UNISYS

Relational Concepts and SQL Programming

Student Guide

Unisys Institute of Technology (UIT)

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Contents

Module 4: More WHERE Clause Operators

Module 5: The IPF SQL Interface

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Course Description

Relational Concepts and SQL Programming

Objectives:

To prepare the student to write, test, and debug SQL programs.

Audience:

Application programmers, systems analysts, systems designers, and support personnel

Prerequisites:

Extensive COBOL programming experience in the 1100/2200 environment

Key Topics:

- Introduction to RDMS
- SQL command set
- Embedding SQL in programs
- Error handling and debugging
- IPF SQL
- MAPPER Relational Interface (MRI)

Relational Concepts and SQL Programming

EL3605 5 DAYS

About This Course

How to Use This Document

This student guide supports the material the instructor presents. A complete listing of referenced product information is provided under the Referenced Product Information heading.

There are written and/or laboratory practices at the end of most modules to help you understand the material presented. Two modules, modules 3 and 9, contain laboratory exercises in the middle of the module.

Learning Environment

This course is designed to provide you with the background and skills to manipulate an RDMS 1100 database. The concepts of relational database are introduced from a programming viewpoint. The SQL command set is used to enable you to access and manipulate relational data through COBOL host language programs. The IPF SQL and MAPPER Relational Interface are introduced as other ways to access RDMS 1100 databases. Lab exercises provide you with the opportunity to practice coding skills in relational data creation, retrieval, and updating, and use of alternative interfaces to RDMS 1100.

Trademark Information

- MAPPER is a registered trademark of Unisys Corporation
- LINC and ALLY are registered trademarks of Unisys Corporation

Referenced Product Information

OS 1100 UDS Relational Data Management System (UDS RDMS 1100) and IPF SQL Interface End Use Guide 7831 0778-000

OS 1100 UDS Relational Data Management System (UDS RDMS 1100) SQL Programming Reference Manual 7830 8160-002

OS 1100 UDS Relational Data Management System (UDS RDMS 1100) Administration Guide 7831 0760-002

OS 1100 Universal Compiling System (UCS) COBOL Programming Reference Manual Volume 2: Compiler and System Interface 7831 0455-000

OS 1100 Universal Compiling System (UCS) Application Development Programming Guide, Volume 1 . . . . . 7831 4077-001

MAPPER Relational Interface (MRI) Relational Database Interface (RDI) Operations Guide 7831 9795-000

Note: *Consult the Series 1100 and 2200 Systems Product Information Library Directory, if needed, for specific levels of these documents and other Unisys documentation. The proper level of a document is needed to match release of installed software for your system.*

Agenda

Day 1

Introduction

Retrieving Data with the SELECT Statement

Using SQL in Application Programs

Day 2

More WHERE Clause Operators

The IPF SQL Interface

The MAPPER Relational Interface

Day 3

Grouping Functions

Joining Tables

More Retrieval Considerations

Day 4

Data Manipulation

Keys and Updating

Obtaining Table Definition Information

Day 5

Views

More About Threads and UDS

Getting Physical - Tables and Storage Areas

1

Introduction

Module 1
Introduction

Module Objectives

Upon completion of this module, you should be able to

- Identify some of the basic features of a relational database management system.
  - Describe the uses and advantages.
  - Correctly use the terms to describe a table, primary keys, tuples, and the operations that can be performed on tables.
  - Identify three interfaces into RDMS databases.

Benefit Statement

It is important that you have a few, fundamental concepts and terms in order to visualize and work with a relational database. You will realize the several options you have for accessing the database and understand how these options are implemented.

Materials

- OS 1100 UDS Relational Data Management System (UDS RDMS 1100) and IPF SQL Interface End Use Guide

Relational Database

A database in which all the data is represented by tables. Table 1-1 illustrates a table.

Table 1-1. National League Winners

YEAR	CLUB	WON	LOST	MANAGER
1876	CHICAGO	52	14	SPAULDING, ALBERT
1877	BOSTON	31	17	WRIGHT, HARRY
1878	BOSTON	41	19	WRIGHT, HARRY
1879	PROVIDENCE	55	23	WRIGHT, GEORGE
1880	CHICAGO	67	17	ANSON, ADRIAN
1881	CHICAGO	56	28	ANSON, ADRIAN
1882	CHICAGO	55	29	ANSON, ADRIAN
1883	BOSTON	63	35	MORRILL, JOHN
1884	PROVIDENCE	84	28	BANCROFT, FRANK
1885	CHICAGO	87	25	ANSON, ADRIAN
1886	CHICAGO	90	34	ANSON, ADRIAN

- Relational database terms
  - Schema
  - Entity
  - Table (relation)
  - Column (attribute)
  - Row (tuple)
  - Primary key
  - Data value
  - Secondary key

Operations on Tables

There are three basic types of operations that can be performed on tables:

- RESTRICT - Choose rows from a table
- PROJECT - Choose columns from a table
- JOIN - Combine two or more tables that have a column in common

These are the formal names for operations in the database literature. They are not the commands used in SQL to perform the operations, but are listed to illustrate the kind of processing that is possible.

The result of any of the above operations is always a conceptual table.

These three operations may be combined to produce the exact data desired.

RESTRICT Operation

The RESTRICT operation extracts a subset of the rows of an existing table. The desired rows are selected by stating the conditions that the data values in specified columns must satisfy. RESTRICT creates a horizontal subset of the existing table. From Table 1-2 we extract only the winners from 1880 to 1885 creating Table 1-3.

Table 1-2. National League Winners

YEAR	CLUB	WON	LOST	MANAGER
1876	CHICAGO	52	14	SPAULDING, ALBERT
1877	BOSTON	31	17	WRIGHT, HARRY
1878	BOSTON	41	19	WRIGHT, HARRY
1879	PROVIDENCE	55	23	WRIGHT, GEORGE
1880	CHICAGO	67	17	ANSON, ADRIAN
1881	CHICAGO	56	28	ANSON, ADRIAN
1882	CHICAGO	55	29	ANSON, ADRIAN
1883	BOSTON	63	35	MORRILL, JOHN
1884	PROVIDENCE	84	28	BANCROFT, FRANK
1885	CHICAGO	87	25	ANSON, ADRIAN
1886	CHICAGO	90	34	ANSON, ADRIAN

Table 1-3. Winners from 1880 to 1885.

YEAR	CLUB	WON	LOST	MANAGER
1880	CHICAGO	67	17	ANSON, ADRIAN
1881	CHICAGO	56	28	ANSON, ADRIAN
1882	CHICAGO	55	29	ANSON, ADRIAN
1883	BOSTON	63	35	MORRILL, JOHN
1884	PROVIDENCE	84	28	BANCROFT, FRANK
1885	CHICAGO	87	25	ANSON, ADRIAN

PROJECT Operation

The PROJECT operation extracts a subset of the columns of an existing table. The desired columns are selected by stating the column names.

PROJECT creates a vertical subset of the existing table. Table 1-5 is produced from Table 1-4 by projecting the YEAR, CLUB and MANAGER columns.

Table 1-4. National League Winners

YEAR	CLUB	WON	LOST	MANAGER
1880	CHICAGO	67	17	ANSON, ADRIAN
1881	CHICAGO	56	28	ANSON, ADRIAN
1882	CHICAGO	55	29	ANSON, ADRIAN
1883	BOSTON	63	35	MORRILL, JOHN
1884	PROVIDENCE	84	28	BANCROFT, FRANK
1885	CHICAGO	87	25	ANSON, ADRIAN
1886	CHICAGO	90	34	ANSON, ADRIAN

Table 1-5. Projected Columns

YEAR	CLUB	MANAGER
1880	CHICAGO	ANSON, ADRIAN
1881	CHICAGO	ANSON, ADRIAN
1882	CHICAGO	ANSON, ADRIAN
1883	BOSTON	MORRILL, JOHN
1884	PROVIDENCE	BANCROFT, FRANK
1885	CHICAGO	ANSON, ADRIAN
1886	CHICAGO	ANSON, ADRIAN

JOIN Operation

The JOIN operation creates a virtual table by combining the columns from two or more tables. The tables must each have a column the values of which come from the same domain (have the same data type). The user specifies which columns to use for the JOIN and how to compare them.

Table 1-6. Club Winners

YEAR	CLUB WINNER
1880	CHICAGO
1881	CHICAGO
1882	CHICAGO
1883	BOSTON
1884	PROVIDENCE
1885	CHICAGO
1886	CHICAGO

Table 1-7. Team Names

CLUB	NICKNAME
CHICAGO	WHITE STOCKINGS
BOSTON	RED STOCKINGS
PROVIDENCE	GRAYS

Tables 1-6 and 1-7 are joined to display for each year the year, club, and nickname in Table 1-8.

Table 1-8. Team Winners for 1880 - 1886

YEAR	CLUB	NICKNAME
1880	CHICAGO	WHITE STOCKINGS
1881	CHICAGO	WHITE STOCKINGS
1882	CHICAGO	WHITE STOCKINGS
1883	BOSTON	RED STOCKINGS
1884	PROVIDENCE	GRAYS
1885	CHICAGO	WHITE STOCKINGS
1886	CHICAGO	WHITE STOCKINGS

Advantages of the Relational Model

- All data is viewed as two-dimensional tables
  - Simplicity: easily understood by users with no programming experience
  - Uniformity: all data is stored in tables and output is in table format
- No need to know how the data is stored
  - Access is through data values
  - Query language (SQL) is simple
- Relationships are implicit in the data
  - Allows easy handling of unanticipated uses of the data or ad hoc queries
  - Enables addition or modification of related data

What is RDMS 1100?

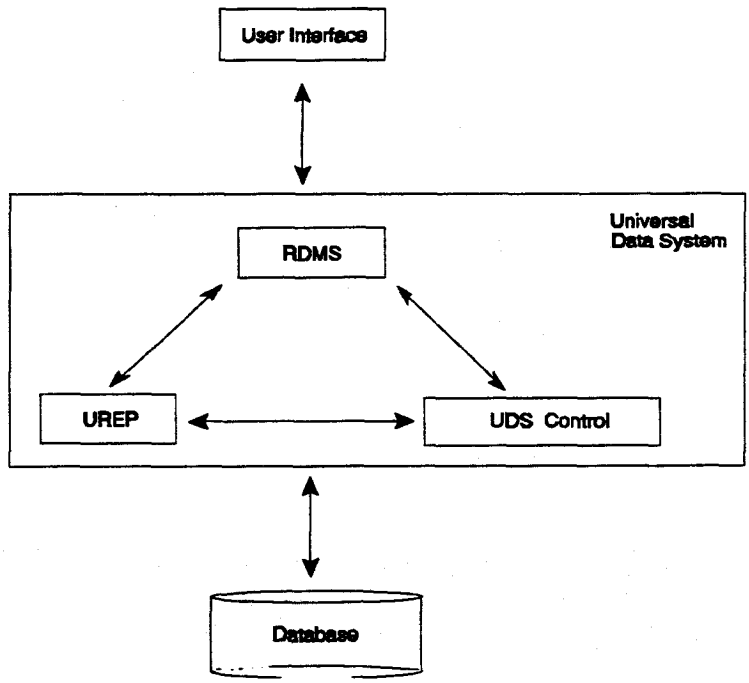


Figure 1-1. RDMS 1100

Relational Data Management System (RDMS)

The database manager for relational data.

Unisys Repository Manager (UREP)

The Unisys database management software that organizes data for user applications in an integrated information management system and in individual files. UREP also maintains the repository.

Universal Data System (UDS) Control

On-line data manager for all three UDS data models. Provides control for common functions such as I/O, locking, queuing, memory management, and recovery.

Universal Data System (UDS)

A suite of Unisys software products for database management, data processing, and database application development. Together with other software components and database software products, UDS provides an integrated environment for control, maintenance, and recovery of user databases.

Interfaces to RDMS I

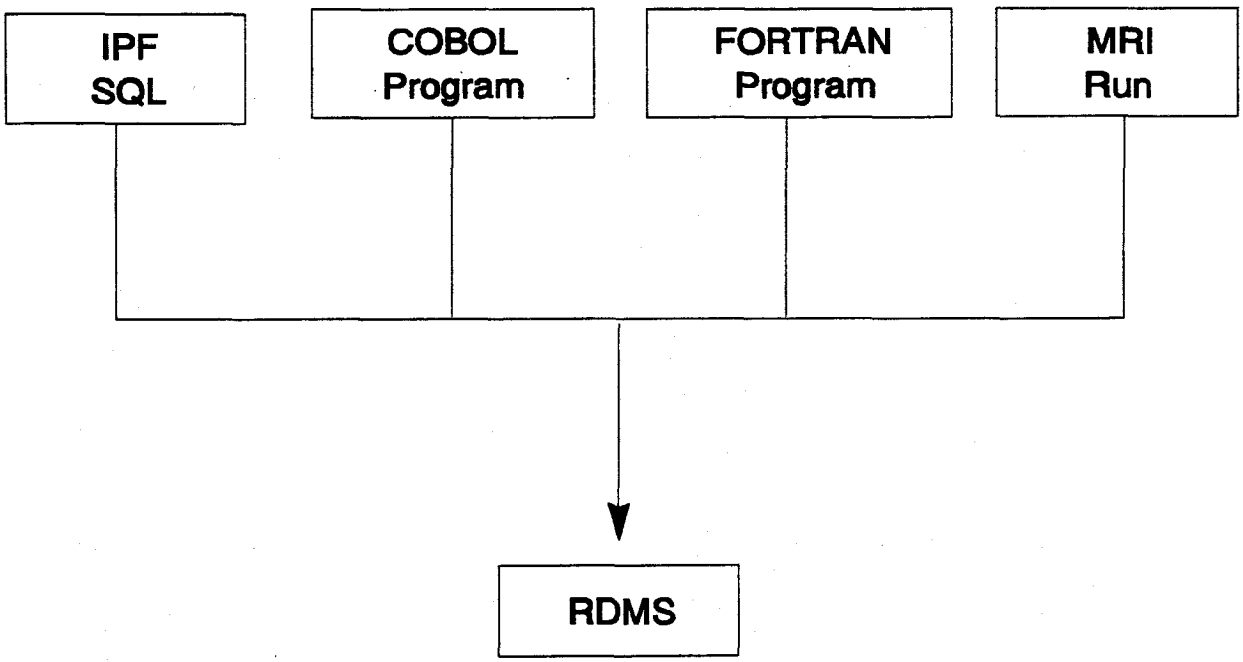


Figure 1-2. RDMS Interfaces

- Figure 1-2 describes the interfaces discussed and illustrated in this course.

- RDMS also provides these other interfaces:
  - Pascal and C programs from the Universal Compiling System (UCS)
  - Query Language Processor (QLP)
  - Logic and Information Network Compiler II (LINC II)
  - ALLY Software
  - SQL*Plus 1100
  - SQL*Report 1100
  - SQL*OCI 1100

Interfaces to RDMS II

- Application programs
  - SQL commands can be placed in ASCII COBOL and ASCII FORTRAN programs
  - SQL commands can be placed in Universal Compiling System (UCS) programs written in COBOL, FORTRAN, C and Pascal
- IPF SQL
  - Interactive access to RDMS databases using SQL commands
  - SQL files can be created and run in IPF to execute a series of SQL commands
- MAPPER Relational Interface (MRI)
  - Interactive menu-driven interface to construct SQL commands
  - Data selected is returned as a MAPPER report
  - Report can be further manipulated with MAPPER functions
  - Run statements also available for embedding in MAPPER runs

The Structured Query Language (SQL)

- Industry standard relational programming language
  - "English-like" non-procedural language
  - Users do not specify how to access the data
- SQL can be interactive or programmatic
  - Embedded in COBOL, FORTRAN, Pascal, or C programs, or MAPPER runs
  - Ad hoc queries through IPF SQL or MAPPER MRI
- Language statements in four categories
  - Queries = SELECT...FROM...
  - Data Manipulation = DELETE, INSERT, UPDATE
  - Data Definition = CREATE, ALTER, DROP
  - Data Control = GRANT, REVOKE

Exercise 1-1

Provide answers or definitions as requested.

1. List at least three advantages of using a relational database management system.

English-like commands
Non procedural
No programming experience required

2. Identify three interfaces to RDMS 1100 data.

ACOB
IPF
MRI

3. Define the following relational database terms:

   a. relation

table

   b. tuple

row

   c. attribute

column

   d. primary key

sort key

2

Retrieving Data with the SELECT Statement

Module 2
Retrieving Data with the SELECT Statement

Module Objectives

Upon completion of this module, you should be able to

- Formulate simple SELECT statements to retrieve data from a database.
  - Including basic use of the WHERE clause.
  - Using arithmetic operators to retrieve data derived from numeric columns of a table.

Benefit Statement

The most basic SQL command is the SELECT query specification. You will need this command to retrieve information from your database. It will be used alone or in combination with other commands. A few simple SELECT command clauses will give you a great deal of power for your database accesses.

Materials

- OS 1100 UDS Relational Data Management System (UDS RDMS 1100) and IPF SQL Interface End Use Guide
- OS 1100 UDS Relational Data Management System (UDS RDMS 1100) SQL Programming Reference Manual

SQL Queries

- The SELECT statement is used to retrieve data from a table in the database.
- Variations of the SELECT statement are used to perform all table operations
  - Restrict
  - Project
  - Join
- Can SELECT
  - Entire table
  - Some columns
  - Some rows
- Can display columns in any order desired
- Order of rows displayed is not (logically) significant

Sample Tables for Examples and Exercises

Table 2-1. EMP

EMPNO	ENAME	JOB	MGR	DNO	HIREDATE	SAL	COMM
5010	FOSTER	SALESREP	5234	200	860714	2700	400
5146	BROWN	CLERK	5234	200	871011	1000	
5234	WOODWORTH	MANAGER	5784	200	790219	3250	
5237	ROCKWELL	ACCOUNTANT	5743	100	840618	2175	
5437	MARTIN	SALESREP	5234	200	870326	2500	300
5469	ADAMS	SALESREP	5234	200	811102	2250	500
5630	GLASS	ACCOUNTANT	5743	100	871220	1850	
5702	TURNER	CLERK	5743	100	890515	900	
5743	LAWSON	MANAGER	5784	100	830510	3400	
5765	JOHNSON	CLERK	5984	400	891221	975	
5784	WILLIAMS	PRESIDENT		300	781015	5200	
5896	SMITH	CLERK	5984	400	880913	1050	
5942	FORD	SALESREP	5234	200	890316	2375	0
5984	HYDE	MANAGER	5784	400	850901	2900	

Table 2-2. DEPT

DNO	DNAME	LOC
100	ACCOUNTING	ATLANTA
200	SALES	NEW YORK
300	MARKETING	DETROIT
400	DISTRIBUTION	PRINCETON

Table 2-3. SAL_GRADE

GRADE	LOSAL	HISAL
1	800	1599
2	1600	2199
3	2200	2799
4	2800	3699
5	3700	5999

Table 2-4. AUX_EMP

EMPNO	GRADE	SEX	MAR_STAT	DEPENDENTS
5010	3	F	S	0
5146	1	M	M	2
5234	4	M	S	0
5237	2	M	S	0
5437	3	F	M	1
5469	3	M	M	2
5630	2	M	M	3
5702	1	F	M	0
5743	4	M	M	3
5765	1	M	S	0
5784	5	F	S	0
5896	1	M	S	0
5942	3	F	M	2
5984	4	F	S	0

SELECT Command

```
SELECT [ DISTINCT ] column1, column2, column3 ...
FROM   tablename
```

- Select-list lists columns to return in desired order

- To display all columns replace select-list with *

Example:

```
SELECT *
FROM DEPT
```

```
DNO  DNAME          LOC
---  -------------  ------------
100  ACCOUNTING     ATLANTA
200  SALES          NEW YORK
300  MARKETING      DETROIT
400  DISTRIBUTION   PRINCETON
```

Selecting Columns

- Columns are displayed in the order requested in the select-list

Example: Display the department name, location, and department number, in that order, of all departments in the DEPT table.

```
SELECT DNAME, LOC, DNO
FROM  DEPT
```

```
DNAME          LOC           DNO
-------------  ----------    ------
ACCOUNTING     ATLANTA       100
SALES          NEW YORK      200
MARKETING      DETROIT       300
DISTRIBUTION   PRINCETON     400
```

- Not all columns need be displayed

Example: Display the department name and department number columns from the DEPT table.

```
SELECT DNAME, DNO
FROM  DEPT
```

```
DNAME            DNO
-------------    ------
ACCOUNTING       100
SALES            200
MARKETING        300
DISTRIBUTION     400
```

DISTINCT Values

- The DISTINCT keyword is used to suppress duplicate values in a column selected for output.

Example: Display the different types of jobs in all the departments without repetition.

```
SELECT DISTINCT JOB
FROM  EMP
```

```
JOB
----------
ACCOUNTANT
CLERK
MANAGER
PRESIDENT
SALESREP
```

- If more than one column is selected, DISTINCT selects unique combinations of values in those columns.

Example: Display all different jobs existing in each department

```
SELECT DISTINCT DNO, JOB
FROM  EMP
```

```
 DNO   JOB
 ---   ----------
 100   ACCOUNTANT
 100   CLERK
 100   MANAGER
 200   CLERK
 200   MANAGER
 200   SALESREP
 300   PRESIDENT
 400   CLERK
 400   MANAGER
```

The WHERE Clause

```
SELECT  select-list
FROM    tablename
WHERE   condition
```

- Used to specify which rows to retrieve

- Specifies condition(s) which the column value must satisfy

Example: Display the employee information for all employees named Hyde.

```
SELECT *
FROM EMP
WHERE ENAME = 'HYDE'
```

```
EMPNO  ENAME      JOB        MGR   DNO  HIREDATE  SAL   COMM
----   ---------- ---------- ----  ---  --------  ----  ----
5984   HYDE       MANAGER    5784  400   850901   2900
```

Example: Display the name and position of everyone in Department 200.

```
SELECT ENAME, JOB
FROM EMP
WHERE DNO = 200
```

```
ENAME      JOB
---------  ----------
FOSTER     SALESREP
BROWN      CLERK
WOODWORTH  MANAGER
MARTIN     SALESREP
ADAMS      SALESREP
FORD       SALESREP
```

WHERE Clause Operators

These binary operators are used to compare two values, either numeric or literal.

- = Equal
  - WHERE JOB = 'MANAGER'
- <> Not equal
  - WHERE DNO <> 400
- > Greater than
  - WHERE COMM > SAL
- < Less than
  - WHERE COMM < SAL
- >= Greater than or equal to
  - WHERE HIREDATE >= 820101
- <= Less than or equal to
  - WHERE HIREDATE <= 850331

WHERE Clause Usage

- Columns named in the WHERE clause must belong to the table named in the FROM clause.

- Columns named in the WHERE clause need not be in the select-list
  - The values tested in the condition do not need to be displayed in the resulting table

- Character string data must be enclosed in single quotes or apostrophes

- Case is significant in character strings.
  - 'HYDE' is not equal to 'Hyde'

The ORDER BY Clause

SORT

```
SELECT  select-list
FROM    tablename
WHERE   condition
ORDER BY  sort-specification-list
```

- Controls how rows returned are displayed
- Sort specification format

  [*unsigned-integer* | *column-name*] [ASC | DESC]

- Integer refers to position in the *select-list*
- Default order is ascending ASC

Example: Display the employee information for department 400 in alphabetical order by employee name

```
SELECT EMPNO, ENAME, JOB, MGR, DNO, HIREDATE, SAL
FROM EMP
WHERE DNO = 400
ORDER BY ENAME ASC
```

EMPNO	ENAME	JOB	MGR	DNO	HIREDATE	SAL
5984	HYDE	MANAGER	5784	400	850901	2900
5765	JOHNSON	CLERK	5984	400	891221	975
5896	SMITH	CLERK	5984	400	880913	1050

Arithmetic Expressions

Arithmetic expressions can be used to display data that is derived from values in columns of the select-list. An expression is composed of column names and constant numeric values connected by an arithmetic operator.

Table 2-5. Arithmetic Operators

+	ADD
-	SUBTRACT
*	MULTIPLY
/	DIVIDE

Example: Display the names and yearly salaries of all employees in Department 400.

```
SELECT ENAME, SAL * 12
FROM EMP
WHERE DNO = 400
```

```
ENAME
-----      ------
JOHNSON    11700
SMITH      12600
HYDE       34800
```

Order of Precedence

In evaluating expressions, the order of precedence of operators is as follows:

- Unary operators positive (+) and negative (-)
- Multiplication (*) and division (/)
- Addition (+) and subtraction (-)

Equal precedence operations, like addition and subtraction, are performed in order, left to right as encountered.

Parentheses are used to clarify or change the order of operations. Nested parentheses are evaluated beginning with the innermost and working outward.

Example:

```
SAL + COMM * 12 - 200  is evaluated as


SAL + COMM * 12 - 200.
      -----1---
----2----------
----------------3----
```

Parentheses can change the order in which expressions are evaluated.

```
(SAL + COMM) * 12 - 200 is evaluated as


(SAL + COMM) * 12 - 200.
-----1------
------------2---
-----------------3----
```

Exercise 2-1

Write the SQL statement necessary to access either the EMP or DEPT table to retrieve the following information. Indicate which records will be displayed.

1. Display the department name and department number for the department in Atlanta.

```
Select  ENAME, DNO  from  DEPT
        where  LOC = 'ATLANTA'
```

2. Display the names of all employees whose total compensation is more than $2600 per month.

```
select ENAME from EMP
       where (SAL+COMM) > 2600
```

3. Display the name, monthly salary, daily salary, and hourly salary for all employees. Assume the SAL column is monthly salary and that there are 22 working days in a month and 8 hours in a working day.

```
Select  ENAME, SAL, SAL/22, SAL/22/8.  FROM  EMP
```

4. Display the names and total compensation of all employees whose commissions are more than 20% of their salaries. Have the names displayed in order by ename name within the departments.

```
Select  ENAME, SAL+COMM  from  EMP
        where (COMM*5) > SAL
        order by
```

3

Using SQL in Application Programs

Module 3
Using SQL in Application Programs

Module Objectives

Upon completion of this module, you should be able to

- Incorporate SQL commands in a host programming language.
  - Describe the flow of processing in a host program that accesses RDMS 1100.
  - Use the BEGIN THREAD and END THREAD commands to establish and terminate a thread with UDS Control.
  - Use SQL commands in a program to retrieve data from an RDMS database.
  - Use host or embedded (ESQL) variables to pass parameters between RDMS and host programs.
  - Include error code in a host program to handle RDMS errors.
  - Compile and run a program containing SQL commands.

Benefit Statement

The SELECT command you have already seen is standard SQL. If you use an interactive interface like IPF SQL, you would enter the command just as you have seen it.

However, if you are not performing ad hoc queries and need to further manipulate the data after it has been retrieved, your SQL commands must be embedded in a third-generation language (3GL) program. This module tells you how to incorporate SQL into COBOL or FORTRAN programs in the 1100/2200 environment. As a programmer, you need to be familiar with the interfaces between RDMS and UDS and your 3GL program.

Materials

- OS 1100 Universal Compiling System (UCS) COBOL Programming Reference Manual Volume 2: Compiler and System Interface
- OS 1100 Universal Compiling System (UCS) Application Development Programming Guide, Volume 1
- OS 1100 UDS Relational Data Management System (UDS RDMS 1100) SQL Programming Reference Manual

Using SQL Commands in 3GL Programs

Accessing RDMS 1100 Data

RDMS 1100 data can be accessed using standard SQL syntax in your program. RDMS 1100 also supports some SQL extensions and alternative formats that are not part of the ANSI standard. The syntax and commands that are nonstandard will be made clear to you in the text. If you are concerned about portability of your program, use only the standard syntax.

You have seen that a SELECT command returns a whole table or a subset of a table. A third-generation language (3GL) program typically deals with only one record or row of the returned table at a time. How to transfer one record of the returned table to the program, and how to code program variables that reference them are important issues.

3GL Interfaces

Unisys provides two interfaces for 3GL programming languages - an interpretive SQL and embedded SQL or ESQL.

Interpretive SQL incorporates the SQL statement as a string literal passed as an argument to RDMS on a procedure call. This interface was originally available from ASCII COBOL and ASCII FORTRAN, and made available to the languages in the Universal Compiling System (UCS), namely UCS COBOL, UCS FORTRAN, UCS C, and UCS Pascal. RDMS must interpret each SQL statement each time it is encountered during program execution. Interpretive SQL will be abbreviated ISQL in this student guide whenever an ISQL - ESQL distinction is important.

The Embedded SQL interface, which is only available from UCS COBOL, fully conforms to the SQL standard and provides some extensions as well. Each SQL command begins with an embedded SQL prefix, EXEC SQL, and ends with an embedded SQL terminator, END-EXEC. The embedded SQL commands are fully compiled along with the host program. Execution of ESQL commands will be significantly faster than their interpreted counterparts. This is particularly noticeable in program loops. Interpretive and embedded SQL commands can be used in the same program.

Several other differences exist between the two implementations. ASCII COBOL and UCS COBOL will be used to illustrate these differences.

UDS Environment Commands

Another important issue is how to incorporate your program into the UDS environment so that it takes advantage of the UDS recovery and locking features. Specific commands needed to accomplish this are also shown.

SQL and Unisys Extensions

- Accessing RDMS 1100 data
  - ANSI standard SQL
  - Unisys extensions
  - One record at a time
- 3GL interfaces
  - Interpretive SQL
  - Embedded SQL
- UDS environment commands
  - Provide recovery
  - Set up UDS environment
  - Use Unisys extensions

Summary of Selected SQL Commands

Table 3-1 groups the standard SQL commands that will be covered in this course. Unless noted by the asterisk in Table 3-1, RDMS supports the SQL 89 form of the command and, in many cases, offers one or more extensions to it. Table 3-1 is derived from the SB4R4 system release, which is release 5R3 of RDMS.

Refer to the OS 1100 UDS Relational Data Management System (UDS RDMS 1100) SQL Programming Reference Manual for more the details on the supported extensions for the above commands.

Table 3-1. Standard SQL Commands

Function	Command
Data Definition	CREATE TABLE *
Data Retrieval	DECLARE CURSOR
	OPEN
	CLOSE
	FETCH
	SELECT Single Row
Data Creation/	INSERT
Manipulation	DELETE
	COMMIT
	ROLLBACK
	BEGIN DECLARE (ESQL)
	END DECLARE (ESQL)
	UPDATE Searched
	UPDATE Positioned
Miscellaneous	GRANT
	WHENEVER (ESQL) *

* RDMS does not support the SQL 89 form of this command and offers no extensions to it

Table 3-2 lists the SQL extensions available from Unisys that will be covered in this course.

Table 3-2. Common Unisys Extensions for the 1100/2200 Environment

Function	Command
Data Definition	ALTER TABLE
	DROP TABLE
	CREATE INDEX
	DROP INDEX
	CREATE VIEW
	DROP VIEW
Data Retrieval	DROP CURSOR **
	FETCH (next/prior/first/last/current)
	FETCH NEXT n
	LOCATE
Data Locking	LOCK
	UNLOCK
Thread Control	BEGIN THREAD
	END THREAD
Miscellaneous	GETERROR
	USE DEFAULT

** Not allowed in embedded SQL (ESQL)

Comparing Embedded and Interpretive SQL

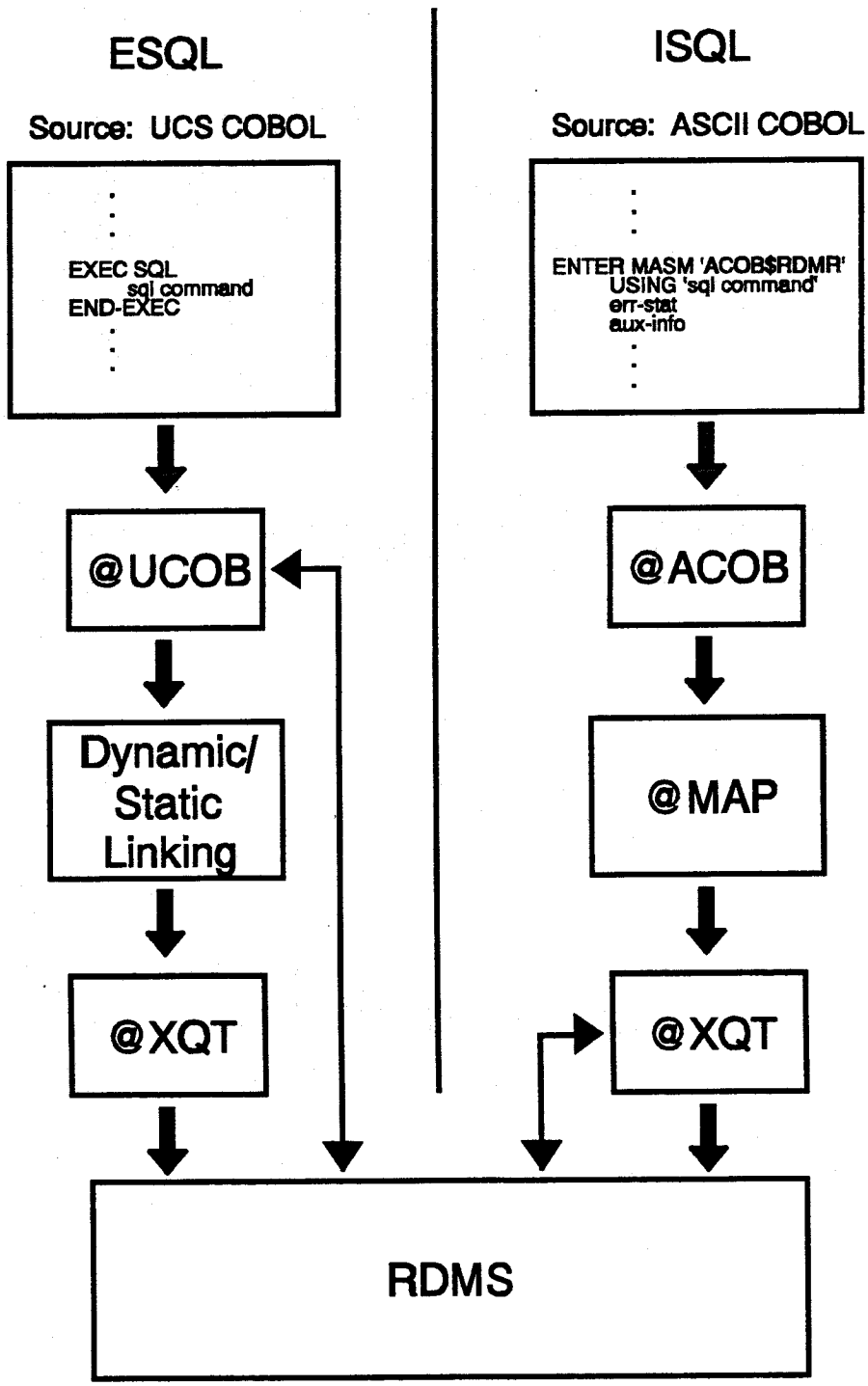


Figure 3-1. ESQL/ISQL Comparison

Source

- Place embedded UCOB SQL (ESQL) commands in packets delimited by EXEC SQL and END-EXEC.
- Format interpretive SQL commands (ISQL) according to the host language conventions
  - ASCII or UCS COBOL - ENTER MASM 'ACOB$RDMR' commands
  - ASCII or UCS FORTRAN - CALL F$RDMR commands
  - UCS Pascal - procedure call statement to F$RDMR
  - UCS C - include the system header file rsa.h, then call the rsa function

Compilation

- Embedded commands are fully compiled
  - Analyze SQL syntax
  - Create an internal form of the command
  - Resolve table and column names (tables must be already created)
  - Optimize access path
- Interpreted commands are not compiled (no prior creation of tables needed)

Collection or Link

- Resolve references between user elements and support libraries
- Create an executable program structure

Execution

- Embedded SQL commands executed to access database
- Interpretive SQL commands are compiled, then executed if no syntax errors exist

SQL Commands in COBOL Programs

Interpretive SQL

Format 1

```
ENTER MASM 'ACOB$RDMR' USING
    'SQL-COMMAND        ; ',
    err-stat,
    aux-info.
```

Format 2

```
MOVE sql-com-string-variable TO rcom.
ENTER MASM 'ACOB$RDMR' USING rcom, err-stat, aux-info.
```

Syntax Notes

- The SQL command or the contents of SQL-COM-STRING-VARIABLE must end with a semicolon (;).

- The item *err-stat* defines an error status returned by RDMS for an SQL command; normal completion is 0000.

- The item *aux-info* contains useful information about the error status.

ISQL Example

```
    .
    .
    .
DATA DIVISION.
WORKING-STORAGE SECTION.
    .
    .
    .
01  rcom.
    05  rlin              PIC  X(40) OCCURS 10 TIMES.
01  err-stat              PIC  9(4).
01  aux-info              PIC  S1(36).
    .
    .
    .
PROCEDURE DIVISION.
    .
    .
    .
ENTER MASM 'ACOB$RDMR' USING
    'BEGIN THREAD FOR udssrc READ          ; ',
       err-stat,
       aux-info.
    .
    .
    .
MOVE 'DECLARE employee CURSOR SELECT * FROM emp ;'
    TO rcom.
ENTER MASM 'ACOB$RDMR' USING rcom, err-stat, aux-info.
    .
    .
    .
```

Embedded SQL

Format 1

```
EXEC SQL
   SQL-COMMAND
END-EXEC.
```

Format 2

```
SQL-COMMAND.
```

Syntax Notes

- Format 1
  - Required by SQL standard
  - Delimit packets for the compiler with EXEC SQL and END-EXEC
  - Insert only one SQL command into a packet
- Format 2
  - For five commands that do not require the packet delimiters (packet is optional)
    - BEGIN THREAD
    - END THREAD
    - COMMIT
    - ROLLBACK
    - GETERROR
  - Command must end with a period
  - Command cannot be part of a larger command structure, for example an IF statement

ESQL Command Scoping

- Five commands are acted upon during compilation
  - DECLARE CURSOR
  - USE DEFAULT
  - WHENEVER
  - DEBUG (static format only)
  - SET STATISTICS
- Must be placed physically ahead of other commands they affect in the source program

Note: *This course will address static ESQL only. Dynamic ESQL provides a subset of SQL commands, typically involving a database update, that are not processed at compile time, but at execution time. Dynamic ESQL is the functional equivalent of the ENTER MASM interpretive interface for COBOL. A program can contain a mixture of both static ESQL and interpretive SQL; this fact may be important in a migration to ESQL from ISQL.*

ESQL Example

Notice the SQL commands in the Procedure Division illustrated below that do or do not require ESQL packets. Part of required Data Division is illustrated; it will be more fully discussed with error handling in this module.

```
    .
    .
    .
DATA DIVISION.
WORKING-STORAGE SECTION.
    .
    .
    .
01  SQLCODE                PIC S9(9) USAGE BINARY.
    EXEC SQL                BEGIN DECLARE SECTION  END-EXEC.
01  RDMCA.
    05  ERROR-STATUS       PIC 9(4).
    05  AUX-INFO           PIC S9(9) USAGE BINARY.
    EXEC SQL                END DECLARE SECTION    END-EXEC.
    .
    .
    .
PROCEDURE DIVISION.
    .
    .
    .
    EXEC SQL
       WHENEVER SQLERROR GO TO :rdms-err-para
    END-EXEC.
    .
    .
    .
    BEGIN THREAD FOR udssrc READ.
    .
    .
    .
    EXEC SQL
       DECLARE employee CURSOR SELECT * FROM emp
    END-EXEC.
    .
    .
    .
rdms-err-para.
    .
    .
    .
```

Command Building Blocks

Constants

String Literals

A string literal is a character sequence surrounded by string delimiters. Single quotes (apostrophes) are string delimiters.

ENTER MASM 'ACOB$RDMR' USING 'SQL Command' ... uses a string literal to pass the command to RDMS.

Numeric Literals

Numeric literals are either integers or real numbers. Real numbers contain a decimal point, but integers do not. You can write them with or without the leading sign. Numeric literals cannot be longer than 21 digits. This limit does not include either the sign or the decimal point.

NULL Values

A data item that has no assigned value has a NULL value. NULL values are distinct from zero values or spaces. NULLs are used instead of inserting dummy values that may be mistaken for assigned values. NULL values may not be used in arithmetic or Boolean expressions. There are special functions that test for NULL values.

Naming Database Objects

1. Names may contain from 1 to 30 characters.

2. Names may use characters A-Z, a-z, 0-9, and _(underscore).

3. Names must begin with a letter, and cannot end with an underscore.

4. Names are not case sensitive.

5. The name may not be a reserved word.

6. The above rules can be ignored if the name is enclosed in double quotes.

Table 3-3 illustrates several valid and invalid names for database objects.

Table 3-3. Examples of Database Object Names

Valid	Invalid
sales_reps	sales-reps
PURCHASE_PRICE	PURCHASE*PRICE
"TABLE"	TABLE

RDMS 1100/2200 Data Types

Every literal or variable has a data type. A data type associates a fixed set of properties with a value. It also restricts the values the data item may contain.

A value in the database takes on the data type of the column to which it belongs. When a table is created or modified, the column is assigned a data type. When a query is executed and values are returned to your program, the program variables into which the values will go must correspond to the data type of the database item.

RDMS supports two character and seven numerical data types.

Character Data Types

The character data types and their definition formats are

CHARACTER (*size*)

NCHARACTER (*size*)

CHARACTER data types contain ASCII or any other 9-bit data. Character(5) specifies a five-position character string. A corresponding COBOL program variable should be defined as PIC X(5).

NCHARACTER contains 16-bit data, such as Kanji characters.

Numerical Data Types

There are several data types that hold numerical information. Numerical data types can be either exact or approximate.

Exact Numerical Data Types

The exact numerical data types and their definition formats are:

DECIMAL [(*sign-and-digits-precision*[,*scale*])]

NUMERIC [*digits-precision*[,*scale*)]

INTEGER

SMALLINT

The value of *sign-and-digits-precision* specifies the total number of digits in the column including the leading sign. This must be an integer between 2 and 22, inclusive. For example, DECIMAL(6.2) allows 6 positions, 2 of which are decimal. A corresponding COBOL program variable would be defined as PIC S999V99. Decimal(4) should be declared as PIC S9(3).

The *digits-precision* is the number of digits in the column and must be no larger than 11.

The *scale* is a non-negative integer that indicates the number of digits for the fractional portion of the column. This can be no larger than *digits-precision* - 1 for NUMERIC and no larger than *sign-and-digits-precision* -1 for DECIMAL.

A period can be used instead of a comma between *digits-precision* and *scale*.

Approximate Numerical Data Types

The approximate numerical data types and their formats are:

REAL

FLOAT [(*binary-precision*)]

DOUBLE PRECISION

The value of *binary-precision* must be a positive integer less than 60. It defines the minimum binary precision in bits.

Consult the OS 1100 UDS Relational Data Management System (UDS RDMS 1100) SQL Programming Reference Manual for more information on the numerical data types.

RDMS and 3GL Data Type Equivalencies

Both RDMS and your host language define data types. You should use equivalent data types for corresponding data items in order to avoid unnecessary conversions, as illustrated in Table 3-4.

Table 3-4. RDMS Data Types and Equivalent Language Definitions

RDMS 1100 Column Definition	UCS COBOL Data Definition	ASCII COBOL Data Definition	ASCII FORTRAN or UCS FORTRAN
CHARACTER(n)	X(n) A(n)	X(n) A(n)	CHARACTER*n
NCHARACTER(n)	X(n) usage disp-2	(no equivalent)	NCHARACTER*n
DECIMAL(d,s)	S9(d-s-1)v9(s) sign leading separate	S9(d-s-1)v9(s) sign leading separate	INTEGER REAL DOUBLE PRECISION
NUMERIC(d,s)	S9(d-s)v9(s) usage binary	S9(d-s)v9(s) usage comp	INTEGER REAL DOUBLE PRECISION
INTEGER	S9(10) usage binary S1(36) usage binary-1	S9(10) usage comp S1(36)	INTEGER
SMALLINT	S9(5) usage binary S1(18) usage binary-1	S9(5) usage comp S1(18)	INTEGER
REAL	usage comp-1	usage comp-1	REAL
DOUBLE PRECISION	usage comp-2	usage comp-2	DOUBLE PRECISION
FLOAT(p)	usage comp-1 usage comp-2	usage comp-1 usage comp-2	REAL DOUBLE PRECISION

RDMS 1100/2200 Terminology

Before you can write a program that incorporates SQL commands in the 1100/2200 environment, there are a few more terms that must be defined. They relate your program to its environment.

Cursor

The definition of the data to retrieve. Used only to return results to a program.

Currency

Currency indicates which row of the cursor is being accessed. This pointer is needed as a way to keep track of the rows being returned to a COBOL or FORTRAN program, one at a time.

Application Group

A software partition that acts as an independent database system and has its own system and data files and its own recovery environment. Applications groups do not share data with other application groups and there is no coordinated locking or recovery between application groups. As a programmer, you need to know the name or alias of the application group to which your program belongs.

Thread

A thread is a work session established with UDS. It defines your UDS environment. Each thread exists in one and only one application group.

Program Flow

Figure 3-2 illustrates the typical program flow of control and some of the SQL commands that are involved.

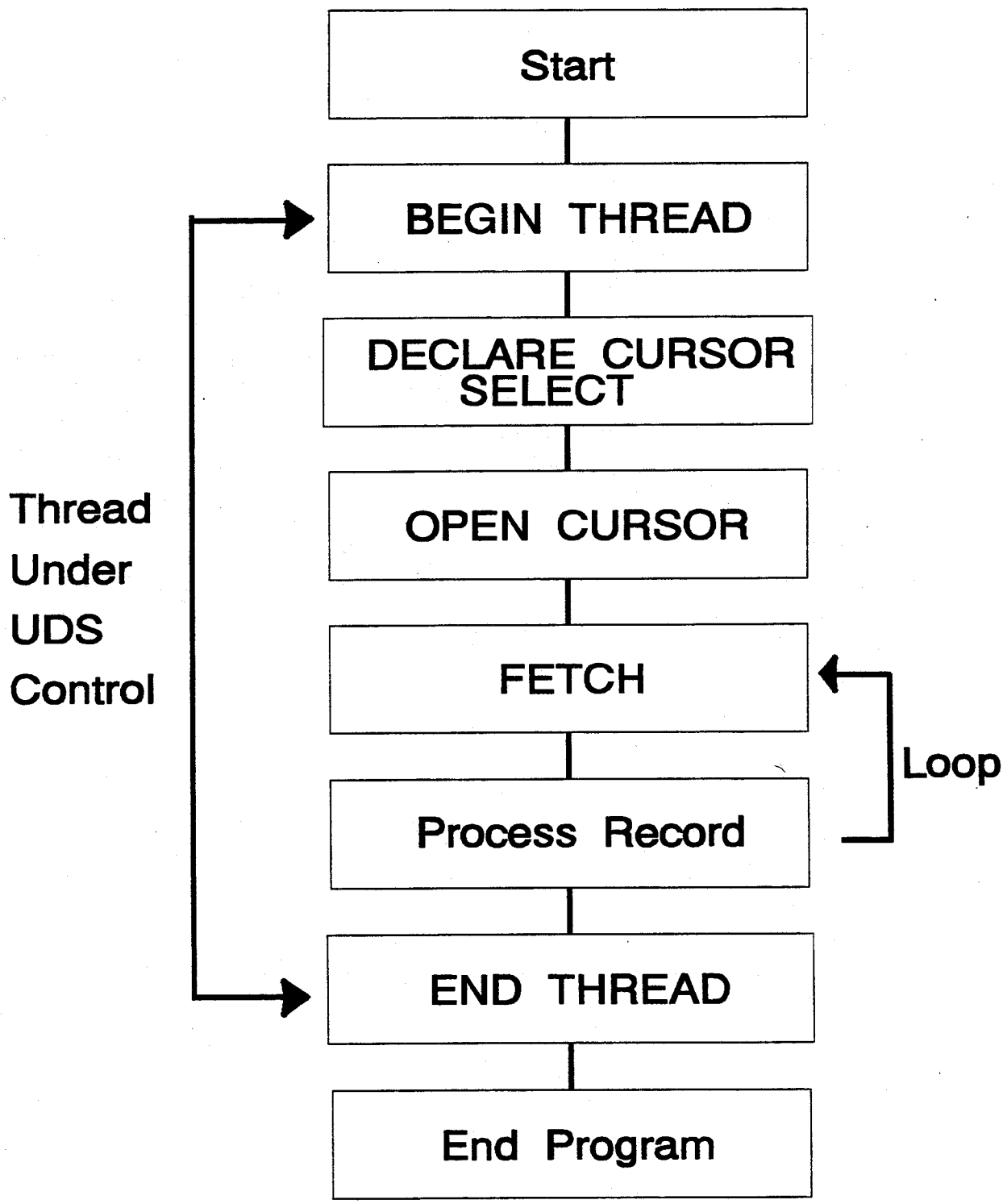


Figure 3-2. Program Flow with SQL Commands

BEGIN THREAD Command

BEGIN THREAD [*thread-name*]
FOR [APPLICATION] *application-name [options]*

- Unisys extension to register thread with UDS 1100
  - Sets up working storage and environment for subsequent SQL commands
  - Specifies application group or alias name for application group to which thread belongs
  - Specifies what type of recovery to use during updates
- Retrieval options
  - READ/RETRIEVE
  - Database access is read only
  - Attempt to update data generates an error
- Message options
  - UDSMSG or UDSMESSAGE or UDSMESSAGES
  - Messages from UDS 1100 are returned immediately

Examples:

```
BEGIN THREAD mythread FOR app1

BEGIN THREAD FOR UDSSRC READ

BEGIN THREAD t1 FOR UDSSRC READ UDSMSG

BEGIN THREAD FOR app2 RETRIEVE UDSMESSAGE
```

DECLARE CURSOR Command

DECLARE *cursor-name* CURSOR
[FOR] *select-clause*
[ORDER BY *sort-specification*]

- Associates a named data area with a particular query
  - Defines a conceptual table containing the rows returned before they are passed to the program, one row at a time
  - A single program may have multiple declared cursors
  - A cursor must be declared before any other references can be made to it
- SELECT clause specifies which data to return
- ORDER BY clause controls how result is displayed

Examples

```
DECLARE emp1 CURSOR
    SELECT * FROM emp

DECLARE c1 CURSOR
    SELECT dname, dno FROM dept
    ORDER BY dno

DECLARE sal_cursor CURSOR
    SELECT ename, sal FROM emp
    WHERE dno = 200
    ORDER BY 2 DESC
```

OPEN CURSOR Command

OPEN *cursor-name*

- Opening the cursor evaluates the query in the DECLARE CURSOR command
  - Sets the cursor's currency pointer to just prior to the first row
  - Sorts the rows if DECLARE CURSOR had ORDER BY clause
- Performed implicitly by first FETCH for ISQL
- Required for static ESQL

Example:

```
OPEN SAL_CURSOR
```

FETCH Command

FETCH *cursor-name* INTO *variable-specification-list*

- FETCH retrieves the next row of the cursor relative to the currency pointer
  - First FETCH retrieves the first row returned based on the cursor definition
  - Usually used in a program loop to read all the rows
- Where *variable-specification-list* is
  - A list of placeholder variables, one for each column in the cursor (ISQL)
  - A set of embedded variables, one for each column in the cursor (ESQL)

ISQL Example:

```
ENTER MASM 'ACOB$RDMR' USING
    'FETCH dept_cursor INTO $p1, $p2, $p3  ;',
    err-stat, aux-info, rr-dno, rr-dname, rr-loc
```

ESQL Example:

```
EXEC SQL
    FETCH dept_cursor INTO :rr-dno, :rr-dname, :rr-loc
END-EXEC.
```

Passing Information Between a Program and RDMS

Figure 3-3 illustrates how data is passed between a program and RDMS.

Note: *Only interpretive SQL requires the placeholder variables, $P1, $P2,and $P3.*

Host Program Variables

Database applications that use third-generation programming languages will need program variables declared in the host program. Host program variables are used to pass information between your program and RDMS.

The host program variable's size and data type is determined from the RDMS column it corresponds to. You can find this information in the table definition. The size and data type of your host program variables must match the size and data type of the table declarations .

You need a host program variable for each column you are inserting values into, retrieving values from, or comparing values against.

Placeholder Variables in ISQL

ISQL statements cannot directly reference program variables, so placeholders are the means of passing values between RDMS 1100 and your program. Placeholder variables are named according to their position in the SQL string in which they are passed; three placeholder variables would be named $P1, $P2, and $P3. Your call to RDMS must have a host program variable for each placeholder variable passed as an additional parameters.

Embedded Variables in ESQL

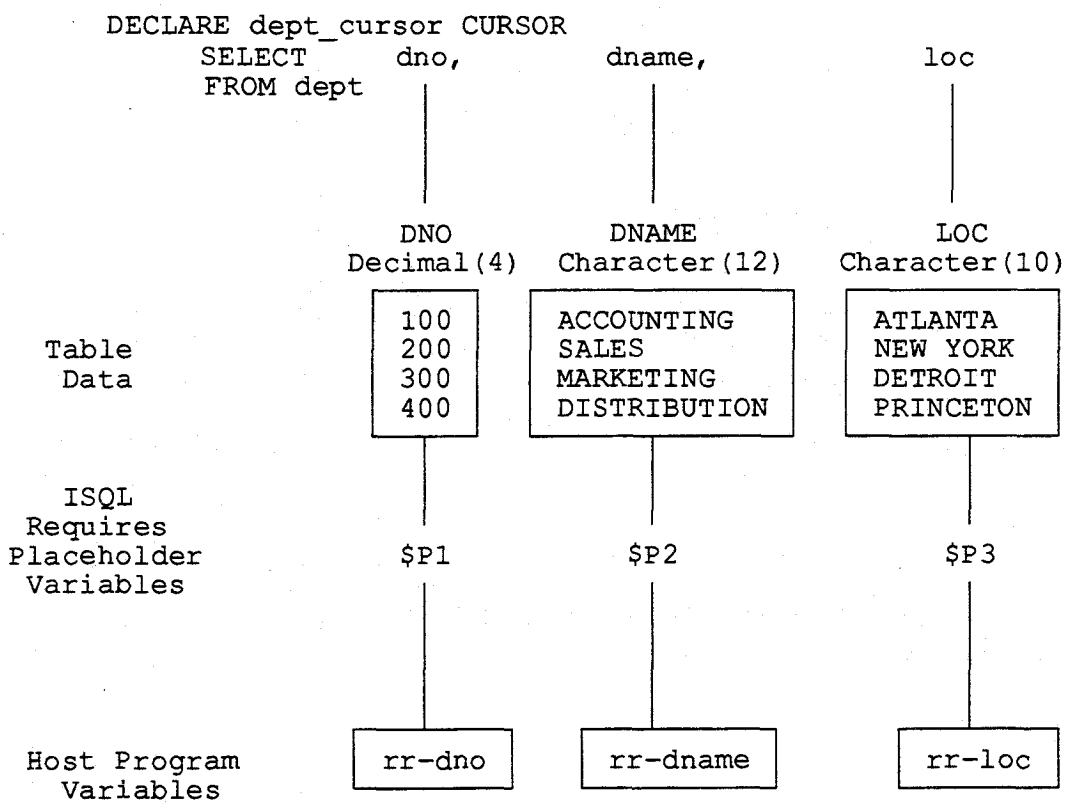
ESQL allows direct references to host program variables, known as embedded variables. According to the SQL standard, you must prefix the host program variable name with a colon (:) and embed it in the command string.

Parameter Passing Limitations

The ASCII COBOL (ACOB) compiler limits the number of parameters passed on an ENTER MASM call to 31.

The UCS COBOL (UCOB) compiler limits the number of parameters passed to 250.

ISQL - Placeholder and Host Program Variables




```
WORKING STORAGE.
01 record-retrieved.
   05 rr-dno        PIC 9(4).
   05 rr-dname      PIC X(12).
   05 rr-loc        PIC X(10).

ENTER MASM 'ACOB$RDMR' USING
   'FETCH dept_cursor INTO $P1, $P2, $P3  ;',
   err-stat,
   aux-info,
   rr-dno,     <
   rr-dname,   <
   rr-loc      <
```

Figure 3-3. Cursor-Program Variable Interaction

END THREAD Command

```
END THREAD
```

- Disconnects thread from UDS Control
- A Unisys extension command needed to end a work session
- Working storage and environment discarded
- Commits database changes if in update mode

USE DEFAULT QUALIFIER Command

USE DEFAULT QUALIFIER *qualifier-name*

- Unisys SQL extension
- Establishes a new default table qualifier
  - Used for duration of thread or until another default is specified
  - System default qualifier is RDMS for all tables referenced
- Table specification
  - Format is: [qualifier.]table-name[:version-name]
  - Table acquires qualifier when created
- Useful when referencing
  - Multiple tables with same qualifier
  - Table-names with long qualifiers

Examples:

USE DEFAULT QUALIFIER VJP	A subsequent reference to table EMP references VJP.EMP
EMP	Refers implicitly to RDMS.EMP
VJP.EMP	Refers explicitly to VJP.EMP

Exercise 3-1

1. Identify which variable names are valid and which are invalid in RDMS.

   MY-TABLE Bad

   EMPCURSOR ok

   Table*2 Bad

   Another_Cursor ok

2. If the following columns were defined in a table called CAR_SALES, how would the program variables into which they were to be retrieved be declared?

REG_NUMBER	DECIMAL(8)	S9(7)
MAKE_AND_MODEL	CHARACTER(10)	X(10)
DATE_PURCH	DECIMAL(7)	S9(6)
SALE_PRICE	DECIMAL(6)	S9(5)
REP_CODE	SMALLINT	S9(5) comp
COMMISSION	NUMERIC(7,2)	S9(5)V99

3. Put a number before each command below to indicate the order in which they would appear in an application program.

   3 OPEN CURSOR

   5 END THREAD

   2 DECLARE CURSOR

   1 BEGIN THREAD

   4 FETCH

4. Code the complete ESQL or ISQL command to define a cursor that selects the employee number, employee name, and total compensation from the EMP table.

5. Code the ESQL or ISQL call to fetch the rows retrieved in item 4 above. What assumptions must you make about the WORKING-STORAGE section of your program?

Lab 3-1

Your instructor will discuss your particular lab set-up and requirements with you. Appendix A is provided to keep track of necessary system usage information.

Using the ACOB or UCOB skeleton provided, write a program to display the employee number, name, position, and hire date of all employees in Department 200. You must complete the working storage section and the appropriate ISQL or ESQL commands.

A hard copy of the ACOB skeleton for the interpretive SQL interface (ISQL) is in Appendix C of this student guide. The ACOB program example in Appendix D should help you decide what work needs to be done.

Similarly, a hard copy of the UCOB skeleton for working with embedded SQL (ESQL) is in Appendix E, and is followed by a complete program in appendix F.

In lab you will edit the on-line skeleton program, compile, and execute the program. The on-line program skeleton names are ACOBSKEL and UCOBSKEL. Information on compiling, collecting or linking, and executing your program can be found in Appendix A.

The flow chart in Figure 3-4 illustrates the basic steps for the examples in the appendixes which read and display all of the records in the employee table EMP. Your program logic will be very similar.

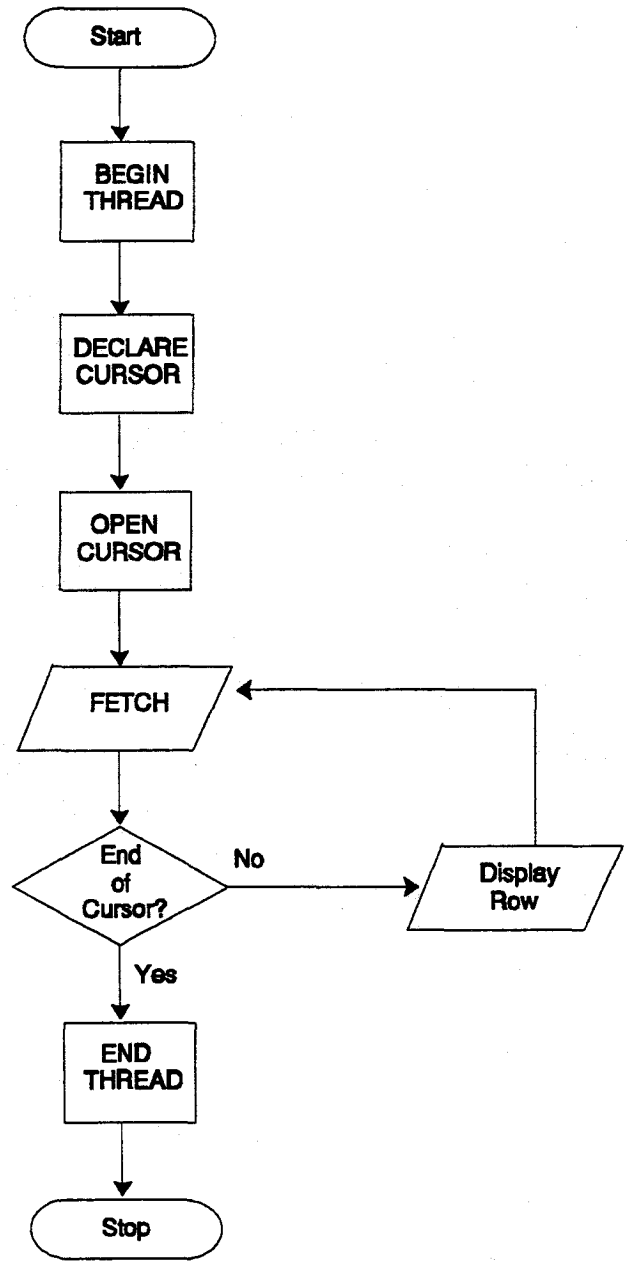


Figure 3-4. Flow Chart of an SQL Retrieval Program

Error Handling Choices

- RDMS error handling
  - Each SQL call returns an error status to a 4 character field
  - Normal completion = 0000
  - End-of-cursor = 6001
  - Any other value is error
- Automatic error printing
  - BEGIN THREAD option of UDSMSG/UDSMESSAGE
  - Immediately prints an error message to output device
  - No other code necessary
  - Prints messages from UDS, UREP, and RDMS
- Programmer-controlled error handling
  - Check error status after each SQL command
  - If error, use GETERROR command to retrieve error text
  - Retrieves messages detected by RDMS, UREP, and UDS Control
  - Print messages when and where you want
- ESQL provides new error handling features
  - Variable SQLCODE for status information
  - BEGIN DECLARE command for ESQL variables
  - Global WHENEVER command for execution errors

RDMS Error Handling

Every RDMS call, except an SQL GETERROR call, returns an error status code and auxiliary information about the completion of the call. The error-status item is a 4 digit variable in the data declarations of the host program. The auxiliary-information item in COBOL is declared as a multipurpose, one-word, numeric item.

You can test the value of error-status variable then decide how to handle the error. A status equal to 6001 indicates a no-find or an end-of-data condition. After fetching from a cursor, this is not an error. Continue to the next processing step.

The auxiliary information variable returns additional information about the error status. When the error status is not between 6000 and 6999, it returns the column number in the command where the syntax error was located. When the error status is between 6000 and 6999, auxiliary information contains other command status and rollback information.

ISQL COBOL Example:

```
    MOVE 'Command string ;'  TO RCOM
    ENTER MASM 'ACOB$RDMR' USING RCOM, ERR-STAT, AUX-INFO
    IF ERR-STAT NOT = 0000 PERFORM ERROR-PRINT
      .
      .
ERROR-PRINT
    DISPLAY 'RDML COMMAND = ' RCOM
    DISPLAY 'ERROR STATUS = ' ERR-STAT
    DISPLAY 'ERROR COLUMN = ' AUX-INFO
```

FORTRAN Example:

```
    rcom = command-string
    CALL F$RDMR (rcom, erstat, auxinf)
    IF (erstat .NE. '0000') THEN
       PRINT '(1X,A)',      'RDMS command: ',rcom
       PRINT '(A26,I3)',    'Error Found at Column ', auxinf
       PRINT '(A16,A4)',    'Error Status: ', erstat
    ENDIF
```

GETERROR Command

GETERROR INTO *variable-list*

- Retrieves the error message from an SQL command
- Unisys extension
- Details on *variable-list*
  - Provides a list of variables separated by commas
  - Each variable must correspond to a host program variable
  - Each host program variable must hold at least 132 ASCII characters
  - Five host program variables usually retrieve entire message
- Retrieved message must be printed or moved before executing the next SQL command

ESQL Example:

```
GETERROR INTO :err(1), :err(2), :err(3), :err(4), :err(5).
```

Example Using GETERROR (ACOB)

```
      .
      .
      .
WORKING-STORAGE SECTION.
      .
      .
      .
01    err-stat                    PIC 9999.
01    aux-info                    PIC S9(18).
01    error-text.
  05  err-s                       PIC X(132) OCCURS 5 TIMES.
01    i                           PIC 9999.
01    err-end-flag                PIC 9999.
      .
      .
      .
PROCEDURE DIVISION.
      .
      .
      .
  MOVE 'BEGIN THREAD T1 FOR udssrc READ  ;'  TO rcom.
  ENTER MASM 'acob$rdmr' USING rcom, err-stat, aux-info.
  IF err-stat NOT = 0 GO TO error-para.
      .
      .
      .
error-para.
  MOVE 0 TO err-end-flag.
  PERFORM do-geterror UNTIL err-end-flag NOT = 0.
  ENTER MASM 'acob$rdmr' USING 'END THREAD ;',
     error-stat, aux-info.
  DISPLAY "Abnormal end of program." UPON PRINTER.
  STOP RUN.
      .
      .
      .
do-geterror.
  MOVE  'GETERROR INTO $P1, $P2, $P3, $P4, $P5;' TO rcom.
  ENTER MASM 'ACOB$RDMR' USING rcom, err-stat,
     aux-info, err-s(1), err-s(2), err-s(3), err-s(4), err-s(5).
  PERFORM print-error VARYING i FROM 1 BY 1 UNTIL i > 5 .
      .
      .
      .
print-error.
  If err-s(i) NOT = SPACE
     DISPLAY err-s(i) UPON PRINTER
  ELSE
     MOVE 5 TO i
     MOVE 1 TO err-end-flag.
      .
      .
      .
```

ESQL Error Handling

If your ESQL error handling must conform to the current standard, you must define the variable SQLCODE, use the global WHENEVER command, and define a new data section with the BEGIN DECLARE command.

The variable SQLCODE must be declared by that name in the Data Division of your program. It holds the completion status of each executed SQL command. A value of 0 indicates normal completion, +100 means no data or no more data, and a negative value indicates an error has occurred.

You will use the WHENEVER command to transfer control to a particular paragraph should a no-find or error condition occur when executing an SQL command.

A new section must define variables you use in ESQL statements. This section, also a part of the SQL standard, is written in the Working-Storage Section as an embedded command. It is defined with the Begin Declare command.

A UCOB compiler option, LEVEL/SQL, can be used on the compiler call to flag nonstandard commands. You can enter this keyword option as you would any other, for example:

```
@UCOB,ES  SQL.LAB3-1/UCOBSKEL,TPF$.UCOB,,,NARROW,LEVEL/SQL
```

If portability is not a concern, the variables ERROR-STATUS and AUX-INFO in the structure RDMCA group item can be used to obtain the command status and auxiliary information returned by RDMS. You must code the variable names and structure name in a precise way in the Declare Section in the Working-Storage Section. You will use the two variables along with the GETERROR command just as you would have in ISQL, but you do not pass them to RDMS with each SQL command.

Data and Commands for ESQL Error Handling

- SQLCODE contains completion status for each executed SQL command
- WHENEVER command
  - Branch on detected SQL execution error
  - Branch on no-find condition
- BEGIN DECLARE command for variables used in SQL commands
- LEVEL/SQL flags nonstandard SQL
- RDMCA group item
  - Contains variables ERROR-STATUS and AUX-INFO
  - Placed in Declare Section

WHENEVER Command

Don't bother with this
Use FS or error stat

```
WHENEVER { SQLERROR | NOT FOUND }
    { CONTINUE | { GOTO | GO TO } paragraph-name }
```

- Detected conditions
  - SQLERROR means SQLCODE is negative, an abnormal error status is returned by RDMS
  - NOT FOUND means SQLCODE = +100, a "not found" status returned by RDMS
- Action to take
  - CONTINUE means to execute the next program statement
  - GO TO/GOTO *paragraph-name* specifies a paragraph to branch to for the detected condition
- A WHENEVER command affects all ESQL commands that follow it, until another WHENEVER command for the detected condition
- To avoid an infinite loop in the error handling paragraph, execute a WHENEVER SQLERROR CONTINUE

Examples:

```
EXEC SQL  WHENEVER SQLERROR CONTINUE  END-EXEC.
```

```
EXEC SQL
    WHENEVER SQLERROR GO TO rdms-error-para
END-EXEC.
```

WHENEVER must be physically before other SQL commands

ESQL Data Area Declarations

Variable SQLCODE

- Returns the status of each executed embedded SQL command
  - 0 = Successful completion
  - +100 No data, no more data
  - Negative = error
- Does not return a status for GETERROR

BEGIN DECLARE Command

```
EXEC SQL  BEGIN DECLARE SECTION  END-EXEC
```

- Marks a data area for variables used in SQL commands in the COBOL Working-Storage Section
- Required by SQL standard, not by RDMS

RDMCA with Variables ERROR-STATUS and AUX-INFO

- RDMS uses variables automatically to return status information for each SQL command, except GETERROR
- Must be defined in a prescribed way

Example Using GETERROR (UCOB)

```
    .
    .
    .
WORKING-STORAGE SECTION.
    .
    .
    .
    EXEC SQL  BEGIN DECLARE SECTION     END-EXEC.
01  SQLCODE                    PIC S9(9) USAGE BINARY.
01  RDMCA.
    05  ERROR-STATUS           PIC 9(4).
    05  AUX-INFO               PIC S9(9) USAGE BINARY.
    EXEC-SQL  END DECLARE SECTION   END-EXEC.
    .
    .
    .
01  error-text.
    05  err-s                  PIC X(132) OCCURS 5 TIMES.
01  err-index                  PIC 9.
    .
    .
    .
PROCEDURE DIVISION.
    .
    .
    .
    EXEC SQL
       WHENEVER SQLERROR GO TO rdms-error-para
    END-EXEC.
    .
    .
    .
rdms-error-para.
    EXEC SQL  WHENEVER SQLERROR CONTINUE   END-EXEC.
    DISPLAY '***SQLCODE =          ' SQLCODE UPON PRINTER.
    DISPLAY '***AUXILIARY INFO = ' AUX-INFO UPON PRINTER.
    DISPLAY '***ERROR STATUS =    ' ERROR-STATUS UPON PRINTER.
    GETERROR INTO  :err-s(1), :err-s(2), :err-s(3),
             :err-s(4), :err-s(5).
    PERFORM VARYING err-index FROM 1 BY 1 UNTIL err-index = 6
    DISPLAY err-s(err-index) UPON PRINTER
    END-PERFORM.
    PERFORM end-thread-to-uds.
    PERFORM termination-para.
    .
    .
    .
```

Lab 3-2

Edit, recompile, and rerun the program from Lab 3-1:

a. With and without UDSMSG on.

b. With and without GETERROR as part of the ERROR-PRINT paragraph.

Insert errors, such as too few program variables or inconsistent data types for program variables to receive query results. Then execute the program to see the types of error messages returned.

Of course, if you are working in ESQL most of your errors are detected and flagged at compilation time. You should force several compile time errors in order to become familiar with the error messages.

4

More WHERE Clause Operators

Module 4
More WHERE Clause Operators

Module Objectives

Upon completion of this module, you should be able to

- Formulate queries that fully exploit the WHERE clause.
  - Using multiple conditions.
  - Using the logical operators AND, OR, and NOT.
  - Using NULL values.
  - Using the BETWEEN...AND, LIKE, and IS NULL operators.

Benefit Statement

In Module 2 you learned the elements of simple queries. This module builds upon that module with extensions to the WHERE clause. You will now be able to construct WHERE clauses that contain multiple conditions, test for NULL values, and use pattern matching.

Materials

- OS 1100 UDS Relational Data Management System (UDS RDMS 1100) and IPF SQL Interface End Use Guide

- OS 1100 UDS Relational Data Management System (UDS RDMS 1100) SQL Programming Reference Manual

Testing Conditions

A condition is an expression that evaluates to TRUE, FALSE, or NULL (unknown). SQL queries return those rows of a table for which the data make the conditions in the WHERE clause evaluate to TRUE.

Multiple Conditions

You have already written simple queries using a single condition in Module 2. But in real life, you must be able to express more complex sets of conditions. In SQL you can construct a query that is as complex as you require by combining conditions with logical operators.

- You can create conditions using the following operators:
  - AND
  - OR
  - NOT
  - BETWEEN ... AND
  - IS [NOT] NULL
  - [NOT] LIKE
- You can control the appearance of the output using ORDER BY.

NULL Values

- Use when actual value for a column is unknown
- Use NULL instead of inserting dummy values
- NULL values are not equivalent to zero or spaces
- Expressions with NULL will evaluate to NULL

```
10 * NULL is NULL
```

- There are special ways to handle displaying NULL values using indicator variables

Testing NULL Values

IS [NOT] NULL

- Tests whether column data value is known
- Allows different handling of result when no value is present
  - Print "Not applicable" instead of NULL in report
- Any arithmetic comparison with NULL is unknown

Example 1. List all employees who do not have a manager.

```
SELECT * FROM EMP
    WHERE MGR IS NULL
```

Example 2. List all employees who are eligible for commissions.

```
SELECT * FROM EMP
    WHERE COMM IS NOT NULL
```

Example 3. Why is the above query different from the following?

```
SELECT * FROM EMP
    WHERE NOT COMM = 0
```

Logical Operators

- AND - Both conditions are true

```
WHERE SAL > 1200
    AND DNO = 200
```

- OR - Either or both conditions are true

```
WHERE SAL > 1200
    OR DNO = 200
```

- NOT - Reverses the truth value of an expression
  - NOT must precede the entire condition
  - It is not used to negate the operator
  - Valid

```
WHERE NOT JOB = 'CLERK'
```

  - Invalid

```
WHERE JOB NOT = 'CLERK'
```

- The word WHERE appears only once, no matter how many conditions are used

Truth Tables for Three-Valued Logic

AND

Table 4-1. AND Truth Table

AND	TRUE	FALSE	NULL
TRUE	TRUE	FALSE	NULL
FALSE	FALSE	FALSE	FALSE
NULL	NULL	FALSE	NULL

OR

Table 4-2. OR Truth Table

OR	TRUE	FALSE	NULL
TRUE	TRUE	TRUE	TRUE
FALSE	TRUE	FALSE	NULL
NULL	TRUE	NULL	NULL

NOT

Table 4-3. NOT Effect

NOT	
TRUE	FALSE
FALSE	TRUE
NULL	NULL

BETWEEN Operator

WHERE *x* BETWEEN *a* AND *b*

- Is a comparison operator, not a logical operator
- Logical equivalent of

```
x >= a  AND  x <= b
```

Example:

```
SELECT * FROM EMP
    WHERE HIREDATE BETWEEN 850101 AND 900101
```

Order of Precedence of Operators

Table 4-4. Operators and Order of Precedence

Operator	Symbol	Order
Arithmetic	Unary + -	1
	* /	2
	+ -	3
Comparison	<> (not equal)	4
	<	4
	>	4
	<=	4
	>=	4
	=	4
	IS [NOT] NULL	4
	[NOT] LIKE	4
Boolean	NOT	5
	AND	6
	OR	7

Table 4-4 shows the operators RDMS accepts and the order of precedence each has been assigned. You can use parentheses to change the order of precedence as needed.

LIKE Operator

column-spec [NOT] LIKE { *string-1* | *variable-spec-1* }
[{ ESCAPE *string-2* | *variable-spec-2* }]

column-spec	A character or ncharacter column containing the data
string-1 *string-2*	A pattern enclosed in apostrophes
variable-spec-1 *variable-spec-2*	A data variable, either an embedded variable or placeholder variable, that contains a pattern

- Performs character string pattern matching in a WHERE clause
  - Case-sensitivity is significant
  - If column is NULL it evaluates as false
- Exact match search should use "=" operator
- Partial string search should use LIKE

Table 4-5. Wild Cards

Wildcard Character	Matches
_ (underscore)	Any single character
% (percent)	Any combination of 0 or more characters

- Two characters, "%" and "_", behave as "wild cards" for the LIKE operator
- Search string may not contain consecutive "%"
- Search for strings that include "%" or "_" by preceding them with escape character specified

LIKE Examples

Example 1. List the employee information from the EMP table for employees whose names have five characters..

```
SELECT * FROM EMP
    WHERE ENAME LIKE '_ _ _ _ _'
```

Example 2. List the employee information from the EMP table for all employees whose last names begin with "W".

```
SELECT * FROM EMP
    WHERE ENAME LIKE 'W%'
```

Example 3. List employees from EMP whose names have an "A" as the third from last character.

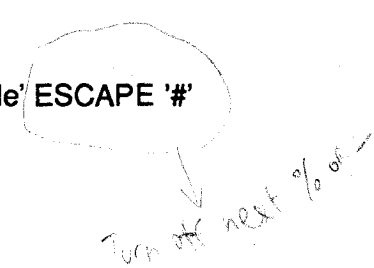
```
SELECT * FROM EMP
    WHERE ENAME LIKE '%A_ _'
```

Example 4. List employee information from the EMP table for employees whose names have an "A" followed by an "S".

```
SELECT * FROM EMP
    WHERE ENAME LIKE '%A%S%'
```

Example 5. From a real estate system, search for a house with a "9% assumable" in the description column.

```
SELECT * FROM HOUSES
    WHERE DESC LIKE '9#% assumable' ESCAPE '#'
```



Exercise 4-1

Indicate whether the following queries have valid or invalid syntax. If invalid, correct the query so that it has valid syntax.

1.
```
SELECT * FROM EMP
    WHERE MGR = NULL
```
IS

2.
```
SELECT * FROM DEPT
    WHERE DNO = 200 OR
    WHERE DNO = 400
```
Select * from DEPT
where (DNO = 200) OR (DNO = 400)

3.
```
SELECT * FROM EMP
    WHERE NOT ENAME LIKE 'F%' AND
    HIREDATE BETWEEN 850101 AND 870631
```

4.
```
SELECT * FROM EMP
    WHERE EMPNO > 5200 AND
    JOB NOT = 'CLERK'
```
NOT JOB = 'CLERK'

5.
```
SELECT * FROM DEPT
    WHERE LOC = 'ATLANTA' OR 'DETROIT'
```
LOC = 'ATLANTA' OR LOC = 'DETROIT'

Write queries to display all the employee information for employees who satisfy the following conditions:

6. All clerks in either department 200 or 400.

```
Select * from EMP
  where JOB = 'CLERK'
  AND (DNO = 200 OR DNO = 400)
```

7. All employees hired after Jan 1, 1986 whose total compensation per month is more than $2500.

```
select * from emp
  where (HIREDATE > '860101')
  AND (SAL + COMM > 2500)
```

8. All sales reps and accountants who earn less than $2300 and more than $2000.

```
Select * from EMP
  where (SAL BETWEEN 2000 AND 2300)
  AND (JOB = 'SALESREP' OR JOB = 'ACCOUNTANT')
```

9. All employees whose name have four or fewer letters.

```
Select * from EMP
  where ENAME LIKE '____' OR
        ENAME LIKE '___' OR
        ENAME LIKE '__' OR
        ENAME LIKE '_'
  WHERE NOT ENAME LIKE '%_____'
```

10. All employees not in department 100 holding any job but president or clerk.

```
Select * from EMP
  Where (DNO <> 100)
  AND (JOB <> PRESIDENT)
  AND (JOB <> CLERK)
```

Lab 4-1

For this lab you will begin with the program as you completed it from Lab 3-1.

You will modify it so that it now uses a more complex query. The two queries that you wrote as answers to questions 7 or 8 in Exercise 4-1 are good candidates for the requested "complex query" for this exercise.

5

The IPF SQL Interface

Module 5
The IPF SQL Interface

Module Objectives

Upon completion of this module, you should be able to

- Invoke and use the IPF SQL interface to RDMS for simple queries.
  - Toggle between line and fullscreen mode.
  - Interactively submit SQL commands.
  - Create, save and run IPF SQL files.

Benefit Statement

The IPF SQL interface is easy to learn and use; it will greatly enhance your mastery of the SQL syntax. You will use this interface for ad hoc queries as well as for prototyping applications being developed.

Materials

- OS 1100 UDS Relational Data Management System (UDS RDMS 1100) and IPF SQL Interface End Use Guide

The IPF SQL Interface to RDMS 1100

- IPF SQL provides online access to RDMS data
- Interactive query and update of tables
- Interfaces with RDMS to parse and execute SQL
- Has online help facility to provide information on commands
  - Type "SQL?" to obtain general information on SQL
  - Type "SQL command ?" to obtain command information, where the command is represented by the first one or two keywords
  - Type "?" to obtain more information until you receive the end of message notice

Using IPF SQL

SQL commands can be used with IPF commands in an IPF session. You can:

- Intersperse SQL and IPF commands when working interactively at a terminal.
- Store SQL commands in a file and execute them all at once
  - The file can be saved, edited, and re-executed at any time
  - Only SQL commands may be included in the file
  - All commands must be preceded by SQL to tell IPF they are SQL commands
- Continue a command to the next line by using the IPF continuation character.
  - It is the ampersand (&) unless you change it.
  - System variable $CONTCHAR sets the continuation character.
- Omit the SQL command termination character (;) in IPF

Invoking IPF

- Invoked by typing "@IPF" after the SOE.
- In IPF you have a choice of two screen modes:
  - Line mode
  - Full-screen mode
- Any IPF or SQL command may be entered following the >~C~> prompt.
- Figure 5-1 illustrates the sequence of commands executed in a typical IPF SQL session.

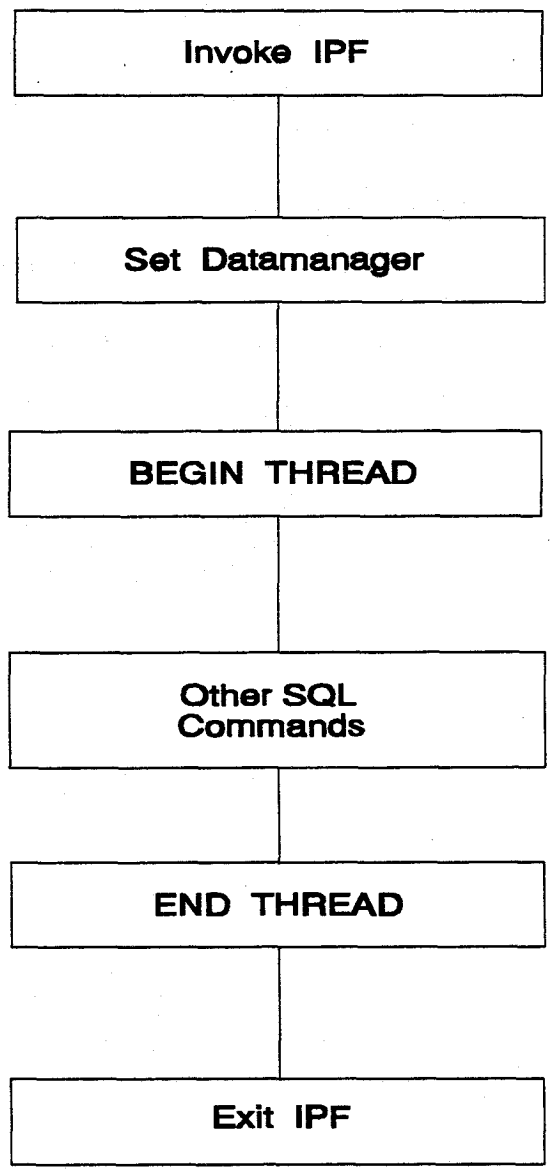


Figure 5-1. Flow of an IPF SQL Session

Sample IPF SQL Session

```
>@IPF TPF$.
>IPF 1100 5R1 02/19/93  09:26:11
>~C~>$DATAMANAGER := RDMS
>~C~>SQL BEGIN THREAD T1 FOR UDSSRC READ
>~C~>SQL USE DEFAULT QUALIFIER ROSVSCHEMA1
>The USE command completed successfully.
>~C~>SQL SELECT * FROM DEPT WHERE DNO >= 200
>-DNO- ---dname---- ---loc----
>  200 SALES        NEW YORK
>  300 MARKETING    DETROIT
>  400 DISTRIBUTION PRINCETON
>3 records were selected.
>~C~>SQL SELECT ENAME, HIREDATE, SAL * 12 FROM EMP &
>~C~&>WHERE HIREDATE BETWEEN 890101 AND 900101
>--ename--- hiredate --------
>TURNER       890515    10800
>JOHNSON      891221    11700
>FORD         890316    28500
>3 records were selected.
>~C~>SQL END THREAD
>~C~>logoff
>END IPF
```

- Start of entry (SOE) character is represented by the greater than symbol (>) above
- $DATAMANAGER can be abbreviated to $DATA

Creating an SQL File

- What is an SQL file?
  - A place to edit, save, and execute SQL commands
  - Typically a symbolic element containing SQL command only
  - It may not contain a mixture of IPF and SQL commands

- How is it created?
  - With the IPF editor in either line or fullscreen mode
  - For fullscreen edit mode, type "MODE SCREEN"
  - Return to line mode by typing "MODE LINE"
  - Screen mode is recommended for entering and editing text, and line mode for executing the file or interactive SQL commands

- How do I get started?
  - Begin a new file by typing "NEW filename" on the command line at the top
  - The file is opened and is in input mode
  - Enter text into the editor
  - Save the file by entering "SAVE" on the command line
  - If the file has already been saved, then you must use the "REPLACE" (REPL) command to save it

Sample IPF SQL File

```
_____ SQL BEGIN THREAD FOR UDSSRC READ
_____ SQL USE DEFAULT QUALIFIER ROSVSCHEMA1
_____ SQL SELECT ENAME, DNO, MGR, SAL * 12 FROM EMP    &
_____             WHERE DNO = 200                      &
_____                OR DNO = 400
_____ SQL SELECT * FROM EMP                             &
_____             WHERE HIREDATE > 870101               &
_____               AND SAL > 2000
_____ SQL END THREAD
```

Executing an SQL File

To execute a file, type "SQL FILE filename" on the command line. When you submit a FILE command, IPF SQL accesses the file or element specified, then reads and executes the SQL commands. It executes all the commands even if it detects errors as it proceeds. IPF returns error messages interspersed with the results of the commands it executes.

Files are better executed in line mode since the screen otherwise returns to the previous edit screen, overlaying the query results. To enter line mode, type "MODE LINE" on the command line.

Saving Query Results in a File

```
>~C~>CREATE FILE=OUTFILE. ACCESS=PUBLIC

>~C~>OUT FILE=OUTFILE.

>~C~>SQL SELECT * FROM EMP

>~C~>OUT FILE=TERMINAL.

>~C~>OLD FILE=OUTFILE.
```

- Steps illustrated above
  - First command creates a data file to receive the output
  - Second command directs output to the file
  - Third command returns results to the output file
  - Fourth command redirects the output the terminal
  - Fifth command copies the contents of the output file to the IPF workspace for viewing
- Output file can be directed to a printer for a hard copy

Lab 5-1

1. Invoke the on-line help facility to obtain information on SQL in general (SQL ?) and SQL commands (SQL command-name ?) in particular.

2. Enter a SELECT command before a BEGIN THREAD to see the kind of error messages that are returned.

   BEGIN MUST BE FIRST

3. Use interactive IPF SQL to perform the following queries:

   a. Display all information about all employees in the EMP table.

   b. List all information about the departments in the DEPT table.

   c. Display the employee number, name, position, and hire date of all employees in department 200.

   d. Display the name, salary, and employee number of all clerks.

4. Create, save, and execute an IPF SQL file that includes any two queries from Exercise 4-1.

6

The MAPPER Relational Interface

Module 6
The MAPPER Relational Interface

Module Objectives

Upon completion of this module, you should be able to

- Invoke the MRI run to retrieve and manipulate data from an RDMS database.

Benefit Statement

An alternative to the IPF interface is the MAPPER Relational Interface (MRI). You will find this interface even easier to use to obtain ad hoc reports, with its menu-driven approach. Of course, MRI supports more sophisticated database accesses as well, and you will be introduced to SQL in MAPPER runs as well.

Materials

- MAPPER Relational Interface (MRI) Relational Database Interface (RDI) Operations Guide

- MAPPER System Run Design Operations Reference Manual

MAPPER Relational Interface (MRI)

- Provides connectivity to relational databases on various architectures
  - Released as a separate product
  - Uses same menus, regardless of architectural platform
- Consists of seven run statements
  - Allows access to relational data
  - Generates code in SQL
  - Performs full range of relational operations
- Provides menu-based interface (RDI run) for ease of use
  - Submits SQL statements in an easy-to-use format
  - Displays table data as a MAPPER result
  - Provides on-line help at all menu levels
- Supplies RDMS information for further manipulation by MAPPER
  - Data reduction
  - Graphics
  - Display/store of data

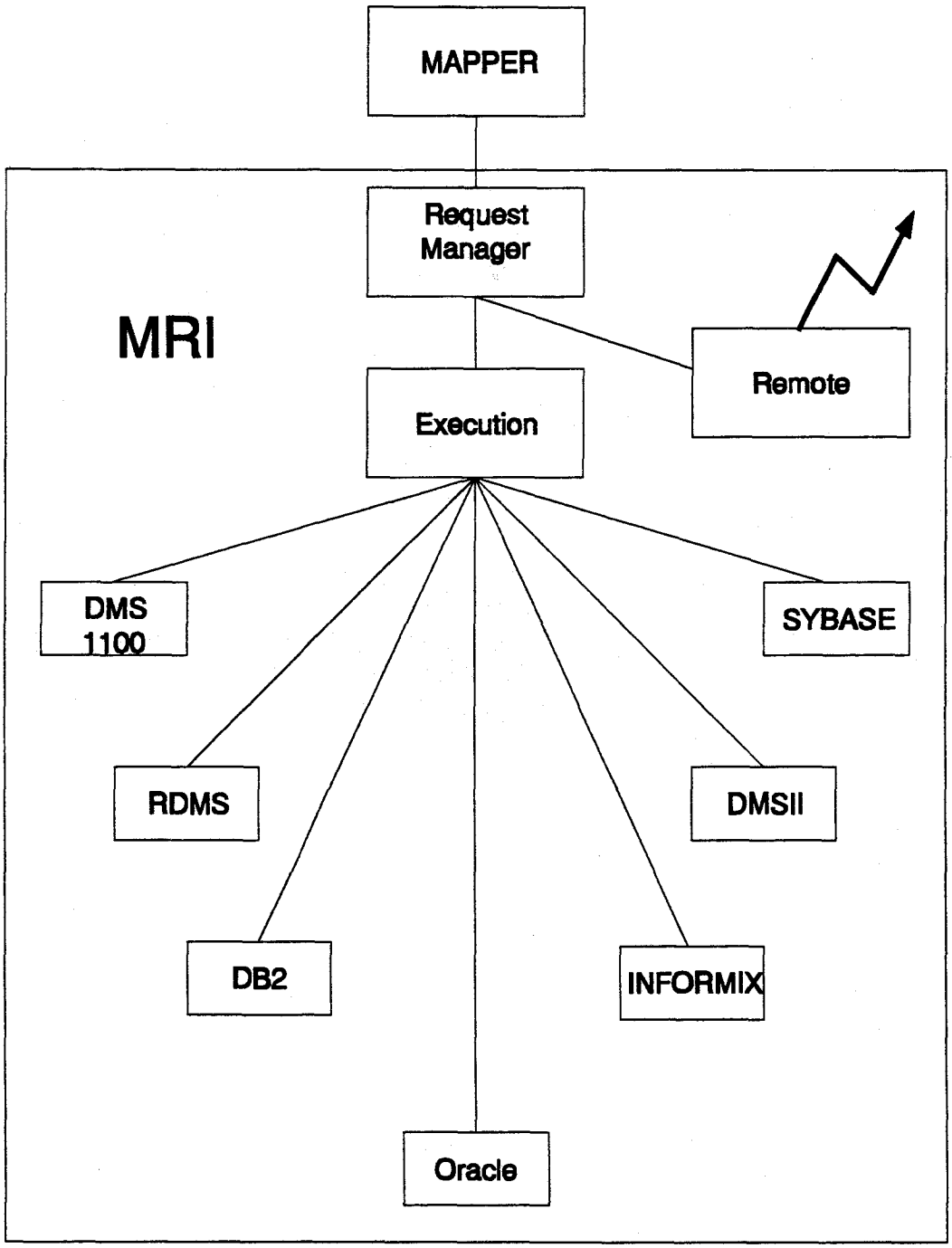


Figure 6-1. MRI Access to Data Managers

Invoking RDI

- Sign-on to MAPPER
- Type RDI on the control line
  - Displays the RDI menu
  - Allows you to select the SQL command to perform
- Figure 6-2 shows RDI entered on the top line, the control line.

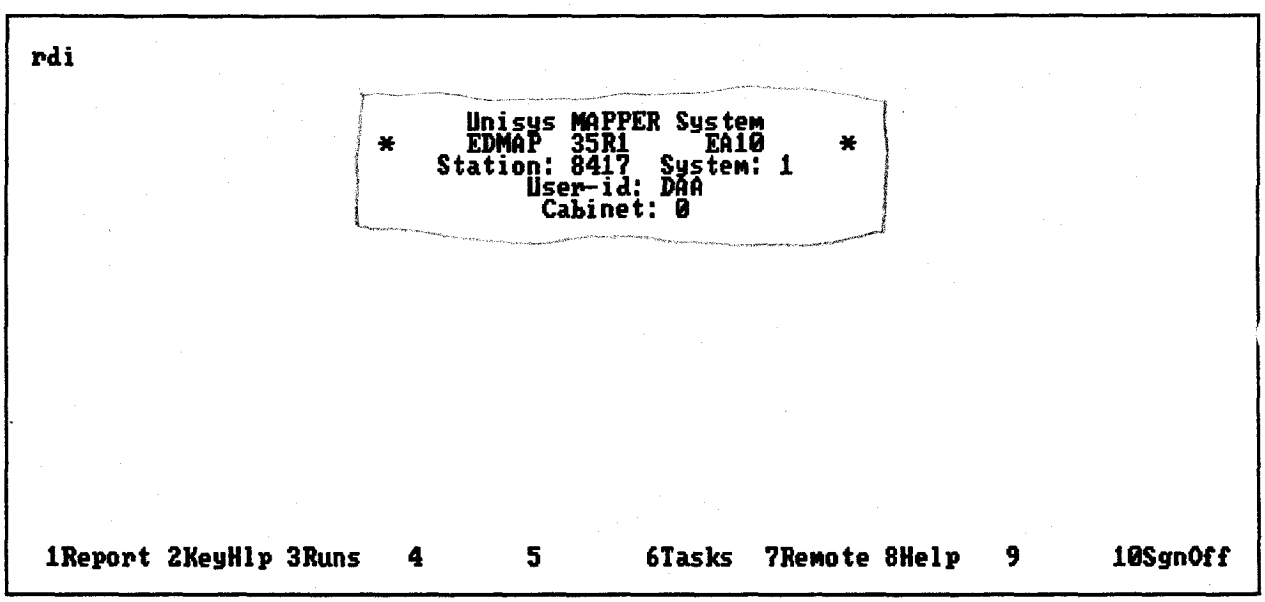


Figure 6-2. Invoking RDI

RDI Menu Selections

- Pictured in Figure 6-3 is the RDI Menu

- Selection choices
  - Top five correspond to SQL commands
  - SQL allows you to submit SQL syntax directly to RDMS
  - Utilities menu allows you to change the design, restrict table access, delete tables, or work with views
  - Detailed help is last selection

- Function keys appear along bottom
  - F6 (DBMS) changes the database manager (Default is RDMS)
  - F7 (Envmnt) changes the RDI environment
  - F8 (Help) is the help key
  - F10 exits the RDI run

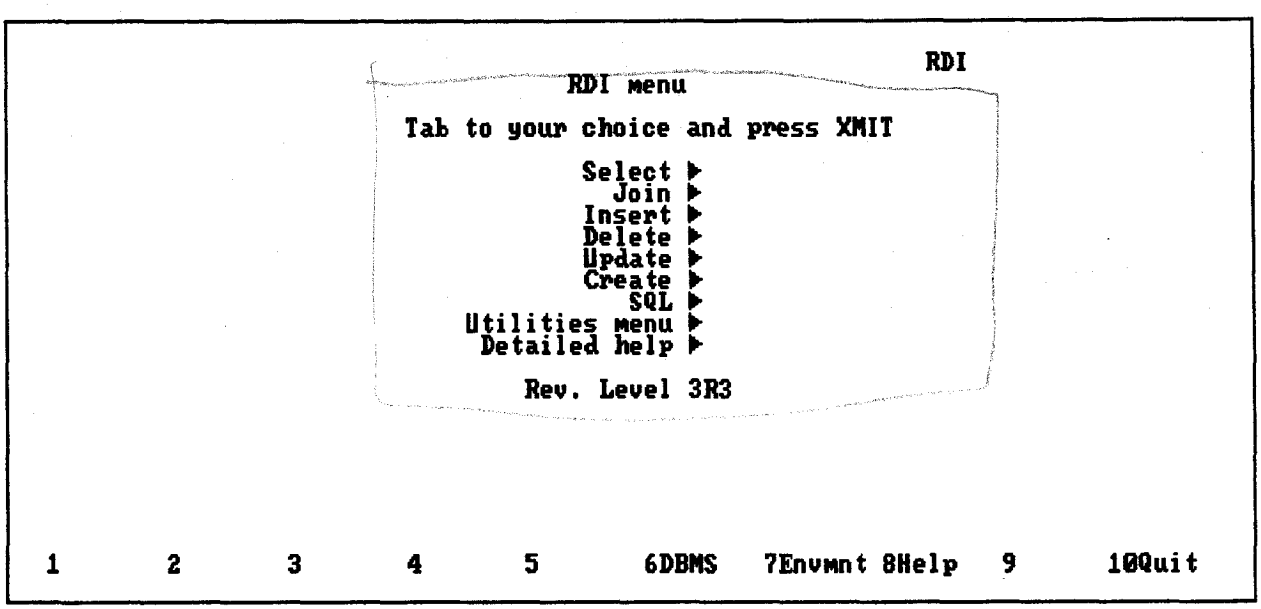


Figure 6-3. RDI Menu

Environment Menu Selections

- Pictured in Figure 6-4 is the Environment Menu
- Selection choices
  - Results are stored by default to cabinet drawer 0A
  - Tracking of SQL syntax to a report can be disabled
  - ROSVSCHEMA1 is the default qualifier entered for future table references
  - Default version, PRODUCTION, has been cleared
- F4 (Return) takes you back to the RDI menu

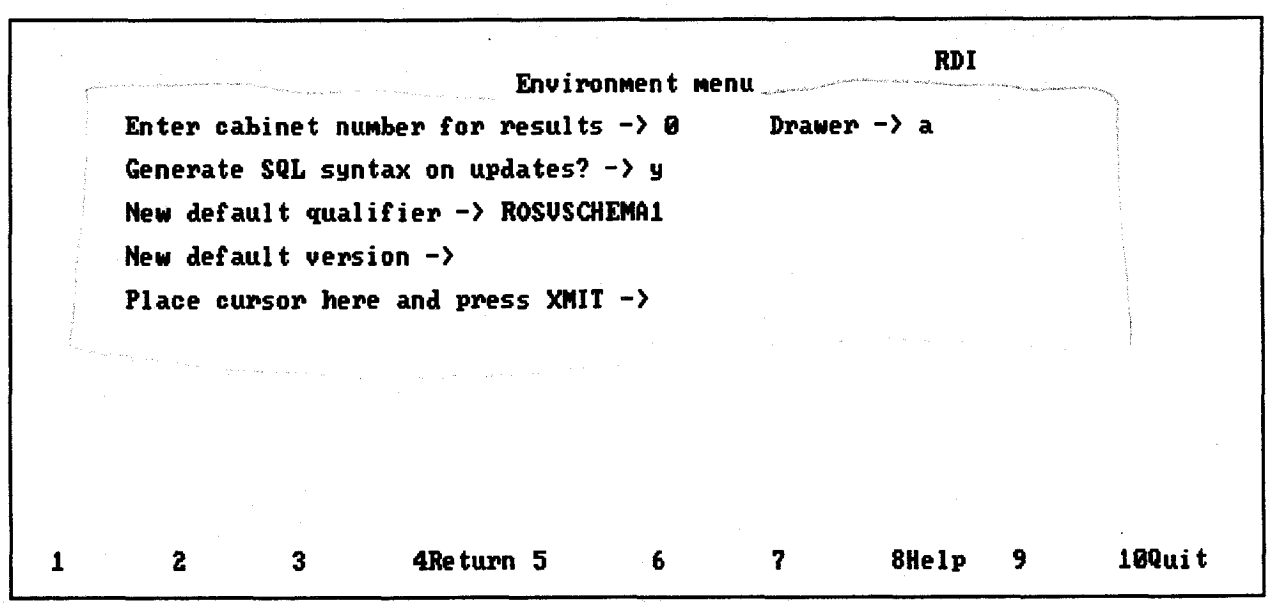


Figure 6-4. Environment Menu

Selection Example 1 - Menu Access

On Figure 6-5 the cursor was positioned to Select and transmitted.

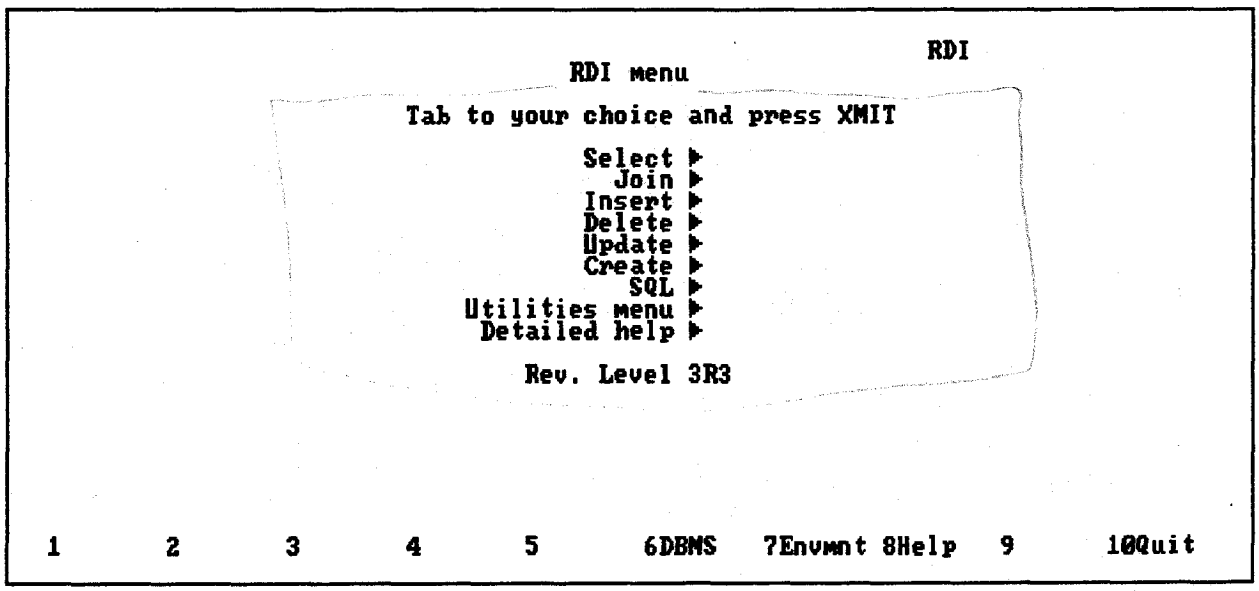


Figure 6-5. Selecting SELECT

On the Select Menu pictured in Figure 6-6, the table name EMP was entered and all columns selected with the *. The cursor was transmitted from the XMIT position.

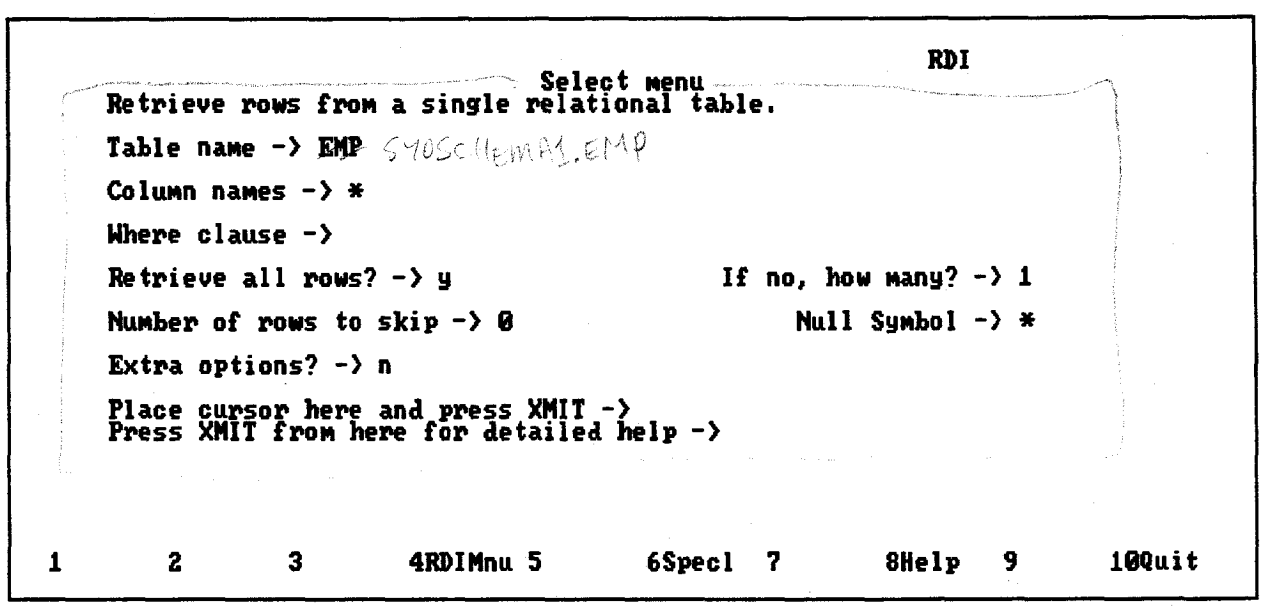


Figure 6-6. Entering the Selection Criteria

The results are shown in Figure 6-7 from the generated SQL command.

```
Line▶ 5          Roll▶ -                                          RESULT
.DATE            18:26:13  RID          19 FEB 93  DAA
*                                      .HIREDAT.
*EMPNO.ENAME     .JOB       .MGR  .DNO .E      .SAL  .COMM
*=====.==========.==========.=====.====.=======.=====.=====
  5010 FOSTER     SALESREP    5234  200  860714  2700   400
  5146 BROWN      CLERK       5234  200  871011  1000
  5234 WOODWORTH  MANAGER     5784  200  790219  3250
  5237 ROCKWELL   ACCOUNTANT  5743  100  840618  2175
  5437 MARTIN     SALESREP    5234  200  870326  2500   300
  5469 ADAMS      SALESREP    5234  200  811102  2250   500
  5630 GLASS      ACCOUNTANT  5743  100  871220  1850
  5702 TURNER     CLERK       5743  100  890515   900
  5743 LAWSON     MANAGER     5784  100  830510  3400
  5765 JOHNSON    CLERK       5984  400  891221   975
  5784 WILLIAMS   PRESIDENT          300  781015  5200
  5896 SMITH      CLERK       5984  400  880913  1050
  5942 FORD       SALESREP    5234  200  890316  2375     0
  5984 HYDE       MANAGER     5784  400  850901  2900
                     ..... END REPORT .....


 1SelMnu 2       3ShwSQL 4Return 5       6Tasks  7View   8       9       10Quit
```

Figure 6-7. Viewing the Results from the Select

Pressing F3 (ShwSQL) on the previous menu produces the SQL shown in Figure 6-8. Pressing F3 (SveSQL) from this menu allows you to save the generated SQL in a report for future use. This was not done in this example.

```
Line▶ 4          Roll▶ -                                          RESULT
.DATE 19 FEB 93  18:26:12     REPORT GENERATION     DAA
.          - RDI Select, SQL request
*=============================================================================
SELECT
*
FROM EMP
;
                     ..... END REPORT .....









 1SelMnu 2       3SveSQL 4Return 5       6       7       8       9       10Quit
```

Figure 6-8. Using F3 to Show SQL

Selection Example 2 - Freeform Entry

In order to enter your SQL syntax directly, first position to SQL on the RDI menu as pictured in Figure 6-9 and transmit.

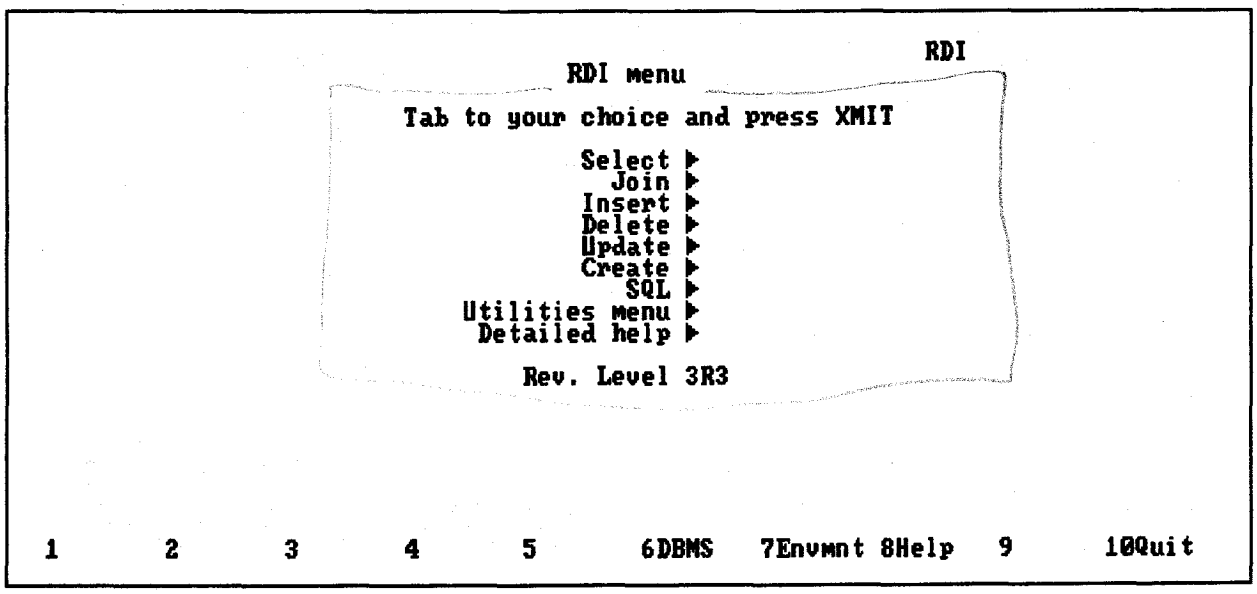


Figure 6-9. Selecting SQL from RDI Menu

On the SQL Menu, merely position the cursor to the XMIT and transmit.

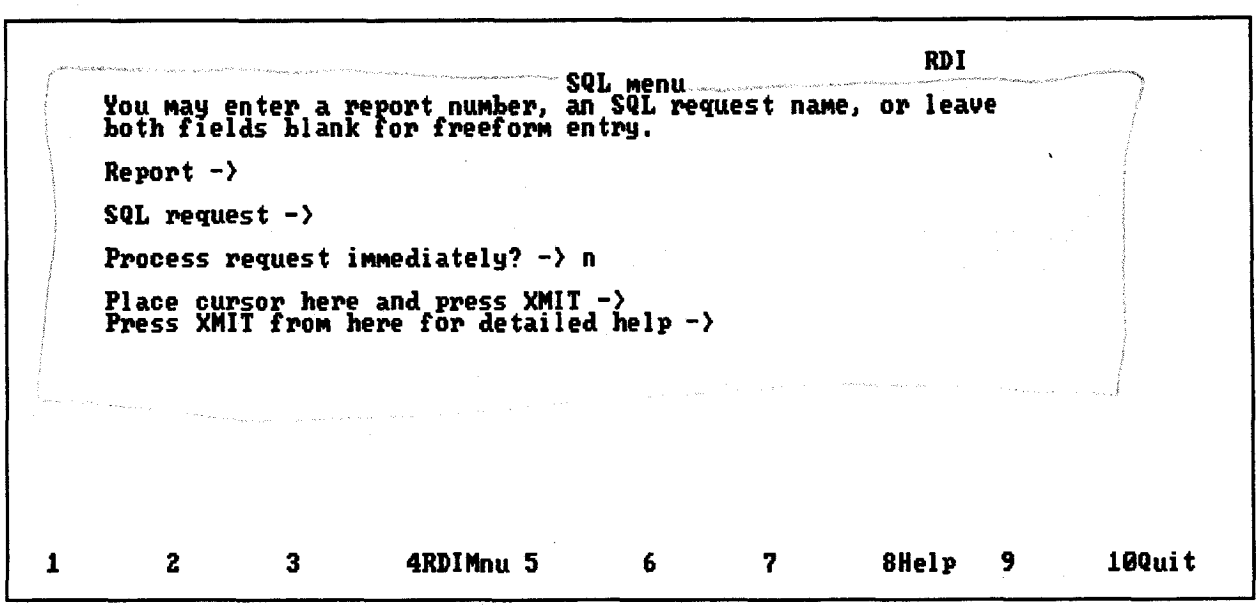


Figure 6-10. SQL Menu

On the free form report, enter your SQL statement as you would normally, ending it with a semicolon. Press XMIT to have the command processed and then F1 to continue. Figure 6-11 illustrates a SELECT command to be submitted.

```
Line▶ 6          Roll▶ -                                          RESULT
.DATE 19 FEB 93  18:38:51     REPORT GENERATION     DAA
. Enter a new SQL statement or make any changes to an existing statement.
. Press XMIT at the end of the statement to accept it.  Press the
. Resume key to continue. ▶
*=============================================================================
SELECT *
  FROM EMP
  WHERE DNO = 200 ;

                      ..... END REPORT .....

 1Resume 2Paint  3       4Return 5       6LineCh 7       8       9       10Quit
```

Figure 6-11. Selection Statement Entered

Figure 6-12 shows the results of the submitted SELECT.

```
Line▶ 5          Roll▶ -                                          RESULT
.DATE            18:41:04  RID            19 FEB 93  DAA
*                .        .        .HIREDAT.        .
*EMPNO.ENAME     .JOB     .MGR  .DNO .E      .SAL  .COMM
*=====.==========.==========.=====.====.=======.=====.=====
  5010 FOSTER     SALESREP    5234  200  860714  2700   400
  5146 BROWN      CLERK       5234  200  871011  1000     0
  5234 WOODWORTH  MANAGER     5784  200  790219  3250     0
  5437 MARTIN     SALESREP    5234  200  870326  2500   300
  5469 ADAMS      SALESREP    5234  200  811102  2250   500
  5942 FORD       SALESREP    5234  200  890316  2375     0
                     ..... END REPORT .....

 1SQLMnu 2       3ShwSQL 4Return 5       6Tasks  7View   8       9       10Quit
```

Figure 6-12. Result from Previous SELECT

Exiting MAPPER

Place an X on the control line to exit MAPPER. Figure 6-13 shows the exit from the RDI menu screen.

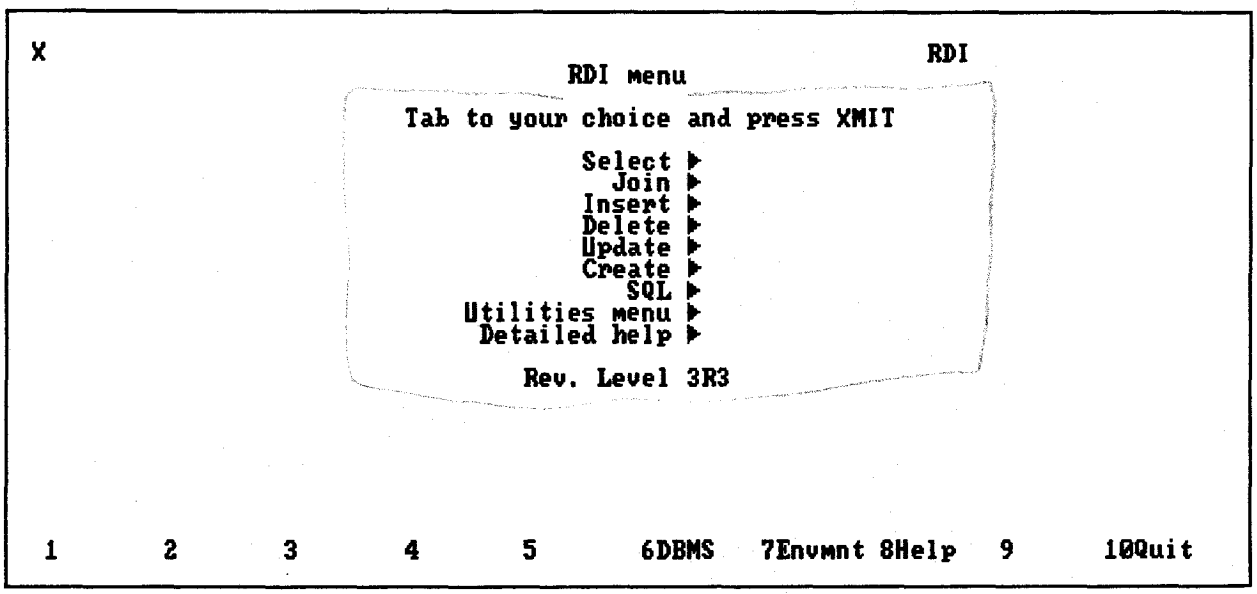


Figure 6-13. Exiting MAPPER

Embedding Commands in MAPPER Runs

- LGN Log On to Relational Database

  Use to initiate a session on the relational database

- SQL Submit SQL

  Use to pass SQL syntax to the relational database and retrieve data in MAPPER variables

- FCH Relational Aggregate Fetch

  Use to retrieve columns and rows from a relational table

- TRC Trace Relational Syntax

  Use to save the SQL syntax generated by run statements

- RAM Relational Aggregate Modify

  Use to create tables, insert rows, or update a table

- DDI Data Definition Information

  Use to retrieve a table description from a relational database

- LGF Log Off Relational Database

  Use to end a session on a relational database

For more information, refer to the *MAPPER System Run Design Operation Reference Manual.*

MAPPER Run Example Using FCH

Figure 6-14 shows an example of a MAPPER run that will perform a simple fetch.

```
LINE▶ 1      FMT▶   RL▶ -      SHFT▶      HLD CHRS▶    HLD LN▶   UNDO▶   1I124    ▶
.DATE 23 FEB 93  08:54:44  RID      1I    19 AUG 92  DAA
.RUN01                                                                  I001760
*=========================================================================.
@LGN,1,Y,0,A,RDMS  READ
@FCH,0,A,1,READ,,,,Y,,I,,,,,,RDMS \
'C * ROSUSCHEMA1.DEPT'
@DSP,-0
@LGF,1,,RDMS
@GTO END .
@1:DSP,-0
                      ..... END REPORT .....
```

Figure 6-14. Fetch All Rows in DEPT

Entering the name of the run on the command line produces the result shown in Figure 6-15.

```
line▶ 1      fmt▶   rl▶ -      shft▶      hld chrs▶    hld ln▶        ▶   RESULT   ▶
.DATE             08:57:16  RID           23 FEB 93  DAA
*DNO .DNAME        .LOC
*====.============.==========
*D4.0 C12          C10
*P
*                  NULL
  100 ACCOUNTING   ATLANTA
  200 SALES        NEW YORK
  300 MARKETING    DETROIT
  400 DISTRIBUTION PRINCETON
                     ..... END REPORT .....
```

Figure 6-15. Result from Run

Lab 6-1

Use the following steps to test the basic RDI functionality.

1. Log on to MAPPER following directions provided by your instructor.

2. Invoke the MRI RDI run by typing RDI at the SOE.

3. Move cursor to SELECT and transmit.

4. Complete the SELECT menu as follows:

   Table name -> Yourqualifier.EMP
   Column Names -> ?
   Move cursor to transmit field and press XMIT.

   The help screen showing the list of columns is displayed.

5. Select columns to display by typing a number in the first field, indicating the order in which they should be displayed.

   Press XMIT to send the selected columns then press F1.

6. Press F4 to return to the SELECT menu.

7. Delete the ? from the column name field. Tab to the WHERE field. Enter a ? and transmit.

   The WHERE assistance screen is displayed.

8. Read the information provided.

   Press F3 to re-display the list of column names in a corner of the screen for reference.
   Press F1 to continue.

9. Type the following in the WHERE field at the bottom of the screen.

   WHERE hiredate between 800101 and 891031.

10. Press XMIT then F1 to execute the query. The result is displayed.

Lab 6-2.

Use the MRI interface to display the EMPNO, ENAME, and MGR columns of EMP where the manager's empno is greater than the employee's empno.

7

Grouping Functions

Module 7
Grouping Functions

Module Objectives

Upon completion of this module, you should be able to

- Formulate queries that group or summarize data retrieved from a table.
  - Identify the summarizing functions that can be embedded in SQL commands.
  - Rename column output with the AS clause.
  - Use the GROUP BY clause.
  - Use the HAVING clause.

Benefit Statement

The grouping functions in this module help answer the question, "What is the bottom line here?" The GROUP BY clause lets you obtain summarized information, and its companion HAVING clause refines the information you obtain. The AS clause provides your report with a meaningful name. So what is the bottom line here? More power for querying your database!

Materials

- OS 1100 UDS Relational Data Management System (UDS RDMS 1100) SQL Programming Reference Manual

- OS 1100 UDS Relational Data Management System (UDS RDMS 1100) and IPF SQL Interface End Use Guide

Grouping Functions

Grouping functions operate on a group or set of rows and return one row of summary information for each group. The default group is the entire table, but other groups may be specified.

- The grouping functions are:
  - SUM Computes the total value of the group
  - AVG Computes the average value of the group
  - MIN Computes the minimum value of the group
  - MAX Computes the maximun value of the group
  - COUNT Counts the number of values in the group
  - COUNT(*) Counts the number of rows in the table, including duplicates and NULLs

  Note: *COUNT and COUNT(*) are discussed separately in this module.*

- Syntax for AVG, MAX, MIN, SUM

  SELECT *group_function*([ALL] { *column-spec* | *arithmetic-expression* })
  FROM *table-name*

  SELECT *group_function*(DISTINCT *column-spec*)
  FROM *table-name*

  Note: *An arithmetic-expression must include a column specification.*

AS Clause

select-expression AS *title-name*

- Use the AS clause to name or rename an item in the select list
  - Provides a meaningful title for a report
  - Simplifies sort descriptions in the ORDER BY clause

- Provide a title-name for:
  - A column name
  - A result of an arithmetic expression
  - A constant
  - A result of a function

Example: Display the names and yearly salaries of all employees in Department 400.

```
SELECT ENAME, SAL * 12 AS NEWSAL
FROM EMP
WHERE DNO = 400
```

```
ENAME      NEWSAL
-----      ------
JOHNSON    11700
SMITH      12600
HYDE       34800
```

Function Examples

Example 1. Compute the total salary for all employees.

```
SELECT sum(sal) AS "total emp sal"
    FROM EMP

-----total emp sal-----
                  32,525
```

Example 2. Compute the average salary for all employees in the company.

```
SELECT avg(sal) AS sal_avg
    FROM EMP

-------sal_avg-------
323.21428571428571429
```

Example 3. Compute the minimum and maximum salaries paid in the company.

```
SELECT MIN(SAL) AS minsal, MAX(SAL) AS maxsal
    FROM EMP

minsal    maxsal
   900      5200
```

Example 4. What is the earliest date on which someone was hired and what was the most recent date on which someone was hired?

```
SELECT MIN(HIREDATE), MAX(HIREDATE)
    FROM EMP

-------- --------
  781015   891221
```

Grouping Functions Usage

- There are various names for these functions:
  - Grouping (or group by) functions
  - Summarizing functions
  - Aggregate functions
  - Set functions
- Use functions only in a SELECT list or in a HAVING clause
- Functions which apply to a group of records return a single value for the group.
- The DISTINCT keyword used within a grouping function makes the function consider only distinct values of the expression.
  - Use the ALL keyword to consider all values including duplicates.
  - Do not specify DISTINCT or ALL for AVG and SUM functions, since ALL is assumed.
- Any of the functions may be used with numeric columns.
  - Only MIN, MAX, and COUNT may be used with character columns.
  - You cannot pass a column specification in a variable.
- MIN/MAX functions use the ASCII collating sequence to order and select
- NULL values are ignored in the evaluation of SUM, AVG, MAX and MIN.

COUNT Function

CNT

```
SELECT COUNT { ( * | DISTINCT column-specification ) }
    FROM table-name
```

- Counts the number of rows returned by a query
- NULL values are ignored
- Asterisk may be used to refer to all columns since all have the same number of rows

Example 1. Display the total number of employees in the EMP table.

```
SELECT COUNT(*)
    FROM EMP

-----
   14
```

Example 2. Count the number of different job titles in the EMP table.

```
SELECT COUNT(DISTINCT JOB)
    FROM EMP

-------
      5
```

Example 3. Count the number of people who work in department 400.

```
SELECT COUNT(*)
    FROM EMP
    WHERE DNO = 400

-----
    3
```

GROUP BY Clause Usage

- The GROUP BY clause is used to cluster rows into groups.
  - A group is a set of records that have the same value in one or more columns.
  - The column(s) used to define the group must be identified in the GROUP BY clause
  - The grouping function in the SELECT clause then returns one row for each group instead of one row for the whole table.

For example, grouping by department number causes a row of summary information to be returned for each department (100, 200, 300, and 400), since those are the distinct values in the DNO column.

- Parameters in the select-list must either be:
  - The column(s) used to define the group in the GROUP BY clause, or
  - Grouping functions.
  - Literals

All columns in Select must be in Group By

Valid Example

```
SELECT COUNT(*), AVG(SAL), DNO
    FROM EMP
    GROUP BY DNO<-----------┘
```

Invalid Example

```
SELECT ENAME, AVG(SAL), DNO
    FROM EMP
    GROUP BY DNO
```

Note: *ENAME is not a grouping function and is not a column-name in the GROUP BY clause and therefore returns an error.*

Grouping on More Than One Column

```
SELECT group-by-columns or functions
    FROM table-name
    GROUP BY column1, column2, ...
```

- One group is formed for each unique combination of values in the GROUP BY columns.

- Each row contains summary information for that group.

Example Count the number of people who hold each type of job in each department.

```
SELECT DNO, JOB, COUNT(*)
    FROM EMP
    GROUP BY DNO, JOB
```

```
--dno-- ---job----- ---
 300    PRESIDENT     1
 200    SALESREP      4
 100    CLERK         1
 200    CLERK         1
 400    CLERK         2
 100    MANAGER       1
 200    MANAGER       1
 400    MANAGER       1
 100    ACCOUNTANT    2
```

WHERE and GROUP BY Clauses Together

The WHERE clause can be used in conjunction with GROUP BY, to select rows from a table upon which the grouping functions will be performed.

```
SELECT group-by-columns or functions
    FROM table-name
    WHERE conditions
    GROUP BY column1, column2, ...
```

Example: Determine the average salary for accountants and sales representatives and the number of each in each department.

```
SELECT DNO, AVG(SAL), COUNT(*)
    FROM EMP
    WHERE JOB = 'ACCOUNTANT' OR JOB = 'SALESREP'
    GROUP BY DNO

--dno- ------- -------
   100 2012.50       2
   200 2456.25       4
```

Note: *The average salary in this example was truncated to two decimal places.*

HAVING Clause

```
SELECT group-by-columns or functions
    FROM table-name
    GROUP BY column1, column2, ...
    HAVING group-conditions
```

- Specifies which groups should be returned, after the grouping functions have been computed

- Similar to a WHERE clause
  - It states conditions that the results must satisfy
  - But refers to group values, not data-item values

- HAVING clause conditions may refer to:
  - A column in the GROUP BY clause
  - A built-in function for a selected column

Example:

```
SELECT DNO, JOB, COUNT(*) AS TOTAL
    FROM EMP
    GROUP BY DNO, JOB
    HAVING COUNT(*) >= 2

-dno- ---job----- ---total----
  200 SALESREP                4
  400 CLERK                   2
  100 ACCOUNTANT              2
```

SQL SELECT MGR, COUNT(*) AS OVER1500 FROM EMP
WHERE SAL > 1500 GROUP BY MGR
HAVING COUNT(*) > 2 ;

Full Query Specification

```
SELECT [ ALL | DISTINCT ] { * | select-list }
    FROM table-specification-list
    [ WHERE Boolean-expression ]
    [ GROUP BY column-specification-list ]
    [ HAVING Boolean-expression ]
    [ ORDER BY sort-specification-list ]
```

- SELECT statements may contain WHERE, GROUP BY, and HAVING clauses
  - SELECT clause identifies columns
  - FROM, WHERE, GROUP BY, and HAVING clauses identify the tables and rows
  - WHERE clause can improve performance

- Order of execution
  1. The FROM clause creates a conceptual table from the tables to be used.
  2. If there is a WHERE clause, rows not meeting its requirements are discarded from the conceptual table made in step 1.
  3. If there is a GROUP BY clause, a conceptual grouped table is formed from the previously derived rows.
  4. If there is a HAVING clause, rows not meeting its requirements are discarded from the grouped table made in step 3.
  5. The SELECT clause is executed to determine which columns of the remaining rows are to be used.

Example:

```
SELECT DNO
    FROM EMP
    WHERE JOB = 'CLERK'
    GROUP BY DNO
    HAVING COUNT(*) >= 2

    -dno-
    400
```

Exercise 7-1

Using the functionality you have learned so far, write and execute the SQL statements that will retrieve the requested data from the EMP and DEPT tables.

1. What is the average annual salary per job in each department? Recall the SAL column is monthly salary.

```
SELECT   AVG(SAL)*12, JOB, DNO
  FROM EMP
    GROUP BY DNO, JOB
```

2. Display the department number and number of employees who receive salaries only in the entire company.

PER DEPT

```
SELECT DNO, COUNT(*) FROM EMP
WHERE COMM IS NULL OR COMM = 0
  GROUP BY DNO
```

3. **Compute the average, minimum, and maximum salaries of those employees who are clerks or managers. Display the job titles and results.**

```
SELECT  AVG(SAL) AS AVSAL,
        MIN(SAL) AS MINSAL,
        MAX(SAL) AS MAXSAL, JOB
FROM EMP
WHERE JOB = 'CLERK'
  OR  JOB = 'MANAGER'
GROUP BY JOB
```

4. **Display the department number of departments that have more than one clerk.**

```
SELECT DNO FROM EMP WHERE JOB = 'CLERK'
GROUP BY DNO
HAVING COUNT(*) > 1
```

8

Joining Tables

Module 8
Joining Tables

Module Objectives

Upon completion of this module, you should be able to

- Formulate queries to join data from one or more tables.

Benefit Statement

Thus far the queries you have created have dealt with one table. This module expands your capabilities to involve more than one table. The data that you will need to access will frequently be in more than one table.

Materials

- OS 1100 UDS Relational Data Management System (UDS RDMS 1100) and IPF SQL Interface End Use Guide

- OS 1100 UDS Relational Data Management System (UDS RDMS 1100) SQL Programming Reference Manual

Joins

- A join combines some or all columns and rows from two or more tables

- Types of joins
  - Equijoins
  - Cartesian joins
  - Self joins
  - Non-equijoins

Equijoins

```
SELECT columns-from-tables-in-from-clause
    FROM table1, table2, ...
    WHERE table1.column = table2.column
        AND other-conditions
```

- An equijoin links rows from tables based on the equality of a common attribute (column)
  - The columns on which the tables are joined must have the same data type
  - If column names are the same, they must be unambiguously referenced as table.column

- Figure 8-1 illustrates joining two tables based on the department number field (DNO)

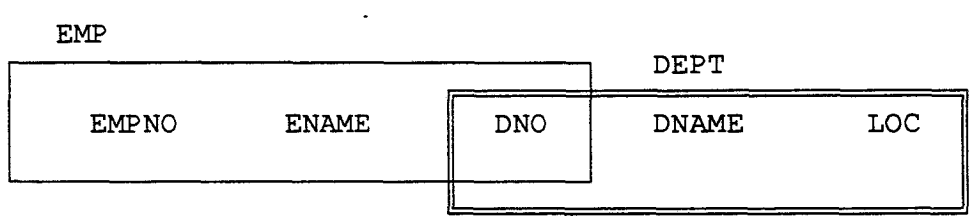


Figure 8-1. Joining EMP and DEPT Tables

Equijoin Examples

Example 1. For each employee display the employee name, department number, name, and location.

```
SELECT ENAME, JOB, EMP.DNO, DNAME, LOC
    FROM EMP, DEPT
    WHERE EMP.DNO = DEPT.DNO
```

```
FOSTER      SALESREP     200   SALES         NEW YORK
BROWN       CLERK        200   SALES         NEW YORK
WOODWORTH   MANAGER      200   SALES         NEW YORK
ROCKWELL    ACCOUNTANT   100   ACCOUNTING    ATLANTA
MARTIN      SALESREP     200   SALES         NEW YORK
ADAMS       SALESREP     200   SALES         NEW YORK
GLASS       ACCOUNTANT   100   ACCOUNTING    ATLANTA
TURNER      CLERK        100   ACCOUNTING    ATLANTA
LAWSON      MANAGER      100   ACCOUNTING    ATLANTA
JOHNSON     CLERK        400   DISTRIBUTION  PRINCETON
WILLIAMS    PRESIDENT    300   MARKETING     DETROIT
SMITH       CLERK        400   DISTRIBUTION  PRINCETON
FORD        SALESREP     200   SALES         NEW YORK
HYDE        MANAGER      400   DISTRIBUTION  PRINCETON
```

Example 2.

```
SELECT ENAME, JOB, EMP.DNO, DNAME, LOC
    FROM DEPT, EMP
    WHERE EMP.DNO = DEPT.DNO
```

Note: *The second example will produce the same results as the first.*

Join Guidelines

- The tables to be joined are specified in the FROM clause
- The WHERE clause specifies how to join the tables as well as any other selection conditions as in single table queries.
- The "matching criteria" for the tables are called the join criteria
- More than one pair of columns may be used to specify the join condition between any two tables
- Columns from either table may be named in the SELECT list
- Table.* is used to select all columns of the table specified
- If a column has the same name in both tables, it must be unambiguously referenced as table-name.column-name in the SELECT or WHERE clause.
- The join is more efficient if the columns used to perform the join are indexed
- As many tables as desired may be joined together, although more than three may cause performance slowdown
- If the WHERE clause does not use primary or secondary keys, the order of the tables in the FROM list is not important.
  - Think of RDMS 1100/2200 as scanning the list from left to right
  - Only the records "found" in the first table need to be joined with records in the second and subsequent tables
  - Specify as the first table the one with the fewest expected "hits"

Multi-Table Joins

- If joining more than two tables, specify a join criterion for each pair of tables being joined.

- For joining n tables, there should be n-1 join criteria in the WHERE clause.

Example

Assume there is a third table named AUX_EMP that contains personnel information on each employee, such as GRADE, and having a primary key of EMPNO. If you want to display the employee's name, grade, position, department number, and location, the information can be collected from EMP, DEPT, and AUX_EMP. The three tables could be joined with a query such as the following:

```
SELECT ENAME, GRADE, JOB, EMP.DNO, DNAME, LOC
    FROM EMP, AUX_EMP, DEPT
    WHERE EMP.DNO = DEPT.DNO
    AND EMP.EMPNO = AUX_EMP.EMPNO
```

```
ENAME   GRADE    JOB        DNO    DNAME          LOC

HYDE      4      MANAGER    400    DISTRIBUTION   PRINCETON
ADAMS     3      SALESREP   200    SALES          NEW YORK
LAWSON    4      MANAGER    100    ACCOUNTING     ATLANTA
  .
  .
  .
```

Note: *The WHERE clause specifies the join conditions. Only a part of the resulting table is shown for the above SELECT.*

Cartesian Joins

If you do not specify a join criterion, then RDMS does not know how you want the rows of one table matched with the rows of the second table. The table that results is a Cartesian product; every row of the first table is matched with every row of the second. This produces a large table and is usually not what was wanted.

Cartesian joins exist for operational completeness, but when you get one, it is usually an accident. You probably forgot to specify the desired join condition. The resulting table has as many rows as the product of the number of rows in each table.

Example: Modify the previous equijoin example, omitting the WHERE clause and displaying both department number fields. The query would be:

```
SELECT ENAME, JOB, EMP.DNO AS E_DNO, DEPT.DNO AS D_DNO,
    DNAME, LOC FROM EMP, DEPT
```

The table answering that query would have 14 x 4 or 56 rows. The top of the table would appear as follows:

```
--ENAME---    ---JOB---    E_DNO   D_DNO  ---DNAME---     ---LOC-----
FOSTER        SALESREP       200     100  ACCOUNTING      ATLANTA
FOSTER        SALESREP       200     200  SALES           NEW YORK
FOSTER        SALESREP       200     300  MARKETING       DETROIT
FOSTER        SALESREP       200     400  DISTRIBUTION    PRINCETON
BROWN         CLERK          200     100  ACCOUNTING      ATLANTA
BROWN         CLERK          200     200  SALES           NEW YORK
BROWN         CLERK          200     300  MARKETING       DETROIT
BROWN         CLERK          200     400  DISTRIBUTION    PRINCETON
WOODWORTH     MANAGER        200     100  ACCOUNTING      ATLANTA
WOODWORTH     MANAGER        200     200  SALES           NEW YORK
WOODWORTH     MANAGER        200     300  MARKETING       DETROIT
WOODWORTH     MANAGER        200     400  DISTRIBUTION    PRINCETON
ROCKWELL      ACCOUNTANT     100     100  ACCOUNTING      ATLANTA
      .
      .
      .
```

Note: *There are four entries for each employee; one for each row of possible values from the DEPT table.*

Table Aliases

FROM *table1 alias1, table2 alias2, ...*

- Any table may be given another name or table alias
- Long, descriptive names can be shortened
- When joining a table with itself, it must be given aliases to clarify the column references

Example 1

```
FROM customer_info ci, houses_available ha
    WHERE ci.price > ha.price
```

Example 2

```
FROM EMP WORKER, EMP MANAGER
    WHERE WORKER.MGR = MANAGER.EMPNO
```

EMP (WORKER)

EMPNO	ENAME	JOB	MGR
5010	FOSTER	SALESREP	5234
5146	BROWN	CLERK	5234
5234	WOODWORTH	MANAGER	5784
5237	ROCKWELL	ACCOUNTANT	5743
5437	MARTIN	SALESREP	5234
5469	ADAMS	SALESREP	5234
5630	GLASS	ACCOUNTANT	5743
5702	TURNER	CLERK	5743
5743	LAWSON	MANAGER	5784
5765	JOHNSON	CLERK	5984
5784	WILLIAMS	PRESIDENT	
5896	SMITH	CLERK	5984
5942	FORD	SALESREP	5234
5984	HYDE	MANAGER	5784

EMP (MANAGER)

EMPNO	ENAME	JOB	MGR
5010	FOSTER	SALESREP	5234
5146	BROWN	CLERK	5234
5234	WOODWORTH	MANAGER	5784
5237	ROCKWELL	ACCOUNTANT	5743
5437	MARTIN	SALESREP	5234
5469	ADAMS	SALESREP	5234
5630	GLASS	ACCOUNTANT	5743
5702	TURNER	CLERK	5743
5743	LAWSON	MANAGER	5784
5765	JOHNSON	CLERK	5984
5784	WILLIAMS	PRESIDENT	
5896	SMITH	CLERK	5984
5942	FORD	SALESREP	5234
5984	HYDE	MANAGER	5784

Self-Joins

SELECT *alias1.column, alias2.column, ...*
FROM *table alias1, table alias2*
WHERE *alias1.column = alias2.column*
AND *other-conditions*

- Joins a table to itself, comparing values in two different columns with the same data type.

- The column names in the select-list must be qualified with the alias to distinguish which to display since the column names in the tables are identical.

Example: Display the number, name, and job of each employee, and the number, name, and job of the employee's manager.

```
SELECT WORKER.EMPNO, WORKER.ENAME, WORKER.JOB, WORKER.MGR,
    MANAGER.EMPNO, MANAGER.ENAME, MANAGER.JOB
    FROM EMP WORKER, EMP MANAGER
    WHERE WORKER.MGR = MANAGER.EMPNO
```

EMPNO	ENAME	JOB	MGR	MGR EMPNO	MGR ENAME	MGR JOB
5010	FOSTER	SALESREP	5234	5234	WOODWORTH	MANAGER
5146	BROWN	CLERK	5234	5234	WOODWORTH	MANAGER
5234	WOODWORTH	MANAGER	5784	5784	WILLIAMS	PRESIDENT
5237	ROCKWELL	ACCOUNTANT	5743	5743	LAWSON	MANAGER
5437	MARTIN	SALESREP	5234	5234	WOODWORTH	MANAGER
5469	ADAMS	SALESREP	5234	5234	WOODWORTH	MANAGER
5630	GLASS	ACCOUNTANT	5743	5743	LAWSON	MANAGER
5702	TURNER	CLERK	5743	5743	LAWSON	MANAGER
5743	LAWSON	MANAGER	5784	5784	WILLIAMS	PRESIDENT
5765	JOHNSON	CLERK	5984	5984	HYDE	MANAGER
5896	SMITH	CLERK	5984	5984	HYDE	MANAGER
5942	FORD	SALESREP	5234	5234	WOODWORTH	MANAGER
5984	HYDE	MANAGER	5784	5784	WILLIAMS	PRESIDENT

Note: *The WORKER.MGR and MANAGER.EMPNO columns are displayed for illustration of the matching column references.*

Self-Join Guidelines

- A table can be joined with itself as if joining two separate tables
- Self-join is used to join one row in a table with another in the same table
- The columns specified in the join criterion must have the same data type
- The table must be given two aliases to identify which columns are coming from which copy of the table
- In the previous example, note the following:
  - Both the EMPNO and MGR columns contain the same type of information, employee numbers as four numeric digits
  - For each row in the EMP table, EMPNO is the employee number of the employee named in the row
  - For each row in the EMP table, MGR is the employee number of the employee's manager
  - To obtain the name of the employee's manager, the EMP table must be joined with itself on the MGR column, comparing that to the EMPNO column, then locating the ENAME associated with that employee number

```
SQL> SELECT T1.ENAME AS EMPLOYEE,
            T2.ENAME AS MANAGER
     FROM EMP T1, EMP T2
     WHERE T1.MGR = T2.EMPNO
```

Non-Equijoins

- Most joins are based on the equality of values in the joined column; therefore they are called equijoins.

- Non-equijoins are based on other comparison operators:
  - <>
  - <
  - >
  - <=
  - >=
  - BETWEEN ... AND

Example: List the salary grade, name, salary, and job title of each employee. Order by grade, and within grade by salary.

```
SELECT GRADE, ENAME, SAL, JOB
    FROM EMP, SAL_GRADE
    WHERE SAL BETWEEN LOSAL AND HISAL
    ORDER BY GRADE, SAL
```

GRADE	ENAME	SAL	JOB
1	TURNER	900	CLERK
1	JOHNSON	975	CLERK
1	BROWN	1000	CLERK
1	SMITH	1050	CLERK
2	GLASS	1850	ACCOUNTANT
2	ROCKWELL	2175	ACCOUNTANT
3	ADAMS	2250	SALESREP
3	FORD	2375	SALESREP
3	MARTIN	2500	SALESREP
3	FOSTER	2700	SALESREP
4	HYDE	2900	MANAGER
4	WOODWORTH	3250	MANAGER
4	LAWSON	3400	MANAGER
5	WILLIAMS	5200	PRESIDENT

How RDMS Joins Tables

- Determine the cross product of the tables listed in the FROM clause
  - Produces a conceptual table, the cross-product table
  - Contains all the columns from all the joined tables
  - Number of rows is the product of the number of rows in each table
    - Three tables with 4 rows each means 4 X 4 X 4 = 64 rows
    - If one table is empty, resulting cross-product table is empty

- Apply the conditions of the WHERE clause to every row in the cross-product table
  - Produces the reduced cross-product table
  - Number of columns remains the same
  - Number of rows is reduced

- Apply the query specification clause to the reduced cross-product table
  - Use the conditions in the SELECT clause
  - Report only columns requested

Note: *If the query has multiple WHERE conditions, they are typically AND'ed together. A common mistake is to OR the conditions, selecting far too many rows.*

Exercise 8-1

Using the functionality you have learned so far, write and execute SQL statements that will retrieve data from the EMP and DEPT tables to answer the following questions.

1. Which employees work in Atlanta?

```
Select ENAME
  From EMP, DEPT
  where EMP.DNO = DEPT.DNO
    AND LOC = 'ATLANTA'
```

2. How many employees work in New York?

```
Select COUNT(*) AS "NEW YORK"
  from EMP, DEPT
  where EMP.DNO = DEPT.DNO
    AND LOC = 'NEW YORK'
```

3. List the employees' names and the cities in which they work. Order the list by city.

```
Select ENAME, LOC
  from EMP, DEPT
  where EMP.DNO = DEPT.DNO
  ORDER BY LOC
```

4. Retrieve the name and salary of employees who earn more than their managers.

```
Select T1.ENAME, T1.SAL from EMP T1, EMP T2
where T1.MGR = T2.EMPNO
  AND T1.SAL > T2.SAL
```

None

5. List the department number, location, and number of employees for every location.

```
Select DNO, LOC, COUNT(*) FROM EMP, DEPT
  where EMP.DNO = DEPT.DNO
  GROUP BY LOC, DNO
```

9

More Retrieval Considerations

Module 9
More Retrieval Considerations

Module Objectives

Upon completion of this module, you should be able to

- Describe and use any of the various programming or processing features that will help solve retrieval problems, including:
  - Using indicator variables
  - Passing more than 28 values in an ACOB SQL command
  - Processing forward or backward through a cursor
  - Random access of the database
  - Reusable cursors
  - Retrieving a single record
  - Retrieving multiple records from a single fetch
  - Efficiently accessing the database using primary or secondary keys

Benefit Statement

This module equips you with skills needed to solve retrieval problems. In addition, many of the considerations covered will give you insights into how to make your retrieval programs more efficient.

Note: *This modules contains a large number of Unisys extensions to SQL '89. If your code must be portable, you will avoid using the extensions.*

Materials

- OS 1100 UDS Relational Data Management System (UDS RDMS 1100) SQL Programming Reference Manual

- OS 1100 UDS Relational Data Management System (UDS RDMS 1100) Administration Guide

Data Access Considerations

Indicator Variables

Could use this always to stop unexpected errors.

host-var1 [INDICATOR] *ind-var1*, *host-var2* [INDICATOR] *ind-var2*, . . .

- Use to determine two different conditions
  - Tell whether or not the retrieved data value is NULL
  - Tell if a retrieved CHARACTER data column has been truncated

Table 9-1. Indicator Variable Values

Value	Meaning
Negative	NULL data value
0	Data value is non-NULL and fits into receiving field
Positive	True length of truncated data value

- Anywhere that a placeholder variable ($P) or embedded variable refers to a NULLS ALLOWED column, an indicator variable must follow it.
  - Indicator variables are required in a program accessing that column.
  - Indicator variables provide programmer control over handling NULL values.

- Declare the host program variable corresponding to an indicator placeholder variable or the embedded variable that serves as the indicator variable as signed numeric
- COBOL picture clause

```
PIC S9(4)  SIGN LEADING SEPARATE
```

Indicator Variable Examples

Requirement: To compute total compensation

ACOB ISQL Example

```
WORKING-STORAGE SECTION.
01  SAL-IND              PIC S9(4)     SIGN LEADING SEPARATE.
01  COMM-IND             PIC S9(4)     SIGN LEADING SEPARATE.


   PROCEDURE DIVISION.

      .
      .
      ENTER MASM 'ACOB$RDMR' USING
         'FETCH all_comp INTO $P1, $P2 $P3, $P4 $P5 ;',
         ERR-STAT, AUX-INFO,
         EMPNO-OUT,
         SAL-OUT,
         SAL-IND,    <
         COMM-OUT,
         COMM-IND.   <

      IF COMM-IND < 0    MOVE 0 TO COMM-OUT.
      COMPUTE TOTAL-COMP = SAL-OUT + COMM-OUT.
```

UCOB ESQL Example

```
WORKING-STORAGE SECTION.

    EXEC SQL BEGIN DECLARE SECTION END-EXEC.
01  SAL-IND              PIC S9(4)     SIGN LEADING SEPARATE.
01  COMM-IND             PIC S9(4)     SIGN LEADING SEPARATE.
    EXEC SQL END DECLARE SECTION END-EXEC.

   PROCEDURE DIVISION.

      .
      .
      EXEC SQL
         FETCH all_comp INTO :EMPNO-OUT, :SAL-OUT :SAL-IND,
            :COMM-OUT :COMM-IND
      END-EXEC.

      IF COMM-IND < 0    MOVE 0 TO COMM-OUT
      COMPUTE TOTAL-COMP = SAL-OUT + COMM-OUT
```

Handling Tables with More Than 28 Columns (ACOB)

ENTER MASM 'RSA$PARAM' USING *list-of-program-variables*

- ACOB limits the number of parameters on any ENTER MASM call to 31.
- RDMS uses the first three parameters for:
  - The SQL command
  - Error status code
  - Auxiliary information
- This leaves 28 data and indicator parameters on any call to ACOB$RDMR.
- If a table has more than 28 columns, use the subroutine RSA$PARAM
  - Build a parameter list
  - Then call ACOB$RDMR to execute the command
- Pass the program variables in the same order as the corresponding host variables in the SQL command.

Example:

```
ENTER MASM 'RSA$PARAM' USING PV1, PV2, ... PV31.
ENTER MASM 'RSA$PARAM' USING PV32, PV33,.. PV62.
STRING    'FETCH NEXT MY-CURSOR INTO ',
          '($P1, $P2, ...,',
          ' ... $P61, $P62);'
          DELIMITED BY SIZE INTO RCOM.
ENTER MASM 'ACOB$RDMR' USING RCOM, ERR-STAT, AUX-INFO.
```

Reusing Cursors

Cursor Review

You may recall that cursors provide a way to deliver rows extracted from a table to your program. The FETCH command already discussed retrieves one row of the cursor and correlates the values with your program variables.

The cursor defined in the DECLARE CURSOR command remains in existence until the end of the thread or until it is dropped. A cursor uses system resources - space in RDMS's internal tables - so it helps to free this space as soon as possible.

Describe Reusable

Suppose you were writing a program that would first print all the employees in Department 100, then all the employees in Department 200, and so on. There are two ways you could do this:

- Declare a separate cursor for each department, and have multiple open cursors in your program, or

- Declare a single cursor and reuse it, re-evaluating the query for each different value of DNO

Declaring one cursor saves system resources and is more efficient. RDMS supports multiple open cursors in a program, but you should save them for the occasions when they are necessary.

Host Program Variables in Cursors

In the above example, it is possible to declare a cursor for the first department, print the department information, then drop the cursor. You would have to re-declare the cursor for each department. At least the departments to specify are already known.

But what if you needed to accept the desired department as input from a user? How is that information passed to the cursor?

Host Program Variables!

Just as host program variables were used to pass retrieved information back to your program in a FETCH, they can be used to pass information from your program to an SQL command, such as OPEN CURSOR.

This capability is possible from ISQL, not ESQL. The ENTER MASM call makes the correspondence between the placeholder variables and your host program variables.

Program Flow for Reusing Cursors

Figure 9-1 illustrates the typical program flow of a program that reuses cursors.

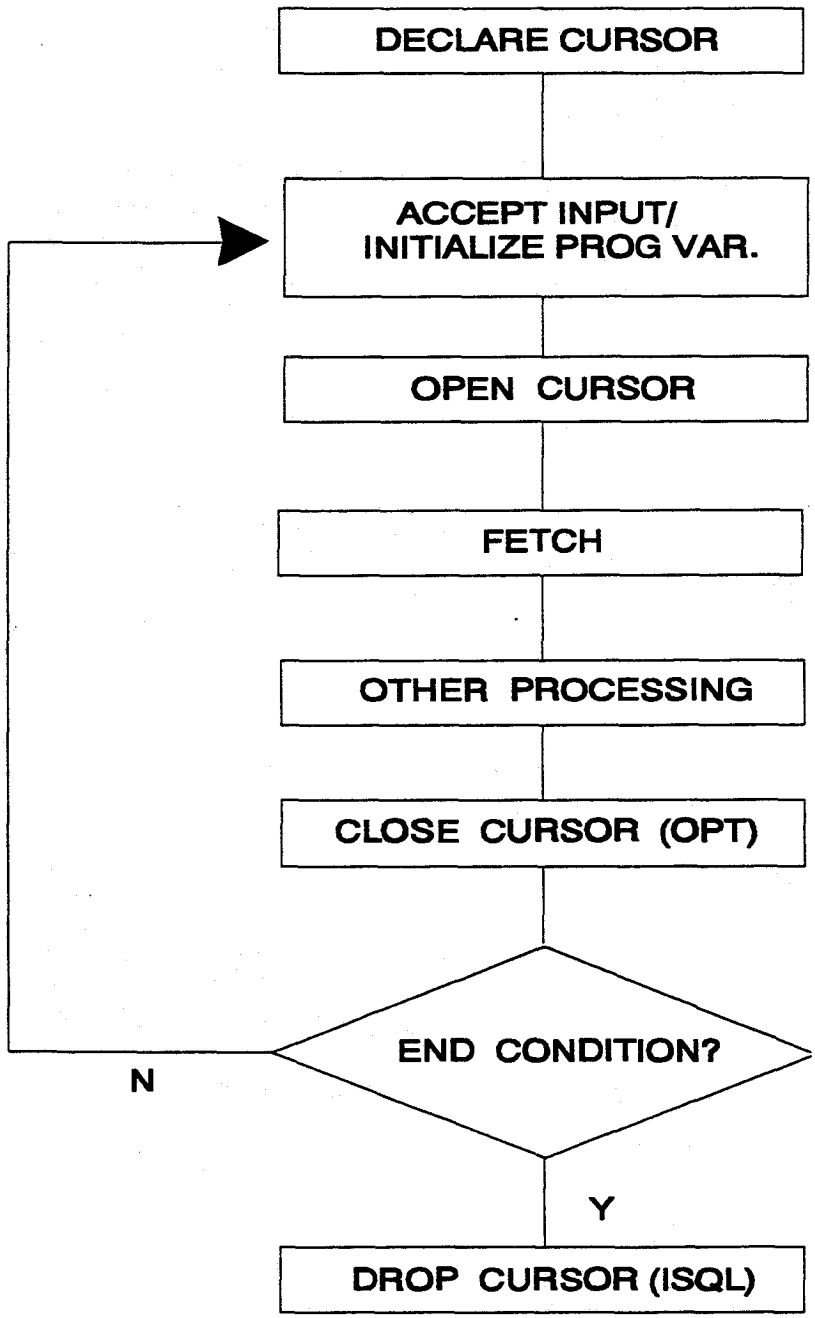


Figure 9-1. Program Flow for Reusing Cursors

CLOSE Command

CLOSE *cursor-name*

- Closes a previously opened cursor.
- Releases system space associated with the evaluation of the corresponding query with current parameters
- Allows query to be re-evaluated with new parameters on next OPEN command
- Embedded (ESQL) - Interpreter (ISQL) interface differences
  - CLOSE is optional for ISQL
  - Consecutive OPENs invoke an implicit CLOSE for ISQL
  - In ESQL, an attempt to open an opened cursor results in an error
- RDMS automatically closes cursors if you execute a thread control command, END THREAD for example, or if you encounter a rollback error

Example:

```
CLOSE HI_LO_SAL
```

DROP CURSOR Command

DROP CURSOR *cursor-name*

- Unisys SQL extension for the interpreter interface (ISQL), not for ESQL
- Undoes the DECLARE CURSOR command
- Frees the system space used to define the cursor and its associated query
- References to a dropped cursor generate an error

Examples:

```
DROP CURSOR HI_LO_SAL

DROP CURSOR DEPT200
```

OPEN ... USING Command

OPEN *cursor-name* USING *host-variable-list*

- Unisys extension to for ISQL, the interpreter interface, not for ESQL
- Host variables used must correspond to those in DECLARE CURSOR
  - $P1 in the DECLARE CURSOR must correspond to the $P1 in the OPEN
  - DECLARE may use same variable more than once in WHERE clause
  - OPEN references variable just once
  - Order of host variables should be same as in DECLARE CURSOR for clarity
- Variables must be initialized (in working-storage or as input) before OPEN refers to them
- Query in DECLARE CURSOR is evaluated with values from OPEN call to determine result

Open examples:

```
OPEN dept_cursor USING $P1

OPEN hi_lo_sal USING $P1, $P2
```

Example of Host Variables in Cursor

Requirement: To read and display the name and employee number of employees who fall in the salary range between hi-sal-in and lo-sal-in which are input by a user.

The following example illustrates the interpreter interface in a UCS COBOL program. Recall that UCS COBOL supports both the interpreter interface (ISQL) as well as the embedded interface (ESQL).

```
    .
    .
    .
WORKING-STORAGE SECTION.

01  HI-SAL-IN                          PIC 9(4)     VALUE ZEROS.
01  LO-SAL-IN                          PIC 9(4)     VALUE ZEROS.
01  RECORD-RETRIEVED
    05 ENAME-OUT                       PIC X(10)    VALUE SPACES.
    05 EMPNO-OUT                       PIC 9(4)     VALUE ZEROS.
    .
    .
    .
PROCEDURE DIVISION.
    .
    .
    .
    MOVE 'DECLARE HI_LO_SAL CURSOR          '  TO RCOM
    MOVE '  SELECT ENAME, EMPNO FROM EMP    '  TO RLIN(2)
    MOVE '  WHERE SAL BETWEEN $P1 AND $P2 ;' TO RLIN(3)
    ENTER MASM 'ACOB$RDMR' USING RCOM, ERR-STAT,
       AUX-INFO, LO-SAL-IN, HI-SAL-IN
    .
    .
    .
    ACCEPT LO-SAL-IN
    ACCEPT HI-SAL-IN
    .
    MOVE 'OPEN HI_LO_SAL  USING $P1, $P2  ;'  TO RCOM
    ENTER MASM 'ACOB$RDMR' USING RCOM, ERR-STAT,
       AUX-INFO, LO-SAL-IN, HI-SAL-IN
    .
    .
    .
    PERFORM UNTIL ERR-STAT = 6001
       MOVE 'FETCH HI_LO_SAL INTO $P1, $P2  ;'  TO RCOM
       ENTER MASM 'ACOB$RDMR' USING RCOM, ERR-STAT,
          AUX-INFO, ENAME-OUT, EMPNO-OUT
       DISPLAY RECORD-RETRIEVED
    END-PERFORM
    .
    .
    .
    MOVE 'CLOSE HI_LO_SAL                   ;'  TO RCOM
    ENTER MASM 'ACOB$RDMR' USING RCOM, ERR-STAT, AUX-INFO
    .
    .
    .
    MOVE 'DROP CURSOR HI_LO_SAL             ;'  TO RCOM
    ENTER MASM 'ACOB$RDMR' USING RCOM, ERR-STAT, AUX-INFO
    .
    .
    .
```

Lab 9-1

Reusing Cursors

Write and execute a COBOL program that uses only one cursor to do the following:

Retrieve and display the employee number, name, department number, and commission of all employees except those in a specified department. If the commission is NULL, display the word "NONE" in the commission column. Accept the department as input and repeat the display until a dummy department number of 999 is keyed in.

Sequential and Random Processing on a Cursor

Currency and Fetching

- A cursor associates a named data area with a query
  - Think of it as a "virtual table" that has currency
  - Opening the cursor sets the pointer to just prior to the first row of the virtual table.
- Currency allows processing through the cursor using different FETCH commands.
  - FETCH FIRST
  - FETCH [NEXT]
  - FETCH LAST
  - FETCH PRIOR
  - FETCH CURRENT

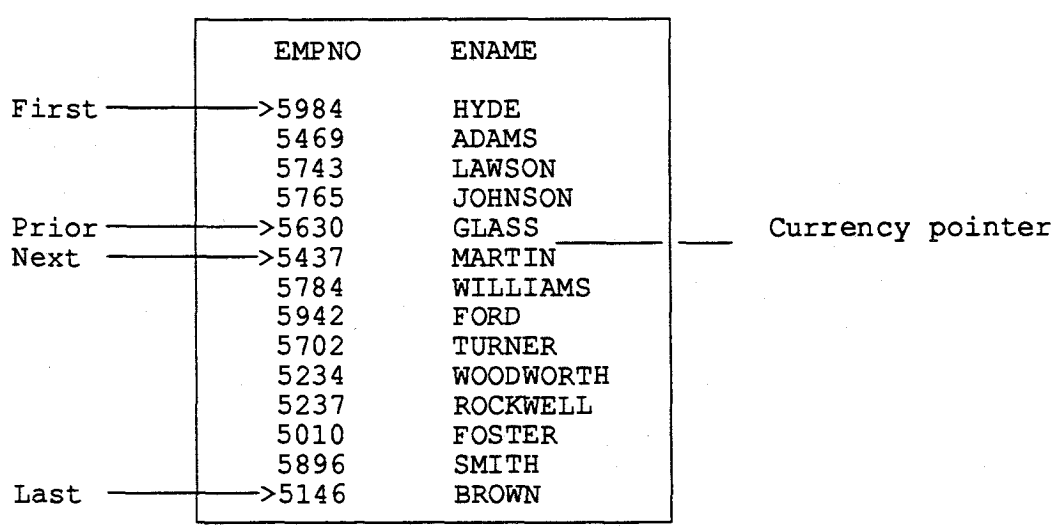


Figure 9-2. FETCH Options

FETCH [*option*] Command

FETCH [*option*] cursor-name INTO *variable-specification-list*

- Unisys SQL extension
- Where *option* may be FIRST, NEXT, LAST, PRIOR
  - NEXT is default
  - Cannot fetch LAST or PRIOR from a cursor declared with a GROUP BY, HAVING, or ORDER BY clause
- The *variable-specification-list* is a list separated by commas consisting of:
  - Placeholder variables for ISQL
  - Embedded variables for ESQL
- Retrieves one row from the cursor relative to the current pointer position
- If the cursor is positioned after the last row and you execute a FETCH or FETCH NEXT, or if you execute a FETCH PRIOR from before the first row of the cursor, an end-of-cursor status is returned to you.

Introduction to Random Processing on a Cursor

Unisys SQL extensions allow you to perform random processing on a cursor. The commands that support this are not part of the ANSI standard SQL. Be aware of this if you have concerns about the portability of your program.

Suppose you want to process different parts of a cursor separately. For example, from the EMP table, display first the two rows starting with 5010, then the next two starting with 5784, then three more starting with 5469.

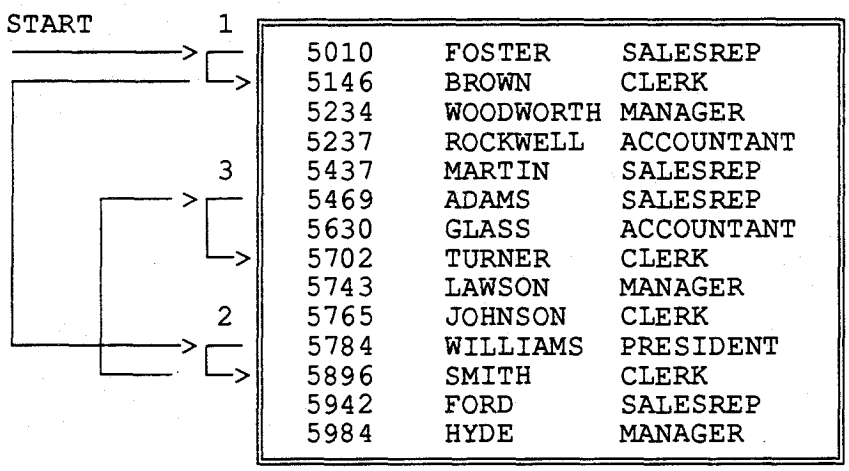


Figure 9-3. Random Processing

- To perform this type of random processing the steps are:
  - DECLARE a cursor for random access
  - Set the currency pointer with a LOCATE command
  - FETCH the current row
  - FETCH NEXT or PRIOR as desired
  - Loop back to the LOCATE command

DECLARE CURSOR Command

```
DECLARE cursor-name CURSOR
    FOR RANDOM [ ACCESS ]
    SELECT select-list
    FROM   table-name
    [ WHERE condition(s) ]
```

- Unisys extension to SQL
- SEQUENTIAL is the default
- A RANDOM ACCESS cursor can refer to only one table in the FROM clause
  - Cannot contain FOR UPDATE, GROUP BY, or ORDER BY clauses
  - Cannot refer to a view or built-in function
  - Cannot include the DISTINCT keyword

LOCATE Command

```
LOCATE cursor-name
    ON table-name
    USING VALUES ( primary-key-value )
```

- Unisys extension to SQL
- LOCATE uses the index of the primary key to position the currency pointer
  - Is allowed on random access cursor only
  - Does not retrieve any data

- The *primary-key-value*
  - Is a list of values (separated by commas) of the column or columns of the table's primary key
  - Must be the same as when the table was created

- If *primary-key-value* from LOCATE does not exist in table:
  - Auxiliary information variable is set to 1 (0 if it does exist)
  - Currency pointer is positioned to where key would be located if it existed, but cursor does not have a current row
  - FETCH CURRENT returns 6001 end-of-cursor status
  - FETCH NEXT returns next record after currency pointer

FETCH Command

FETCH CURRENT *cursor-name*
INTO *host-variable-list*

- Unisys extension to SQL

- FETCH CURRENT returns row to which currency pointer is set

Random Processing Example

Processing requirement:

From the EMP table, display first the two rows starting with 5010, then the next two starting with 5784, then three more starting with 5469.

```
    MOVE 'OPEN EMPS                                ; ' TO RCOM
    ENTER MASM 'ACOB$RDMR' USING RCOM, ERR-STAT, AUX-INFO

    MOVE 'LOCATE EMPS ON EMP                        ' TO RCOM
    MOVE '   USING VALUES (5010)                   ;' TO RLIN(2)
    ENTER MASM 'ACOB$RDMR' USING RCOM, ERR-STAT, AUX-INFO

    MOVE 'FETCH CURRENT EMPS INTO $P1, $P2         ;' TO RCOM
    ENTER MASM 'ACOB$RDMR' USING RCOM, ERR-STAT, AUX-INFO,
       EMPNO-OUT, ENAME-OUT
    DISPLAY RECORD-RETRIEVED
    PERFORM FORWARD-READ


    MOVE 'LOCATE EMPS ON EMP                        ' TO RCOM
    MOVE '   USING VALUES (5784)                   ;' TO RLIN(2)
    ENTER MASM 'ACOB$RDMR' USING RCOM, ERR-STAT, AUX-INFO

    MOVE 'FETCH CURRENT EMPS INTO $P1, $P2         ;' TO RCOM
    ENTER MASM 'ACOB$RDMR' USING RCOM, ERR-STAT, AUX-INFO,
       EMPNO-OUT, ENAME-OUT
    DISPLAY RECORD-RETRIEVED
    PERFORM FORWARD-READ


    MOVE 'LOCATE EMPS ON EMP                        ' TO RCOM
    MOVE '   USING VALUES (5469)                   ;' TO RLIN(2)
    ENTER MASM 'ACOB$RDMR' USING RCOM, ERR-STAT, AUX-INFO

    MOVE 'FETCH CURRENT EMPS INTO $P1, $P2         ;' TO RCOM
    ENTER MASM 'ACOB$RDMR' USING RCOM, ERR-STAT, AUX-INFO,
       EMPNO-OUT, ENAME-OUT
    DISPLAY RECORD-RETRIEVED
    PERFORM FORWARD-READ 2 TIMES

FORWARD-READ.
    MOVE 'FETCH NEXT EMPS INTO $P1, $P2            ;' TO RCOM
    ENTER MASM 'ACOB$RDMR' USING RCOM, ERR-STAT, AUX-INFO,
       EMPNO-OUT, ENAME-OUT
    DISPLAY RECORD-RETRIEVED.
```

Lab 9-2

Write the PROCEDURE DIVISION that would read and display the rows of the DEPT table in reverse DNO order.

Retrieval Efficiency Considerations

Singleton SELECT Command

```
SELECT [ ALL | DISTINCT ] { * | select-list }
    INTO variable-specification-list
    FROM table-specification-list
    [ WHERE Boolean-expression ]
    [ GROUP BY column-specification-list ]
    [ HAVING Boolean-expression ]
```

- Replaces DECLARE, OPEN, FETCH, and DROP with one command
  - SELECT, FROM, WHERE, GROUP BY, and HAVING clauses are the same as for the query specification
  - INTO clause is the same as for the FETCH command
- Returns one row from a table or tables to a program, typically using the primary key value to guarantee only one row will be returned
- ISQL/ESQL differences
  - For ISQL, if the WHERE clause does not identify a single row, the row retrieved is the first one found
  - For ESQL, the singleton SELECT must result in 0 or 1 rows being selected, or RDMS returns an error

Singleton SELECT Example

Singleton SELECT:

```
    .
    .
    .
ENTER MASM 'ACOB$RDMR' USING
'SELECT ename, sal
   INTO $P1, $P2
   FROM emp
   WHERE empno = 5237        ;',
   err-stat, aux-info, ename-out, sal-out
   .
   .
   .
```

Replaces:

```
    .
    .
    .
ENTER MASM 'ACOB$RDMR' USING
'DECLARE CURSOR my_cursor
   SELECT ename, sal FROM emp
   WHERE empno = 5237         ;',
   err-stat, aux-info
   .
   .
   .
ENTER MASM 'ACOB$RDMR' USING
'OPEN my_cursor              ;',
   err-stat, aux-info
   .
   .
   .
ENTER MASM 'ACOB$RDMR' USING
'FETCH my_cursor INTO $P1, $P2       ;',
   err-stat, aux-info, ename-out, sal-out
   .
   .
   .
```

FETCH NEXT n Command

FETCH NEXT *number-of-rows* [FROM] *cursor-name*
INTO *variable-specification-list*

- Use to fetch multiple rows from a cursor
- Available through the embedded interface (ESQL), not ISQL
- This command is not available in SQL 89
- The *number-of-rows* must be a positive integer constant
- The *variable-specification-list* is a list of embedded variables
  - Each is a one-dimensional array, declared as an elementary item
  - Array size is determined by *number-of-rows*
- Status information returned by RDMS
  - Auxiliary information is the number of rows returned
  - Auxiliary information should always be checked after a FETCH NEXT n
  - If fewer than n rows are fetched, error status = 6001 and SQLCODE = +100

FETCH NEXT n Example

This example illustrates the PROCEDURE DIVISION and corresponding DATA DIVISION items in a UCS COBOL program for fetching 5 rows of the employee table at a time into an array. Only the column corresponding to RR-COMM allowed NULLs.

```
      .
      .
      .
01  REC-RETRIEVED.
    05  RR-EMPNO          OCCURS 5  PIC 9(5).
    05  RR-ENAME          OCCURS 5  PIC X(10).
    05  RR-JOB            OCCURS 5  PIC X(10).
    05  RR-MGR            OCCURS 5  PIC 9(5).
    05  RR-DNO            OCCURS 5  PIC 9(4).
    05  RR-HIREDATE       OCCURS 5  PIC 9(7).
    05  RR-SAL            OCCURS 5  PIC 9(5).
    05  RR-COMM           OCCURS 5  PIC 9(5).
01  REC-COMM-IND.
    05  RR-COMM-IND       OCCURS 5  PIC S9(4)
                          SIGN LEADING SEPARATE.
      .
      .
      .
    EXEC SQL
       DECLARE C1 CURSOR SELECT * FROM EMP
    END-EXEC.
      .
      .
      .
    EXEC SQL
       OPEN CURSOR C1
    END-EXEC.
      .
      .
      .
    EXEC SQL
       FETCH NEXT 5 FROM C1 INTO :RR-EMPNO, :RR-ENAME,
          :RR-JOB, :RR-MGR, :RR-DNO, :RR-HIREDATE,
          :RR-SAL, :RR-COMM  :RR-COMM-IND
    END-EXEC.
      .
      .
      .
```

How RDMS Retrieves Data

When programming for better performance, it helps to know how RDMS works and to take advantage of its features. It is easy to write SQL queries and RDMS will eventually return the rows requested no matter how inefficiently the query is written. But, there are steps you can take to make it easier and more efficient to find the data. To be able to write better queries, you need to know how RDMS locates the data you request.

Retrieval Using the Primary Key

This is the most efficient type of access. Tables are stored in primary key order and RDMS can go directly to the page on which a row identified by primary key value is located.

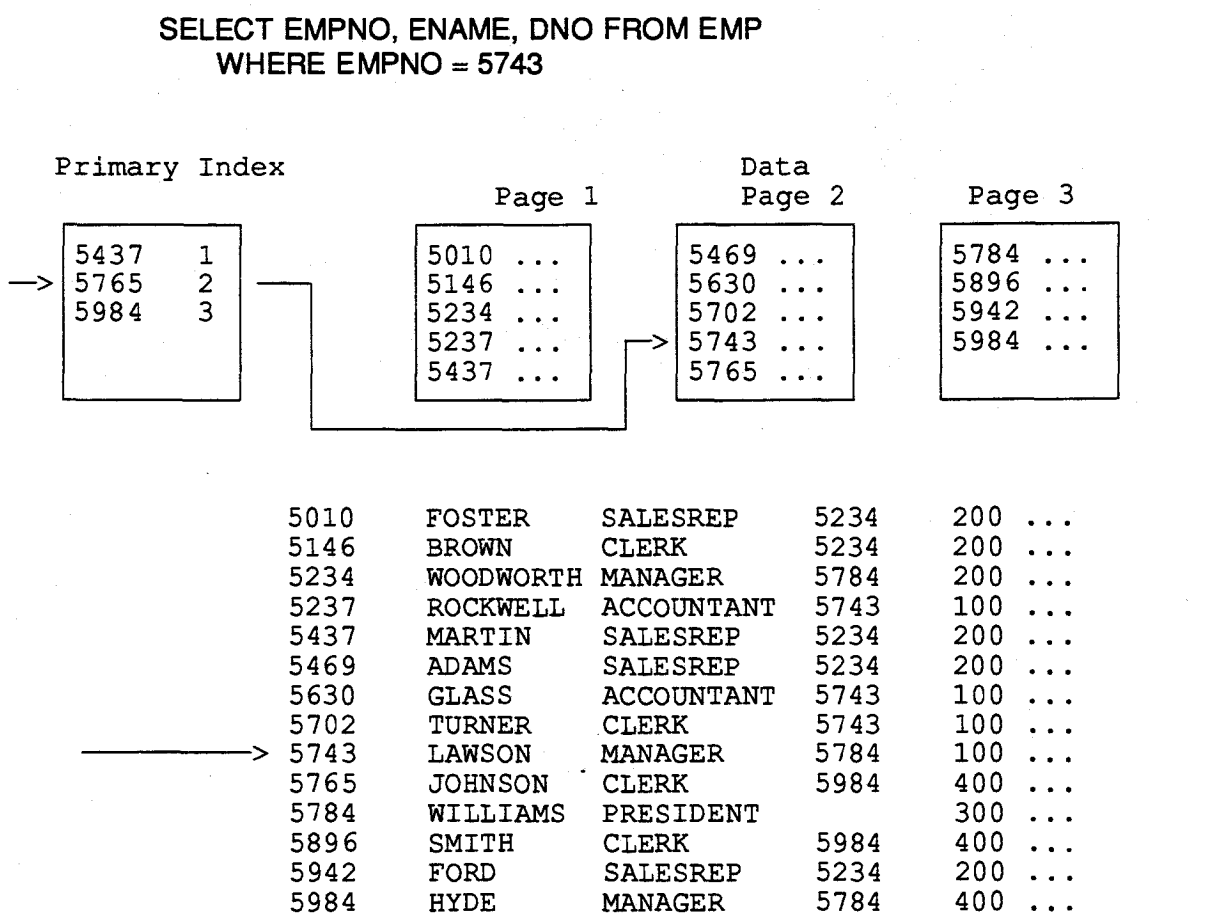


Figure 9-4. Primary Key Usage

Retrieval Using No Key

This is the slowest type of access. RDMS must walk the entire table, "looking at" each row, and evaluating whether it satisfies the conditions of the query.

DNO has not been specified as a secondary key.

```
SELECT EMPNO, ENAME, DNO FROM EMP
    WHERE DNO = 100
```

->5010	FOSTER	SALESREP	5234	200	...	
->5146	BROWN	CLERK	5234	200	...	
->5234	WOODWORTH	MANAGER	5784	200	...	
->5237	ROCKWELL	ACCOUNTANT	5743	100	...	Satisfies
->5437	MARTIN	SALESREP	5234	200	...	
->5469	ADAMS	SALESREP	5234	200	...	
->5630	GLASS	ACCOUNTANT	5743	100	...	Satisfies
->5702	TURNER	CLERK	5743	100	...	Satisfies
->5743	LAWSON	MANAGER	5784	100	...	Satisfies
->5765	JOHNSON	CLERK	5984	400	...	
->2784	WILLIAMS	PRESIDENT		300	...	
->5896	SMITH	CLERK	5984	400	...	
->5942	FORD	SALESREP	5234	200	...	
->5984	HYDE	MANAGER	5784	400	...	

Figure 9-5. No Key Usage

Retrieval Using A Secondary Key

This is a fast type of access. RDMS has an index that lists the secondary key values and the corresponding primary key. RDMS can then index into the data using the primary key. If a column is used very frequently for access but is not the primary key, and the processing requires fast response, the database designer may implement it as a secondary key.

DNO has been specified as a secondary key.

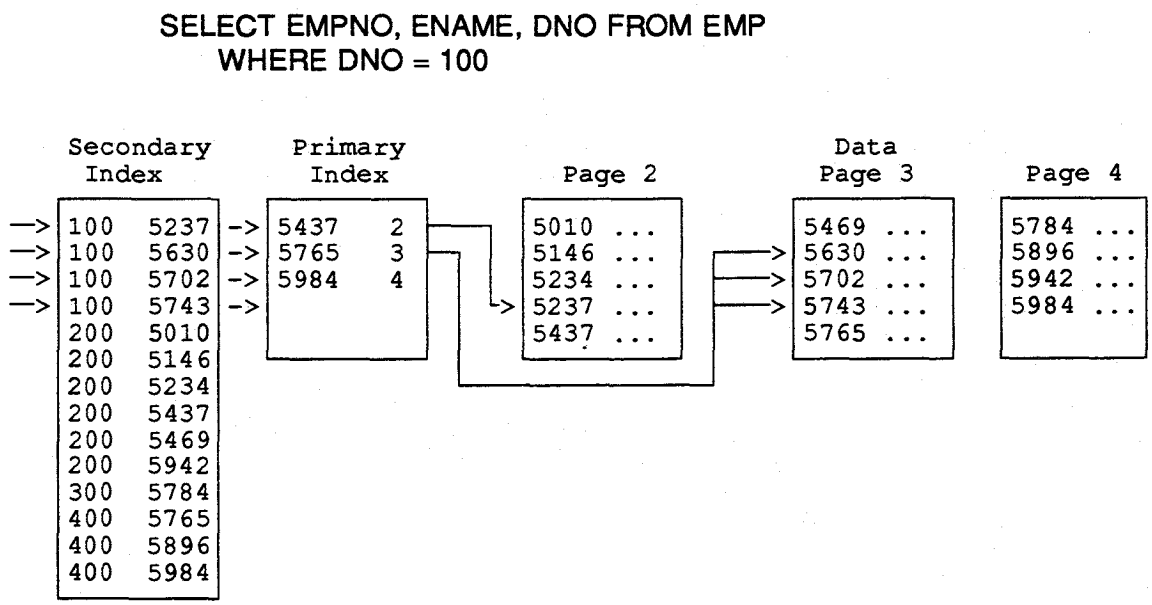


Figure 9-6. Secondary Key Usage

Secondary Keys

- A secondary key is a set of one or more columns for which RDMS creates an index that provides fast access to those columns

- A secondary index should be created when:
  - Rows are frequently accessed using those columns
  - The table has many rows

- If the EMP table were often queried using DNO and ENAME, an index for each should be declared

DNO INDEX

DNO	EMPNO
100	5237
100	5630
100	5702
100	5743
200	5010
200	5146
200	5234
200	5437
200	5469
200	5942
300	5784
400	5765
400	5896
400	5984

ENAME INDEX

ENAME	EMPNO
ADAMS	5469
BROWN	5146
FORD	5942
FOSTER	5010
GLASS	5630
HYDE	5984
JOHNSON	5765
LAWSON	5743
MARTIN	5437
ROCKWELL	5237
SMITH	5896
TURNER	5702
WILLIAMS	5784
WOODWORTH	5234

Figure 9-7. DNO and ENAME Indexes

Accessing Data Using Keys

- Performance is improved when the columns selected by your query are all part of the primary or secondary key

Example:

```
SELECT ENAME, DNO
    FROM EMP
    WHERE DNO = 200
```

- When multiple secondary indices exist, RDMS uses the one declared first in the CREATE TABLE command (other factors being equal)

Example:

```
SELECT ENAME, SAL
    FROM EMP
    WHERE DNO = 200
      AND ENAME = 'FORD'
```

- If the key is multi-column, the index is used only if the WHERE clause uses the leading column(s) of the index

Exercise 9-1

Describe the programming or processing features that might help solve the following retrieval problems.

1. Nothing returned when two fields were added together.

check for null

2. Trying to fetch 40 columns of information on a given fetch.

Use RSASPARAM call

3. Problems encountered when multiple cursors were operative.

Too many cursors
Re-use cursor
Close unwanted cursors

4. Ability to easily retrieve employee records given their social security number.

Primary key

5. An ability to retrieve a single employee record quickly.

Singleton Select

6. Database programs that need to run much faster.

Primary Keys
Secondary Keys
Indexes

10

Data Manipulation

Module 10
Data Manipulation

Module Objectives

- Change the data in your tables.
  - Open a thread for update.
  - Use the UPDATE, INSERT, and DELETE commands to modify data.
  - Use the ROLLBACK command to reverse the effects of data changes.

Benefit Statement

You will see in this module how easy it is to modify your database with a few SQL commands. You probably realize, having said that it is easy to change, that you will need to deploy safeguards to guarantee the integrity of your database. A few of the integrity capabilities are touched on here as well, but more on that later.

Note: *There are several Unisys extensions for the UPDATE command and one for the INSERT command. Those syntax extensions are not discussed in this module, only the SQL 89 formats are presented. If you are maintaining or migrating SQL code, consult the PRM listed below for the details on the extensions.*

Materials

- OS 1100 UDS Relational Data Management System (UDS RDMS 1100) and IPF SQL Interface End Use Guide
- OS 1100 UDS Relational Data Management System (UDS RDMS 1100) SQL Programming Reference Manual

Data Manipulation

- Data manipulation commands change the data residing in the data tables
  - INSERT - Add new rows to a table
  - UPDATE - Change values of columns of existing rows
  - DELETE - Remove rows from a table
- Query commands are often used to check the results of changes
- Update command structure similar to query structure
  - If issued from an application program, DECLARE CURSOR is not always required
  - Just MOVE update command to RCOM
- Typically, you should use the BEGIN THREAD command
  - Notify RDMS 1100 that you will update, not just read data
  - Specify type of recovery desired

BEGIN THREAD Command Revisited

BEGIN THREAD [*thread-name*]
FOR [APPLICATION] *alias-name* [*options*]

- This is a Unisys extension
- For retrieval, the *options* discussed were:

  [READ | RETRIEVE] [UDSMSG | UDSMESSAGE | UDSMESSAGES]

- For insertion, deletion, or update, the *options* are:

  UPDATE(*recovery-option*) [UDSMSG | UDSMESSAGE | UDSMESSAGES]

- Choices for *recovery-option* are:
  - COMMANDLOOKS
  - DEFERRED (the default)
  - QUICKLOOKS
  - NONE

Examples:

```
BEGIN THREAD FOR UDSSRC UPDATE(DEFERRED) UDSMSG

BEGIN THREAD T1 FOR APP1 UPDATE(QUICKLOOKS)

BEGIN THREAD FOR TEST1 UPDATE(DEFERRED) UDSMESSAGE
```

ROLLBACK Command

ROLLBACK WORK

- Before making any changes, it is important to know how to "undo" any modifications in case of error

- ROLLBACK command discards any changes made to the database since the last thread control command or rollback

- ROLLBACK will also
  - Close all open cursors
  - Release all implicit locks on data or tables that were changed

- ROLLBACK is useful in application programs
  - When several updates are to be performed, but only if all of them can be performed
  - To do temporary updates to generate "what if" reports

Inserting Rows into Tables

Introduction to INSERT

- Before inserting data into a table:
  - The table must exist
  - Data must satisfy any key and NULL value constraints
- Table need not initially contain any data
- INSERT command is used for interactive or small-scale row insertions
- Large-scale, initial load process is performed differently

Examples. Insert two new departments into the DEPT table as illustrated in Figure 10-1.

```
INSERT INTO DEPT
    VALUES (500, 'RESEARCH', 'BOSTON')

INSERT INTO DEPT (DNAME, DNO, LOC)
    VALUES ('OPERATIONS', 600, 'SALT LAKE')
```

DNO	DNAME	LOC
100	ACCOUNTING	ATLANTA
200	SALES	NEW YORK
300	MARKETING	DETROIT
400	DISTRIBUTION	PRINCETON
500	RESEARCH	BOSTON
600	OPERATIONS	SALT LAKE

Figure 10-1. Inserting New Departments

INSERT Command

INSERT INTO *table-specification* [(*column-name-list*)]
{ VALUES (*value-list*) | *query-specification* }

- Adds one or more rows to a new or existing table or view
  - "Position" in table is determined by primary key value
  - Duplicate primary key entry generates error message
- The *column-name-list* is used when:
  - Inserting fewer columns than exist in the table definition
  - Entering values in a sequence different than the table definition
  - If omitted, the *value-list* must correspond to the way the table was created, both by order and number of columns
- The *value-list* provides values separated by commas supplied as
  - Numeric constants or string literals
  - Host program variables ($P*n* or embedded variables)
  - Arithmetic expressions to be evaluated
  - The keywords NULL or USER
- The *query-specification* inserts rows by selecting values from other tables
  - Items in the SELECT list must correspond one to one, in order, with the column-name-list
  - If the *column-name-list* is omitted, the items in the SELECT list must correspond to the way the table was created, both by order and number of columns

```
INSERT INTO ROSVSCHEMA1.DEPT
    SELECT * FROM ROSVSCHEMA2.DEPT
        WHERE DNO > 400
```

INSERT INTO DEPT (DNO, DNAME,
VALUES (500, 'X')

Changing Existing Data

Introduction to UPDATE

- As long as primary key and foreign key constraints are obeyed, any data value in any column or row can be changed.
  - Change a primary key to another valid key value
  - Change all the values in an entire column
  - Change a value in rows selected by a WHERE clause
- SQL 89 supports two forms of the UPDATE command
  - Single row update
  - Multiple row update

Note: *Both forms of the command rely upon a WHERE clause to restrict the scope of the update. If you omit the WHERE clause, all rows will be updated!*

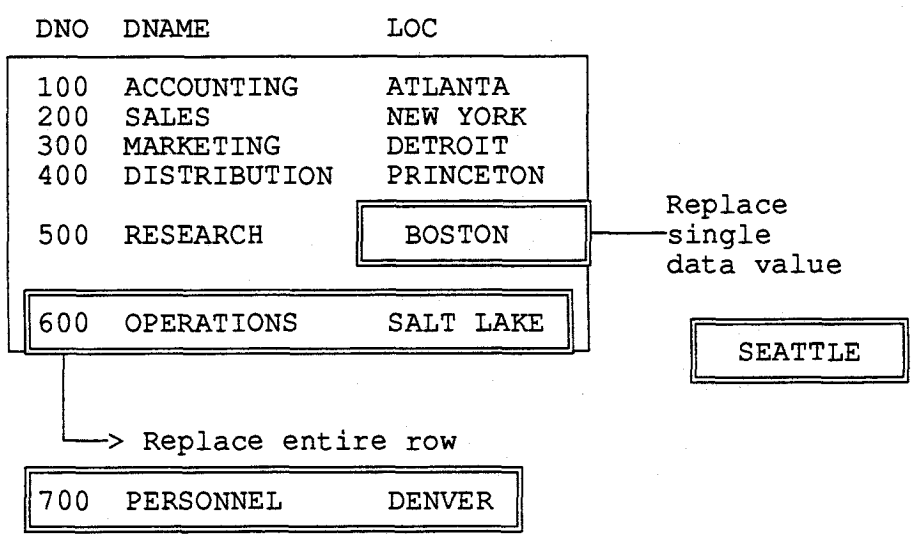


Figure 10-2. Possible Updates

UPDATE Positioned Command

Use FETCH to position cursor then UPDATE record.

```
UPDATE table-specification
    SET change-specification
    WHERE CURRENT OF cursor-name
```

LNT

- Use to change the content of columns within the current row of the cursor

- The *change-specification* is a list of column names and values
  - Form: *column-name = value-specification* [*,column-name = value-specification*] ...
  - Where *value-specification* may be a numeric constant, string literal, an arithmetic expression, the keyword NULL, the keyword USER, or a variable specification

- Rules for referencing the cursor
  - Cursor must be declared with the FOR UPDATE OF clause, a Unisys extension
  - Only columns named in the FOR UPDATE OF clause can be updated
  - Table names for DECLARE and UPDATE commands must match
  - A successful FETCH must immediately precede the UPDATE

Example. Change Smith's job description from clerk to administrative assistant.

```
DECLARE UPDAT CURSOR
    SELECT EMPNO, ENAME, JOB FROM EMP
    WHERE EMPNO = 5896
    FOR UPDATE OF JOB
FETCH UPDAT INTO :RR-EMPNO, :RR-ENAME, :RR-JOB
UPDATE EMP
    SET JOB = 'ADMN ASST'
    WHERE CURRENT OF UPDAT

SELECT * FROM EMP
    WHERE EMPNO = 5896
```

EMPNO	ENAME	JOB	MGR	DNO	HIREDATE	SAL	COMM
5896	SMITH	ADMN ASST	5984	400	880913	1050	

UPDATE Searched Command

Search - Update
Tot
UPD

UPDATE *table-specification*
SET *column-change-specification*
[WHERE *Boolean-expression*]

- Change the content of columns within a subset of the existing rows of a table
- The *change-specification* is a list of column names and values
  - Form: *column-name* = *value-specification* [,*column-name* = *value-specification*] ...
  - Where *value-specification* may be a numeric constant, string literal, an arithmetic expression, the keyword NULL, the keyword USER, or a variable specification
- The *Boolean-expression* specifies the rows to be updated

Example: Give all people in Department 200 who do not receive a commission a 7 percent increase in salary and a commission that is 10 percent of their original salary.

```
UPDATE EMP
SET SAL = SAL * 1.07,
   COMM = SAL * .10
WHERE DNO = 200
     AND COMM IS NULL

SELECT * FROM EMP
WHERE DNO = 200
```

EMPNO	ENAME	JOB	MGR	DNO	HIREDATE	SAL	COMM
5010	FOSTER	SALESREP	5234	200	860714	2700	550
5146	BROWN	CLERK	5234	200	871011	1070	100
5234	WOODWORTH	MANAGER	5784	200	790219	3478	325
5437	MARTIN	SALESREP	5234	200	870326	2500	300
5469	ADAMS	SALESREP	5234	200	811102	2250	500
5942	FORD	SALESREP	5234	200	890316	2375	0

Sample COBOL Update Program

Requirement: Prompt and read data from a user to update an entire row in the EMP table. Program is written in ISQL for UCS COBOL.

```
@UCOB,S DEV.MOD10/UCOBUPDT,TPF$.UPDT,,,NO-OPTIONS,NARROW
UCOB- 5R2(910816) LSS- 6R1A(910814) 930419 13:37:59
1               IDENTIFICATION DIVISION.
2               PROGRAM-ID. update-emp.
3               ENVIRONMENT DIVISION.
4               CONFIGURATION SECTION.
5               SOURCE-COMPUTER. UNISYS-2200.
6               OBJECT-COMPUTER. UNISYS-2200.
7
8               DATA DIVISION.
9               WORKING-STORAGE SECTION.
10
11              01  thread-flag                PIC 9     VALUE ZERO.
12                  88  thread-has-begun                VALUE 1.
13              01  err-end-flag               PIC 9     VALUE ZERO.
14                  88  no-more-msgs                   VALUE 1.
15
16                  EXEC SQL BEGIN DECLARE SECTION END-EXEC.
17
18              01  update-record.
19                  05  up-empno               PIC 9(4).
20                  05  up-ename               PIC X(10).
21                  05  up-job                 PIC X(10).
22                  05  up-mgr                 PIC 9(4).
23                  05  up-dno                 PIC 9(3).
24                  05  up-hiredate            PIC 9(6).
25                  05  up-sal                 PIC 9(4).
26                  05  up-comm                PIC 9(4).
27              01  record-out.
28                  05  empno-out              PIC 9(4).
29                  05                         PIC X(2) VALUE SPACES.
30                  05  ename-out              PIC X(10).
31                  05                         PIC X(2) VALUE SPACES.
32                  05  job-out                PIC X(10).
33                  05                         PIC X(2) VALUE SPACES.
34                  05  mgr-out                PIC 9(4).
35                  05                         PIC X(2) VALUE SPACES.
36                  05  dno-out                PIC 9(3).
37                  05                         PIC X(2) VALUE SPACES.
38                  05  hiredate-out           PIC 9(6).
39                  05                         PIC X(2) VALUE SPACES.
40                  05  sal-out                PIC 9(4).
41                  05                         PIC X(2) VALUE SPACES.
42                  05  comm-out               PIC 9(4).
43
```

```
44              01  SQLCODE                        PIC S9(9)   USAGE BINARY.
45
46              01  RDMCA.
47                  05  ERROR-STATUS               PIC 9(4).
48                  05  AUX-INFO                   PIC S9(9)   USAGE BINARY.
49
50              01  err-text.
51                  05  err-s                      PIC X(132)  OCCURS 4 TIMES.
52
53              01  err-s-index                    PIC 9.
54                  EXEC SQL END DECLARE SECTION END-EXEC.
55
56
57              PROCEDURE DIVISION.
58              000-main.
59
60             ************************************************************
61             *     Begin thread                                         *
62             ************************************************************
63
64                  EXEC SQL
65                       WHENEVER NOT FOUND GO TO 400-done
66                  END-EXEC.
67
68                  EXEC SQL
69                       WHENEVER SQLERROR GO TO 900-rdms-error
70                  END-EXEC.
71
72                  BEGIN THREAD FOR UDSSRC UPDATE(DEFERRED).
73
74             ************************************************************
75             *     Prompt and read input                                *
76             ************************************************************
77
78                   DISPLAY 'Enter the current 4 digit employee number'
79                   ACCEPT up-empno
80                   DISPLAY 'Enter employee last name'
81                   ACCEPT up-ename
82                   DISPLAY 'Enter job title'
83                   ACCEPT up-job
84                   DISPLAY 'Enter employee number of manager'
85                   ACCEPT up-mgr
86                   DISPLAY 'Enter department number'
87                   ACCEPT up-dno
88                   DISPLAY 'Enter hiredate'
89                   ACCEPT up-hiredate
90                   DISPLAY 'Enter employee monthly salary'
91                   ACCEPT up-sal
92                   DISPLAY 'Enter commission, or NULL if not applicable'
93                   ACCEPT up-comm
94
```

```
95          ************************************************************
96          *     Update row                                           *
97          ************************************************************
98
99               EXEC SQL
100                 UPDATE rosvschema2.emp
101                 SET empno = :up-empno, ename = :up-ename, job = :up-job,
102                 mgr = :up-mgr, dno = :up-dno, hiredate = :up-hiredate,
103                 sal = :up-sal, comm = :up-comm
104                 WHERE empno = :up-empno
105              END-EXEC.
106
107              DISPLAY 'Update Performed'.
108
109         ************************************************************
110         *     Display updated row                                  *
111         ************************************************************
112
113              EXEC SQL
114                 SELECT * INTO :empno-out, :ename-out, :job-out,
115                    :mgr-out, :dno-out, :hiredate-out, :sal-out,
116                    :comm-out  FROM  rosvschema2.emp
117                    WHERE empno = :up-empno
118              END-EXEC.
119
120              DISPLAY 'The record was changed to: '
121              DISPLAY record-out.
122
123         ************************************************************
124         *     End thread                                           *
125         ************************************************************
126
127          400-done.
128
129              END THREAD.
130              MOVE 0 TO thread-flag.
131
132              DISPLAY 'Program has completed'.
133              STOP RUN.
134         ************************************************************
135         **   Do the RDMS error handling - display codes & messages
136         ************************************************************
137
138         ***  Come here when RDMS errors are detected
139
140          900-rdms-error.
141
142         ***  Turn off error handling, print error status variables
143
144              EXEC SQL  WHENEVER SQLERROR CONTINUE  END-EXEC.
145
146              DISPLAY '***SQL Code = ' SQLCODE.
147              DISPLAY '***Error Code = ' ERROR-STATUS.
148              DISPLAY '***Auxiliary Info = ' AUX-INFO.
149         *
150         ***  Issue the error messages, end the thread, and exit
151         *
152              MOVE 0 TO err-end-flag.
153              PERFORM 940-geterror UNTIL no-more-msgs.
154              DISPLAY 'Error termination'.
155              END THREAD.
156              STOP RUN.
```

```
157           *
158           ***  Fill the error buffers using GETERROR
159           *
160            940-geterror.
161                GETERROR INTO :err-s(1), :err-s(2), :err-s(3), :err-s(4).
162                PERFORM 980-print-error
163                   VARYING err-s-index FROM 1 BY 1 UNTIL err-s-index > 4.
164           *
165           ***  Display the error buffers
166           *
167            980-print-error.
168                IF err-s(err-s-index) NOT = SPACE
169                   DISPLAY err-s(err-s-index)
170                ELSE
171                   MOVE 5 to err-s-index
172                   MOVE 1 TO err-end-flag.
SIZES: CODE(EM4): 624 DATA: 1674
END UCOB- 0 ERRORS(MAJOR) 0 ERRORS(MINOR)
@XQT

Enter the current 4 digit employee number

Enter employee last name

Enter job title

Enter employee number of manager

Enter department number

Enter hiredate

Enter employee monthly salary

Enter commission, or NULL if not applicable

Update Performed

The record was changed to:

5469  ADAMS       SALESREP    5234  200  870326  4000  1000

Program has completed

@BRKPT PRINT$
```

Deleting Rows from Tables

DELETE Command

```
DELETE FROM table-name
    [ WHERE { Boolean-expression | CURRENT OF cursor-name } ]
```

- Deletes all rows satisfying the WHERE condition
  - *Boolean-expression* specifies the row or rows to delete
  - CURRENT OF deletes the row where the cursor pointer is currently positioned
  - All rows are deleted if there is no WHERE clause
- Rules for referencing the cursor
  - Cursor cannot be read-only or for RANDOM ACCESS
  - Table names must match for the DECLARE and DELETE commands
  - A successful FETCH must immediately precede the DELETE command
  - Cursor does not need to be declared with the FOR UPDATE OF clause
- RDMS returns the number of rows deleted through the auxiliary information parameter

DELETE Examples

Example 1. Remove the department where DNO = 200

```
DELETE FROM DEPT
    WHERE DNO = 200
```

Example 2. Remove all employees in Department 200

```
DELETE FROM EMP
    WHERE DNO = 200
```

Example 3. Empty the DEPT table

```
DELETE FROM DEPT
```

Example 4. Remove all employees named Smith

```
DELETE FROM EMP
    WHERE ENAME = 'SMITH'
```

Sample COBOL Delete Program

Requirement: Prompt and read an employee number from a user and delete that row. Continue prompting and deleting rows until a dummy value of 9999 is read.

```
@ACOB,SE  DEV.ACOBDELT,TPF$.REL
ACOB 7R1A    R 75R3JQ 03/05/93 18:15:43 (0)        1100 ASCII COBOL 08/12/91 10:02
                                 1100 ASCII COBOL SOURCE LISTING


      1
      2              IDENTIFICATION DIVISION.
      3              PROGRAM-ID. TERMINATOR.
      4              ENVIRONMENT DIVISION.
      5              CONFIGURATION SECTION.
      6              SOURCE-COMPUTER. UNISYS-2200.
      7              OBJECT-COMPUTER. UNISYS-2200.
      8             *
      9              DATA DIVISION.
     10              WORKING-STORAGE SECTION.
     11              01  RCOM.
     12                  05 RLIN                      PIC X(40) OCCURS 12 TIMES.
     13              01  ERR-STAT                     PIC 9(4).
     14              01  AUX-INFO                     PIC S1(36).
     15              01  ERROR-TEXT.
     16                  05   ERR-S                   PIC X(132) OCCURS 4 TIMES.
     17              01  THREAD-FLAG                  PIC 9      VALUE ZERO.
     18                  88   THREAD-HAS-BEGUN                  VALUE 1.
     19              01  D-EMPNO                      PIC 9(4).
     20             *
     21              PROCEDURE DIVISION.
     22             ****************************************************************
     23             *              Main Control Paragraph                          *
     24             ****************************************************************
     25              000-MAIN.
     26                   PERFORM 200-INIT THRU 299-INIT-EX.
     27                   PERFORM 400-LOOP THRU 499-LOOP-EX
     28                           UNTIL D-EMPNO = 9999.
     29                   PERFORM 600-FIN THRU 699-FIN-EX.
     30                   STOP RUN.
     31             ****************************************************************
     32             *     Begin thread, read an employee number                    *
     33             ****************************************************************
     34              200-INIT.
     35                   MOVE 'BEGIN THREAD FOR UDSSRC        ' TO RCOM.
     36                   MOVE ' UPDATE (DEFERRED)          ; ' TO RLIN(2).
     37                   ENTER MASM 'acob$rdmr' USING RCOM, ERR-STAT, AUX-INFO.
     38                   IF ERR-STAT NOT = 0 GO TO 900-ERROR-PRINT.
     39                   MOVE SPACES TO RCOM.
     40                   MOVE 1 TO THREAD-FLAG.
     41                   DISPLAY 'Enter 4 digit employee number' UPON PRINTER.
     42                   ACCEPT D-EMPNO.
     43              299-INIT-EX.
     44                   EXIT.
```

```
       45                ****************************************************************
       46                *     Delete a row, solicit another                            *
       47                ****************************************************************
       48                 400-LOOP.
       49                      MOVE 'DELETE FROM ROSVSCHEMA2.EMP    '  TO RCOM.
       50                      MOVE 'WHERE EMPNO = $P1              ;'  TO RLIN(2).
       51                      ENTER MASM 'ACOB$RDMR' USING RCOM, ERR-STAT,
       52                           AUX-INFO, D-EMPNO.
       53                      IF ERR-STAT NOT = 0 GO TO 900-ERROR-PRINT.
       54                      DISPLAY 'Record deleted' UPON PRINTER.
       55                      DISPLAY 'Enter 4 digit employee number' UPON PRINTER.
       56                      ACCEPT D-EMPNO.
       57                 499-LOOP-EX.
       58                      EXIT.
       59                ****************************************************************
       60                *     End the thread, issue all done                           *
       61                ****************************************************************
       62                 600-FIN.
       63                      MOVE 'END THREAD ;'  TO RCOM.
       64                      ENTER MASM 'ACOB$RDMR' USING RCOM, ERR-STAT, AUX-INFO.
       65                      IF ERR-STAT NOT = 0000 PERFORM 900-ERROR-PRINT.
       66                      DISPLAY 'ALL DONE.' UPON PRINTER.
       67                      MOVE SPACES TO RCOM.
       68                 699-FIN-EX.
       69                      EXIT.
       70                ****************************************************************
       71                *     Print the error message, and the thread, shut it down    *
       72                ****************************************************************
       73                 900-ERROR-PRINT.
       74                      DISPLAY 'RDML COMMAND = ' RCOM.
       75                      DISPLAY 'ERROR STATUS = ' ERR-STAT.
       76                      DISPLAY 'ERROR COLUMN = ' AUX-INFO.
       77                *
       78                      MOVE  'GETERROR INTO $P1, $P2, $P3, $P4  ;' TO RCOM.
       79                      ENTER MASM 'ACOB$RDMR' USING RCOM, ERR-STAT, AUX-INFO,
       80                          ERR-S(1), ERR-S(2), ERR-S(3), ERR-S(4).
       81                      DISPLAY ERR-S(1) UPON PRINTER.
       82                      DISPLAY ERR-S(2) UPON PRINTER.
       83                      DISPLAY ERR-S(3) UPON PRINTER.
       84                      DISPLAY ERR-S(4) UPON PRINTER.
       85                *
       86                      IF THREAD-HAS-BEGUN
       87                          MOVE 'END THREAD                    ;' TO RCOM
       88                          ENTER MASM 'ACOB$RDMR' USING RCOM,
       89                          ERR-STAT, AUX-INFO.
       90                *
       91                      DISPLAY 'ERROR END' UPON PRINTER.
       92                      STOP RUN.
END ACOB DIAGNOSTIC TOTALS         0 WARNING       0 MINOR          0 SERIOUS       0
FATAL    0 LEVELING
COMPILE TIME IS     4.33 SECONDS   CORE: MIN=  63601 / 64000  MAX=  66560 WORDS
```

```
@MAP,S    ,TPF$.ABS
Collector 33R1A (910808 1521:53) 1993 Mar 05 Fri 1815:44
          1.                  NOT TPF$.
          2.                  IN  TPF$.REL
          3.                  IN  SYS$LIB$*RSA.CBEP$$RSA
          4.                  IN  SYS$LIB$*RSA.RDMR-ACOBDAT
          5.                  END

AFCM status of output element is SETAFCM
Quarter-word sensitive

ADDRESS LIMITS    001000 001726       471 IBANK WORDS DECIMAL
                  040000 061623      9108 DBANK WORDS DECIMAL
STARTING ADDRESS  001336


            SEGMENT $MAIN$          001000 001726     040000 061623

ERU$/RLIBT12                                                          24
MAY 90   10:37:08
M$PKT$                                          $(0)     040000 040005 03
AUG 90   16:10:55
                                                $(012)   MEM$ERR
C$NPADS                                         $(0)     040006 040014 26
AUG 90   19:05:18
C$S400                                          $(0)     040015 040027 21
DEC 90   13:37:46
C$RET0                    $(1)    001000 001005                       26
AUG 90   18:58:21
MEM$ERR(COMMONBLOCK)                                     040030 040032
C$S300                                          $(0)     040033 040730 25
JAN 91   11:32:50
                                                $(012)   MEM$ERR
C$PCRLOG                                        $(0)     040731 041030 12
AUG 91   09:47:08
CBEP$$ACOB/PART-LIB-CB                                                12
AUG 91   10:13:59
REL                       $(1)    001006 001350 $(0)     041031 041431 05
MAR 93   18:15:44
                          $(3)    001351 001355 $(4)     041432 041567
                                                $(6)     041570 041606
                                                $(010)   041607 041746
CBEP$$RSA                                                             24
AUG 91   01:01:32
RDMR-ACOBDAT              $(1)    001356 001726 $(0)     041747 061622 10
JAN 92   13:23:24
                                                $(2)     061623 061623

                      Common Banks referenced
                      ------ ----- ----------
C$S30S       0400103    C$S115       0400105    RDMR$FTNCONT 0401074

END MAP.  ERRORS: 0  TIME: 23.502  STORAGE: 016412/015204/016170/0/0130076
@XQT
Enter 4 digit employee number
Record deleted
Enter 4 digit employee number
ALL DONE.
```

Cursor Requirements for Commands

Table 10-1. Command Summary

Command	Cursor Requirements
INSERT	None required
UPDATE Positioned	DECLARE of cursor must be with the FOR UPDATE OF clause Only columns named in the FOR UPDATE OF clause can be updated Cursor cannot be declared read-only or for RANDOM ACCESS Successful FETCH must immediately precede the UPDATE
UPDATE Searched	None required
DELETE	Cursor cannot be declared read-only or for RANDOM ACCESS Successful FETCH must immediately precede the DELETE Cursor does not need to be declared with the FOR UPDATE clause

Exercise 10-1

Write the SQL code to perform the following data manipulation.

1. Change the salary for the employee with EMPNO = 5146 to 1250.

```
UPDATE EMP SET SAL = 1250
WHERE EMPNO = 5146
```

2. Change the commission for each salesman to 500.

```
UPDATE EMP SET COMM = 500
WHERE JOB = 'SALESREP'
```

3. Change EMPNO 5437 to 5620.

```
UPDATE EMP SET EMPNO = 5620
WHERE EMPNO = 5437
```

4. Give all managers a 12 percent raise.

```
UPDATE EMP SET SAL = SAL * 1.12
WHERE JOB = 'MANAGER'.
```

Lab 10-1

Write and execute a COBOL program that reads values for a row of the DEPT table and insert the row into the table. Have the program display the inserted row.

Extension: Continue to read and insert rows until a dummy value of 999 is entered for DNO.

11

Keys and Updating

Module 11
Keys and Updating

Module Objectives

Upon completion of this module, you should be able to

- Update tables containing foreign keys.
  - Define primary keys and foreign keys.
  - Describe possible update anomalies and a method of maintaining referential integrity.
  - List the effects of foreign keys on deletions and updates.

Benefit Statement

How can you maintain consistency between tables? This is the main question answered in this module. And once you establish the mechanisms to maintain consistency, how do you update your database?

Materials

- OS 1100 UDS Relational Data Management System (UDS RDMS 1100) Administration Guide

Primary Keys

- Unique identifier of each row
  - One column or combination of columns
  - Multi-column key called "composite key"
- Primary keys are specified when table is created
  - Table is indexed on primary key
  - Columns must be defined as NOT NULL
- Other columns may be specified as secondary indexes
  - Advantage = Speeds up retrieval
  - Disadvantage = Adds overhead on updates

INDEX
100
200
300
400

DNO	DNAME	LOC
100	ACCOUNTING	ATLANTA
200	SALES	NEW YORK
300	MARKETING	DETROIT
400	DISTRIBUTION	PRINCETON

Figure 11-1. Primary Keys Illustrated

Update Anomalies

- Anomaly - Deviation from the expected
- What would happen to the EMP table below if you executed the following updates?

```
UPDATE DEPT
SET DNO = 500
WHERE DNO = 200
```

changing DEPT not EMP

```
INSERT INTO EMP
VALUES (5999,'GOOD','SALESREP',5234,600,900701,2300,NULL)
```

dept

Add 1 line

- DNO is primary key of DEPT, but is also a column of EMP
- Possibility of update anomalies can be reduced by good database design
- RDMS can perform some integrity checking for you (see over)

Table 11-1. EMP

EMPNO	ENAME	JOB	MGR	DNO	HIREDATE	SAL	COMM
5010	FOSTER	SALESREP	5234	200	860714	2700	400
5146	BROWN	CLERK	5234	200	871011	1000	
5234	WOODWORTH	MANAGER	5784	200	790219	3250	
5237	ROCKWELL	ACCOUNTANT	5743	100	840618	2175	
5437	MARTIN	SALESREP	5234	200	870326	2500	300
5469	ADAMS	SALESREP	5234	200	811102	2250	500
5630	GLASS	ACCOUNTANT	5743	100	871220	1850	
5702	TURNER	CLERK	5743	100	890515	900	
5743	LAWSON	MANAGER	5784	100	830510	3400	
5765	JOHNSON	CLERK	5984	400	891221	975	
5784	WILLIAMS	PRESIDENT		300	781015	5200	
5896	SMITH	CLERK	5984	400	880913	1050	
5942	FORD	SALESREP	5234	200	890316	2375	0
5984	HYDE	MANAGER	5784	400	850901	2900	

Foreign Keys

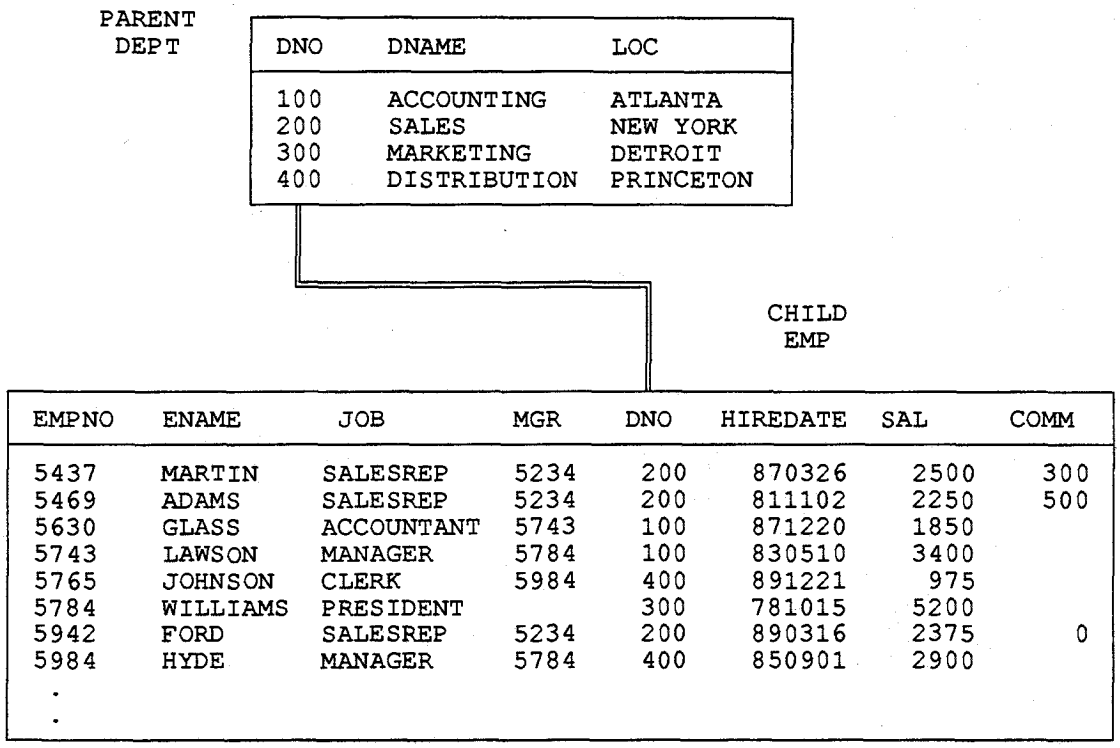
Introduction

- A foreign key is a column in a table that is a primary key in another table
- Used to maintain data consistency between tables
- Defines a relationship between tables
- Causes data checking when tables are updated
- May be declared in CREATE TABLE command by DBA or added later

```
CREATE TABLE EMP
IN MY_AREA
COLUMNS ARE EMPNO : DECIMAL(4),
            ENAME : CHARACTER(10), ...
PRIMARY KEY KEY1 IS EMPNO ASCENDING
FOREIGN KEY KEY2 IS DNO
    REFERS TO DNO OF DEPT
```

Parent Table / Child Table Relationships

- Table in which column is primary key is parent table
- Table in which column is foreign key is child table
- Figure 11-2 illustrates the parent - child relationship.



PARENT DEPT

DNO	DNAME	LOC
100	ACCOUNTING	ATLANTA
200	SALES	NEW YORK
300	MARKETING	DETROIT
400	DISTRIBUTION	PRINCETON

CHILD EMP

EMPNO	ENAME	JOB	MGR	DNO	HIREDATE	SAL	COMM
5437	MARTIN	SALESREP	5234	200	870326	2500	300
5469	ADAMS	SALESREP	5234	200	811102	2250	500
5630	GLASS	ACCOUNTANT	5743	100	871220	1850	
5743	LAWSON	MANAGER	5784	100	830510	3400	
5765	JOHNSON	CLERK	5984	400	891221	975	
5784	WILLIAMS	PRESIDENT		300	781015	5200	
5942	FORD	SALESREP	5234	200	890316	2375	0
5984	HYDE	MANAGER	5784	400	850901	2900	
.							
.							

Figure 11-2. DNO in the Parent and Child Tables

Foreign Key Considerations

- One table can be parent of up to 50 children
- One table can be child of up to 25 parents
- A table may be parent of one foreign key and child of another
- Column-names of foreign key-primary key may be different, but datatypes of the columns must be the same
- If foreign key relationship is added after tables have data, RDMS does not check retroactively if data satisfy integrity constraints

Foreign Keys and INSERT

- Insert a row into child table
  - Parent table must have a row with the primary key value corresponding to the foreign key
  - Then insert row in child table
- Sample problem
  - If foreign key DNO is defined as a foreign key, as shown in Figure 11-2, and the following INSERT is executed:

```
INSERT INTO EMP
VALUES (5999,'GOOD','SALESREP',5234,600,900701,2300)
```

  - An error message is generated, since there is no DNO = 600
- Problem solution: Add the corresponding department to the DEPT table, then insert the row in EMP

Foreign Keys and DELETE

- Delete row in parent table
  - There must be no rows in child table having primary key value from parent as the foreign key
  - Change rows in child table so foreign key is a valid primary key value
  - Or, delete rows in child table
- Sample problem
  - Attempt to delete a row in the DEPT table

```
DELETE FROM DEPT
WHERE DNO = 200
```

  - Generates an error message since all the rows in EMP having DNO = 200 will be stranded
- Solution to problem
  - Delete all rows in EMP with DNO = 200
  - Then delete row from DEPT where DNO = 200

Foreign Keys and UPDATE

- Update primary key value in parent table
  - There must be no rows in child table having old primary key value from parent as the foreign key
  - Change rows in child table so foreign key is a valid primary key value
  - Or, delete rows in child table

- Sample Problem: The following UPDATE generates an error message since all the rows in EMP having DNO = 200 will be stranded

```
UPDATE DEPT
SET DNO = 500
WHERE DNO = 200
```

- Solution to above problem
  - Insert a row in DEPT with DNO = 500
  - Update the DNO of employees to 500 where DNO = 200
  - Delete row from DEPT where DNO = 200

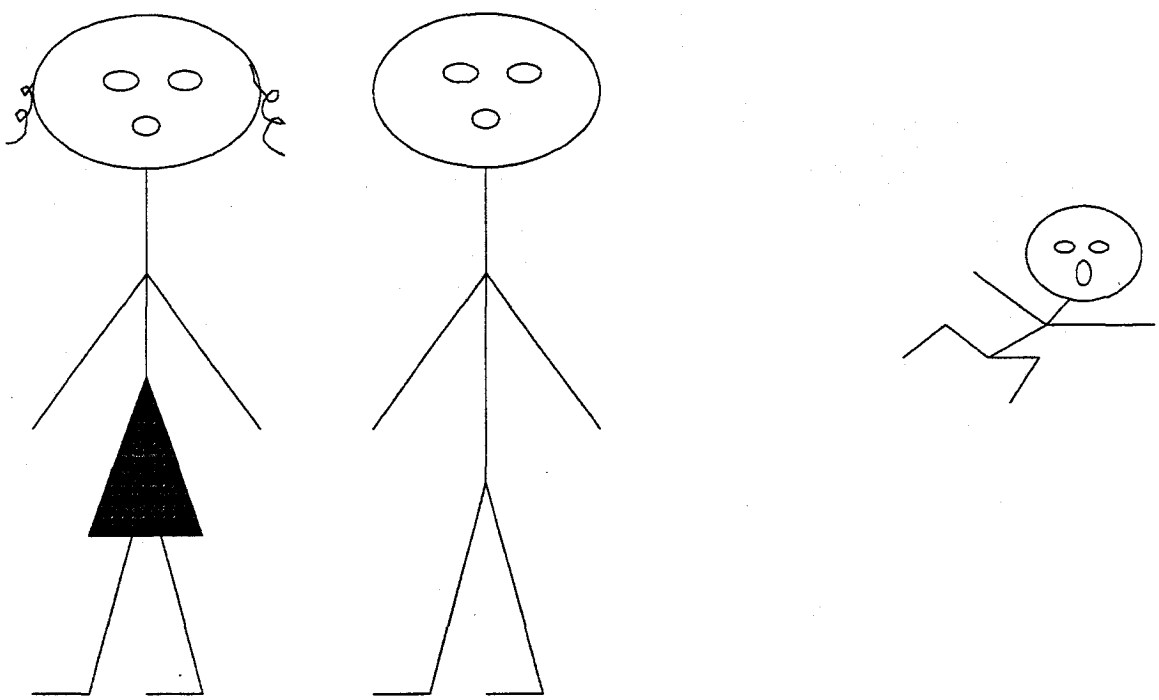
- Update foreign key value in child table
  - May be changed to any other primary key value from parent table

- Example: Transfers Brown from Department 200, Sales, to 400, Distribution

```
UPDATE EMP
SET DNO = 400
WHERE EMPNO = 5146
```

Rules for Parent - Child Relationships

Cannot create children without parents



Cannot leave an orphan

Figure 11-3. Summary of Rules

Lab 11-1

Use IPF SQL or MAPPER to perform the following updates.

The tables you have been working with have a foreign key. The column DNO in EMP is declared as a foreign key referring to DNO in DEPT. You will not use these tables again after this exercise. You may commit or rollback the changes you make.

1. Try to insert a row with a non-existent DNO into EMP.

2. Perform the correct procedure for inserting the same row as above into EMP.

3. Try to delete a row directly from DEPT whose primary key is associated with one or more rows in EMP.

4. Perform the procedure described in number 3 correctly.

5. Try to update a row in EMP, changing the DNO to a currently non-existent value.

6. Update a row as above, changing DNO from one its current value to another valid value.

7. Try to change a DNO in DEPT which has a corresponding foreign key value in EMP.

8. Perform the steps necessary to accomplish number 7 correctly.

12

Obtaining Table Definition Information

Module 12
Obtaining Table Definition Information

Module Objectives

Upon completion of this module, you should be able to

- Obtain table definition information in one of two ways:
  - Using the MAPPER MRI interface
  - Using UREP

Benefit Statement

You will need to obtain table information to discover the data types and sizes for the columns in tables. This information is needed for writing host program variables. The table information provided by UREP will also tell you about primary, secondary, and foreign keys that exist for your tables.

Materials

- MAPPER Relational Interface (MRI) Relational Database Interface (RDI) Operations Guide
- OS 1100 UDS Unisys Repository Manager (UDS UREP) Programming Reference Manual

MAPPER RDI Access

How to obtain table column information using the MAPPER RDI interface.

Step 1. On the RDI Menu, transmit from the Select entry as shown in Figure 12-1.

```
                                                        RDI
                              RDI menu

                    Tab to your choice and press XMIT

                                  Select ▶
                                    Join ▶
                                  Insert ▶
                                  Delete ▶
                                  Update ▶
                                  Create ▶
                                     SQL ▶
                            Utilities menu ▶
                            Detailed help ▶

                                Rev. Level 3R3

 1       2       3       4       5       6DBMS   7Envmnt 8Help   9       10Quit
```

Figure 12-1. RDI Menu

Step 2. On the Select menu, enter the table name and a question mark in the Column names field. Notice that the table name is qualified by the name ROSVSCHEMA1.

```
                                                        RDI
                              Select menu
Retrieve rows from a single relational table.
Table name -> rosvschema1.emp
Column names -> ?
Where clause ->
Retrieve all rows? -> y                  If no, how many? -> 1
Number of rows to skip -> 0                   Null Symbol -> *
Extra options? -> n
Place cursor here and press XMIT ->
Press XMIT from here for detailed help ->


 1       2       3       4RDIMnu 5       6Specl  7       8Help   9       10Quit
```

Figure 12-2. Select Menu

Step 3. The RESULT displayed contains the column information for the EMP table, as shown in Figure 12-3.

```
Line▶ 8          Roll▶ -                                          RESULT
.DATE 03 MAR 93  09:38:39     REPORT GENERATION     DAA
. Table 1  - rosvschema1.emp
. To select column names, enter the numbers 1-126 in the first field (#)
. and press XMIT.  The columns will be displayed from left to right
. in the order you specify.  Press the Resume key to continue. ▶
* # .TAB. COLUMN NAME                    . TYPE          .SIZE .DECPT.NF.PK
*==.===.============================.===============.=====.=====.==.==
       1 EMPNO                         DECIMAL             5     0  N  Y
       1 ENAME                         CHARACTER          10        N  N
       1 JOB                           CHARACTER          10        Y  N
       1 MGR                           DECIMAL             5     0  Y  N
       1 DNO                           DECIMAL             4     0  Y  N
       1 HIREDATE                      DECIMAL             7     0  Y  N
       1 SAL                           DECIMAL             5     0  Y  N
       1 COMM                          DECIMAL             5     0  Y  N

.
. SIZE  = size of column indicated by COLUMN NAME
. DECPT = number of decimal places if TYPE = decimal
. NF    = null flag. N = nulls not allowed, Y = nulls allowed
. PK    = primary key.  Y = primary key, N = not primary key
                  ..... END REPORT .....
 1Resume 2Paint  3       4Return 5       6LineCh 7       8       9       10Quit
```

Figure 12-3. Result with Table Column Information

- Column information includes:
  - Column number
  - Number of the table being displayed
  - Column name
  - Data type of the column
  - Number of characters or size
  - Number of decimal places, if allowed
  - If nulls area allowed
  - If the column is the primary key or a part of the primary key

Unisys Repository Manager (UREP 1100)

Introduction

- Provides a focal point for management of corporate information resources
- UREP manages the repository, a meta-database, a relational database
- Benefits
  - Locate information
  - Identify how information is used
  - Identify who uses information
  - See how changes affect other related information
- When tables or views are created, information is written to the database
  - Column names, data types, and sizes
  - Keynames and composition
  - Foreign key relationships
- Reports are available to provide information on how the tables and views are defined

Calling the Repository Manager

@DD,*option source-input-element,source-output-element,application-group*

- Some of the processor options include:
  - E echoing the incoming processor commands; they are not printed otherwise
  - D demand execution
  - B batch execution
  - X terminating UREP in error mode if executing in batch and an error is encountered
- The *source-input-element* optionally specifies UREP commands
- The *source-output-element* optionally contains the output
- The *application-group* specifies the application group containing your tables
  - If omitted, the default UDS Control application is used
  - The UREP standard release default is UDSSRC
- Commands are written in the Data Dictionary System (DDS) command language

Note: *Consult OS 1100 UDS Unisys Repository Manager (UDS UREP) Programming Reference Manual for details on the commands.*

@DD,E ,,TIPSYS
PROCESS TABLE EMP FOR SCHEMA SYSSCHEMA1 REPORT,

UREP Example

The following example illustrates the commands to obtain table information for the EMP and DEPT tables.

```
@DD,E
UREP 1R2 (08/16/91 11:09:26) 03/26/93 15:48:14
*REMARK* UREP7403 The default UDS application ( UDSSRC ) will be used.
     1              process table emp for schema rosvschema1 report .

*** Report for Table EMP for Schema ROSVSCHEMA1 ***

Logical Filename: EMPLOYEE for Schema ROSVSCHEMA1

Preamble Length :                 14
Rdt Length :                      52
Total Length :                    66

Owner Userid :
Data Access Control :             ACTIVE
Base Relation Code :              1
Record Size(words) :              13
Number of Non-deleted Items :     8
Last Non-deleted Item :           8
Number of Foreign Keys :          0
Number of Member Relations :      0
Loading Order :                   RANDOM
Item Mod Flag :                   FALSE
Current Number Indexes :          0
Matching Order Flag :             TRUE
Screen Type :                     COLUMNAR

Columns :
Name                              Code      Type          Size    Scale /
Nulls                                                             Precision
EMPNO                              1    DECIMAL          5       0
NOT-ALLOWED
ENAME                              2    CHARACTER        10      0
NOT-ALLOWED
JOB                                3    CHARACTER        10      0
ALLOWED
MGR                                4    DECIMAL          5       0
ALLOWED
DNO                                5    DECIMAL          4       0
ALLOWED
HIREDATE                           6    DECIMAL          7       0
ALLOWED
SAL                                7    DECIMAL          5       0
ALLOWED
COMM                               8    DECIMAL          5       0
ALLOWED

Primary Key :                     ENO
 Column, Direction
     EMPNO, ASCENDING
```

REPORT SCHEMA ALL
REPORT TABLE ALL FOR SCHEMA SCHEMA1.

```
    2               process table dept for schema rosvschema1 report .

*** Report for Table DEPT for Schema ROSVSCHEMA1 ***

Logical Filename: DEPARTMENT for Schema ROSVSCHEMA1

Preamble Length :                14
Rdt Length :                     41
Total Length :                   55

Owner Userid :
Data Access Control :            ACTIVE
Base Relation Code :             1
Record Size(words) :             7
Number of Non-deleted Items :    3
Last Non-deleted Item :          3
Number of Foreign Keys :         0
Number of Member Relations :     1
Loading Order :                  RANDOM
Item Mod Flag :                  FALSE
Current Number Indexes :         0
Matching Order Flag :            TRUE
Screen Type :                    COLUMNAR

Columns :
Name                             Code      Type          Size     Scale /
Precision
Nulls
DNO                               1    DECIMAL          4        0
NOT-ALLOWED
DNAME                             2    CHARACTER        12       0
NOT-ALLOWED
LOC                               3    CHARACTER        10       0
ALLOWED

Primary Key :                    K1
 Column, Direction
     DNO, ASCENDING

Member Relations (foreign key #) :
     ROSVSCHEMA1. EMP_FOR_KEY( 1)

END UREP ( 0 )FATALS ( 0 )ERRORS ( 0 )WARNINGS ( 1 )REMARKS .
```

PROCESS SCHEMA PS100-PSTART REPORT.
PROCESS TABLE EMP-FOR-KEY FOR SYSSCHEMA1 REPORT.

REPORT STORAGE-AREA FOR SCHEMA SYSSCHEMA1 REPORT.

Lab 12-1

Use the MAPPER MRI interface or UREP directly to obtain table information for the EMP table you are working with. How does the information received compare to the information contained in this module?

CAT a file <file>
then in IFF

> SQL UNLOAD TO FILE <file>
SELECT * FROM EMP
WITH DESCRIPTION ONLY

IN COBOL

> DECLARE CURSOR <> CURSOR
Select * from EMP
> GET DESCRIPTION <> INTO $P1, $P2 $P9
Cursor table name version Column etc

13

Views

Module 13
Views

Module Objectives

Upon completion of this module, you should be able to

- Create and use views
  - Define a view and identify the advantages of views
  - Identify the limitations of updates allowed on views
  - Drop views

Benefit Statement

By working with views you will be able to solve several database problems. You will see how to limit the information that is viewed or that can be updated by users. You also will be able to safeguard your table from updates with "unrealistic" values.

Materials

- OS 1100 UDS Relational Data Management System (UDS RDMS 1100) and IPF SQL Interface End Use Guide

- OS 1100 UDS Relational Data Management System (UDS RDMS 1100) SQL Programming Reference Manual

Views

Basic Definition

A view is a window into the data. Views provide multiple perspectives of the same underlying tables.

Figure 13-1 shows three columns and a few rows that comprise the EMPMGR view.

EMPMGR View

EMPNO	ENAME	JOB
5010	FOSTER	SALESREPT
5146	BROWN	CLERK
5234	WOODWORTH	MANAGER
5237	ROCKWELL	ACCOUNTANT

EMP Table

			MGR	DNO	HIREDATE	SAL	COMM
			5234	200	860714	2700	550
			5234	200	871011	1000	
			5784	200	790219	3250	
			5743	100	840618	2175	
5437	MARTIN	SALESREP	5234	200	870326	2500	300
5469	ADAMS	SALESREP	5234	200	811102	2250	500
5630	GLASS	ACCOUNTANT	5743	100	871220	1850	
5702	TURNER	CLERK	5743	100	890515	900	
5743	LAWSON	MANAGER	5784	100	830510	3400	
5765	JOHNSON	CLERK	5984	400	891221	975	
5784	WILLIAMS	PRESIDENT		300	781015	5200	
5896	SMITH	CLERK	5984	400	880913	1050	
5942	FORD	SALESREP	5234	200	890316	2375	0
5986	HYDE	MANAGER	5784	400	850901	2900	

Figure 13-1. Picturing a View

What is a View?

- A view is:
  - A virtual table derived from underlying base tables
  - Defined with a query specification (SELECT statement)
  - Stored in the repository
  - A direct window to the data in the tables
  - Referenced in the same way as a table

    Qualifier.View-name.Column-name

- A view can present:
  - A subset of the data in a table
    - Some of the columns
    - Some of the rows
  - A join of several tables

- A view is based on logical, not physical tables

- A view does not have its own data storage

Purpose of Views

- Hides underlying database structure
- Simplifies data access (SELECT clause)
  - Pre-selects columns
  - Joins tables
- Masks unnecessary data
- Restricts access to confidential information
- Prevents users from inserting bad data

CREATE VIEW Command

CREATE VIEW [*Qualifier.*]*view-name*
[(*column1*, *column2*, *column3*...)]
AS *query-specification*
[WITH CHECK OPTION]
[WITH ACCESS CONTROL]

- Unisys supports the SQL 89 form of this commmand; the WITH ACCESS CONTROL clause is a Unisys extension to the standard command
- Qualifier defaults to RDMS or name in USE QUALIFIER
- Version-names not allowed with view-names
- Column names default to names from SELECT list
- Definition of view is stored in repository
- Owner of a view is the user-id that created it; you cannot transfer ownership
- The *query-specification* cannot have an aggregate operation if you specify a view in the FROM clause that had an aggregate operation in its query specification; aggregate operations include:
  - DISTINCT keyword in the select list
  - GROUP BY clause
  - HAVING clause
  - Built-in functions: SUM, AVG, MAX, MIN, COUNT

View Example

```
CREATE VIEW EMP_LOC
(NAME, LOCATION)
AS SELECT ENAME, LOC
FROM EMP, DEPT
WHERE EMP.DNO = DEPT.DNO
```

Defines the virtual table:

```
--Name--- -Location-
FOSTER    NEW YORK
BROWN     NEW YORK
WOODWORTH NEW YORK
ROCKWELL  ATLANTA
MARTIN    NEW YORK
ADAMS     NEW YORK
GLASS     ATLANTA
TURNER    PRINCETON
LAWSON    ATLANTA
JOHNSON   PRINCETON
WILLIAMS  DETROIT
SMITH     PRINCETON
FORD      NEW YORK
HYDE      PRINCETON
```

A view can be queried just like a base table.

```
SELECT DISTINCT LOCATION FROM EMP_LOC
```

```
-Location-
PRINCETON
ATLANTA
NEW YORK
DETROIT
```

Columns in Views

- Columns can be renamed
- Number of columns must equal number of items in SELECT list
- Order of column names corresponds to order of items in SELECT list
- Columns can be derived values using:
  - Functions
  - Arithmetic expressions
  - Constants
- Column name list is mandatory when SELECT list contains:
  - Duplicate column names
  - Calculations (arithmetic expressions/functions)
  - Constants

Example:

```
CREATE VIEW BONUS
(EMPNO, NAME, SALARY, COMM, BONUS)
AS SELECT EMPNO, ENAME, SAL, COMM, SAL*.10
FROM EMP
```

Data Checking

WITH CHECK OPTION

- Used to create domain constraints on column values
- UPDATE and INSERT commands have values checked against WHERE clause of the definition of the view

Example:

```
CREATE VIEW CHECKED_VIEW
AS SELECT * FROM EMP
WHERE HIREDATE > 900101
WITH CHECK OPTION
```

Security

WITH ACCESS CONTROL

- Controls who can access the view
- Owner of view is user who creates it
- Owner can use GRANT and REVOKE commands for privileges on view
- Owner inherits privileges from base tables on which view is defined

Example:

```
CREATE VIEW PRIVATE_VIEW
AS SELECT EMPNO, SAL FROM EMP
WITH ACCESS CONTROL
```

Updating Views

- All changes to a view are reflected in the base table and vice versa
- Views are either read-only or updatable
- View is read-only if the CREATE VIEW command includes any of the following
  - DISTINCT keyword
  - An entry in the select list other than a column specification or *
  - A column specification that appears more than once in the select list
  - A GROUP BY clause
  - A HAVING clause
  - A FROM clause that references more than one table or view
  - A FROM clause that identifies a read-only view
- INSERT and DELETE restrictions
  - View must meet all UPDATE conditions
  - View must select all columns in base table

FOR UPDATE ONLY COLUMN NAMES OR * ALLOWED

DROP VIEW Command

DROP VIEW [*qualifier.*]*view-name*

- This command is not available in SQL 89
- Removes a view definition from the repository
- Only owner can drop a view
- Views are dropped automatically when:
  - Column in base table is changed or dropped
  - Base table or view is dropped
  - Owner's access to base table is removed
  - Access control is activated for a different owner for an underlying base table

Example:

```
DROP TABLE QUAL1.TABLE1, TABLE2, QUAL2.TABLE3
     VIEW
```

Exercise 13-1

Views

1. What is a view?

Window

2. List four advantages of using views.

Security

Page 13-6

3. What must be true to be able to perform updates on a view?

Page 13-11

4. What must be true to be able to perform inserts or deletes on a view?

must show all columns from only one table

plus all of question above

Lab 13-1

Use the IPF SQL to perform the following exercise.

1. Create a view based on EMP and DEPT, and another view based on EMP alone. Incorporate renaming some columns and use of functions and/or arithmetic expressions.

   - Use the IPF File capability to create the views.
   - Start your commands with a BEGIN THREAD command and end with an END THREAD command.

2. Attempt to update the first view.

3. Attempt to delete a row from the first view; from the second view.

4. Create a third view that will be updatable.

5. Perform an INSERT, UPDATE, and DELETE on the third view.

14

More About Threads and UDS

Module 14
More About Threads and UDS

Module Objectives

Upon completion of this module, you should be able to

- Select recovery options for recoverable steps.
- Describe or use the locking mechanisms:
  - Describe the implicit locking by UDS.
  - Use the explicit locking commands.

Benefit Statement

Two large issues related to database integrity center around disruption of the computer itself and multiple users accessing the data. In this module you will realize the choices you have at your disposal in regard to these issues, as well as the automatic coverage provided by UDS Control and the Integrated Recovery Utility.

Materials

- OS 1100 UDS Relational Data Management System (UDS RDMS 1100) and IPF SQL Interface End Use Guide
- OS 1100 UDS Relational Data Management System (UDS RDMS 1100) SQL Programming Reference Manual
- OS 1100 UDS Relational Data Management System (UDS RDMS 1100) Administration Guide
- OS 1100 Universal Compiling System (UCS) Application Development Programming Guide, Volume 1

Threads

- A thread is a work session with UDS Control
  - Each thread belongs to one user
  - Each thread exists in one application group
  - Several threads may be active at one time
- UDS Control establishes your database session environment
  - Thread control
  - Application groups
  - Error message handling
  - Recovery options
  - Concurrency control
- Thread control commands are processed directly by UDS Control, without invoking RDMS

Threads and Steps

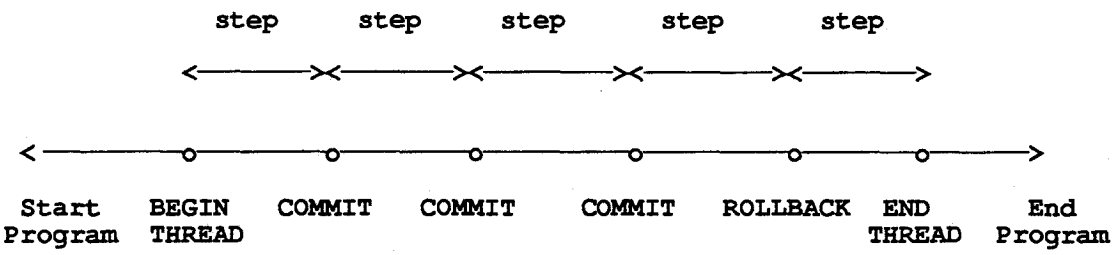


Figure 14-1. Step - Thread Control Relationships

- A thread's session with UDS 1100 can be subdivided into steps
- A step is logical unit of work
  - Sequence of commands that belong together
    - All changes are made permanent or
    - All changes are undone
  - Smallest recoverable unit of a thread
- Integrated Recovery Utility (IRU) recovers to the previous step
- Each step begins and ends with a thread control command

Thread Control Commands

- BEGIN THREAD
  - Establishes a new session with UDS
- COMMIT WORK
  - Ends a step
  - Updates since last thread control command are written to database
- ROLLBACK
  - Ends a step
  - Updates since last thread control command are discarded
- END THREAD
  - Ends thread and commits changes
  - Program must BEGIN THREAD again before issuing more SQL commands

Recovery and Thread Control

- Recovery is the process of returning the database to a consistent state
  - Follows a user error or a hardware/software failure
  - Recovery is a function of UDS Control
  - Integrated Recovery recovers to beginning of step
- The type of recovery performed depends on:
  - Creating table storage-area as recoverable
  - BEGIN THREAD command recovery-option
- As a programmer, it is important to know if the file is recoverable
- BEGIN THREAD command declares the type of recovery to use
- If thread is recoverable, ROLLBACK and COMMIT commands may break it into smaller units of processing (steps)
- At end of ROLLBACK or COMMIT, the data is in a consistent state
  - All changes are discarded (ROLLBACK)
  - All changes are written (COMMIT)

BEGIN THREAD Command Revisited

BEGIN THREAD [*thread-name*]
FOR [APPLICATION] *application-name* [*options*]

- Unisys implementation
- Where *application-name* may be an alias or application group to use
  - Application names are limited to 6 characters
  - Alias names are limited to 12 characters
- The UPDATE *option* has the format:

  UPDATE (*recovery-option*) [UDSMSG | UDSMESSAGE | UDSMESSAGES]

- Where *recovery-option* may be:
  - COMMANDLOOKS
  - DEFERRED
  - QUICKLOOKS
  - NONE

Example

```
BEGIN THREAD t1 FOR APPSVN UPDATE (DEFERRED)
```

Application Groups

- An OS 1100 software partition
  - Purpose is to create multiple working environments
  - Each environment acts as an independent, recoverable system
  - Up to nine application groups supported on a system
  - Each has its own common banks, database files, audit files, repository, and other support components
  - Default application group name is UDSSRC
- BEGIN THREAD determines application group for rest of program execution
- ACOB program with SQL must be collected with proper application group elements
  - Two elements are CBEP$$RSA and RDMR-ACOBDAT
  - Typical default application group file name is SYSLIB*RSA
  - DBA must be consulted for filename for other application groups
- UCOB program with SQL must be linked to proper application group elements
  - Linking to the UDSSRC requires nothing by user
  - ESQL program uses keyword option APPLICATION/*application-name* at compile time for alternate application group (not UDSSRC)
  - ESQL or ISQL dynamically links to alternate application groups with proper @USE before execution

Example: Compile and execute a UCOB ESQL program that will use application group seven

```
@UCOB,se  sql.prog1,tpf$.prog1,,,APPLICATION/APPSVN

@USE  LINK$PF,SYS$LIB$*APP$7.
@XQT  tpf$.prog1
```

Recovery Options

- QUICKLOOKS
  - Snapshot of page is taken before first update of page in a step
  - Database is recoverable to the before-image taken
  - Recommended for large number of updates
- DEFERRED
  - No updates written to database until COMMIT or END THREAD issued
  - Changes saved in temporary file
  - Database has only most recent updated copy of each page
  - Recommended for few updates or intentional ROLLBACKs
  - Default recovery option (New with RDMS 5R1)
- COMMANDLOOKS
  - Snapshot of page is taken before every update command
  - The first before-image is saved until the end of the step
  - If an update command succeeds, the previous commandlook is discarded
  - If update fails, database is restored to before-image state
  - Similar to Quicklooks, but more overhead
  - Recommended for interactive programs where SQL command depends on user input
- NONE
  - No recovery is possible, not a recommended option
  - Use only on storage-areas defined as non-recoverable

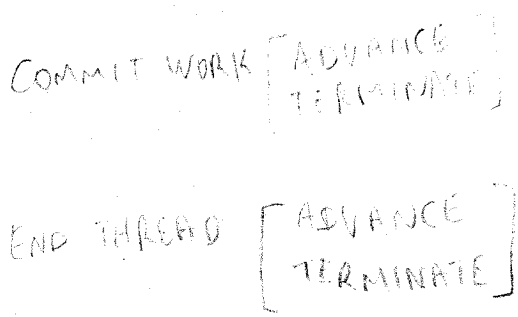
COMMIT Command

COMMIT WORK

- Writes all updates to database since beginning of step
- Thread remains registered with UDS
- ROLLBACK can only recover to previous COMMIT (end of last step)
- Releases all implicit locks set by RDMS

Example:

```
COMMIT WORK
```



Message Recovery on COMMIT/END THREAD

COMMIT [WORK | THREAD] [*step-control-option*]

END THREAD [*step-control-option*]

- SQL extension for COMMIT
- Where *step-control-option* may be:
  - ADVANCE
  - TERMINATE
- Message options apply to Integrated Recovery only
- ADVANCE
  - Terminates current step
  - Begins new step
  - Input message retained
- TERMINATE
  - Terminates current step
  - Releases input message to Message Control Bank (MCB)

Message Recovery on ROLLBACK

ROLLBACK [WORK] [*step-control-option*]

- SQL extension
- Where the *step-control-option* specifies what to do with the message in Integrated Recovery environment

  Note: *Unless you are using TIP with MCB, it may not be relevant to specify this option.*

- Not specified
  - Use the default step-control option
- KEEP
  - Resumes current step
  - Input message is still associated with active step
- DISCARD
  - Terminates current step
  - Releases any deferred messages
  - If input message is recoverable, queue it to a system error program
  - If input message is not recoverable, release it
- REQUEUE
  - Terminates current step
  - Message must be recoverable, so requeue for reprocessing of same step

Locking

Concurrent Access

In a normal database environment, many users will access the same table, maybe even the same rows, simultaneously. If everyone is just looking at the data, there is no problem with concurrent access. The problem occurs when two users want to update, or one user wants to update and another look at the same information. In this case, the database management system software must control who can read and who can update the data.

To ensure that no user is looking at information that is currently being changed, RDMS 1100 places contention locks on the data. Two rules apply:

1. At any given time, only one user can update a row.

2. While a user is updating a row, no one else may read it.

Locking

UDS Control and RDMS 1100 provide a system of locking that gives basic protections to users. You can let RDMS automatically do the locking for you. This is implicit locking. For more efficient processing and specific locking, you can incorporate LOCK commands explicitly in a program.

Types of Locks

- Specified by a combination of *mode* and *usage*
  - The *mode* establishes how strong the lock is and is optional
  - The *usage* establishes whether you are retrieving or updating data
  - Allowed for *mode*: EXCLUSIVE, PROTECTED, SHARED, not-specified
  - Allowed for *usage*: RETRIEVAL, UPDATE
- RETRIEVAL (R)
  - Thread will only read data
- UPDATE (U)
  - Thread may alter data or table definitions
- SHARED (S)
  - Other threads may concurrently access the table
  - Row locks kept even when row is no longer current
  - Prevents others from viewing updated but not yet committed data
- PROTECTED (P)

  LOCK TABLE
  - No other thread may alter the table while the lock is on
- EXCLUSIVE (X)

  LOCK TABLE
  - No other thread can access the table while the lock is on
  - Strongest lock
- Eight types of locks are allowed by RDMS: R, SR, U, SU, PR, PU, XR, and XU

LOCK Command

```
LOCK   [ TABLE ] table-specification-list
       [ IN lock-specification [ MODE ] ]
       [ ON CONFLICT conflict-option ]
```

- Unisys implementation
- Where *table-specification-list* may specify a list of tables separated by commas
  - A view cannot be locked
  - A separate LOCK command should be used for each table
    - An error could occur for the command
    - Some tables could be locked or others not, or queuing could take place for some but not all tables
- The *lock-specification* is in the format [*mode*] [*usage*], default RETRIEVAL
- The *conflict-option* specifies how to handle conflicts, default QUEUE
  - RETURN means RDMS issues an error and control returns to your program
  - QUEUE means RDMS queues your program until the locking conflict is resolved
- Usage guidelines
  - LOCK command precedes OPEN command execution
  - Lock remains until table is explicitly unlocked or thread is ended

Examples:

```
LOCK EMP IN UPDATE MODE

LOCK EMP IN EXCLUSIVE RETRIEVAL MODE ON CONFLICT RETURN
```

Implicit RDMS Row Locks

RDMS implicitly locks rows of a table as they are read or updated. The type and duration of implicit lock depends on the type of explicit table-level lock used. Table 14-1 shows the implicit locks set by RDMS.

Table 14-1. Implicit Row-Level Locks Set by RDMS

Table Lock Specified	RDMS Sets This Implicit Row-level Lock on Retrieved Rows	RDMS Sets This Implicit Row-level Lock on Updated Rows
No lock specified	Command-duration retrieval lock on each retrieved row *	Step-duration exclusive update lock on each updated row
Retrieval	Command-duration retrieval lock on each retrieved row *	Updated not allowed
Shared update	Step-duration protected update lock on each retrieved row	Step-duration exclusive update lock on each updated row
Update	Command-duration retrieval lock on each retrieved row *	Step-duration exclusive update lock on each updated row
Shared retrieval	Step-duration retrieval lock on each retrieved row	Updates not allowed
Protected retrieval	No lock on retrieved rows	Updates not allowed
Protected update	No lock on retrieved rows	Step-duration exclusive update lock on each updated row
Exclusive retrieval	No lock on retrieved rows	Updates not allowed
Exclusive update	No lock on retrieved rows	No locks on updated rows

* *For a cursor declared with the FOR UPDATE clause, RDMS places a retrieval lock on each row as it is fetched, releasing the lock only when you alter the currency of the cursor by fetching a different row from the cursor, closing the cursor, dropping the cursor, or ending the step.*

Locking Conflicts

A locking conflict occurs if two users try to lock the same table at the same time. Table 14-2 summarizes the conditions in which locks from different runs conflict. An * indicates a conflict.

Conflicts apply to both table and row level locks, but table-level locks can only conflict with table-level locks, and row-level locks with row-level locks

Table 14-2. Locking Conflicts

Current Lock → / New Usage ↓	R	SR	U	SU	PR	PU	XR	XU
Retrieval							*	*
Shared Retrieval							*	*
Update					*	*	*	*
Shared Update					*	*	*	*
Protected Retrieval			*	*		*	*	*
Protected Update			*	*	*	*	*	*
Exclusive Retrieval	*	*	*	*	*	*	*	*
Exclusive Update	*	*	*	*	*	*	*	*

- Horizontal axis represents the type of lock currently in place
- Vertical axis represents the type of lock requested by another run

LOCK TABLE EMP IN [SHARED / PROTECTED / EXCLUSIVE] [RETRIEVAL / UPDATE] MODE

Default is

LOCK TABLE EMP IN UPDATE MODE.

Deadlock

Deadlock occurs when two or more runs are queued on locks held by each other so that none of the runs can resume execution.

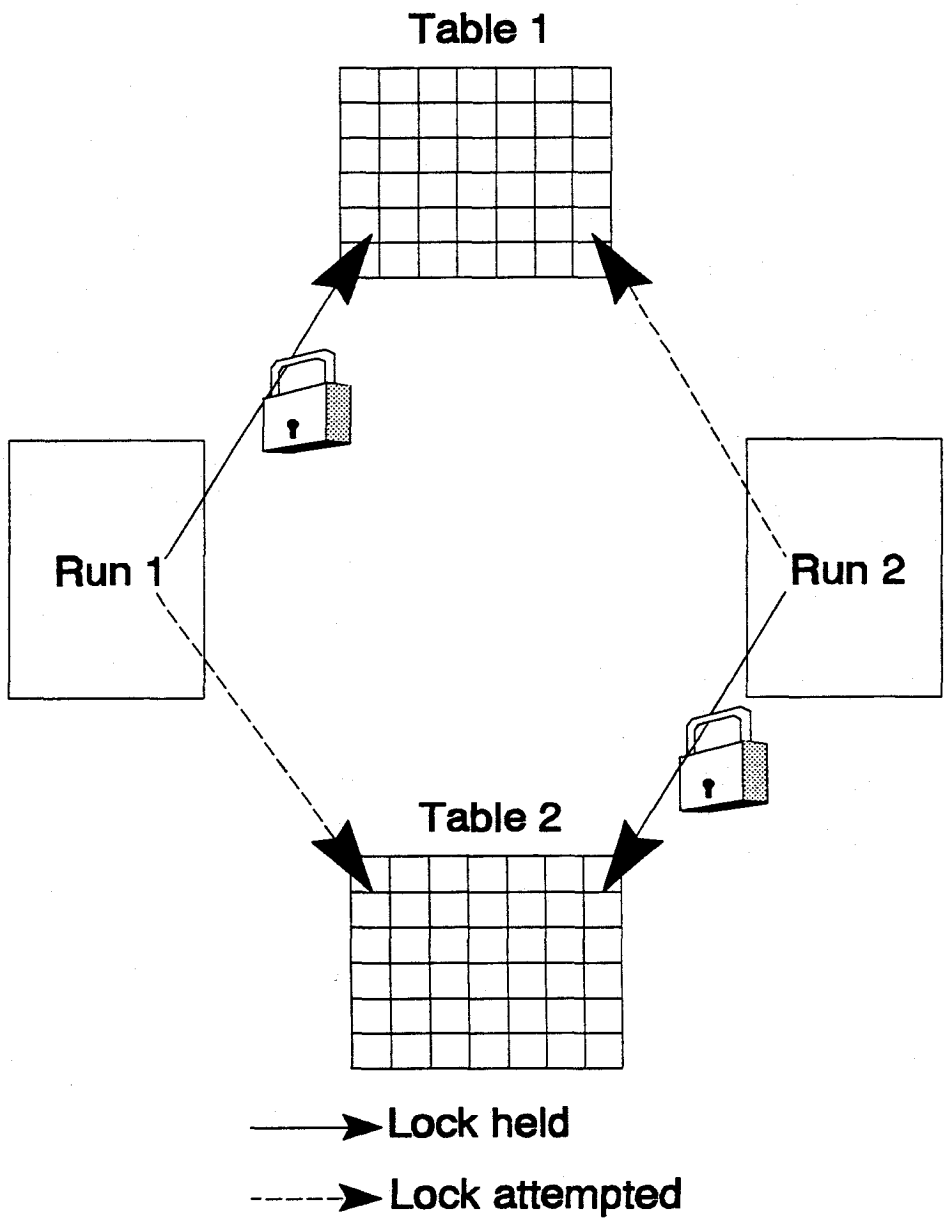


Figure 14-2. Illustrating Deadlock

Resolving Deadlock

- Reduce probability of deadlock by using "strong", explicit locks
- Tradeoff - Strong locks reduce concurrent access
- RDMS returns deadlock status
  - ERR-STAT = 6010
  - Test in program
- Suggested resolution
  - Wait from 1/10 to 1 second
  - Repeat all OPEN, INSERT, DELETE, and UPDATE commands in step rolled back
  - Include in loop
  - Use randomly generated wait times if several threads are doing this
  - Access files in same order in each program
- On conflict, the RETURN option of the LOCK command returns:
  - ERR-STAT = 6004 when locking conflict occurs → if RETURN
  - RDMS performs END THREAD/ROLLBACK → if QUEUE

UNLOCK Command

UNLOCK *table-specification-list*

- Unisys implementation
- Removes lock from table(s)
- Retrieval locks are dropped immediately
- Update locks are dropped at end of step
  - COMMIT
  - END THREAD
- If table is being used by an active cursor, UNLOCK generates an error
- UNLOCK is required to change lock mode on a table

Example:

```
UNLOCK EMP, DEPT
```

Program Flow with Locks

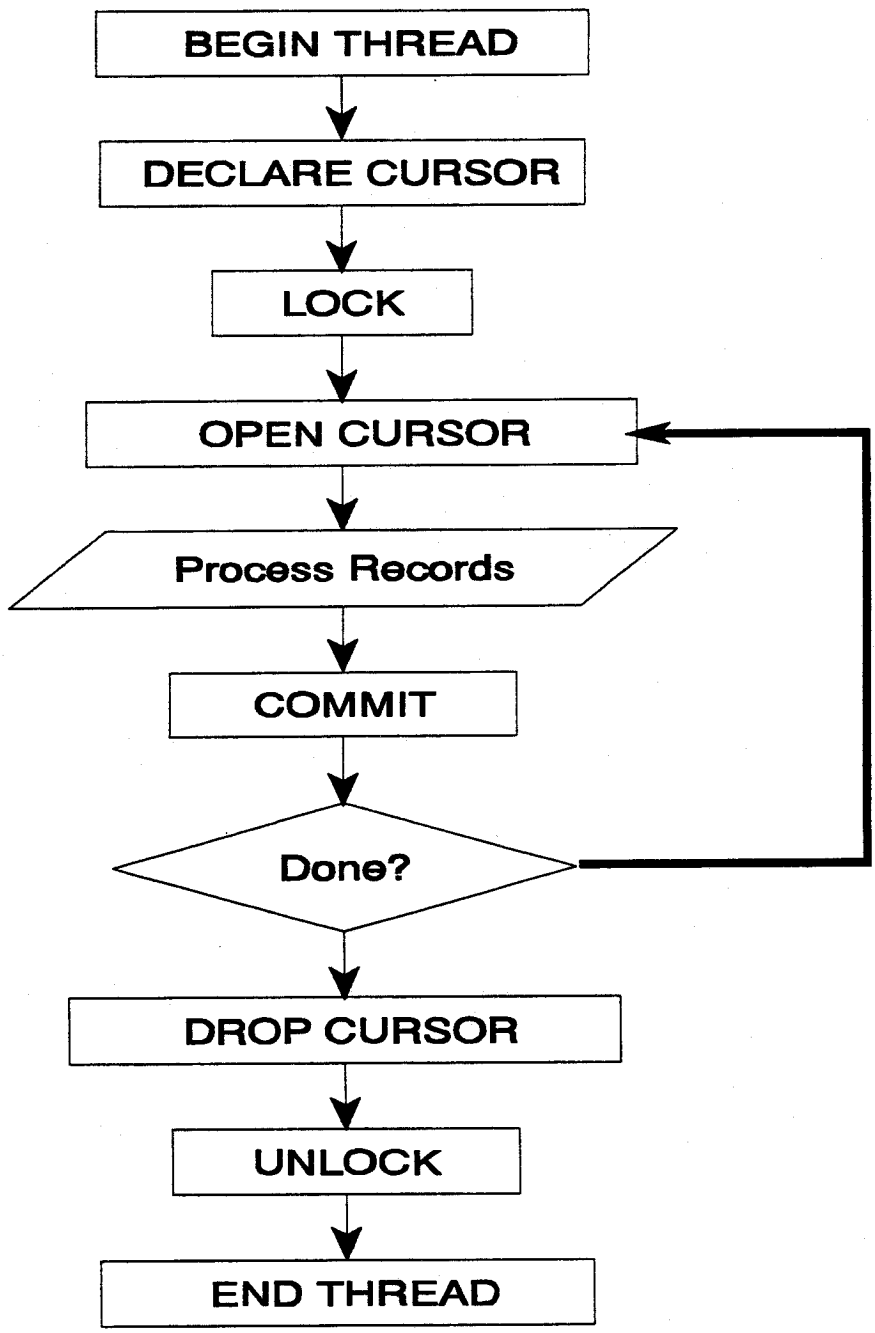


Figure 14-3. Program Flow with Locks

Exercise 14-1

1. What is a step? What is the purpose of breaking a program into steps?

Logical unit of work for Recovery purposes.

2. What occurs when a step is committed?

New step starts
Updates are committed to tables
Locks are released

3. What occurs when a step is rolled back?

Tables are restored to beginning of step.

4. Why does RDMS lock tables?

To prevent simultaneous updates

15

Getting Physical - Tables and Storage Areas

Module 15
Getting Physical - Tables and Storage Areas

Module Objectives

Upon completion of this module, you should be able to

- Describe the process of creating tables
  - Identify the components of a fully qualified table name
  - Set a default table version using the SET DEFAULT VERSION command
  - Describe the difference between a logical and physical table
  - Describe the relationship between physical tables and storage areas

Benefit Statement

Access and manipulating tables have been the main topic for this course, but what if you are responsible for setting up the database. A few insights into creating the tables and how they relate to the database physical attributes are presented here. Your next step may be database administration!

Materials

- OS 1100 UDS Relational Data Management System (UDS RDMS 1100) Administration Guide

- OS 1100 UDS Relational Data Management System (UDS RDMS 1100) SQL Programming Reference Manual

Creating a Database

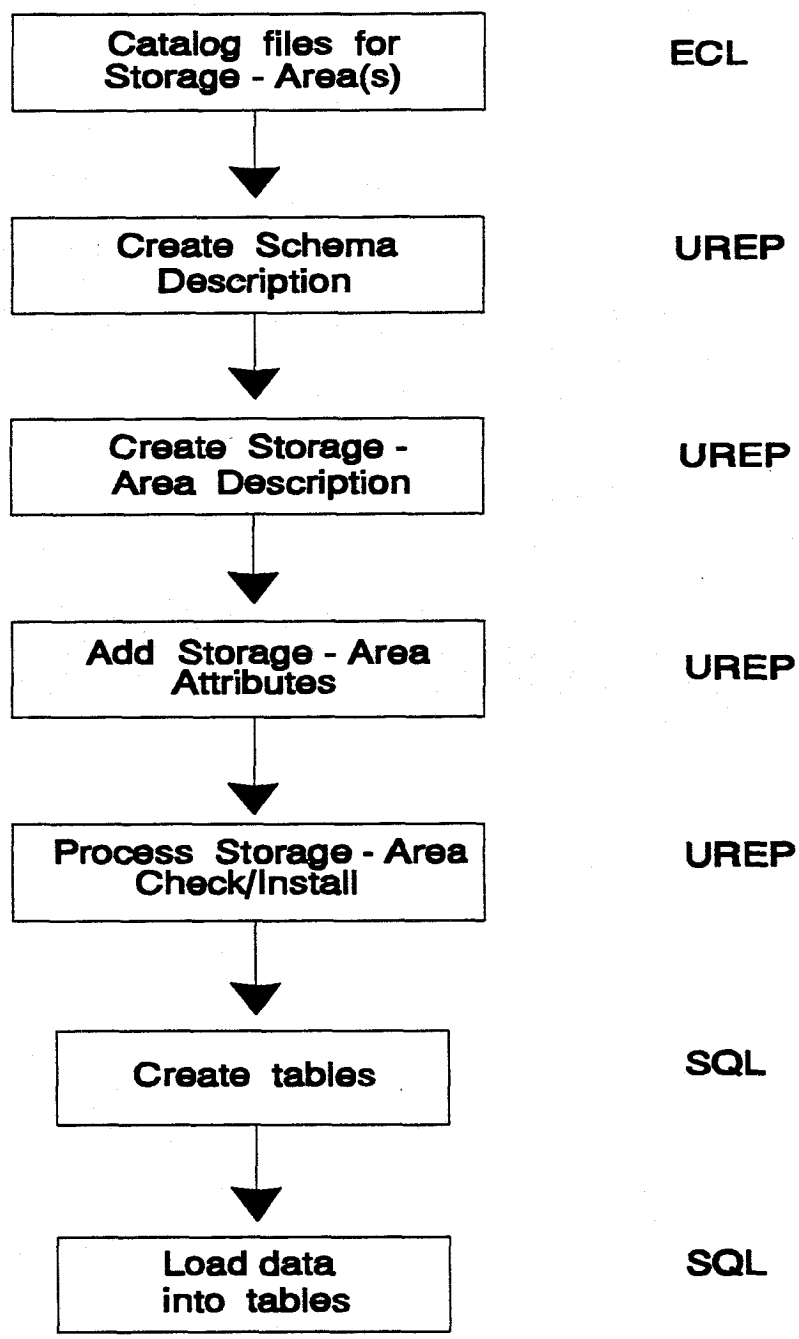


Figure 15-1. Steps to Creating a Database

Schema

- Definition
  - Database definition that describes units of data, such as record types and relations
  - A name that identifies an arbitrary group of storage area definitions and table definitions in repository

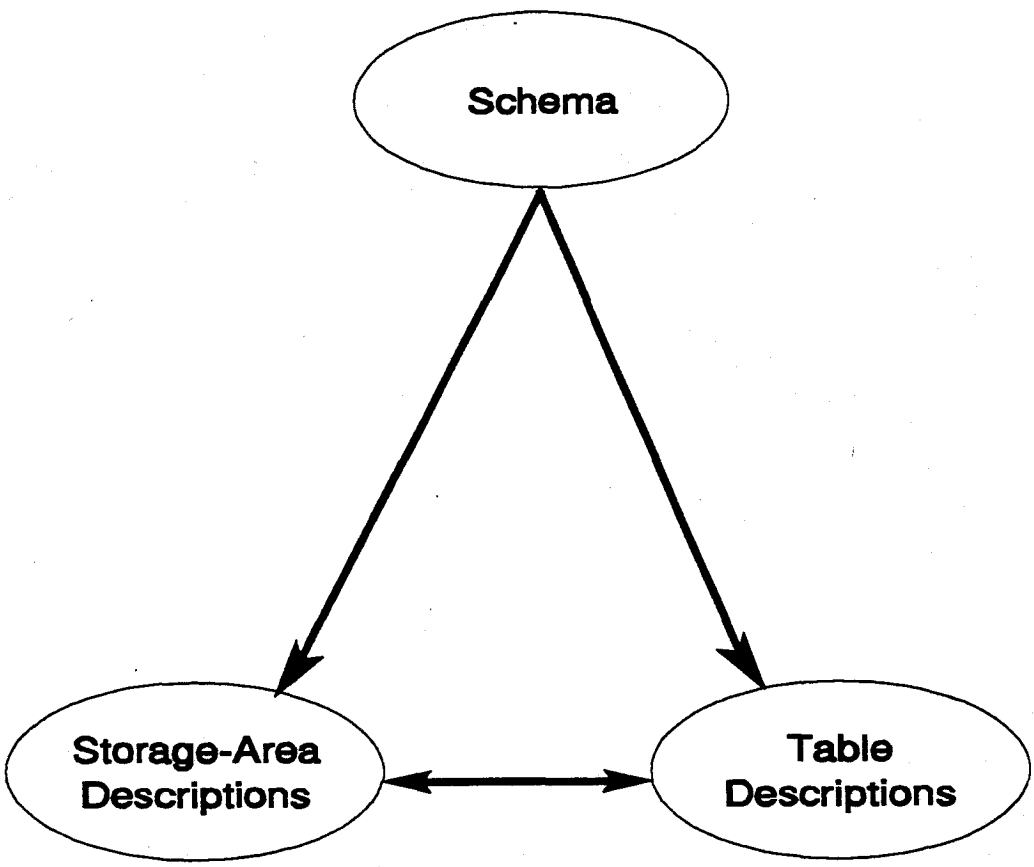


Figure 15-2. Schema Function

Storage-Areas

- Storage-Areas are defined by the Database Administrator
- Definition contains:
  - Storage-Area Name
  - Schema with which it is associated
  - Exec file name or TIP file number
  - Version-name
- Each storage-area is associated with exactly one file
  - Name of storage-area and file may be different
  - Version-name of storage-area is same as that of table which will be stored in it
- Storage-area must be defined before corresponding table
- As programmer, need to know version-name for reference

Storage-Areas, Files, and Tables

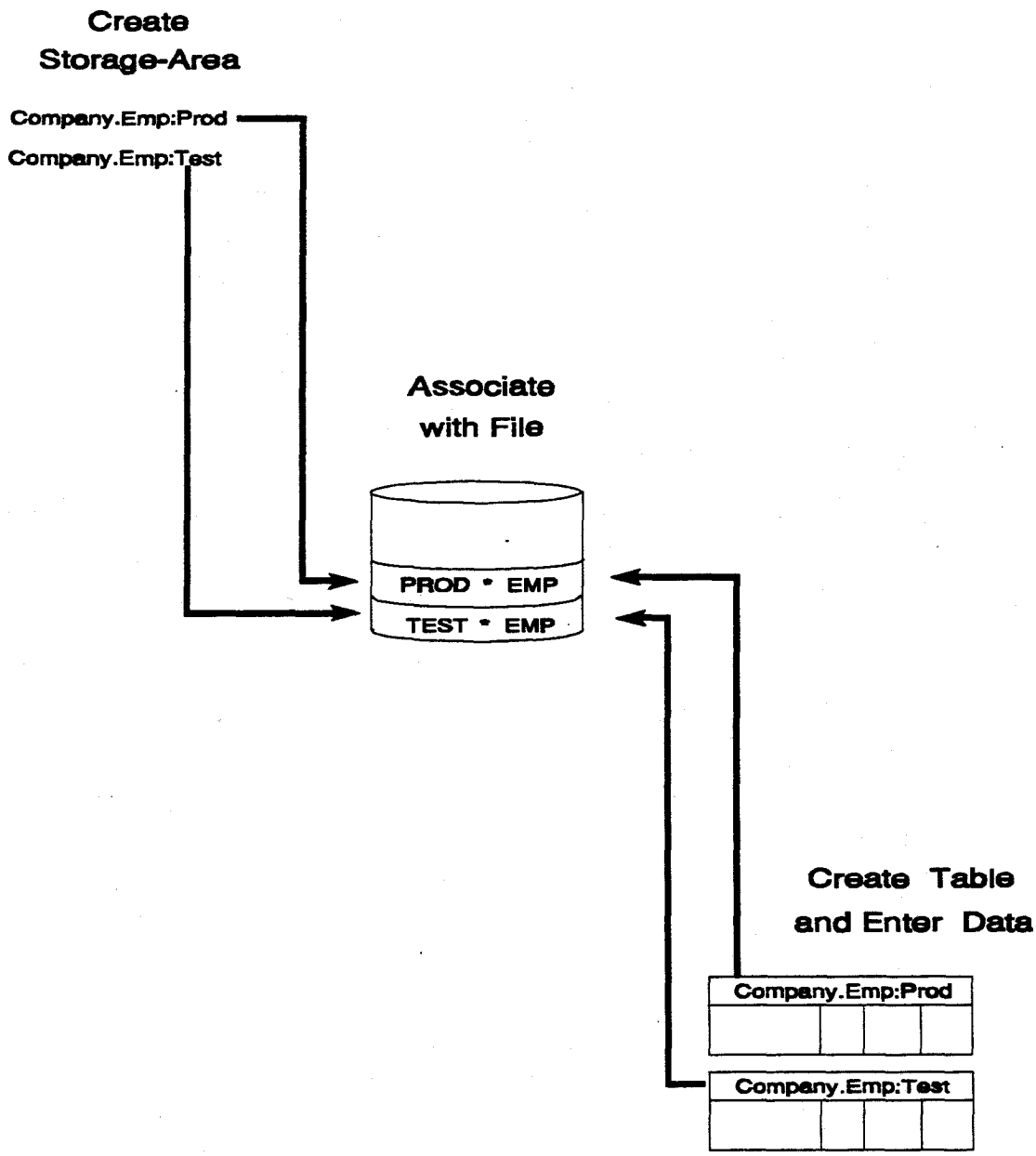


Figure 15-3. Connecting the Pieces

Logical Tables and Physical Files

- Logical table defines:
  - Column layout
  - Datatypes
  - Primary key(s)
  - Secondary key(s)
  - Foreign key(s)
- Versions permit spreading data across multiple physical files
- File-name is specified by storage-area version
- Characteristics of each file may be different
  - Audited/Not audited
  - Recoverable/Not recoverable
  - Pages allocated

Table Versions

- Versions of a table use the same table definition
- Versions of the table are created when different data is loaded in the specified table versions
- Versions can be used to divide a large table into tables with fewer rows

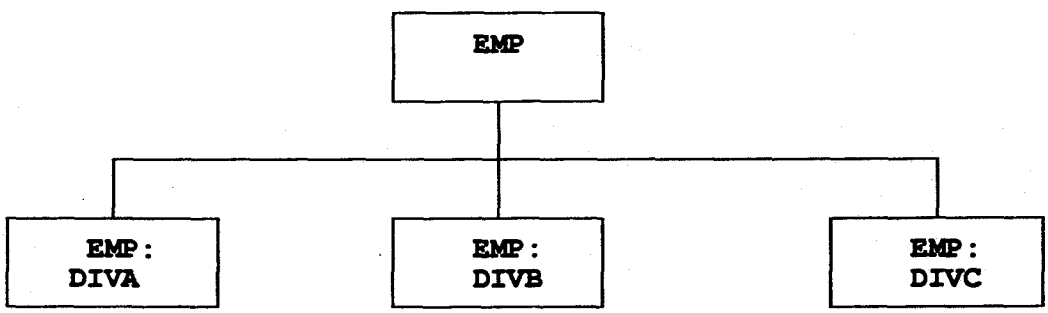


Figure 15-4. Table Versions

Fully Qualified Table-Name

schema-name.table-name:version

- The *schema-name* is used as qualifier for table name
- Default qualifier is RDMS
- Default version
  - For RDMS is PRODUCTION
  - For UREP is blank
  - These two are equivalent
- Table qualifier has nothing to do with EXEC file qualifiers
- Fully qualified table name may be used anywhere table name must be coded
- Can set up own defaults for qualifier/version so only table name is needed

Examples:

Company.Payroll:Production

Company.Payroll:Test

USE DEFAULT Command

USE DEFAULT [QUALIFIER *use-name* | VERSION *version-name*]

- Unisys implementation
- The *use-name* may be:
  - Schema-name
  - Variable containing string to use of 30 or fewer characters
- Remains in effect until next USE command
- The *version-name* may be
  - Name or string
  - Variable containing version-name
- Generalized programs
  - Accept input of qualifier-name or version-name into program variables
  - Then USE DEFAULT to access desired table

Examples:

```
USE DEFAULT QUALIFIER SALES_DEPT

USE DEFAULT QUALIFIER 'R & D'

USE DEFAULT VERSION TEST

USE DEFAULT VERSION $P1
```

How RDMS 1100 Locates Data

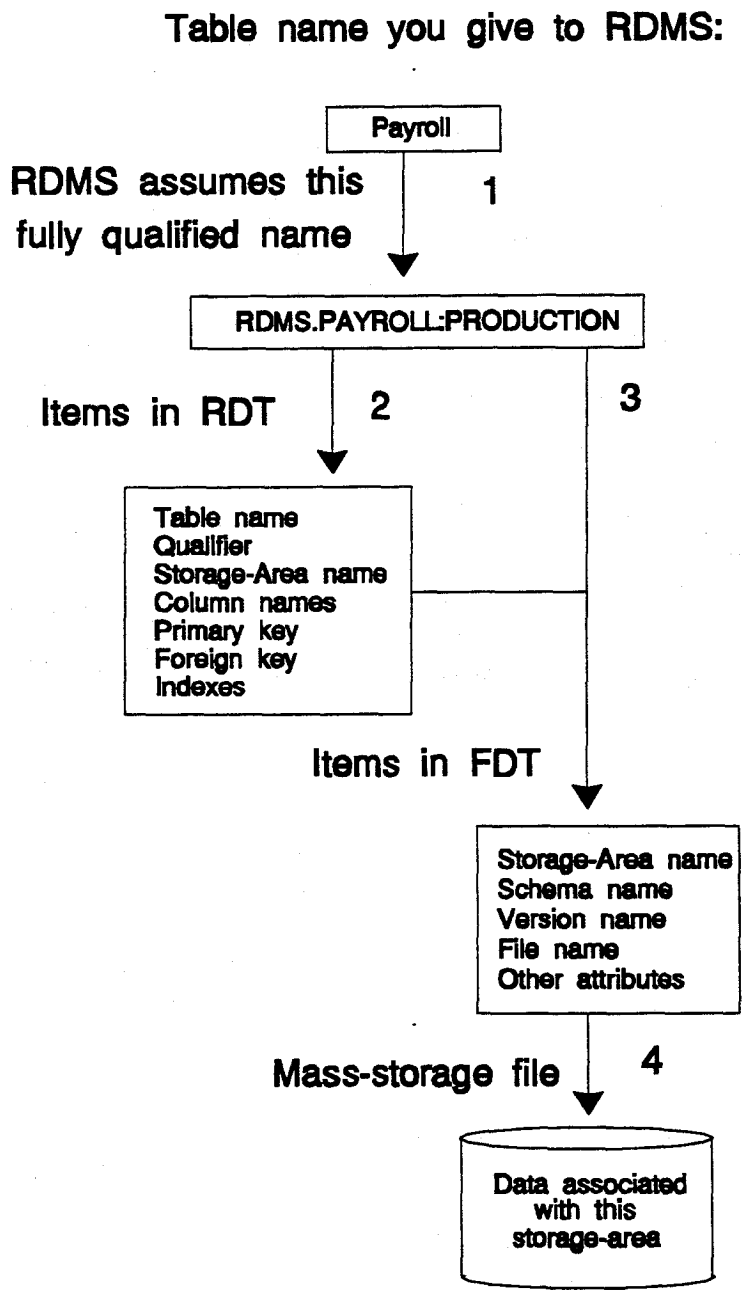


Figure 15-5. RDMS Locating Data

How RDMS 1100 Resolves Table References

1. When you give RDMS a table name, it must first determine the full form of the name in the format schema.table:version.

   - If you do not specify the schema or version, RDMS uses the current default values.

   - Unless a USE command was entered, the default schema is RDMS, and the default version is PRODUCTION.

2. RDMS uses the schema and table names together to find the encoded form of the table description (Relational Table Description or RDT) in the RDT$FILE.

3. RDMS gets the storage-area name from the RDT, and combines it with the version name to identify the File Description Table (FDT) in FDT$FILE.

   - The FDT is the encoded form of the Storage-Area Definition.

   - This contains the name of the file in which the table data is physically stored.

4. RDMS gets the EXEC file name or TIP file number from the FDT. It then goes to the file and locates the table.

Creating Versions Example

```
@CAT,P  KOP*INSTRUCTORS.
@CAT,P  NYC*INSTRUCTORS.
```

First use UREP

```
@DD,E

    CREATE SCHEMA MASTER_INSTRUCTOR.

    CREATE STORAGE-AREA INSTRUCTOR
       VERSION KING_OF_PRUSSIA
       FOR SCHEMA MASTER_INSTRUCTOR.
    ADD QUALIFIER KOP.
    ADD FILENAME INSTRUCTORS.
    ADD FILE-TYPE EXEC.

    PROCESS STORAGE-AREA INSTRUCTOR
       VERSION KING_OF_PRUSSIA
       FOR SCHEMA MASTER_INSTRUCTOR INSTALL.

    CREATE STORAGE-AREA INSTRUCTOR
       VERSION NEW_YORK_CITY
       FOR SCHEMA MASTER_INSTRUCTOR.
    ADD QUALIFIER NYC.
    ADD FILENAME INSTRUCTORS.
    ADD FILE-TYPE EXEC.

    PROCESS STORAGE-AREA INSTRUCTOR
       VERSION NEW_YORK_CITY
       FOR SCHEMA MASTER_INSTRUCTOR INSTALL.
    EXIT.
```

Then, in SQL perform the following:

```
    CREATE TABLE MASTER_INSTRUCTOR.INST_INFO
       IN MASTER_INSTRUCTOR.INSTRUCTOR.
       COLUMNS ARE INST_NAME ...;
       .
       .
       .
    USE DEFAULT QUALIFIER MASTER_INSTRUCTOR;

    INSERT INTO INST_INFO:KING_OF_PRUSSIA
       VALUES('SANDY KNORR', ...);

    INSERT INTO INST_INFO:NEW_YORK_CITY
       VALUES('DONNA KEECH', ...);
```

Exercise 15-1

1. What is a schema? How is it used by RDMS?

It is a group of tables and storage descriptions
Database definitions

2. List three differences between a logical and a physical table.

Logical table holds definition of file
Physical table holds the actual data
Physical can be audited/non-audited etc
Logical table does not have a version name.

3. Write the commands needed to make the table-name EMP resolve to US.EMP:DIV1.

USE DEFAULT QUALIFIER US
USE DEFAULT VERSION DIV1

A

System Usage Information

Appendix A
System Usage Information

System Essentials

Your instructor will assist you in filling out the information needed for this class.

- Demand Login
  - $$open-ID
  - User-ID/Password
  - Run-ID
  - Account
  - Project-ID
- MAPPER Login
  - $$OPEN-ID
  - MAPPER-ID
  - User-ID
  - Password
  - Department-#
- Printer information
  - Printer-ID
  - Printer location
  - Other
- Database information
  - Qualifier/Schema-name
  - Table Names
  - Application group

Demand Session and Instructions

You may need to note changes required by your site for the following "typical" session.

Note: *The greater than sign ">" is used instead of the standard start of entry (SOE) character below.*

```
>$$OPEN DMEA10
>USER-ID/PASSWORD
>Project-ID:     STU _ _    .  System either solicits project... or
>@RUN run-ID,account,stu _ _     .  ... or requires run statement
```

Note: *You will need a couple of files for this class, a program file for your programs and a data file for your printout. The suggested names of the files will both have your STU number as the qualifier. The program file should be named SQL and the printfile named PRFIL. These are the names you will find in the provided runstreams. Change them if you wish, but don't step on someone else's files!*

```
>@CAT,P SQL.          . Use your STU## as the default qualifier
>@CAT,P PRFIL.        . Catalog your files once and assign them at the
>@ASG,A SQL.          .      beginning of each demand session
>@ASG,A PRFIL.
>@ASG,A AL3644*SQL.     .  Contains program skeletons and addstreams
>@COPY,P AL3644*SQL.,STU _ _ *SQL.
>@PRT,T SQL.
```

Note: *The above command lists the elements provided for this class. When an element name has two parts divided by the "/", the first part tells you where this element is used and the second part tells you what it is used for. For example, the element LAB3-1/UCOBSKEL is the element for Lab 3-1 and is a UCS COBOL skeleton. Other elements will be described by your instructor.*

```
>   .
>   .   Demand session stuff:  @IPF, Compile, Execute, etc.
>   .
>@FIN
>$$CLOSE                        . Please close the session when done!
```

Additional Demand Notes:

MAPPER Session and Instructions

You may need to note changes required by your site for the following "typical" session.

```
>$$OPEN T4EA10
>EDMAP                          . Select a specific MAPPER
> .    Enter userid,dept#,password on Menu or on the control line
       after "]"
>RDI                            . Entered from control line
.
.  Other MAPPER session commands
.
>X                              . Entered from control line
                                  .    Exit from MAPPER
>$$CLOSE                        . Close the session
```

Additional MAPPER Notes

Obtaining Printout

Note: *This information is site dependent. You may have an on-site printer, a local attached printer, a remote printer, or no printer available! And how you access the printer will require specific instructions. Please make your notes below.*

Some of the commands that obtain printout include:

```
>@SYM,U PRFIL,,printer-id,,print-banner  . Queue to onsite printer

>@add,1 sql.spool                       . DDP and Queue the file to a
                                        .   remote printer

>~C~>site printer-ID                    . IPF command for on-site printer

>aux                                    . MAPPER uses local printer
                                        . attached to terminal. Menu .

>pr                                     . MAPPER queues output to site
                                        .     printer
```

Printer Notes

Compiling and Executing a Program in IPF

- Login to IPF

  ```
  >@IPF filename
  ```

- Retrieve program file into work space

  ```
  >~C~>old Qual*filename.elt
  ```

- Set datamanager

  ```
  >~C~>Set $data := rdms
  ```

- Run program

  ```
  >~C~>run filename.elt, compiler, library-list
  ```

  ```
  >~C~>run sql.lab3-1/ucobskel, ucob
  ```

  - IPF automatically compiles, links, and executes element
  - Defaults
    - Executes work space
    - Compiler corresponds to file type
    - System library

  ```
  >~C~>run ,ucob
  ```

  Compiles and executes work space using ucob compiler and system library

- Print the program in the work space

  ```
  >~C~>Site printer-ID
  ```

Compiling and Executing a Program using ECL

Use Runstreams

Note: *Runstreams are provided in your student file to automate this process. Please modify them for your use during this class. If the version name of the element contains "r-u-n" it is likely to be a runstream. Example of using one:*

```
>@ADD,L sql.lab3-1/runucobskel
```

ACOB program

The following pieces are intended to operate together in a demand session.

- Compile source program

```
>@ACOB,ES  sql.lab3-1/acobskel,rel   . Relocatable output to TPF$
```

- Collect the program

```
>@ADD sql.map                        . Element map is in your work file
```

- Execute absolute

```
>@xqt abs                              . MAP output was to TPF$.abs
```

UCOB program

- Compile source program

```
>@UCOB,res  sql.lab3-1/ucobskel,om   . Output to TPF$.om
```

- Execute object module

```
>@xqt om                               . Invokes dynamic linking to
                                       .    libraries
```

Saving and Printing Compiler Listings

Using and modifying the provided runstreams automates the process of using the standard ECL. You can save your printfile information in your program file with an ECL copy:

```
>@copy,i prfil.,sql.lab3-1/ranucobskel  . Note the "ran" versus
                                        .   "run" name
```

A popular, but unsupported, pair of processors can be found at most sites: @BK1 and @BK2.

- Execute a breakpoint: @BK1
- Perform interim commands
- End breakpoint and view output in editor: @BK2,opts
  - E for ED, C for CTS, I for IPF
- End breakpoint and queue output to printer: @BK2 printer-ID

Example 1

```
>@BK1
>@UCOB,res sql.lab3-1/ucobskel,om
>@BK2,I
```

Example 2

```
>@BK1
>@ACOB,se  sql.lab3-1/acobskel,rel
>@EOF
>@ADD  sql.map
>@BK2  prin1
```

Basic IPF Commands

Command Line Commands

new	Start a new file
old	Retrieve text of filename into work space
save	Save contents of work space (a new file)
repl	Save contents of work space (existing file)
top	Go to the top of the file
bottom	Go to the bottom of the file
go	Go to the given line number

Text Line Commands

In	Insert n lines after this line
IBn	Insert n lines before this line
G+n	Go to n lines past this line
G-n	Go to n lines before this line
Dn	Delete n lines
DS	Delete start - Start of text to delete
DE	Delete end - End of text to delete
Cn	Copy n lines
CS	Copy start - Start of text to copy
CE	Copy end - End of text to copy
CB	Copy the marked text before this line
CA	Copy the marked text after this line
Mn	Move n lines
MS	Move start - Start of text to move
ME	Move end - End of text to move
MB	Move the marked text before this line
MA	Move the marked text after this line

B

FORTRAN Examples

Appendix B
FORTRAN Examples

SQL Commands in ASCII FORTRAN

Format 1

```
CALL F$RDMR
 ('SQL-COMMAND' ,
  ERSTAT      ,
   AUXINF )
```

Format 2

```
CALL F$RDMR
 (SQL-COM-STRING-VARIABLE ,
  ERSTAT                  ,
   AUXINF )
```

The SQL command or the contents of SQL-COM-STRING-VARIABLE must end with a semicolon (;).

- ERROR-STATUS - A CHARACTER*4 item that contains a status code when RSA detects an error. Normal completion has status 0000.

- AUXILIARY-INFORMATION - An INTEGER item that contains the column position within the source command where RSA detects an error. If there is no error, the contents are meaningless.

Example

```
      .
CHARACTER*132  RCOM
CHARACTER*4    ERSTAT
INTEGER        AUXINF
      .
CALL F$RDMR
*   ( 'BEGIN THREAD FOR UDSSRC READ          ; ' ,
*                     ERSTAT, AUXINF )
      .
      .
RCOM = 'DECLARE EMPLOYEE CURSOR SELECT * FROM EMP;'
  CALL F$RDMR ( RCOM, ERSTAT, AUXINF )
```

Sample ASCII FORTRAN Retrieval Program

If FORTRAN is your programming language, here is a complete program in ASCII FORTRAN.

(At this stage, you don't need to be concerned about the syntax and layout of the commands. This is explained in the modules. For now, look at the way the RDMS commands are embedded in the 'CALL F$RDMR...' commands.)

Requirement: Read and display all the rows of the EMP table, showing all the columns.

```
C
C*****************************************************************
C *    MAIN PROGRAM TO PRINT CONTENTS OF THE "SALESMEN" TABLE
C*****************************************************************
      CHARACTER*511  rcom
      CHARACTER*4    erstat
      INTEGER  auxinf
      INTEGER  rempno
      CHARACTER*10  rename
      CHARACTER*10  rjob
      INTEGER rmgr
      INTEGER rdno
      INTEGER rhirdt
      INTEGER rsal
      INTEGER rcomm
C
C*****************************************************************
C  *    CONNECT TO UDS
*****************************************************************
      RCOM = 'BEGIN THREAD FOR UDSSRC READ UDSMSG ;'
       CALL F$RDMR(RCOM, ERSTAT, AUXINF)
       CALL errchk(erstat, auxinf, ' ', *90, *90)
C
C
C*****************************************************************
C      DECLARE THE CURSOR
C*****************************************************************
      PRINT '('Retrieves entire relation EMP', ///)'
      RCOM = 'DECLARE EMPLOYEE CURSOR SELECT * FROM EMP;'
       CALL F$RDMR(RCOM, ERSTAT, AUXINF)
       CALL errchk(erstat, auxinf, ' ', *90, *90)
```

```
C
C*****************************************************************
C     LOOP TO READ TABLE AND PRINT ROW     *
C*****************************************************************
10     CONTINUE
       RCOM = 'FETCH NEXT EMPLOYEE INTO $P1,$P2,$P3,$P4,$P5,
      *  $P6,$P7,$P8 ;'
       CALL F$RDMR(RCOM, ERSTAT, AUXINF,
      *  REMPNO, RENAME, RJOB, RMGR, RDNO, RHIRDT, RSAL, RCOMM)
       CALL errchk(erstat, auxinf, '6001', *90, *80)
C
       PRINT '(1X,I4,1X,A,1X,A,1X,I4,1X,I3,1X,I6,1X,I4,1X,I4)',
      *  REMPNO, RENAME, RJOB, RMGR, RDNO, RHIRDT, RSAL, RCOMM)
       GO TO 10
C
C
80     CONTINUE
       PRINT 'End of relation EMP.'
       CALL F$RDMR('END THREAD;', ERSTAT, AUXINF)
       CALL errchk(erstat, auxinf, ' ', *90, *90)
       PRINT '(23H0Normal end of program.)'
       STOP
C
90     CONTINUE
       PRINT '(40H0***** Error status program termination.)'
       CALL F$RDMR('END THREAD;', ERSTAT, AUXINF)
       STOP
       END
C
C *-----------------------------------------
C |       SUBROUTINE TO TEST ERROR STATUS      |
C *-----------------------------------------
C
       SUBROUTINE errchk (erstat, auxinf, accept, *, *)
C
       CHARACTER*4     accept    @ Acceptable status for RETURN 2
       INTEGER auxinf
       CHARACTER*4     erstat
C
       IF (erstat .EQ. '0000') RETURN
       IF (erstat .EQ. accept) RETURN 2
C
       PRINT '(29H0**** Unexpected error status ,A,11H
    *     at column,I3)', erstat, auxinf
C
       RETURN 1
```

Example With GETERROR (FTN)

```
CHARACTER*132 E1, E2, E3, E4, E5
   .
   .
   .
   RCOM = 'BEGIN THREAD T1 READ  ;'
   CALL F$RDMR(RCOM, ERSTAT, AUXINF)
   IF ERRCOD .EQ. '0000' THEN (SKIP ROUND ERROR ROUTINE)
   .
   .
   CALL F$RDMR ('GETERROR INTO $P1, $P2, $P3, $P4, $P5  ;' ,
  *  ERSTAT, AUXINF, E1, E2, E3, E4, E5)
   .
   .
   .
   PRINT '(A132)', E1
   PRINT '(A132)', E2
   PRINT '(A132)', E3
   PRINT '(A132)', E4
   PRINT '(A132)', E5
```

C

ACOB Skeleton

```
@PRT,S AL3644*SQL.LAB3-1/RUNACOB
FURPUR  30R2A        (910822 1304:40) 1993 Mar 17 Wed 1510:31
AL3644*SQL(1).LAB3-1/RUNACOB(0)
     1      @BRKPT    PRINT$,prfil.
     2      @PRT,S    sql.lab3-1/runacob
     3      @ACOB,SE  sql.lab3-1/acobskel,TPF$.acobskel
     4      @MAP,S    ,TPF$.ABS
     5           NOT TPF$.
     6           IN  TPF$.acobskel
     7           IN  SYS$LIB$*RSA.CBEP$$RSA
     8           IN  SYS$LIB$*RSA.RDMR-ACOBDAT
     9           END
    10      @XQT
    11      @BRKPT    PRINT$
    12      @IPF      TPF$.
    13      OLD       prfil.
    14      L END,A,A,NUM
    15      MOD SCR
@PRT,S AL3644*SQL.LAB3-1/ACOBSKEL
AL3644*SQL(1).LAB3-1/ACOBSKEL(0)
     1              IDENTIFICATION DIVISION.
     2              PROGRAM-ID. acobskel.
     3              ENVIRONMENT DIVISION.
     4              CONFIGURATION SECTION.
     5              SOURCE-COMPUTER. UNISYS-2200.
     6              OBJECT-COMPUTER. UNISYS-2200.
     7             *
     8             ************************************************************
     9             ***     This program uses interpretive SQL and ACOB to
    10             ***     solve the lab3-1 assignment for SQL Programming
    11             ************************************************************
    12             *
    13              DATA DIVISION.
    14              WORKING-STORAGE SECTION.
    15             *
    16             ************************************************************
    17             ***  Establish RDMS command error buffers and data
    18             ************************************************************
    19             *
    20             ***  Error handling variables and message buffers
    21             *
    22              01  rcom.
    23                  05  rlin                   PIC X(40) OCCURS 12 TIMES.
    24              01  err-stat                   PIC 9(4).
    25              01  aux-info                   PIC S1(36).
    26              01  error-text.
    27                  05  err-s                  PIC X(132) OCCURS 4 TIMES.
    28              01  err-s-index                PIC 9(4).
    29              01  thread-flag                PIC 9      VALUE ZERO.
    30                  88  thread-has-begun                VALUE 1.
    31              01  cursor-flag                PIC 9      VALUE ZERO.
    32                  88  end-of-cursor                   VALUE 1.
    33              01  err-end-flag               PIC 9      VALUE ZERO.
    34                  88  no-more-msgs                   VALUE 1.
    35             *
    36             ***  Place for the retrieved record, set up for printing
    37             *
    38              01  record-retrieved.
    39                  05
    40                  05
```

```
41          ************************************************************
42          ***  BEGIN the thread, do the USE, clear the SQL buffer
43          ************************************************************
44          *
45          ***  Start the thread
46          *
47           PROCEDURE DIVISION.
48           000-main.
49               MOVE '                                          ;' TO rcom.
50               ENTER MASM 'acob$rdmr' USING rcom, err-stat, aux-info.
51               IF err-stat NOT = 0 GO TO 900-error-print.
52          *
53          ***  Set table qualifier, clear buffer, set thread flag
54          *
55               MOVE '                                           ;' TO rcom.
56               ENTER MASM 'acob$rdmr' USING rcom, err-stat, aux-info.
57                                    GO TO 900-error-print.
58          *
59               MOVE 1 TO thread-flag.
60          *
61          ************************************************************
62          ***  Access RDMS - DECLARE and OPEN the cursor
63          ************************************************************
64          *
65          ***  Declare the cursor
66          *
67               MOVE '                                            ' TO rcom.
68               MOVE '                                            ' TO rlin(2).
69               MOVE '                                           ;' TO rlin(3).
70               ENTER MASM 'acob$rdmr' USING rcom, err-stat, aux-info.
71               IF err-stat NOT = 0 GO TO 900-error-print.
72          *
73          ***  Open the cursor
74          *
75               MOVE '                                          ;' TO rcom.
76               ENTER MASM              USING rcom, err-stat, aux-info.
77               IF err-stat NOT = 0 GO TO 900-error-print.
78          *
79          ************************************************************
80          **   Loop thru the rows, end the thread, then do cleanup
81          ************************************************************
82          *
83          ***  Loop to fetch a row and display it
84          *
85           200-loop.
86               MOVE '                                       ' TO rcom.
87               MOVE '                                      ;' TO rlin(2).
88               ENTER MASM 'acob$rdmr' USING rcom, err-stat, aux-info
89
90               IF err-stat = 6001 GO TO 400-drop-cursor.
91               IF err-stat NOT = 0 GO TO 900-error-print.
92          *
93               DISPLAY record-retrieved UPON PRINTER.
94               GO TO 200-loop.
95          *
96           400-drop-cursor.
97               DISPLAY 'No more data on fetch' UPON PRINTER.
98               MOVE 'DROP CURSOR employee                      ;' TO rcom.
99               ENTER MASM 'acob$rdmr' USING rcom, err-stat, aux-info.
100              IF err-stat NOT = 0 GO TO 900-error-print.
101         *
102              MOVE SPACES TO rcom.
103         *
```

```
104          ************************************************************
105          ***  End the thread, shut down the program
106          ************************************************************
107          *
108          ***  Issue the end of the thread
109          *
110               MOVE '                                          ;' TO rcom.
111               ENTER MASM 'acob$rdmr' USING rcom, err-stat, aux-info.
112               IF err-stat NOT = 0 GO TO 900-error-print.
113          *
114          ***  Stop the program
115          *
116               DISPLAY 'Program has completed' UPON PRINTER.
117               STOP RUN.
118          *
119          ************************************************************
120          **   Do the RDMS error handling - display codes, messages
121          ************************************************************
122          *
123           900-error-print.
124          *
125          ***  Print errant command and error status variables
126          *
127               DISPLAY 'RDMS Command = ' rcom      UPON PRINTER.
128               DISPLAY 'Error Status = ' err-stat  UPON PRINTER.
129               DISPLAY 'Auxiliary Info = ' aux-info  UPON PRINTER.
130          *
131          ***  Issue the error messages, end the thread, and exit
132          *
133               MOVE 0 TO err-end-flag.
134               PERFORM 940-geterror UNTIL no-more-msgs.
135               DISPLAY 'Error termination' UPON PRINTER.
136               IF thread-has-begun
137                  MOVE ' END THREAD                            ;' TO rcom
138                  ENTER MASM 'acob$rdmr' USING rcom, err-stat, aux-info.
139               STOP RUN.
140          *
141          ***  Fill the error buffers using GETERROR
142          *
143           940-geterror.
144               MOVE '                                          ;' TO rcom.
145               ENTER MASM 'acob$rdmr' USING
146
147               PERFORM 980-print-error
148                  VARYING err-s-index FROM 1 BY 1 UNTIL err-s-index > 4.
149          *
150          ***  Display the error buffers
151          *
152           980-print-error.
153               IF err-s(err-s-index) NOT = SPACE
154                  DISPLAY err-s(err-s-index) UPON PRINTER
155               ELSE
156                  MOVE 5 to err-s-index
157                  MOVE 1 TO err-end-flag.
```

D

ACOB Examples

```
@PRT,S    DEV.APPD/RUNACOBPROG1
FURPUR  30R2A         (910822 1304:40) 1993 Mar 17 Wed 1210:56
ANDREW*AL3644(1).APPD/RUNACOBPROG1(0)
    1       @BRKPT    PRINT$,PRFIL.
    2       @PRT,S    DEV.APPD/RUNACOBPROG1
    3       @ACOB,SE  DEV.APPD/ACOBPROG1,TPF$.ACOBPROG1
    4       @MAP,S    ,TPF$.ABS
    5            NOT TPF$.
    6            IN  TPF$.ACOBPROG1
    7            IN  SYS$LIB$*RSA.CBEP$$RSA
    8            IN  SYS$LIB$*RSA.RDMR-ACOBDAT
    9            END
   10       @XQT
   11       @BRKPT    PRINT$
   12       @IPF      TPF$.
   13       OLD       PRFIL.
   14       L END,A,A,NUM
   15       MOD SCR
@ACOB,SE  DEV.APPD/ACOBPROG1,TPF$.ACOBPROG1
ACOB 7R1A    R 75R3JQ 03/17/93 12:10:57 (0)        1100 ASCII COBOL 08/12/91 10:02
                                  1100 ASCII COBOL SOURCE LISTING


        1              IDENTIFICATION DIVISION.
        2              PROGRAM-ID. acobprog1.
        3              ENVIRONMENT DIVISION.
        4              CONFIGURATION SECTION.
        5              SOURCE-COMPUTER. UNISYS-2200.
        6              OBJECT-COMPUTER. UNISYS-2200.
        7             *
        8             ************************************************************
        9             ***      This program uses interpretive SQL and ACOB to
       10             ***  illustrate simple fetches and displays from a table
       11             ************************************************************
       12             *
       13              DATA DIVISION.
       14              WORKING-STORAGE SECTION.
       15             *
       16             ************************************************************
       17             ***  Establish RDMS command error buffers and data
       18             ************************************************************
       19             *
       20             ***  Error handling variables and message buffers
       21             *
       22              01  rcom.
       23                  05  rlin                   PIC X(40) OCCURS 12 TIMES.
       24              01  err-stat                   PIC 9(4).
       25              01  aux-info                   PIC S1(36).
       26              01  error-text.
       27                  05  err-s                  PIC X(132) OCCURS 4 TIMES.
       28              01  err-s-index                PIC 9(4).
       29              01  thread-flag                PIC 9      VALUE ZERO.
       30                  88  thread-has-begun                VALUE 1.
       31              01  cursor-flag                PIC 9      VALUE ZERO.
       32                  88  end-of-cursor                   VALUE 1.
       33              01  err-end-flag               PIC 9      VALUE ZERO.
       34                  88  no-more-msgs                   VALUE 1.
```

```
35              *
36              ***  Place for the retrieved record, set up for printing
37              *
38               01  record-retrieved.
39                   05  rr-empno                PIC 9(5).
40                   05  FILLER                  PIC X(2)   VALUE SPACES.
41                   05  rr-ename                PIC X(12).
42                   05  FILLER                  PIC X(2)   VALUE SPACES.
43                   05  rr-job                  PIC X(10).
44                   05  FILLER                  PIC X(2)   VALUE SPACES.
45                   05  rr-dno                  PIC 9(3).
46                   05  FILLER                  PIC X(2)   VALUE SPACES.
47                   05  rr-hiredate             PIC 9(6).
48              *
49              ************************************************************
50              ***  BEGIN the thread, do the USE, clear the SQL buffer
51              ************************************************************
52              *
53              ***  Start the thread
54              *
55               PROCEDURE DIVISION.
56               000-main.
57                   MOVE 'BEGIN THREAD FOR udssrc READ          ;' TO rcom.
58                   ENTER MASM 'acob$rdmr' USING rcom, err-stat, aux-info.
59                   IF err-stat NOT = 0 GO TO 900-error-print.
60              *
61              ***  Set table qualifier, clear buffer, set thread flag
62              *
63                   MOVE 'USE DEFAULT QUALIFIER rosvschema1     ;' TO rcom.
64                   ENTER MASM 'acob$rdmr' USING rcom, err-stat, aux-info.
65                   IF err-stat NOT = 0 GO TO 900-error-print.
66              *
67                   MOVE 1 TO thread-flag.
68              *
69              ************************************************************
70              ***  Access RDMS - DECLARE and OPEN the cursor
71              ************************************************************
72              *
73              ***  Declare the cursor
74              *
75                   MOVE 'DECLARE employee CURSOR                ' TO rcom.
76                   MOVE ' SELECT empno, ename, job, hiredate,   ' TO rlin(2).
77                   MOVE ' dno FROM emp                         ;' To rlin(3).
78                   ENTER MASM 'acob$rdmr' USING rcom, err-stat, aux-info.
79                   IF err-stat NOT = 0 GO TO 900-error-print.
80              *
81              ***  Open the cursor
82              *
83                   MOVE 'OPEN employee                         ;' TO rcom.
84                   ENTER MASM 'acob$rdmr' USING rcom, err-stat, aux-info.
85                   IF err-stat NOT = 0 GO TO 900-error-print.
86              *
87              ************************************************************
88              **   Loop thru the rows, end the thread, then do cleanup
89              ************************************************************
90              *
91              ***  Loop to fetch a row and display it
92              *
93               200-loop.
94                   MOVE 'FETCH employee INTO $P1, $P2, $P3, ' TO rcom.
95                   MOVE ' $P4, $P5                          ;' TO rlin(2).
96                   ENTER MASM 'acob$rdmr' USING rcom, err-stat, aux-info,
97                     rr-empno, rr-ename, rr-job, rr-hiredate, rr-dno.
98                   IF err-stat = 6001 GO TO 400-drop-cursor.
99                   IF err-stat NOT = 0 GO TO 900-error-print.
100             *
```

```
                    DISPLAY record-retrieved UPON PRINTER.
                    GO TO 200-loop.
                *
                 400-drop-cursor.
                    DISPLAY 'No more data on fetch' UPON PRINTER.
                    MOVE 'DROP CURSOR employee                    ;' TO rcom.
                    ENTER MASM 'acob$rdmr' USING rcom, err-stat, aux-info.
                    IF err-stat NOT = 0 GO TO 900-error-print.
                *
                    MOVE SPACES TO rcom.
                *
                ************************************************************
                ***  End the thread, shut down the program
                ************************************************************
                *
                ***  Issue the end of the thread
                *
                    MOVE 'END THREAD                              ;' TO rcom.
                    ENTER MASM 'acob$rdmr' USING rcom, err-stat, aux-info.
                    IF err-stat NOT = 0 GO TO 900-error-print.
                *
                ***  Stop the program
                *
                    DISPLAY 'Program has completed' UPON PRINTER.
                    STOP RUN.
                *
                ************************************************************
                **   Do the RDMS error handling - display codes, messages
                ************************************************************
                *
                 900-error-print.
                *
                ***  Print errant command and error status variables
                *
                    DISPLAY 'RDMS Command = ' rcom      UPON PRINTER.
                    DISPLAY 'Error Status = ' err-stat  UPON PRINTER.
                    DISPLAY 'Auxiliary Info = ' aux-info  UPON PRINTER.
                *
                ***  Issue the error messages, end the thread, and exit
                *
                    MOVE 0 TO err-end-flag.
                    PERFORM 940-geterror UNTIL no-more-msgs.
                    DISPLAY 'Error termination' UPON PRINTER.
                    IF thread-has-begun
                       MOVE ' END THREAD                          ;' TO rcom
                       ENTER MASM 'acob$rdmr' USING rcom, err-stat, aux-info.
                    STOP RUN.
                *
                ***  Fill the error buffers using GETERROR
                *
                 940-geterror.
                    MOVE 'GETERROR INTO $P1, $P2, $P3, $P4     ;' TO rcom.
                    ENTER MASM 'acob$rdmr' USING rcom, err-stat, aux-info,
                       err-s(1), err-s(2), err-s(3), err-s(4).
                    PERFORM 980-print-error
                       VARYING err-s-index FROM 1 BY 1 UNTIL err-s-index > 4.
                *
                ***  Display the error buffers
                *
                 980-print-error.
                    IF err-s(err-s-index) NOT = SPACE
                       DISPLAY err-s(err-s-index) UPON PRINTER
                    ELSE
                       MOVE 5 to err-s-index
                       MOVE 1 TO err-end-flag.
END ACOB DIAGNOSTIC TOTALS          0 WARNING       0 MINOR          0 SERIOUS       0
FATAL    0 LEVELING
COMPILE TIME IS     3.94 SECONDS   CORE: MIN=  63601 / 64000  MAX=  66560 WORDS
```

```
@MAP,S    ,TPF$.ABS
Collector 33R1A (910808 1521:53) 1993 Mar 17 Wed 1211:02
          1.                  NOT TPF$.
          2.                  IN  TPF$.ACOBPROG1
          3.                  IN  SYS$LIB$*RSA.CBEP$$RSA
          4.                  IN  SYS$LIB$*RSA.RDMR-ACOBDAT
          5.                  END

AFCM status of output element is SETAFCM
Quarter-word sensitive

ADDRESS LIMITS    001000 002324       725 IBANK WORDS DECIMAL
                  040000 061765      9206 DBANK WORDS DECIMAL
STARTING ADDRESS  001731


            SEGMENT $MAIN$          001000 002324     040000 061765

ERU$/RLIBT12                                                          24
MAY 90   10:37:08
M$PRT$                                          $(0)     040000 040005  03
AUG 90   16:10:55
                                                $(012)   MEM$ERR
C$NPADS                                         $(0)     040006 040014  26
AUG 90   19:05:18
C$S400                                          $(0)     040015 040027  21
DEC 90   13:37:46
C$RET0                  $(1)    001000 001005                         26
AUG 90   18:58:21
C$DJ13                  $(1)    001006 001270                         26
AUG 90   18:57:50
MEM$ERR(COMMONBLOCK)                                    040030 040032
C$S300                                          $(0)     040033 040730  25
JAN 91   11:32:50
                                                $(012)   MEM$ERR
C$PCRLOG                                        $(0)     040731 041030  12
AUG 91   09:47:08
CBEP$$ACOB/PART-LIB-CB                                                12
AUG 91   10:13:59
ACOBPROG1               $(1)    001271 001743   $(0)     041031 041446  17
MAR 93   12:11:01
                        $(3)    001744 001753   $(4)     041447 041704
                                                $(6)     041705 041723
                                                $(010)   041724 042110
CBEP$$RSA                                                             24
AUG 91   01:01:32
RDMR-ACOBDAT            $(1)    001754 002324   $(0)     042111 061764  10
JAN 92   13:23:24
                                                $(2)     061765 061765

                     Common Banks referenced
                     ------ ----- ----------
C$S30S       0400103    C$S116       0400105    RDMR$FTNCONT 0401074

END MAP.  ERRORS: 0  TIME: 23.552  STORAGE: 016417/015211/016365/0/0130076
```

```
@XQT
05010  FOSTER          SALESREP     200  860714
05146  BROWN           CLERK        200  871011
05234  WOODWORTH       MANAGER      200  790219
05237  ROCKWELL        ACCOUNTANT   100  840618
05437  MARTIN          SALESREP     200  870326
05469  ADAMS           SALESREP     200  811102
05630  GLASS           ACCOUNTANT   100  871220
05702  TURNER          CLERK        100  890515
05743  LAWSON          MANAGER      100  830510
05765  JOHNSON         CLERK        400  891221
05784  WILLIAMS        PRESIDENT    300  781015
05896  SMITH           CLERK        400  880913
05942  FORD            SALESREP     200  890316
05984  HYDE            MANAGER      400  850901
No more data on fetch
Program has completed
@BRKPT    PRINT$
```

E

UCOB Skeleton

```
@PRT,S AL3644*SQL.LAB3-1/RUNUCOB
FURPUR  30R2A        (910822 1304:40) 1993 Mar 17 Wed 1514:48
AL3644*SQL(1).LAB3-1/RUNUCOB(0)
     1       @BRKPT PRINT$,prfil.
     2       @PRT,S sql.lab3-1/runucob
     3       @UCOB,ES  sql.lab3-1/ucobskel,tpf$.ucobskel,,,no-options,narrow
     4       @XQT
     5       @BRKPT PRINT$
     6       @IPF tpf$.
     7       OLD prfil.
     8       1 "END",a,a,numb
     9       mod scr
@PRT,S AL3644*SQL.LAB3-1/UCOBSKEL
AL3644*SQL(1).LAB3-1/UCOBSKEL(0)
     1              IDENTIFICATION DIVISION.
     2              PROGRAM-ID. ucobskel.
     3              ENVIRONMENT DIVISION.
     4              CONFIGURATION SECTION.
     5              SPECIAL-NAMES. PRINTER IS printer.
     6
     7             ************************************************************
     8             ***  This program uses embedded SQL and UCOB to
     9             ***  solve lab 3-1 assignment for SQL Programming
    10             ************************************************************
    11
    12              DATA DIVISION.
    13              WORKING-STORAGE SECTION.
    14
    15              01  thread-flag                PIC 9       VALUE ZERO.
    16              01  err-end-flag               PIC 9       VALUE ZERO.
    17                  88  no-more-msgs                       VALUE 1.
    18
    19             ************************************************************
    20             ***  Establish RDMS command error buffers and data
    21             ************************************************************
    22
    23                  EXEC SQL BEGIN DECLARE SECTION END-EXEC.
    24
    25             ***  Place for the retrieved record, set up for printing
    26
    27              01  record-retrieved.
    28                  05
    29                  05
    30
    31             ***  Error handling variables and message buffers
    32
    33              01  sqlcode                    PIC S9(9)   USAGE COMP.
    34
    35              01  rdmca.
    36                  05  error-status           PIC 9(4).
    37                  05  aux-info               PIC S9(9)   USAGE BINARY.
    38
    39              01  err-text.
    40                  05  err-s                  PIC X(132)  OCCURS 4 TIMES.
    41
    42              01  err-s-index                  PIC 9.
    43                  EXEC SQL END DECLARE SECTION END-EXEC.
    44
```

```
45              ************************************************************
46              ***  Start by setting up error handling and BEGIN thread
47              ************************************************************
48
49               PROCEDURE DIVISION.
50               000-main.
51
52              ***  What to do on no-find
53
54                   EXEC SQL
55
56                   END-EXEC.
57
58              ***  What to do if an SQL error is encountered
59
60                   EXEC SQL
61
62                   END-EXEC.
63
64              ***  Start the thread
65
66
67                   MOVE 1 TO thread-flag.
68
69              ************************************************************
70              **   Access RDMS - USE, DECLARE, OPEN and initial FETCH
71              ************************************************************
72
73              ***  Set up the table qualifier
74
75                   EXEC SQL
76
77                   END-EXEC.
78
79              ***  Declare the cursor
80
81                   EXEC SQL
82
83
84
85                   END-EXEC.
86
87              ***  Open the cursor
88
89                   EXEC SQL
90
91                   END-EXEC.
92
93              ***  Do an initial fetch of a row
94
95                   EXEC SQL
96
97
98                   END-EXEC.
99
```

```
100             ************************************************************
101             **   Loop thru the rows, end the thread, then do cleanup
102             ************************************************************
103
104             ***  Loop to display a row and get another
105
106                  PERFORM UNTIL sqlcode = 100
107                       DISPLAY record-retrieved
108                  EXEC SQL
109                       FETCH
110
111                  END-EXEC
112                  END-PERFORM.
113
114             ************************************************************
115             ***  Handle a no-find, end thread, and terminate program
116             ************************************************************
117
118             ***  Come here when a no find condition exists
119
120              400-no-find.
121
122             ***  Issue the end of the thread
123
124
125                  MOVE 0 TO thread-flag.
126
127             ***  Stop the program
128
129                  DISPLAY 'Program has completed' UPON PRINTER.
130                  STOP RUN.
131
```

```
132             ************************************************************
133             **   Do the RDMS error handling - display codes & messages
134             ************************************************************
135
136             ***  Come here when RDMS errors are detected
137
138              900-rdms-error.
139
140             ***  Turn off error handling, print error status variables
141
142                  EXEC SQL  WHENEVER SQLERROR CONTINUE  END-EXEC.
143
144                  DISPLAY '***SQL Code = ' sqlcode UPON PRINTER.
145                  DISPLAY '***Error Code = ' error-status UPON PRINTER.
146                  DISPLAY '***Auxiliary Info = ' aux-info UPON PRINTER.
147             *
148             ***  Issue the error messages, end the thread, and exit
149             *
150                  MOVE 0 TO err-end-flag.
151                  PERFORM 940-geterror UNTIL no-more-msgs.
152                  DISPLAY 'Error termination' UPON PRINTER.
153                  END THREAD.
154                  STOP RUN.
155             *
156             ***  Fill the error buffers using GETERROR
157             *
158              940-geterror.
159
160                  PERFORM 980-print-error
161                  VARYING err-s-index FROM 1 BY 1 UNTIL err-s-index > 4.
162             *
163             ***  Display the error buffers
164             *
165              980-print-error.
166                  IF err-s(err-s-index) NOT = SPACE
167                     DISPLAY err-s(err-s-index) UPON PRINTER
168                  ELSE
169                     MOVE 5 to err-s-index
170                     MOVE 1 TO err-end-flag.
@BRKPT PRINT$
```

F

UCOB Examples

```
@PRT,S DEV.APPF/RUNUCOBPROG1
FURPUR  30R2A        (910822 1304:40) 1993 Mar 17 Wed 1312:51
ANDREW*AL3644(1).APPF/RUNUCOBPROG1(0)
     1       @BRKPT PRINT$,prfil.
     2       @PRT,S dev.appf/runucobprog1
     3       @UCOB,ES  dev.appf/ucobprog1,tpf$.ucobprog1,,,no-options,narrow
     4       @XQT
     5       @BRKPT PRINT$
     6       @IPF tpf$.
     7       OLD prfil.
     8       l "END",a,a,numb
     9       mod scr
@UCOB,ES  DEV.APPF/UCOBPROG1,TPF$.UCOBPROG1,,,NO-OPTIONS,NARROW
*REMARK(CLARIFICATION) LSS-CSIM20389: Option REMARK has been previously
 set
UCOB- 5R2(910816) LSS- 6R1A(910814) 930317 13:12:52
1              IDENTIFICATION DIVISION.
2              PROGRAM-ID. ucobprog1.
3              ENVIRONMENT DIVISION.
4              CONFIGURATION SECTION.
5              SPECIAL-NAMES. PRINTER IS printer.
6
7             ************************************************************
8             ***  This program uses embedded SQL and UCOB to
9             ***       solve lab exercise 3-1 for AL 3644.
10            ************************************************************
11
12             DATA DIVISION.
13             WORKING-STORAGE SECTION.
14
15             01  thread-flag                 PIC 9       VALUE ZERO.
16             01  err-end-flag                PIC 9       VALUE ZERO.
17                 88  no-more-msgs                        VALUE 1.
18
19            ************************************************************
20            ***  Establish RDMS command error buffers and data
21            ************************************************************
22
23                 EXEC SQL BEGIN DECLARE SECTION END-EXEC.
24
25            ***  Place for the retrieved record, set up for printing
26
27             01  record-retrieved.
28                 05  rr-empno                 PIC 9(5)    VALUE ZEROS.
29                 05                        PIC X(2)    VALUE SPACES.
30                 05  rr-ename                 PIC X(12)   VALUE SPACES.
31                 05                        PIC X(2)    VALUE SPACES.
32                 05  rr-job                   PIC X(10)   VALUE SPACES.
33                 05                        PIC X(2)    VALUE SPACES.
34                 05  rr-dno                   PIC 9(3)    VALUE ZEROS.
35                 05                        PIC X(2)    VALUE SPACES.
36                 05  rr-hiredate              PIC 9(6)    VALUE ZEROS.
37                 05                        PIC X(2)    VALUE SPACES.
38
```

```
39          ***  Error handling variables and message buffers
40
41           01  sqlcode                        PIC S9(9)   USAGE COMP.
42
43           01  rdmca.
44               05  error-status               PIC 9(4).
45               05  aux-info                   PIC S9(9)   USAGE BINARY.
46
47           01  err-text.
48               05  err-s                      PIC X(132)  OCCURS 4 TIMES.
49
50           01  err-s-index                      PIC 9.
51               EXEC SQL END DECLARE SECTION END-EXEC.
52
53          ************************************************************
54          ***  Start by setting up error handling and BEGIN thread
55          ************************************************************
56
57           PROCEDURE DIVISION.
58           000-main.
59
60          ***  What to do on no-find
61
62               EXEC SQL
63                    WHENEVER NOT FOUND GO TO 400-no-find
64               END-EXEC.
65
66          ***  What to do if an SQL error is encountered
67
68               EXEC SQL
69                    WHENEVER SQLERROR GO TO 900-rdms-error
70               END-EXEC.
71
72          ***  Start the thread
73
74               BEGIN THREAD FOR udssrc READ.
75               MOVE 1 TO thread-flag.
76
77          ************************************************************
78          **   Access RDMS - USE, DECLARE, OPEN and initial FETCH
79          ************************************************************
80
81          ***  Set up the table qualifier
82
83               EXEC SQL
84                    USE DEFAULT QUALIFIER rosvschema1
85               END-EXEC.
86
87          ***  Declare the cursor
88
89               EXEC SQL
90                    DECLARE emp CURSOR
91                      SELECT empno, ename, job, hiredate, dno
92                      FROM emp
93               END-EXEC.
94
95          ***  Open the cursor
96
97               EXEC SQL
98                    OPEN emp
99               END-EXEC.
```

```
100
101          ***  Do an initial fetch of a row
102
103               EXEC SQL
104                    FETCH emp INTO :rr-empno, :rr-ename,
105                                   :rr-job, :rr-hiredate, :rr-dno
106               END-EXEC.
107
108          ************************************************************
109          **   Loop thru the rows, end the thread, then do cleanup
110          ************************************************************
111
112          ***  Loop to display a row and get another
113
114               PERFORM UNTIL sqlcode = 100
115                    DISPLAY record-retrieved
116               EXEC SQL
117                    FETCH emp INTO :rr-empno, :rr-ename,
118                         :rr-job, :rr-hiredate, :rr-dno
119               END-EXEC
120               END-PERFORM.
121
122          ************************************************************
123          ***  Handle a no-find, end thread, and terminate program
124          ************************************************************
125
126          ***  Come here when a no find condition exists
127
128           400-no-find.
129
130          ***  Issue the end of the thread
131
132               END THREAD.
133               MOVE 0 TO thread-flag.
134
135          ***  Stop the program
136
137               DISPLAY 'Program has completed' UPON PRINTER.
138               STOP RUN.
139
140          ************************************************************
141          **   Do the RDMS error handling - display codes & messages
142          ************************************************************
143
144          ***  Come here when RDMS errors are detected
145
146           900-rdms-error.
147
148          ***  Turn off error handling, print error status variables
149
150               EXEC SQL  WHENEVER SQLERROR CONTINUE  END-EXEC.
151
152               DISPLAY '***SQL Code = ' sqlcode UPON PRINTER.
153               DISPLAY '***Error Code = ' error-status UPON PRINTER.
154               DISPLAY '***Auxiliary Info = ' aux-info UPON PRINTER.
```

```
155           *
156           ***  Issue the error messages, end the thread, and exit
157           *
158                MOVE 0 TO err-end-flag.
159                PERFORM 940-geterror UNTIL no-more-msgs.
160                DISPLAY 'Error termination' UPON PRINTER.
161                END THREAD.
162                STOP RUN.
163           *
164           ***  Fill the error buffers using GETERROR
165           *
166            940-geterror.
167                GETERROR INTO :err-s(1), :err-s(2), :err-s(3), :err-s(4).
168                PERFORM 980-print-error
169                   VARYING err-s-index FROM 1 BY 1 UNTIL err-s-index > 4.
170           *
171           ***  Display the error buffers
172           *
173            980-print-error.
174                IF err-s(err-s-index) NOT = SPACE
175                   DISPLAY err-s(err-s-index) UPON PRINTER
176                ELSE
177                   MOVE 5 to err-s-index
178                   MOVE 1 TO err-end-flag.
SIZES: CODE(EM4): 448 DATA: 1193
END UCOB- 0 ERRORS(MAJOR) 0 ERRORS(MINOR) 1 REMARK(CLARIFICATION)
@XQT

5010  FOSTER         SALESREP    200  860714

5146  BROWN          CLERK       200  871011

5234  WOODWORTH      MANAGER     200  790219

5237  ROCKWELL       ACCOUNTANT  100  840618

5437  MARTIN         SALESREP    200  870326

5469  ADAMS          SALESREP    200  811102

5630  GLASS          ACCOUNTANT  100  871220

5702  TURNER         CLERK       100  890515

5743  LAWSON         MANAGER     100  830510

5765  JOHNSON        CLERK       400  891221

5784  WILLIAMS       PRESIDENT   300  781015

5896  SMITH          CLERK       400  880913

5942  FORD           SALESREP    200  890316

5984  HYDE           MANAGER     400  850901

Program has completed

@BRKPT PRINT$
```