTFND           PIC S9(9) COMP VALUE IS EXTERNAL VR_DLRENOTFND.
01 NOCANCEL             PIC S9(9) COMP VALUE IS EXTERNAL VR_NOCANCEL.
01 INACTIVE             PIC S9(9) COMP VALUE IS EXTERNAL VR_INACTIVE.
01 DDTM_TIMEOUT         PIC S9(9) COMP VALUE IS EXTERNAL VR_DDTM_TIMEOUT.
*
* Error
*
01 NO_DUP               PIC S9(9) COMP VALUE IS EXTERNAL VR_NO_DUP.
01 DEADLOCK             PIC S9(9) COMP VALUE IS EXTERNAL VR_DEADLOCK.
01 INTEG_FAIL           PIC S9(9) COMP VALUE IS EXTERNAL VR_INTEG_FAIL.
01 LOCK_CONFLICT        PIC S9(9) COMP VALUE IS EXTERNAL VR_LOCK_CONFLICT.
01 CAR_UNAVAILABLE      PIC S9(9) COMP VALUE IS EXTERNAL VR_CAR_UNAVAILABLE.
01 CHK_CANCL_ERR        PIC S9(9) COMP VALUE IS EXTERNAL VR_CHK_CANCL_ERR.
01 HIST_WRITE_ERR       PIC S9(9) COMP VALUE IS EXTERNAL VR_HIST_WRITE_ERR.
01 UPDATE_ERROR         PIC S9(9) COMP VALUE IS EXTERNAL VR_UPDATE_ERROR.
*
* Fatal
*
01 BILLERR              PIC S9(9) COMP VALUE IS EXTERNAL VR_BILLERR.
01 DB_FATAL             PIC S9(9) COMP VALUE IS EXTERNAL VR_DB_FATAL.
```

```
01 ICRECNOTFND          PIC S9(9) COMP VALUE IS EXTERNAL VR_RCRECNOTFND.
```

B.2. VR_LITERALS_INCLUDE.LIB

```
01 C-ZERO       PIC X VALUE "0".
01 C-NINE       PIC X VALUE "9".
01 C-ONE        PIC X VALUE "1".
01 NEG-ONE      PIC S9(4) COMP VALUE -1.
```

B.3. VR_SQL_STATUS_INCLUDE.LIB

```
*
* Define the SQL return status
*
01 SQL_NOTFOUND         PIC S9(9) COMP VALUE +100.
01 SQL_NO_DUP           PIC S9(9) COMP VALUE -803.
01 SQL_DLOCK            PIC S9(9) COMP VALUE -913.
01 SQL_INTEGFAIL        PIC S9(9) COMP VALUE -1001.
01 SQL_LOCK             PIC S9(9) COMP VALUE -1003.
01 SQL_SELMORVAL        PIC S9(9) COMP VALUE -811.
*
```

B.4. VR_CONTEXT_STRUCTURE_INCLUDE.LIB

```
01 CONTEXT-STRUCTURE.
 02 CS-VERSION           PIC S9(9) COMP VALUE 1.
 02 CS-TYPE              PIC S9(9) COMP VALUE 1.
 02 CS-LENGTH            PIC S9(9) COMP VALUE 16.
 02 CS-TID               PIC X(16).
 02 CS-END               PIC S9(9) COMP VALUE 0.
```

Appendix C. Superseded Features

This appendix describes features used in earlier versions of ACMS. Although you can continue to use these features, they have been superseded by new features and are considered to be declining functionality.

ACMSAD$REQ_CANCEL

ACMSAD$REQ_CANCEL — Cancels a task. ACMS writes the task cancellation to the audit trail log. When you include a reason parameter, the call also writes the reason for the cancellation to the audit trail log. This programming service is a declining feature. Starting with ACMS Version 3.2, use ACMS$RAISE_NONREC_EXCEPTION to raise an exception that cancels a task.

Format

ACMSAD$REQ_CANCEL ([*reason.rl.r*])

Parameter

reason

Optional longword address of the reason for canceling, passed by reference as a read-only longword value.

Return Status

The ACMSAD$REQ_CANCEL service can return the following status values:

Status	Severity Level	Description
ACMS$_NORMAL	Success	Normal successful completion.
ACMS$_PENDING	Informational	Successful operation pending asynchronous completion.
ACMS$_EXCPTNACTIVE	Error	An exception of the same or higher level has already been raised. The existing exception is raised in the task as soon as the step procedure completes.
ACMS$_INVREQCANREASON	Error	Task canceled: invalid cancel reasons passed to ACMS$_INVREQCANREASON.
ACMS$_NOCANCELCANPROC	Error	ACMSAD$REQ_CANCEL service may not be called from a server cancel procedure.
ACMS$_TASKNOTACTRC	Fatal	ACMSAD$REQ_CANCEL service may not be called when no task is active.

Notes

The optional parameter *reason* must be a condition value. For example, the parameter can be a symbol in a message file you have created, or it can be an OpenVMS or RMS condition value.

If a reason (that is, an exception code) is not supplied, ACMS uses ACMS$_CANCEL_PROCSVR, "Cancel resulting from procedure server calling ACMSAD$REQ_CANCEL." If a reason is supplied, it must be a failure status. If a reason is supplied that is not a failure status, then ACMS cancels the task with a status of ACMS$_INVCANCELREASON, "invalid cancel reason."

The behavior of ACMSAD$REQ_CANCEL depends on whether or not AST delivery is enabled. If the ACMSAD$REQ_CANCEL service is called with AST delivery enabled, then the nonrecoverable exception is raised immediately, and the service does not return to the procedure. If the ACMSAD$REQ_CANCEL service is called with AST delivery disabled, then the service returns ACMS$_PENDING, and the nonrecoverable exception is raised when AST delivery is once again enabled. Note that the step procedure must enable AST delivery before completing.

This service cannot be called from a cancel procedure or from an initialization or a termination procedure.

Examples

1. ```
   WORKING-STORAGE SECTION.
    01 CNCL_MSG      PIC S9(5)
                        VALUE IS EXTERNAL "MSG_CANCEL".

    PROCEDURE DIVISION.
    .
    .
    .
    CALL "ACMSAD$REQ_CANCEL" USING CNCL_MSG.
   ```

   In this COBOL example, MSG_CANCEL is a message symbol in an external message file. CNCL_MSG is a data item declared with MSG_CANCEL as its value.

2. ```
   CALL ACMSAD$REQ_CANCEL
   ```

   This BASIC example shows how to cancel the task with the default reason of ACMS$_ACMSTP_CALL, ACMSI-E-ACMSTP_CALL, "Cancel resulting from procedure server calling ACMSAD$REQ_CANCEL."