LOAN DOCUMENT

PHOTOGRAPH THIS SHEET

LEVEL

INVENTORY 1

AD-A239 000

DTIC ACCESSION NUMBER

WL-TR-91-8025

DOCUMENT IDENTIFICATION

Jul 1991

DISTRIBUTION STATEMENT

ACCESSION FOR

NTIS GRA&I ☒

DTIC TRAC ☐

UNANNOUNCED ☐

JUSTIFICATION

BY

DISTRIBUTION/

AVAILABILITY CODES

DISTRIBUTION	AVAILABILITY AND/OR SPECIAL	
A-1		

DISTRIBUTION STAMP

DATE ACCESSIONED

DATE RETURNED

91 7 0 067

91-06506

DATE RECEIVED IN DTIC

REGISTERED OR CERTIFIED NUMBER

PHOTOGRAPH THIS SHEET AND RETURN TO DTIC-FDAC

DTIC FORM 70A JUN 90

DOCUMENT PROCESSING SHEET

PREVIOUS EDITIONS MAY BE USED UNTIL STOCK IS EXHAUSTED

LOAN DOCUMENT

HANDLE WITH CARE

WL-TR-91-8025

PRODUCT DEFINITION DATA INTERFACE (PDDI)

Access Software User's Manual

McDonnell Aircraft Company
McDonnell Douglas Corporation
P. O. Box 516
St. Louis, MO 63166

July 1991

Final report

MANUFACTURING TECHNOLOGY DIRECTORATE
WRIGHT LABORATORY
AIR FORCE SYSTEMS COMMAND
WRIGHT-PATTERSON AIR FORCE BASE, OHIO 45433-6533

NOTICE

When Government drawings, specifications, or other data are used for any purpose other than in connection with a definitely Government-related procurement, the United States Government incurs no responsibility or any obligation whatsoever. The fact that the government may have formulated or in any way supplied the said drawings, specifications, or other data, is not to be regarded by implication, or otherwise in any manner construed, as licensing the holder, or any other person or corporation; or as conveying any rights or permission to manufacture, use, or sell any patented invention that may in any way be related thereto.

This report is releasable to the National Technical Information Service (NTIS). At NTIS, it will be available to the general public, including foreign nations.

This technical report has been reviewed and is approved for publication.

Alan R. Winn — 30 May 91

ALAN R. WINN
Project Manager

DATE

FOR THE COMMANDER:

Bruce Rasmussen — 31 May 91

BRUCE A. RASMUSSEN, Chief
Integration Technology Division
Manufacturing Technology Directorate

DATE

If your address has changed, if you wish to be removed from our mailing list, or if the addressee is no longer employed by your organization please notify WL/MTIB , WPAFB, OH 45433-6533 to help us maintain a current mailing list.

Copies of this report should not be returned unless return is required by security considerations, contractual obligations, or notice on a specific document.

UNCLASSIFIED
SECURITY CLASSIFICATION OF THIS PAGE

REPORT DOCUMENTATION PAGE

1a. REPORT SECURITY CLASSIFICATION UNCLASSIFIED	1b. RESTRICTIVE MARKINGS
2a. SECURITY CLASSIFICATION AUTHORITY	3. DISTRIBUTION / AVAILABILITY OF REPORT APPROVED FOR PUBLIC RELEASE DISTRIBUTION UNLIMITED
2b. DECLASSIFICATION / DOWNGRADING SCHEDULE	
4. PERFORMING ORGANIZATION REPORT NUMBER(S)	5. MONITORING ORGANIZATION REPORT NUMBER(S) WL-TR-91-8025
6a. NAME OF PERFORMING ORGANIZATION McDonnell Aircraft Company 6b. OFFICE SYMBOL (If applicable) McAir	7a. NAME OF MONITORING ORGANIZATION Manufacturing Technology Dir. (WL/MTIB) Wright Laboratory
6c. ADDRESS (City, State, and ZIP Code) McDonnell Douglas Corporation P. O. Box 516, St. Louis, MO 63166	7b. ADDRESS (City, State, and ZIP Code) Wright-Patterson AFB, OH 45433-6533
8a. NAME OF FUNDING / SPONSORING 8b. OFFICE SYMBOL (If applicable)	9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER F33615-82-C-5036
8c. ADDRESS (City, State, and ZIP Code) Wright-Patterson Air Force Base, Ohio 45433-6533	10. SOURCE OF FUNDING NUMBERS PROGRAM ELEMENT NO. 78011F; PROJECT NO. 3095; TASK NO. 06; WORK UNIT ACCESSION NO. 29

11. TITLE (Include Security Classification)
PRODUCT DEFINITION DATA INTERFACE (PDDI), Access Software User's Manual

12. PERSONAL AUTHOR(S)
(see reverse side)

13a. TYPE OF REPORT	13b. TIME COVERED	14. DATE OF REPORT (Year, Month, Day)	15. PAGE COUNT
Final	FROM _____ TO _____	July 1991	144

16. SUPPLEMENTARY NOTATION

17. COSATI CODES			18. SUBJECT TERMS (Continue on reverse if necessary and identify by block number)	
FIELD	GROUP	SUB-GROUP	Produce Definition Data	ICAM Architecture
			Life Cycle Document	CAD/CAM
			Engrg./Mfg. Interface	(continued on back)

19. ABSTRACT (Continue on reverse if necessary and identify by block number)

This document is the Access Software User's Manual for the Product Definition Data Interface (PDDI) Extensions contract. This document provides procedures for Application Programmers to use the PDDI Access Software. User's Manual UM560130000A provides procedures for use of the PDDI Translator.

20. DISTRIBUTION / AVAILABILITY OF ABSTRACT	21. ABSTRACT SECURITY CLASSIFICATION
☒ UNCLASSIFIED/UNLIMITED ☐ SAME AS RPT. ☐ DTIC USERS	Unclassified

22a. NAME OF RESPONSIBLE INDIVIDUAL	22b. TELEPHONE (Include Area Code)	22c. OFFICE SYMBOL
Alan Winn	(513) 255-8787	WL/MTIB

DD FORM 1473, 84 MAR — 83 APR edition may be used until exhausted. All other editions are obsolete.

SECURITY CLASSIFICATION OF THIS PAGE
UNCLASSIFIED

12. Personal Author(s):

Chi, Kelly
Baldridge, Gary
Magnuson, Charles
Mehl, Kenneth
Oakes, Janet
Shreve, Edward
Ulmer, Beth
White, George

18. Subject Terms:

Needs Analysis Document
System Requirement Document
State-of-the-Art Document
System Specification Document
SS - Draft Standard
System Design Specification
Product Specification
Operators Manual
Users Manual - Translator

FOREWORD

This document was produced under Air Force Contract F33615-82-C-5036, Product Definition Data Interface (PDDI). This contract is sponsored by the Air Force Wright Aeronautical Laboratories, Materials Laboratory, Air Force Systems Command, Wright-Patterson, Air Force Base, Ohio.

This program is being administered under the technical direction of Lt. Eric Gunther, ICAM Project Manager. The MCAIR Program Manager is Mr. Jerry Weiss and Mr. Herb Ryan is the Deputy Program Manager.

This document was prepared in accordance with the ICAM Configuration Management Life Cycle Documentation requirements for the Configuration Item.

TABLE OF CONTENTS

TABLE OF CONTENTS

USER'S MANUAL

SECTION 1

SCOPE

1.1 Identification

This User's Manual provides a guide for the use of ACCESS Software developed for the Product Definition Data Interface (PDDI) Project 5601. This project was developed under Air Force Contract F33516-82-C-5036.

1.2 Introduction

Capabilities documented in this manual include:

- o Access Software Initialization
- o Entity Operations
- o List Operations

This PDDI software operates on IBM 43xx, 308xx or DEC VAX 11/780 computers. The environmental requirements are described in Section 3.

The PDDI system documentation does not address local (native) system or computing environment documentation.

This manual addresses IBM procedures and terminology only.

1.3 Other system Manuals

The associated Operator's Manual (OM) describes the system operation and installation procedures. It is intended for use by computer operators and programming personnel.

An associated User's Manual (UM 560130000) is provided for users of the PDDI Translator.

The PDDI Product Specification (PS) provides routine descriptions, data dictionary listings and PDDI system messages for system maintenance purposes.

1.4 Approach

This User's Manual is divided into six (6) main sections:

Section 1 - Scope of this document.

Section 2 - Reference documentation applicable to PDDI and this document.

Section 3 - The PDDI architecture at a high level and introduction to the use of the Access Software.

Section 4 - Entity and List Operations needed to access the data structures passed back to the Application program.

Section 5 - Descriptions of the general utilities routines available with the Access Software.

Section 6 - Sample programs using the Access Software in Pascal and FORTRAN.

Appendix A - Access Software Calling Parameter Index

Appendix B - Alphabetical Access Software Routine Index

Appendix C - Access Software Return Code Index

Appendix D - Access Software FORTRAN Schema Diagram

Appendix E - Access Software Pascal Schema Diagram

Appendix F - General Techniques/Guidelines

Appendix G - Run-Time Environment

Appendix H - Error and Warning Return Code Index

SECTION 2

REFERENCES

2.1 Applicable Documents

2.1.1 Specification:

DOD-D-1000B	Drawings, Engineering and Associated Lists
MIL-D-5840	Requirements for Data, Engineering and Technical Reproduction

2.1.2 Standards:

ANSI Y14.5	Dimensioning and Tolerancing
ANSI Y14.26M	Digital Representation Communication of Production Definition Data
ANSI B46.1	Surface Texture (Surface Roughness, Waviness and Lay)
ANSI B92.1	Involute Splines and Inspection
DOD-STD-100C	Engineering Drawing Practices
MIL-STD-9	Screw Thread Conventions and Methods of Specifying
MIL-STD-12	Abbreviations for Use on Drawings, Specifications, Standards and in Technical Documents
IDS150120000C	ICAM Documentation Standards
IEEE STD 829	Standards for Software Test Documentation
ISO/TC184/SC4/WG1	4.2:2 The Step File Structure (Working Paper Version 1.0 28 April 1981

2.1.3 Other Publications:

CLD150120000	ICAM Document Catalog
FTR110210000U	ICAM Architecture
FTR110232000U	ICAM Architecture Part II, Automated IDEF0 Development

Product Definition Data Interface

ITR560130001U	First Interim Technical Report (Period 1 Oct 82 - 31 Dec 82)
ITR560130002U	Second Interim Technical Report (Period 1 Jan 83 - 31 Mar 83)
ITR560130003U	Third Interim Technical Report (Period 1 Apr 83 - 30 June 83)
ITR560130004U	Fourth Interim Technical Report (Period 1 Jul 83 - 30 Sep 83
ITR560130005U	Fifth Interim Technical Report (Period 1 Oct 83 - 1 Dec 83)
ITR560230006U	Sixth Interim Technical Report (Period 1 Jan 84 - 31 Mar 84)
ITR560130007U	Seventh Interim Technical Report (Period 1 Apr 84 - 30 Jun 84)
ITR560130008U	Eighth Interim Technical Report (Period 1 Jul 84 - 30 Sep 84)
ITR560130009U	Ninth Interim Technical Report (Period 1 Oct 84 - 31 Dec 84)
ITR560130010U	Tenth Interim Technical Report (Period 1 Jan 84 - 31 Mar 85)
FTR560130001U	Task I, Final Technical Report - System Test Methodology, Volume III
	Technical Operating Report - Product Assurance/Quality Assurance - 15 Oct 85
SD 560130001U	Scoping Document
NAD560130000	Needs Analysis Document
SAD560130000	State-of-the-Art Document
SRD560130000	System Requirement Document

SDS560130000	System Design Specification Document
SS 560130100	System Specification Document
SS 560130200	System Specification Document - Draft Standard
STP560130000	System Test Plan
STR560130000	System Test Report
PS 560130000	Product Specification
OM 560130000	Operator's Manual
UM 560130000	User's Manual (Translator)

2.2 Terms and Abbreviations

The following list explains terminology, acronyms, and other abbreviations used in this document.

ACCESS SOFTWARE - A set of routines for creating, managing and querying an incore Working Form model.

ANSI - American National Standard Institute.

APPLICATION - Refers generically to any software modules which are used in CAD/CAM functions.

APPLICATION REQUEST - A request initiated by an application program, either through batch or interactive processing, which will interrogate the model through the PDDI Access Software to obtain or operate on specific information regarding the model and its components or elements.

APPLICATION REQUESTED DATA - The data which fulfills the application's original request and which is in the proper format and readable by the application.

ASCII - American Standard Code for Information Interchange.

ATTRIBUTE - An item of information about an entity. A key attribute identifies the entity; a role iterate gives a fact about an entity.

CAD/CAM - Computer Aided Design/Computer Aided Manufacturing.

CLASS - A collection of entities that are alike in some manner.

CLIST - IBM Command lists.

CONSTITUENT - A specific instance of an entity that is used in the definition of some other entity.

CONTEXT-FREE GRAMMAR - The syntax of the language gives a precise specification of the data without interpretation of it.

DOMAIN - The set of values permissible in a given context. A natural domain is the value set native to a given machine architecture; an imposed domain is a specific subset of the natural domain.

DYNAMIC ALLOCATION - The allocation (and deallocation) of memory resources as required by the application. The opposite is static allocation where a fixed size segment of memory is available to the application.

EBCDIC - Extended Binary Coded Decimal Interchange Code (IBM character set).

ENTITY - A collection of facts (attributes) about something of interest.

EXTERNAL REFERENCE - A reference to some quantity of data that exists somewhere outside the scope of the immediate body of information.

FUNCTIONALITY - (1) To show that the configuration item has fulfilled the specified requirements. (2) The receiving and sending systems can operate on the entity in the same manner with the same results within a pre-defined tolerance.

INCLUDE FILE - Pascal source code from another file or library included on the compilation of a Pascal source file.

INPUT DATA - That information which the application needs to supply in order to interrogate or operate on the model. This data may assume only these forms prescribed by the PDDI Access Software specifications.

INTERPRETED REQUEST - Input data which has been appropriately modified to conform to the PDDI Access Software's internal data representation so that it may be further processed.

JCL - Job Control Language - IBM language used to identify a job and describe its requirements to an operating system.

KEY - An item of data that uniquely identifies some specific instance of an entity.

MAS - MCAIR's acronym for the PDDI Access Software (Model Access System).

METAMODEL - A body of data that defines the characteristics of a data model or structure.

MODEL - A collection of PDD that is transferable, displayable, accessible, and equivalent to a Part. The internal representation of the application data, as initiated and organized by the user. The model is also referred to as the Working Form.

MODEL NETWORK DEFINITION - The set of rules and definitions which outline in detail the data structure whereby higher order entities may be composed of lower order entities, or constituents, and the lower order entities may be constituents of one or more higher order entities.

NATIVE SYSTEM - The PDD and applications in a format that is unique to the database of a CAD system.

PARSE - The process of analyzing input strings (records) to identify fields and to verify that the data has a valid format.

PDD - Product Definition Data.

POST-PROCESSOR - A phase of the translator where data is received from the Exchange Format and is converted to the Working Form.

PRE-PROCESSOR - A phase of the translator where data is taken from the Working Form and is converted to the Exchange Format.

QUALITY - The composite of all the attributes or characteristics including performance of an item or product.

QUALITY ASSURANCE - The planned and systematic establishment of all actions (management/engineering) necessary to provide adequate confidence and nonconformance prevention provisions and reviews are established during the design phase and performed throughout the software development and life cycle phases.

QUALITY CONTROL - The planned and systematic application of all actions (management/technical) necessary to control raw materials or products through the use of test, inspect, evaluate, and control of processes.

REQUESTED DATA - See Application Request Data.

RUN SYSTEM - The Translator sub-package which provides the communication interface between the user and the pre/post-processors.

SCHEMA - Those definitions which describe the content of the data and the relationship between the various elements or components of the data.

SOFTWARE QUALITY ASSURANCE (SQA) - The planned and systematic establishment of all actions necessary to provide adequate confidence that nonconformance prevention provisions and reviews are established during the design phase and performed throughout the software development and life cycle phases.

SOFTWARE QUALITY ASSURANCE PLAN (SQAP) - An organized description of the methods, policies, and procedures necessary to conduct software quality assurance and control activities during the design, development, delivery, and maintenance phases.

SOFTWARE QUALITY CONTROL - The planned and systematic application of all actions (management/technical) necessary to ensure that the software under development or maintenance satisfies the technical requirements through the use of tests, demonstrations, inspections, evaluations, and control of processes.

SYSTEM CONSTRAINTS - Those hardware and software environmental constraints which will be imposed upon the PDDI Access Software that will limit its implementation and application. An example of such constraints might be the particular compiler used to compile the PDDI Access Software package.

TRANSFER DATA - The data required to make an exchange of data between systems (e.g., delimiters, record counts, record length, entity counts, numeric precision).

TRANSLATOR - A software MECHANISM that is used for passing data between the Exchange Format and Working Form of the PDD.

TREE - A collection of the data that makes up an instance of an entity. The information is stored as records in a linked list.

TREE STRUCTURE - The arrangement of information within a tree.

TSO - Time Sharing Option - IBM function which provides conversational time sharing from remote terminals.

USER COMPUTER SYSTEM - The specific hardware, operating systems, and applications software systems that the user will employ to implement the PDDI Access Software.

WORKING FORM - A memory resident form of a model that supports rapid access to entities via the Access Software.

WORKING FORMAT - The physical representation of the Working Form within the computer.

SECTION 3

SYSTEM OVERVIEW

3.1 Introduction

The purpose of the PDDI Software System is to provide a prototype for the communication of complete Production Definition Data (PDD) between dissimilar CAD/CAM Systems. This system will serve as the information interface between Engineering and Manufacturing functions. It is composed of Access Software, Conceptual Schema, Exchange format and a Translator. (See Figure 3-1).

The Access Software is a set of callable utility programs that will allow applications to manipulate and query PDD. The Conceptual Schema contains the human readable data needed to define a CAD/CAM model. The Exchange Format is a neutral physical sequential format for passing data between dissimilar systems. The PDDI Translator is the software mechanism for passing this data between the Exchange Format and the Working Form of the PDD.

3.2 System Interfaces

The PDDI software must interface with the computer system on which it is installed, the local (native) CAD/CAM database, the Exchange Format, the Working Form, and the user (application). It does this via PDDI Access Software, the PDDI Translator and local (native) developed software packages. Note: Simple interim database software is included in the Translator software. This software is an interim program to be used until an interface to the native database system is available. See Appendix D for an explanation. Figure 3-3 shows the environment in which the PDDI system was developed. This figure also shows the versatility of the system and the multi-hardware environment in which it may be used. The left-hand side of Figure 3-3 shows the PDDI development environment.

3.3 System Environment

The PDDI system was developed in the following computing environment:

Computer/Operating System

IBM 43XX/MVS with TSO and associated tape drives, disk drives and terminals.

DEC VAX 11/780 VMS with associated tape drives, disk drives and terminals.

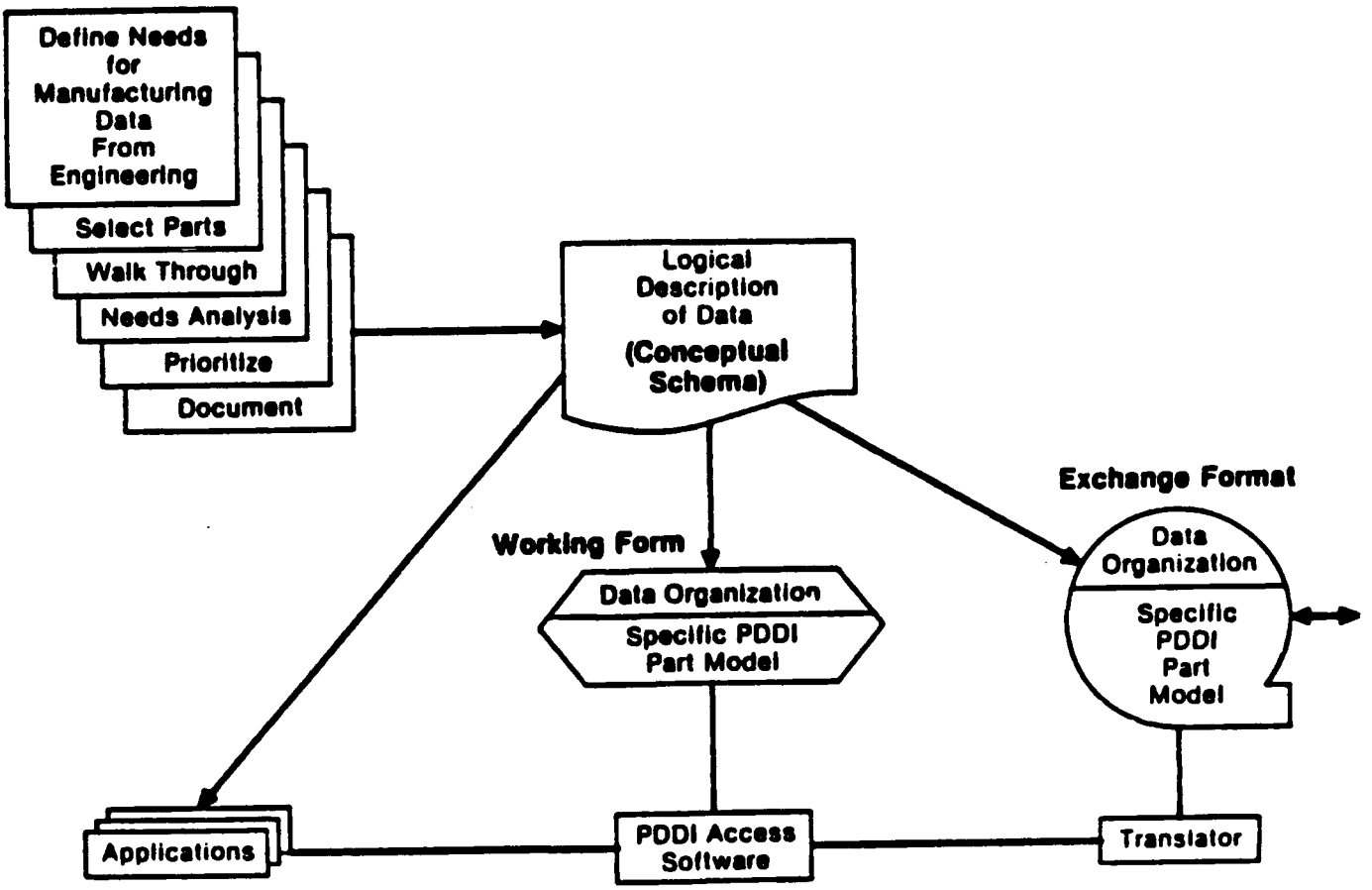


Figure 3-1 PDDI System Architecture

Storage (Core) Requirements

The minimum core requirements for the PDDI software and database is 1.0M plus the size of the model. (The PDDI Mechined Rib model required .57M)

* PDDI Machine Rib

Compilers

IBM-PASCAL/VS Release 2.2
DEC-PASCAL V3.3, FORTRAN 77 V4.4

Terminals

E&S PS300 (or equivalent for graphics applications)
IBM 3270 (or equivalent)

The PDDI system is transportable to other computing systems. However, appropriate local (native) interfaces (translator) must be provided. The right-hand side of Figure 3-2 shows the PDDI commercial demonstration architecture for UNIGRAPHICS and Computervision Systems.

3.4 Physical Schemas

The Working Form physical schema is determined through a data dictionary or PASCAL include files. An explanation of the form and the use of these files can be found in Appendix A. The Exchange Format physical schema is defined by the PDDI conceptual schema and the specification for the neutral file format.

3.5 Software Packages

The software for the system consists of two (2) packages - Access Software and Translator.

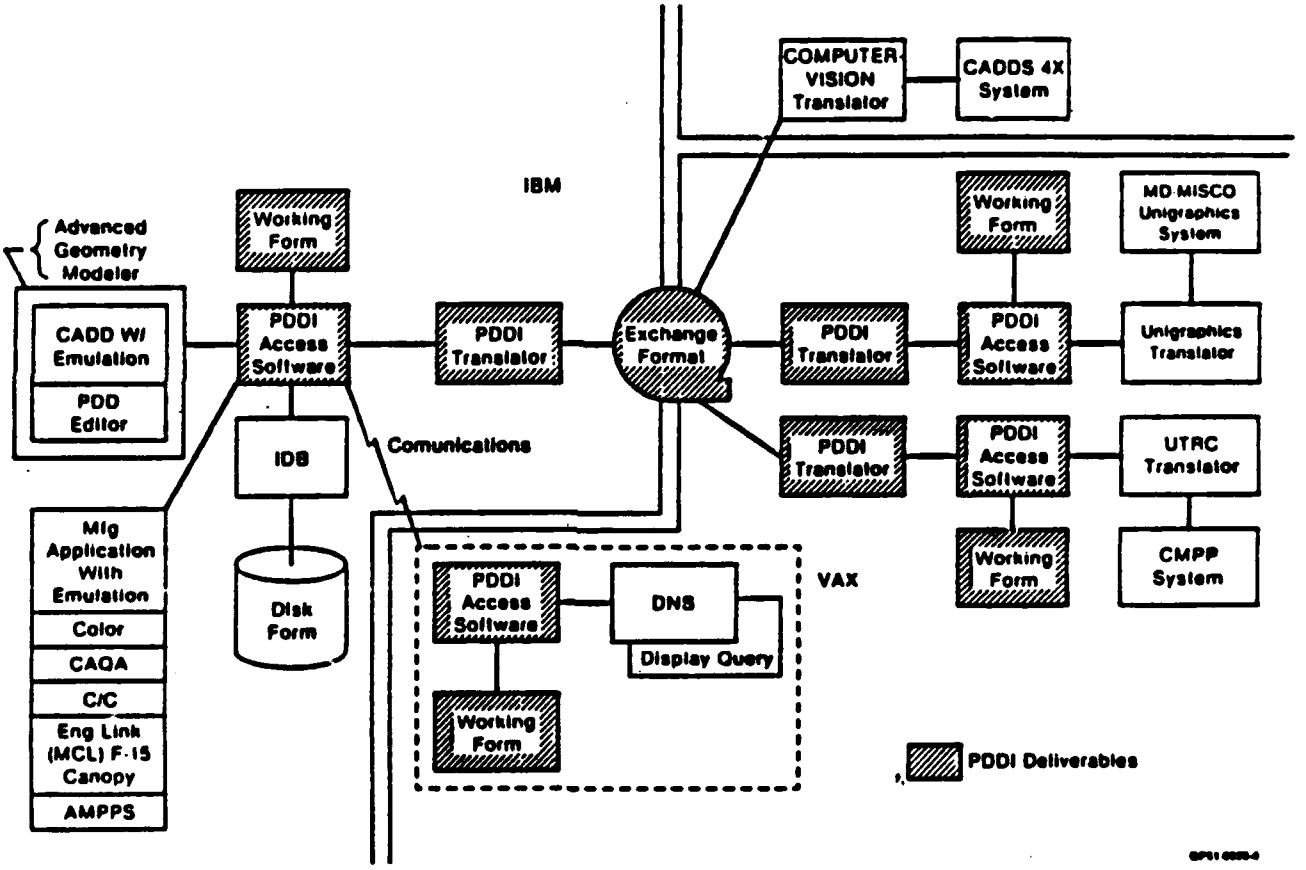


Figure 3-2 PDDI Environment

3.6 Translator

The PDDI Translator is the software package used to format PDD for transmission between systems. The Translator is broken up into three main sub-packages. These sub-packages are: "Run System", "Pre-Processor" and "Post-Processor". (See Figure 3-3).

The Run System is the interface between the user and the "processors". This package provides menus, queries and system responses for the user.

Functions performed by this package include: Perform system configuration activities, determine files needed by the processors and make them available, and provide messages to aid user interfaces.

Access to the native database is also provided by this package via calls to user-supplied routines. Data from this database is placed into or obtained from the Working Form using calls to the Access Software. The pre-processor or post-processor is then called to perform the desired translation.

The Pre-Processor provides the interface from the Working Form to the Exchange Format.

Working Form entities, in the Working Form physical schema, are accessed via the Access Software. Tables, obtained from the Run System, are then used to map the Working Form entities to the Exchange Format physical schema. The Exchange Format entities are then encoded and placed into the Exchange Format file.

Transfer data is collected during entity processing. This data is encoded and placed into the Exchange Format file.

Error messages or condition codes are sent to the "Run System" to indicate the status of the transfer.

The Post-Processor provides the interface from the Exchange Format to the Working Form.

A set of tables, obtained from the Run System, is used to map the Exchange Format entities to the Working Form physical schema. The Access Software is then used to place these entities into the Working Form.

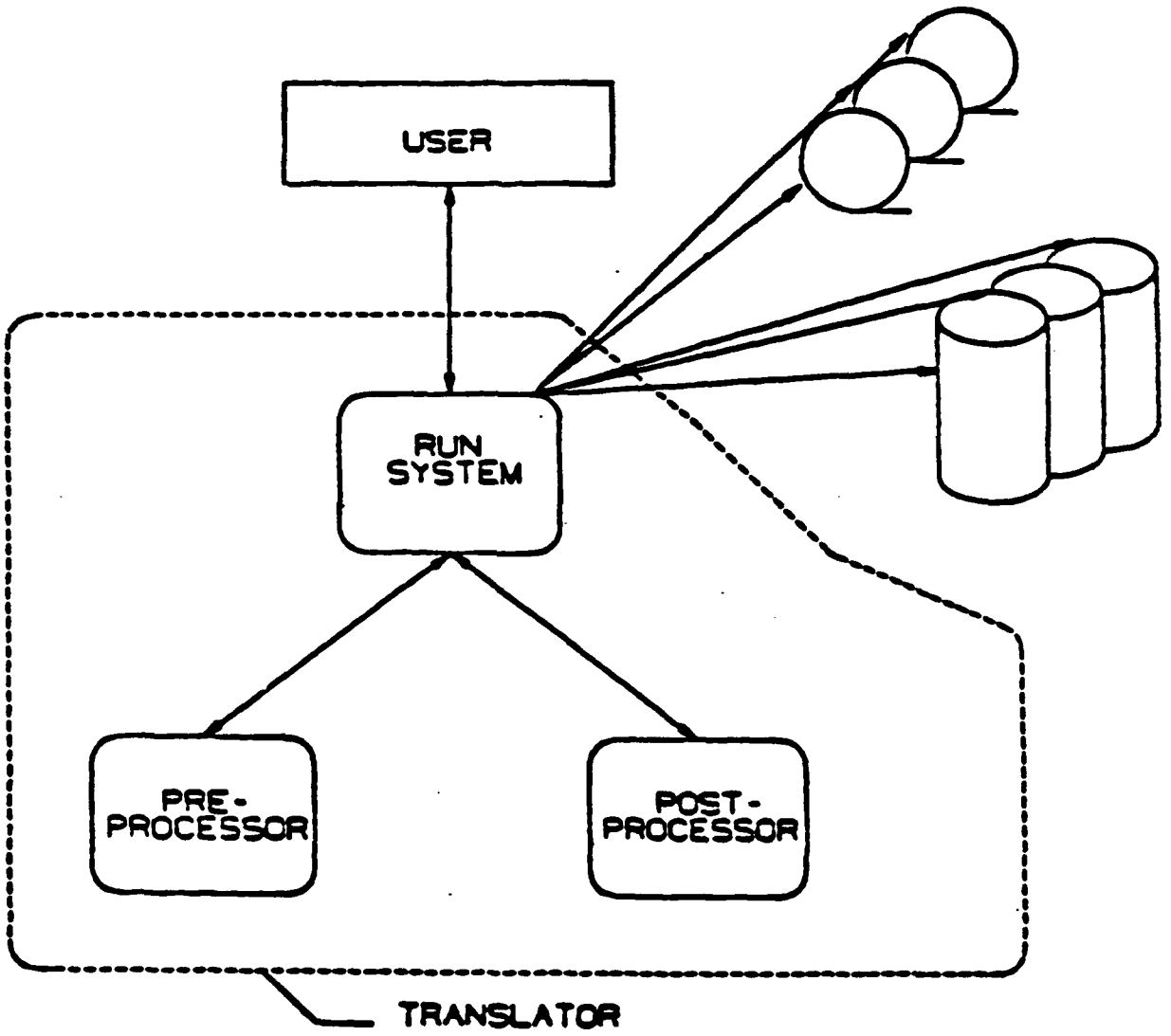


Figure 3-3 Translator Architecture

3.7 Model Access Software

The PDDI Access Software is a set of Pascal procedures that maintains the physical structure of related user data in computer memory. This user data is referred to as the working form model. The package provides an interface to the working form model for application programs to create, relate, and access elements of user data.

The application programs are independent of the physical structure of the stored data elements. This independence ensures that as different structure techniques are implemented, the application programs need not change.

This package manages two types of data: entities and lists. An entity is an element of data supplied by the application to be stored in the working form. A list is a collection of entity keys. The package manages lists created by the application in the working form.

The Access Software allows the structuring of the user data. The entities can be related in user/constituent order. An entity may be related to multiple user entities, creating a network structure in the working form. An entity may also contain multiple constituent entities.

3.8 DATA ITEMS

The Access Software manages two types of data items within the working form - Entities and Lists.

ENTITY

An entity is the principle data item managed by the Access Software, and is:

- o Defined by the conceptual schema in the application creating the entity.
- o Accessed by a unique key return from the create entity function
- o A node in the working form structure containing an Attribute Data Block(ADB), and references to other entities in Constituent Relationships and/or User Relationships

ATTRIBUTE DATA BLOCK

An Attribute Data Block(ADB) is a collection of data embedded in a single contiguous block of memory. Individual pieces of data within an ADB are call attributes. MAS manages only the first three items in the structure of an ADB. These three attributes, KIND, LENGTH, and SYSUSE, are required in every entity. A short description of each attribute follows:

KIND - Must be the first item defined in the ADB. The KIND defines the entity type code. This code cannot be changed.

LENGTH - Must be the second item defined in the ADB. The LENGTH defines the number of bytes in the ADB including KIND, LENGTH, and SYSUSE.

SYSUSE - One full word of system use data reserved for internal purposes. This data is never used by the application, and should never be inspected or modified.

NOTE: All other attribute data in the ADB is managed by the application program.

CONSTITUENT RELATIONSHIP

A constituent entity is used in the definition of the user entity. Inclusive constituents of an entity encompass all descendents, their descendents, and so forth until there are no more descendents. For example in Figure 3-4, Point 0 (P0) and Point 1 (P1) are constituents of Line 1.

```
LINE = ENTITY(5008);
  IDENT  : KEY T_IDENT;
  DISPLA : T_DISPLAY;
  P0     : POINT;
  P1     : POINT;
  END_ENTITY;
```

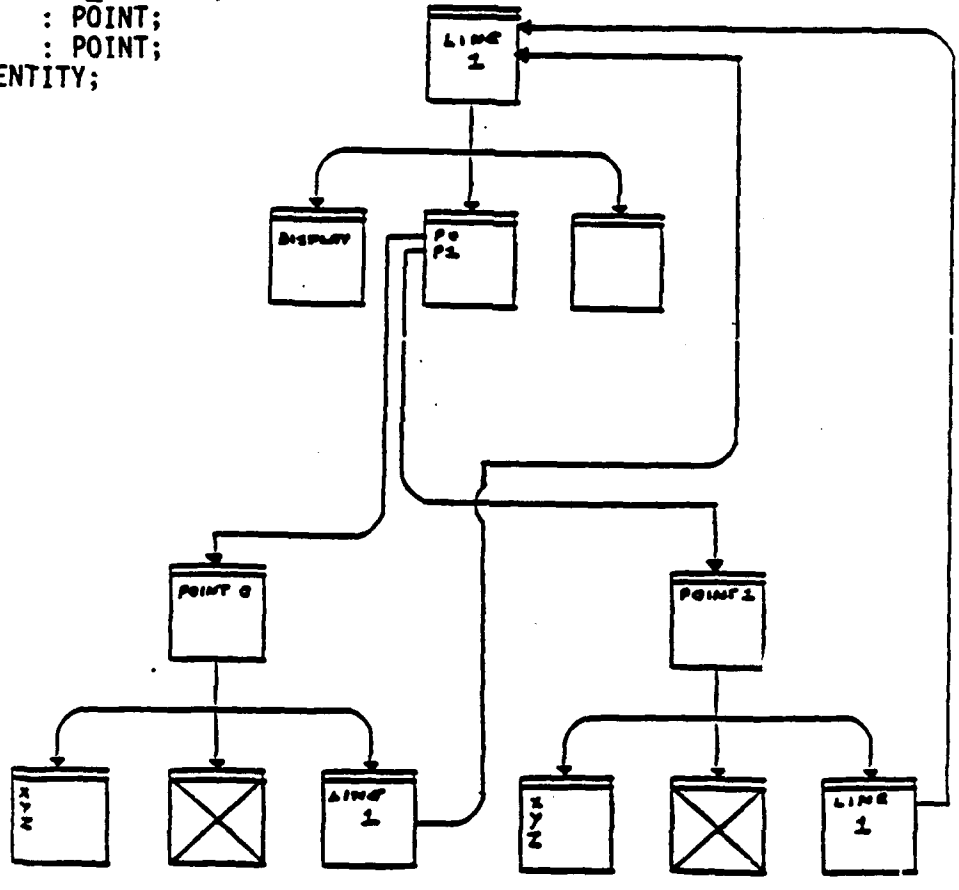


Figure 3-4 LINE: An Entity With Constituents

USER RELATIONSHIPS

A user entity uses constituent entities in its definition. Inclusive users of an entity include all ancestors, their ancestors, and so forth until there are no more ancestors. For example in Figure 1-1, Line 1 is a user of Point 0 (P0) and Point 1 (P1).

LIST

A list is a collection of entity keys which is:

- Created by the Application program.
- Accessed by a unique list key returned from the Create List Functions.
- Used by the Application to store selected entity keys for subsequent processing.

3.9 INTERFACE PARAMETERS

Each interface parameter has a name and a type. This information is shown as follows:

DATA-NAME:DATA-TYPE.

DATA-NAME PARAMETERS

The following conventions are used to name parameters:

- Keys are named KEY1, KEY2,...KEYN.
- The ADB is named ENTDEF.
- Text parameters are named according to their purpose.
- Integer parameters are named according to their purpose.
- A return code is produced by every interface routine/operation. This parameter is a full word integer and is always named IRC. (See Appendix for a return code list.)

DATA-TYPE PARAMETERS

Data-Type parameters may be one of the following:

ANYKEY - Access key of an entity or list.

ENTBLOCK - Entity data block definition.
- In Pascal, probably declared as a record.
- In Fortran, declared as a common or dimension array.

CHARACTER - A single character as defined by the system.

INTEGER - A full word integer.

FORMAL DATA TYPES

The following is a reference list of data-types for interface calls in this MAS document.

```
          ANYKEY       = INTEGER
          LISTKEY      = ANYKEY
          ENTKEY       = ANYKEY
          ORD_KIND     = INTEGER
          EXT_RET_CODE = INTEGER
          LISTPSTN     = INTEGER
          LISTINDX     = INTEGER
          LISTSIZE     = INTEGER
          ROUTINE      = ARRAY(1...8) OF CHARACTER
          NAMTYP       = ARRAY(1...6) OF CHARACTER

(ADB)     ENTBLOCK     = RECORD OF
            KIND         = ORD_KIND
            SIZE         = INTEGER
            SYSUSE       = INTEGER
            DATA         = (USER DEFINED)
```

PASCAL APPLICATIONS

The formal declarations for the Access Software interface routines are maintained in the member APL TYP of the library "CAD5.FRMI.MASymmdd.INCLD"

Where:

y = year
mm = month
dd = day

of the latest Access Software release.

3.10 MEMORY MANAGER

A Model Access Memory Manager was developed to replace the PASCAL run-time memory manager. It reduces the number of bytes of overhead required for free-space collection, and isolates the working form model from all other PASCAL dynamic allocations.

This memory manager is currently in the MAS package and requires no user intervention for utilization.

SECTION 4

INTERFACE OPERATIONS

INTERFACE OPERATIONS (CONTINUED)

4.1 INTRODUCTION

The Entity Operations and List Operations sections provide the applications programmer with the interface operations needed to access the data structures passed back to the application program. (See appendix for Pascal and FORTRAN Schema Diagrams.)

Figure 4-1 illustrates the interrelationships of the Access Software interface operations shown in these sections.

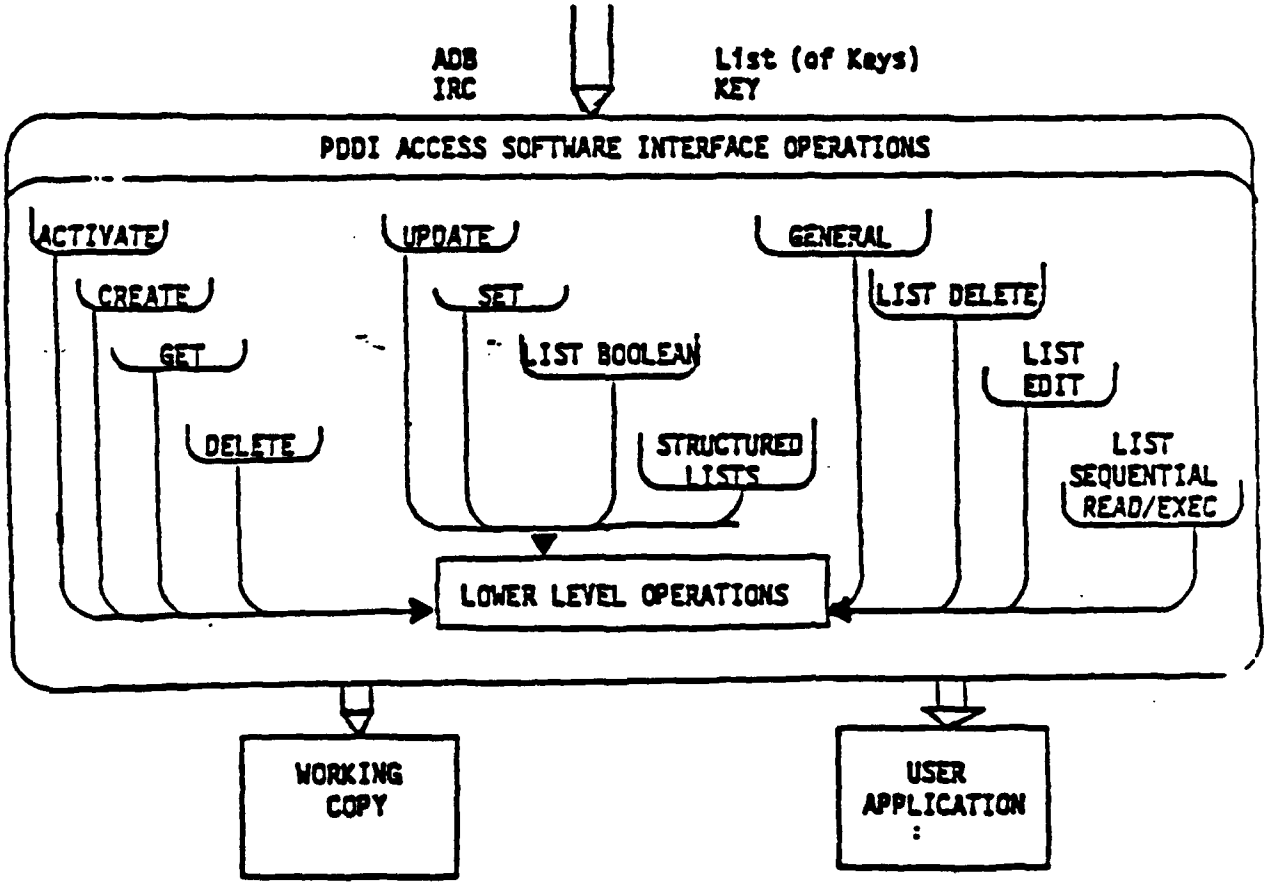


Figure 4-1 Interface Operations

4.2 INITIALIZATION/DELETION OF THE MAS ENVIRONMENT

Two routines provide the interface used to initialize the Access Software.

The basic initialization operation (MAINIT) creates a working model and enables the Access Software.

The MAKILL function is used to destroy the working model and disable the Access Software.

An application does not have to install a data dictionary. It can create and use entities on an *ad hoc* basis. If a data dictionary is not installed, the following limitations are imposed:

1. Any entity type will be permitted.

2. The interface routines will not validate any operation other than outright errors; e.g., defining an ADB with a negative length. The application is - "on its own".

3. There will be no provision for organization of entities by class.

Included with the initialization and deletion operations descriptions that follow are the error and warning messages that may be returned. Appendix A contains a complete list of these messages along with their numeric codes.

MAINIT

FUNCTION: Initialize the working model.

FORMAT: MAINIT (IRC)

INPUT:
None

OUTPUT:
IRC: INTEGER
The procedure return code.

DESCRIPTION: The working model will be initialized.

The Access Software is enabled.

ERRORS:

Message	Explanation
MAS_INIT_FAILED	Could not create schema and its root.
MAINIT_ALREADY_DONE	Root already created.
NOT_ENOUGH_ROOM	*No more core memory.*

NOTE: Do not call MAINIT twice in succession. This will result in 2 Access Software environments. Use a MAKILL to delete the current environment before initializing another.

MAKILL

FUNCTION: Delete the current working model.

FORMAT: MAKILL (IRC)

INPUT:
None

OUTPUT:
IRC: INTEGER
The procedure return code.

DESCRIPTION: The entire working model is destroyed.

The Access Software is disabled.

ERRORS: None.

4.3 ENTITY OPERATIONS

The basic entity operations can be categorized by the following functions:

Activate
Create
Get
Delete
Update
Process Flags
Application Flags

All operations performed on entity constituent lists are done by list operations, with the exception of creating an entity with constituents.

Included with the entity operations descriptions presented on the pages that follow are the error and warning messages that may be returned. Appendix A contains a complete list of these messages along with their numeric codes.

4.3.1 CREATE OPERATIONS

These operations allow the creation of entities in the working model. The application creates the entity in its local memory space. This includes the specification of KIND, LENGTH, and any other attribute data as needed. The KIND value cannot change. The LENGTH value can be changed by the MAEUD function.

The create routines are shown in the following table.

DESCRIPTION	ROUTINE
Create an entity.	MAECR
Create an application list of constituent entity references.	MAEC
Create an application list of inclusive constituent entities.	MAECI
Create an application list of inclusive constituents by KIND.	MAECIK
Create an application list of user entity references.	MAEU
Create an application list of inclusive user entities.	MAEUI
Create an application list of inclusive users by KIND.	MAEUIK

MAECR

FUNCTION: Create an entity.

FORMAT: MAECR(ENTDEF,KEY1,KEY2,IRC)

INPUT:

ENTDEF : ENTBLOCK
The application data structure which contains the entity definition.

KEY1 : ANYKEY
The entity or list of entities to be made constituents of the entity being created.

OUTPUT:

KEY2 : ENTKEY
The key of the newly created entity.

IRC : INTEGER
The return code.

DESCRIPTION: The entity is added to the model. Constituent entities are connected to the entity. If KEY1 is an entity key then only that entity will become a constituent. If KEY1 is a list key then all entities in the list will become constituents.

A nil key may be used if the entity being created is to have no constituents(a full word integer zero can be used as a nil key).

NOTE: The application is responsible for the format of the AD[illegible] data after the first three items (KIND, SIZE, SYSUSE).

EXAMPLE: See Sample Programs Section.

ERRORS:

Message	Description
BAD_LIST_POSITION	Incorrectly built model.
BAD_ENT_KIND	Kind of given key undefined.
NOT_ENOUGH_ROOM	No more core memory.

MAEC

FUNCTION: Create an application list of constituent entities.

FORMAT: MAEC(KEY1,KEY2,IRC)

INPUT:

KEY1 : ANYKEY
The entity or list of entities for which a list of direct constituents is wanted.

OUTPUT:

KEY2 : LISTKEY
The returned key of the application list of direct constituents.

IRC : INTEGER
The return code.

DESCRIPTION: KEY2 is created. If KEY1 is an entity key then the constituent list of KEY1 will be copied into KEY2. If KEY1 is a list key then the constituent lists of each entity will be copied into KEY2.

ERRORS:

Message	Description
BAD_LIST_REFERENCE	Given key not an entity or a list.
BAD_ENT_KEY	Nil key.
NOT_ENOUGH_ROOM	No more core memory.

MAECI

FUNCTION: Create an application list of inclusive constituent entities.

FORMAT: MAECI(KEY1,KEY2,IRC)

INPUT:

KEY1 : ANYKEY
The entity or list of entities whose inclusive constituents are wanted.

OUTPUT:

KEY2 : LISTKEY
The returned key of the inclusive application list of constituents.

IRC : INTEGER
The return code.

DESCRIPTION: KEY2 is created. If KEY1 is an entity key, then the inclusive constituent list of KEY1 will be copied into KEY2. If KEY1 is a list key, then the inclusive constituent lists of each entity will be copied into KEY2. KEY1 is not included in KEY2.

No duplicate keys will exist. Entities are marked as "processed" when placed in the output list. If a processed entity is encountered again on another constituent list, it will not be repeated on the output list.

EXAMPLE: See Sample Programs Section.

NOTE: See the System Overview Section for further explanation of inclusive constituents.

ERRORS:

Message	Description
BAD_LIST_REFERENCE	Given key not an entity or a list.
BAD_ENT_KEY	Nil key.
NO_MORE_ROOM	No more core memory.

WARNING: NO_LIST_CREATED

MAECIK

FUNCTION: Create an application list of inclusive constituents of a specified KIND.

FORMAT: MAECIK(KEY1,KIND,KEY2,IRC)

INPUT:

KEY1 : ANYKEY
The entity or list of entities whose inclusive constituents are to be searched for by specified KIND.

KIND : INTEGER
The KIND code of an entity or an entity class.

OUTPUT:

KEY2 : LISTKEY
The key of a list which will contain all entities of the specified KIND found within the inclusive constituents of KEY1.

IRC : INTEGER
The return code.

DESCRIPTION: KEY2 is created. If KEY1 is an entity key then the inclusive constituents of the specified KIND will be copied into KEY2. If KEY1 is a list key then the inclusive constituents of all entities on the list of the specified KIND will be copied into KEY2.

No duplicate keys will exist.

NOTE: See Entity in the System Overview for further explanation of inclusive constituents.

ERRORS:

Message	Description
BAD_LIST_REFERENCE	Given key not an entity or a list.
BAD_ENT_KEY	Nil key.
NO_MORE_ROOM	No more core memory.

WARNING: NO_LIST_CREATED

MAEU

FUNCTION: Create an application list of user entity references.

FORMAT: MAEU(KEY1,KEY2,IRC)

INPUT:

KEY1 : ANYKEY
The entity or list of entities for which a list of direct users is wanted.

OUTPUT:

KEY2 : LISTKEY
Returned key of the application list of direct users.

IRC : INTEGER
The return code.

DESCRIPTION: KEY2 is created. If KEY1 is an entity key then the user list of KEY1 will be copied into KEY2. If KEY1 is a list key then the user lists of each entity will be copied into KEY2.

EXAMPLE: See Sample Program Section.

ERRORS:

Message	Description
BAD_ENT_KEY	Nil key.
NO_MORE_ROOM	No more core memory.

WARNING: NO_LIST_CREATED

MAEUI

FUNCTION: Create an application list of inclusive user entities.

FORMAT: MAEUI(KEY1,KEY2,IRC)

INPUT:
KEY1 : ANYKEY
The entity or list of entities whose inclusive users are wanted.

OUTPUT:
KEY2 : LISTKEY
The returned key of the inclusive application list of users.

IRC : INTEGER
The return code.

DESCRIPTION: KEY2 is created. If KEY1 is an entity key, then the inclusive user list of KEY1 will be copied into KEY2. If KEY1 is a list key, then the inclusive user lists of each entity will be copied into KEY2. KEY1 is not included in KEY2.

No duplicate keys will exist.

NOTE: See the System Overview Section for further explanation of inclusive users.

ERRORS:

Message	Description
BAD_LIST_REFERENCE	Given key not an entity or a list.
BAD_ENT_KEY	Nil key.
NO_MORE_ROOM	No more core memory.

WARNING: NO_LIST_CREATED

MAEUIK

FUNCTION: Create an application list of inclusive users by KIND.

FORMAT: MAEUIK(KEY1,KIND,KEY2,IRC)

INPUT:

KEY1 : ANYKEY
The entity or list of entities whose inclusive users are to be searched for by specified KIND.

KIND : INTEGER
The KIND code of an entity or an entity class.

OUTPUT:

KEY2 : LISTKEY
The key of a list which will contain all entities of the given KIND found within the inclusive users of KEY1.

IRC : INTEGER
The return code.

DESCRIPTION: KEY2 is created. If KEY1 is an entity key, then the inclusive users of the specified KIND will be copied into KEY2. If KEY1 is a list key, then the inclusive users of all entities on the list of the specified KIND will be copied into KEY2.

NOTE: See the System Overview Section for further explanation of inclusive users.

ERRORS:

Message	Description
BAD_LIST_REFERENCE	Given key not an entity or a list.
BAD_ENT_KEY	Nil key.
NO_MORE_ROOM	No more core memory.

WARNING: NO_LIST_CREATED

4.3.2 GET OPERATIONS

These operations are used to get the MAS copy of a specified entity attribute block and load it into the application memory area. Get operations are also used to get a specified attribute in the entity ADB.

The get routines are shown in the table below.

DESCRIPTION	ROUTINE
Get the KIND value of a specific entity.	MAEGKN
Get the ADB of a specific entity.	MAEGTK

MAEGKN

FUNCTION: Get the KIND value of a specific entity.

FORMAT: MAEGKN(KEY1,KIND,IRC)

INPUT:
- KEY1 : ENTKEY
  The entity whose kind is to be gotten.

OUTPUT:
- KIND : INTEGER
  The KIND value of the specified entity.
- IRC : INTEGER
  The return code.

DESCRIPTION: The stored ADB is located. The KIND value in the ADB is moved to the application ADB.

ERRORS:

Message	Description
BAD_ENT_KEY	Nil key or not an entity.
NO_MORE_ROOM	No more core memory.

MAEGTK

FUNCTION: Get the ADB of a specific entity.

FORMAT: MAEGTK(KEY1,ENTDEF,IRC)

INPUT:
- KEY1 : ENTKEY
  The key of the entity to be gotten.

OUTPUT:
- ENTDEF : ENTBLOCK
  The ADB to receive the stored entity.
- IRC : INTEGER
  The return code.

DESCRIPTION: The stored ADB is located and moved to the application ADB. If KEY1 is a nil key, then a nil KIND and a zero LENGTH is returned.

EXAMPLE: See Sample Program Section.

ERRORS

Message	Description
BAD_ENT_KEY	Nil key or not an entity.
NO_MORE_ROOM	No more core memory.

4.3.3 UPDATE OPERATIONS

These operations are used to update the ADB for specified entities. In general, the application should use the MAEGTK function to get the ADB before the update function is used.

The update routine is shown in the following table.

DESCRIPTION	ROUTINE
Update the attribute data block of an entity.	MAEUD

MAEUD

FUNCTION: Update the attribute data block of an entity.

FORMAT: MAEUD(KEY1,ENTDEF,IRC)

INPUT:

KEY1 : ENTKEY
The entity to be updated. This must be an entity key.

ENTDEF : ADB
The ADB supplying the update values.

OUTPUT:

IRC : INTEGER
The return code.

DESCRIPTION: The ADB of KEY1 will be updated. The value of KIND must agree with the Model Access Software copy of this entity. Otherwise, an error will result. If the LENGTH is greater than the current LENGTH, then a new ADB will be created with more space.

ERRORS:

Message	Description
BAD_ENT_KIND	Kind or given key is undefined.
BAD_ENT_KEY	Given key is nil.
CANT_UPDATE_ENTITY	
NO_MORE_ROOM	No more core memory.

4.3.4 DELETE OPERATIONS

These operations address how you delete entities from the MAS working form model. The entities in the working model currently are grouped into the following classifications:

- o Dependent
- o Support
- o Primary
- o Secondary

Delete rules have been established for the entities in these classifications. For a new entity kind, the default classification is "Dependent" unless it is otherwise defined.

DELETE RULES

The delete rules apply to the constituent relationships with which entities are defined. They determine whether a constituent entity can be deleted by checking each of its user entities. For example, the delete rules applied to entity (A) in relation to a specific user entity (B) may be different than the delete rules for that same entity (A) in relation to another specific user entity (C).

The action taken for the IDB/MAS delete classifications are determined by the combinations of yes/no (Y/N) answers to the following conditions, posed as questions:

(1) Can this constituent entity be deleted from a specific user entity?

(2) Does the deletion of this (constituent) entity cause deletion of a specific user?

(3) Does deletion of a specific user cause deletion of this entity (constituent)?

CONDITION			
(1)	(2)	(3)	DELETE CLASSIFICATION
N	N	N	Dependent
N	N	Y	Support
N	Y	N	Primary
Y	N	N	Secondary

The delete classifications are defined as follows:

Dependent - Constituent entity cannot be deleted because the user entity is dependent on its existence. The user entity may be deleted without deleting the constituent entity.

Support - Constituent entity cannot be deleted because the user entity is dependent on its existence. The user entity may be deleted; however, the constituent entity will also be deleted unless another user entity does not permit the deletion of the constituent entity.

Primary - Constituent entity can be deleted, but only if the user entity can, and will, also be deleted. The user entity may be deleted without the constituent entity being deleted.

Secondary - If the number of constituents falls below an established minimum, the constituent entity can be deleted and, if possible, the user entity will also be deleted. If the user entity cannot be deleted, none of the minimum constituents can be deleted. If the number of constituents is greater than or equal to the minimum, the constituent entity can be deleted.

Test routines are provided to return the entities or lists that would be deleted if actual delete routines were used.

DELETE ROUTINES

The IDB/MAS delete routines are presented in the following table. The first two routines actually delete entities (MAED, MAEDI). The third and fourth routines test the delete function, allowing the programmer to see the results of a potential delete without modifying the stored data (MAEDT, MAEDTI).

When deleting a list of entities that includes users and constituents, the list should be ordered so that the users are processed before the constituents. The routines MALROR and MALRORI perform this function on an application list. (An entity constituent list should never be reordered.)

DESCRIPTION	ROUTINE
Delete an entity or list of entities.	MAED
Delete an entity or list of entities and the inclusive constituents.	MAEDI
Delete test an entity or list of entities.	MAEDT
Delete test an entity or list of entities and the inclusive constituents.	MAEDTI

MAED

FUNCTION: Delete an entity or list of entities.

FORMAT: MAED(KEY1,KEY2,IRC)

INPUT:
- KEY1 : ANYKEY
  The entity or list of entities to be deleted.

OUTPUT:
- KEY2 : LISTKEY
  The list of entities marked for deletion.
- IRC : INTEGER
  The return code.

DESCRIPTION: KEY1 may be either an entity key or a list key, and the order of the entities in the list may be important. KEY2 will list any entities from the KEY1 list that were not deleted. If all entities are deleted, the mark list will be empty.

ERRORS:

Message	Description
BAD_LIST_REFERENCE	Given key not an entity or a list.
RULE_DOES_NOT_MATCH	Rules defined incorrectly.
NO_MORE_ROOM	No more core memory.

WARNINGS:

EMPTY_MARK_LIST	No entities marked for delete.

MAEDI

FUNCTION: Delete an entity or list of entities and their inclusive constituents.

FORMAT: MAEDI(KEY1,KEY2,IRC)

INPUT:
- KEY1 : ANYKEY
  The entity or list of entities to be deleted.

OUTPUT:
- KEY2 : LISTKEY
  The list of entities marked for delete.
- IRC : INTEGER
  The return code.

DESCRIPTION: KEY1 may be either an entity key or a list key, and the order of the entities in the list may be important. KEY2 will list any entities from the KEY1 list that were not deleted. If all entities are deleted, the mark list will be empty.

ERRORS:

Message	Description
BAD_LIST_REFERENCE	Given key not an entity or a list.
RULE_DOES_NOT_MATCH	Rules defined incorrectly.
NO_MORE_ROOM	No more core memory.

WARNINGS:

EMPTY_MARK_LIST	No entities marked for delete.

MAEDT

FUNCTION: Delete test an entity or list of entities.

FORMAT: MAEDT(KEY1,KEY2,KEY3,IRC)

INPUT:

KEY1 : ANYKEY
The entity or list of entities to be tested.

OUTPUT:

KEY2 : LISTKEY
The list containing entities that would be deleted by MAED.

KEY3 : LISTKEY
The list containing entities that would be marked by MAED.

IRC : INTEGER
The return code.

DESCRIPTION: The MAEDT delete routine simulates the output of the MAED routine without actually deleting the entities or marking them inactive.

ERRORS:	Message	Description
	BAD_DELETE_KEY	Given key not an entity or a list.
	RULE_DOES_NOT_MATCH	Rules defined incorrectly.
	NO_MORE_ROOM	No more core memory.
WARNINGS:	EMPTY_DELETE_LIST	Given delete list was empty.
	EMPTY_MARK_LIST	No entities marked for delete.

MAEDTI

FUNCTION: Delete test an entity or list of entities and their inclusive constituents.

FORMAT: MAEDTI(KEY1,KEY2,KEY3,IRC)

INPUT:

KEY1 : ANYKEY
The entity or list of entities to be tested.

OUTPUT:

KEY2 : LISTKEY
The list containing entities that would be deleted by MAEDI.

KEY3 : LISTKEY
The list containing entities that would be marked by MAEDI.

IRC : INTEGER
The return code.

DESCRIPTION: The MAEDTI delete routine simulates the output of the MAEDI routine without actually deleting the entities or rendering them inactive.

	Message	Description
ERRORS:	BAD_LIST_REFERENCE	Given key not an entity or a list.
	BAD_DELETE_KEY	Given key is nil.
	RULE_DOES_NOT_MATCH	Rules defined incorrectly.
	NO_MORE_ROOM	No more core memory.
WARNINGS:	EMPTY_DELETE_LIST	Given delete list was empty.
	EMPTY_MARK_LIST	No entities marked for delete.

MAEDTS

FUNCTION: Delete test an entity or list of entities and return three lists.

FORMAT: MAEDTS(KEY1,KEY2,KEY3,KEY4,IRC)

INPUT:

KEY1	:	ANYKEY The entity or list of entities to be tested.

OUTPUT:

KEY2	:	LISTKEY The list of entities that would be deleted by MAED.
KEY3	:	LISTKEY The list of entities that would not be deleted by MAED.
KEY4	:	LISTKEY The list of entities that would be marked for delete by MAED.
IRC	:	INTEGER The return code.

DESCRIPTION: The MAEDTS routine is similar to MAEDT except that three lists are returned. KEY2 and KEY4 can be submitted to directly delete and mark entities without checking the delete rules.

ERRORS:

Message	Description
BAD_LIST_REFERENCE	Given key not an entity or a list.
BAD_DELETE_KEY	Given key is nil.
RULE_DOES_NOT_MATCH	Rules defined incorrectly.
NO_MORE_ROOM	No more core memory.

WARNINGS:

EMPTY_DELETE_LIST	Given delete list was empty.
EMPTY_MARK_LIST	No entities marked for delete.

4.3.5 ACTIVATE OPERATIONS

These operations are used to activate an entity. An entity is deactivated when a delete was attempted, but was not completed because of the user's dependency condition on the entity. (See Delete Operations Section)

The activate routines are shown in the table below.

DESCRIPTION	ROUTINE
Activate an entity or list of entities.	MAEA
Activate an entity or list of entities and their inclusive constituents.	MAEAI
Find the present value of the activation setting for an entity.	MAEAV

NOTE:

- Activation is not the same as rejection after a delete. If an entity was deleted, then it cannot be recovered with these functions.
- Activation functions will activate any entity regardless of when or how it was made inactive.

MAEA

FUNCTION: Activate an entity or list of entities.

FORMAT: MAEA (KEY1,IRC)

INPUT:
KEY1 : ANYKEY
The entity or list of entities to be activated.

OUTPUT:
IRC : INTEGER
The return code.

DESCRIPTION: KEY1 may be either an entity key or a list key. If KEY1 is an entity key then only that entity will be activated. If KEY1 is a list key then all entities in the list will be activated.

ERRORS:

Message	Explanation
BAD_LIST_REFERENCE	Given key not an entity or a list.
BAD_ENT_KEY	Nil key.
NOT_ENOUGH_ROOM	No more core memory.

MAEAI

FUNCTION: Activate an entity or list of entities and their inclusive constituents.

FORMAT: MAEAI(KEY1,IRC)

INPUT:
KEY1 : ANYKEY
The entity or list of entities to be activated.

OUTPUT:
IRC : INTEGER
The return code.

DESCRIPTION: KEY1 may be either an entity key or a list key. If KEY1 is an entity key then only that entity and its inclusive constituents will be activated. If KEY1 is a list key then all entities in the list and their inclusive constituents will be activated.

See the System Overview Section for further explanation of inclusive constituents.

ERRORS:

Message	Description
BAD_LIST_REFERENCE	Given key not an entity or a list.
NOT_ENOUGH_ROOM	No more core memory.

MAEAV

FUNCTION: Find the present value of the activation setting for an entity.

FORMAT: MAEAV(KEY1,IAVAL,IRC)

INPUT:
KEY1 : ENTKEY
The entity to be examined.

OUTPUT:
IAVAL : INTEGER
The activation code.
- 0 if set for delete
- 1 if not set for delete

IRC : INTEGER
The return code.

DESCRIPTION: Returns the current value of the activation setting for the specified entity.

ERRORS:

Message	Description
BAD_ENT_KEY	Given key not an entity.
NOT_ENOUGH_ROOM	No more core memory.

4.3.6 APPLICATION FLAG OPERATIONS

These operations are used to get or set any application accessible flag associated with an entity.

The Application Flag routines are shown in the following table.

DESCRIPTION	ROUTINE
Reset any application accessible flag for all entities in the model.	MAERST
Determine the value of a given application accessible flag of an entity.	MAQURY
Update the value of a given application accessible flag of an entity or list of entities.	MAUPDT
Determine whether the user compresses with its constituent.	MAECQY
Create a list of constituents with which the input entity compresses.	MAECMP
Reset Process Flag for all entities in the model.	MAESWA
Set the Process Flag in an entity or list of entities.	MAESWT
Find the Process Flag setting of an entity.	MAESVL

MAERST

FUNCTION: Reset given application accessible flag in all entities in the model.

FORMAT: MAERST(FLAGNAME,IRC)

INPUT:
FLAGNAME : NAMTYP
The name of the flag to be reset in all entities in the model. Can have the following values:

1) 'MRDFLG' activation flag
2) 'PRCFLG' process flag
3) 'ABSFLG' absent/present flag
4) 'APLFLG' application flag
=0 off
=1 on

OUTPUT:
IRC : INTEGER
The return code.

DESCRIPTION: Determine what flag is to be reset in every entity in the model. Resets that flag to 'off'.

ERRORS:

Message	Description
INVALID_FLAG_NAME	Given flag name undefined.
SCHEMA_ROOT_NIL	No model active.
NO_MORE_ROOM	No more core memory.

MAQURY

FUNCTION: Determine the value of a given application accessible flag for the entity.

FORMAT: MAQURY(KEY1,FLAGNAME,FLGVAL,IRC)

INPUT:

KEY1 : ENTKEY
The entity whose specified flag value is to be gotten.

FLAGNAME : NAMTYP
The name of the flag to be gotten. Can have the following values:

1) 'MRDFLG' activation flag
2) 'PRCFLG' process flag
3) 'ABSFLG' absent/present flag
4) 'APLFLG' application flag
   =0 off
   =1 on

OUTPUT:

FLGVAL : INTEGER
The value of the specified flag.
0 = false
1 = true

IRC : INTEGER
The return code.

DESCRIPTION: Determine what flag's value is to be gotten. Get that flag's value.

ERRORS:

Message	Description
BAD_LIST_REFERENCE	Given reference nil or not an entity.
INVALID_FLAG_NAME	Given flag name undefined.
NO_MORE_ROOM	No more core memory.

MAUPDT

FUNCTION: Update the value of a given application accessible flag for an entity or list of entities.

FORMAT: MAUPDT(KEY1,FLGNAME,FLGVAL,IRC)

INPUT:

KEY1 : ANYKEY
The entity or list of entities whose specified flag value will be updated.

FLAGNAME : NAMTYP
The name of the flag to be updated. Can have the following values:

1) 'MRDFLG' activation flag
2) 'PRCFLG' process flag
3) 'ABSFLG' absent/present flag
4) 'APLFLG' application flag
=0 off
=1 on

FLGVAL : INTEGER
The value of the specified flag to be used when updating.
0 = false
1 = true

IRC : INTEGER
The reutrn code.

DESCRIPTION: Determine what flag's value is to be updated. Update that flag's value.

ERRORS:

Message	Description
BAD_LIST_REFERENCE	Given key not an entity or a list.
INVALID_FLAG_NAME	Given flag name undefined.
NO_MORE_ROOM	No more core memory.

MAECQY

FUNCTION: Determine whether the user compresses with its constituent.

FORMAT: MAECQY(KEY1, KEY2, CMPFLG, IRC)

INPUT:

KEY1 : ENTKEY
Key of the entity thats constituent is to be checked.

KEY2 : ENTKEY
Key of the constituent thats rule is to be checked.

OUTPUT:

CMPFLG : INTEGER
Value of the user's compress rule in relation to its constituent.
1 = true
0 = false

IRC : INTEGER
Return code
0 = Good return
<0 Critical error
>0 Warning

DESCRIPTION: Query constituent compress rule to its user.

MAECMP

FUNCTION: Create a list of constituents with which the input entity compresses.

FORMAT: MAECMP(KEY1, KEY2, IRC)

INPUT:

KEY1 : ENTKEY
Key of the entity thats compressibility is determined by the constituents(s).

OUTPUT:

KEY2 : LISTKEY
List of the constiutents that cause the compression of the input entity.

IRC : INTEGER
Return code
0 = Good return
<0 Critical error
>0 Warning

DESCRIPTION: Each constituent thats delete rule states that the input entity will also be compressed will be added to the output list.

MAESWA

FUNCTION: Reset Process Flag for all entities in the model.

FORMAT: MAESWA(IRC)

INPUT:
NONE

OUTPUT:
IRC : INTEGER
The return code.

DESCRIPTION: The Process Flag is set to OFF in all entities in the working-form model.

ERRORS:

Message	Description
NO_MORE_ROOM	No more core memory.

MAESWT

FUNCTION: Set the Process Flag in an entity or a list of entities.

FORMAT: MAESWT(KEY1,ISWT,IRC)

INPUT:

KEY1 : ANYKEY
The entity or list of entities whose process flag is to be set.

ISWT : INTEGER
The input value of the process flag.

OUTPUT:

IRC : INTEGER
The return code.

DESCRIPTION: The process flag will be set to the value specified by ISWT. If KEY1 is an entity key, then the flag in that entity will be set. If KEY1 is a list key, then the flag in all entities referenced by the list will be set. ISWT should be "1" for flag setting of true and "0" for flag setting of false.

ERRORS:

Message	Description
BAD_LIST_REFERENCE	Given key not an entity or a list.
NO_MORE_ROOM	No more core memory.

MAESVL

FUNCTION: Find the Process Flag setting of an entity.

FORMAT: MAESVL(KEY1,ISET,IRC)

INPUT:

KEY1 : KEY
The entity for which the flag setting is wanted. This must be an entity key.

OUTPUT:

ISET : INTEGER
The output value of the process flag.

IRC : INTEGER
The return code.

DESCRIPTION: The value of the process flag for KEY1 will be returned. If the flag is true, then the value "1" will be returned. If the flag is false, then the value "0" will be returned.

ERRORS:

Message	Description
BAD_ENT_KEY	Given key is nil or not an entity.
NO_MORE_ROOM	No more core memory.

4.4 LIST OPERATIONS

This section explains the use of the MAS list operations. A list is a temporary internal structure that contains references to entities. Since the application can build lists that take up space in the working model, it is necessary that the applications periodically delete the lists that are no longer needed.

Many list operations will accept either a list key or an entity key as input keys. When an entity key is supplied, it is assumed that the constituent list of the entity becomes the list to be operated on.

Some operations on lists may result in the same entity being in the output list more than once. The operation (MALRDE) can be used to remove duplicate entities from the list.

All operations that create an application list automatically set the position of the list to the beginning. Once a list has been read to the end, it must be reset before the sequential read process can begin again.

When an entity is deleted, all references to it in all application lists are automatically removed and the current positions of the affected lists are adjusted to retain their original meaning.

The basic list operations can be categorized by the following functions:

Boolean
Structure
General
Delete
Edit
Sequential Read
Execute

Included with the list operations descriptions are the error and warning messages that may be returned. Appendix A contains a complete list of these messages along with their numeric codes.

4.4.1 BOOLEAN OPERATIONS

For Boolean operations, there are two input lists and one output list. The application is responsible for providing two input lists consisting with the Boolean operation to be performed. No validation checking is done. If one or both of the input lists contain duplicate entities, then the output list may also contain duplicate entities. This result may not be consistent with the Boolean theory operation being performed.

The Boolean routines are shown in the following table.

DESCRIPTION	ROUTINE
Create a list from a Boolean "AND" on two input lists.	MALAND
Create a list from a Boolean "NOT" on two input lists.	MALNOT
Create a list from a Boolean "OR" on two input lists.	MALOR

MALAND

FUNCTION: Create a list from a Boolean "AND" on two input lists.

FORMAT: MALAND(KEY1,KEY2,KEY3,IRC)

INPUT:
KEY1 : ANYKEY
An entity or a list that is to be AND'ed.

KEY2 : ANYKEY
An entity or a list that is to be AND'ed.

OUTPUT:
KEY3 : LISTKEY
The list of entities that occurred in both KEY1 and KEY2.

IRC : INTEGER
The return code.

DESCRIPTION: KEY1 may be either an entity key or a list key. If KEY1 is an entity key, then the constituent list of KEY1 is AND'ed with KEY2. If KEY1 is a list key, then KEY1 is AND'ed with KEY2. KEY2 may be either an entity key or a list key. If KEY2 is an entity key then the constituent list of KEY2 is AND'ed with KEY1. If KEY2 is a list key then KEY2 is AND'ed with KEY2. The list KEY3 is created, corresponding to the set theoretical intersection of KEY1 and KEY2.

ERRORS:

Message	Description
BAD_LIST_REFERENCE	Given key(s) nil or not a list.
NO_MORE_ROOM	No more core memory.

WARNINGS: NO_LIST_CREATED

MALNOT

FUNCTION: Create a list from a Boolean "NOT" on two input lists.

FORMAT: MALNOT(KEY1,KEY2,KEY3,IRC)

INPUT:
KEY1 : ANYKEY
An entity or a list that is to be NOT'ed.

KEY2 : ANYKEY
An entity or a list that is to be NOT'ed.

OUTPUT:
KEY3 : LISTKEY
The list of entities that occurred in KEY1 but not in KEY2.

IRC : INTEGER
The return code.

DESCRIPTION: KEY1 may be either an entity key or a list key. If KEY1 is an entity key, then the constituent list of KEY1 is NOT'ed with KEY2. If KEY1 is a list key, then KEY1 is NOT'ed with KEY2. KEY2 may be either an entity key or a list key. If KEY2 is an entity key, then the constituent list of KEY2 is NOT'ed with KEY1. If KEY2 is a list key, then KEY2 is NOT'ed with KEY1. The list KEY3 is created, corresponding to the set theoretical difference of KEY1 and KEY2.

ERRORS:

Message	Description
BAD_LIST_REFERENCE	Given key not an entity or a list.
BAD_ENT_KEY	Given key nil.
NO_MORE_ROOM	No more core memory.

WARNINGS: NO_LIST_CREATED

MALOR

FUNCTION: Create a list from a Boolean "OR" on two input lists.

FORMAT: MALOR(KEY1,KEY2,KEY3,IRC)

INPUT:
KEY1 : ANYKEY
An entity or a list that is to be OR'ed.

KEY2 : ANYKEY
An entity or a list that is to be OR'ed.

OUTPUT:
KEY3 : LISTKEY
The list of entities that occurred in either KEY1 or KEY2.

IRC : INTEGER
The return code.

DESCRIPTION: KEY1 may be either an entity key or a list key. If KEY1 is an entity key, then the constituent list of KEY1 is OR'ed with KEY2. If KEY1 is a list key, then KEY1 is OR'ed with KEY2. KEY2 may be either an entity key or a list key. If KEY2 is an entity key, then the constituent list of KEY2 is OR'ed with KEY1. If KEY2 is a list key, then KEY2 is OR'ed with KEY1. The list KEY3 is created, corresponding to the set theoretical union of KEY1 and KEY2. If there is an entity in KEY1 that is also in KEY2, there will be duplicates in KEY3.

ERRORS

Message	Description
BAD_LIST_REFERENCE	Given key not an entity or a list.
BAD_ENT_KEY	Given key(s) nil.
NO_MORE_ROOM	No more core memory.

WARNINGS: NO_LIST_CREATED

4.4.2 STRUCTURE OPERATIONS

The following table presents the structure routines:

DESCRIPTION	ROUTINE
Create a list of entities with a given KIND.	MALK
Create a list of entities with a given KIND that are found within another list.	MALKL

MALK

FUNCTION: Create a list of entities with a given KIND.

FORMAT: MALK(KIND,KEY1,IRC)

INPUT:
KIND : INTEGER
A valid KIND code that may be either the KIND of an entity or class of entities.

OUTPUT:
KEY1 : LISTKEY
The list of all entities of the specified KIND.

IRC : INTEGER
The return code.

DESCRIPTION: KEY1 is created. KEY1 will contain all entities of KIND. If a data dictionary is specified, then the KIND may be a class of enities. In this case, the elements of the list will be a (logical) concatenation of the content of each entity class as they are encountered from left to right in the entity class structure.

ERRORS:

Message	Description
CANT_CREATE_LIST	Given kind undefined.
BAD_SCHEMA_KIND	Given not of an instance or class.
BAD_LIST_POSITION	Schema root inconsistent.
NO_MORE_ROOM	No more core memory.

WARNINGS:

NO_SUCH_SCHEMA	Kind undefined.
NO_LIST_CREATED	

MALKL

FUNCTION: Create a list of entities with a given KIND that are found within another list.

FORMAT: MALKL(KEY1,KIND,KEY2,IRC)

INPUT:

KEY1 : ANYKEY
The entity or list of entities whose list is to be searched for the specified KIND.

KIND : INTEGER
The KIND code of an entity or an entity class.

OUTPUT:

KEY2 : LISTKEY
The list that will contain all entities of the given KIND found within the list specified by KEY1.

IRC : INTEGER
The return code.

DESCRIPTION: If KEY1 is an entity key, put all constituents of entity KEY1 into KEY2 that match on kind. If KEY1 is a list key, put all entities in the KEY1 list into KEY2 that match on kind.

ERRORS:

Message	Description
BAD_ENT_KIND	No such kind.
BAD_LIST_REFERENCE	Given key nil or not an entity or not a list.
BAD_LIST_POSITION	Schema root inconsistent.
NO_MORE_ROOM	No more core memory.

WARNINGS: NO_LIST_CREATED

4.4.3 GENERAL OPERATIONS

The following table presents the general routines:

DESCRIPTION	ROUTINE
Creates an empty list.	MAL
Create an empty list of specified size.	MALN
Makes a copy of a list.	MALCPY
Find the position of an entity in a list.	MALFND
Count the entities in a list.	MALNO
Get the Nth key from a list.	MALGTK

MAL

FUNCTION: Creates an empty list.

FORMAT: MAL(KEY1,IRC)

INPUT:
None

OUTPUT:
KEY1 : LISTKEY
The key of the empty list.

IRC : INTEGER
The return code.

DESCRIPTION: An empty list is created.

EXAMPLE: See Sample Programs Section.

ERRORS:

Message	Description
CANT_CREATE_LIST	Memory allocation problems.
NO_MORE_ROOM	No more core memory.

MALN

FUNCTION: Create an empty list of specified size.

FORMAT: MALN(LSIZE,KEY1,IRC)

INPUT:
LSIZE: INTEGER
The number of entries in the list.

OUTPUT:
KEY1 : LISTKEY
The key of the empty list of specified size.

IRC : INTEGER
The return code.

DESCRIPTION: An empty application list will be created with sufficient space to accommodate LSIZE entries. All entries are initialized to nil.

ERRORS:

Message	Description
CANT_CREATE_LIST	Memory allocation problems.
MAXIMUM_LIST_SIZE	Requested size too large.
NO_MORE_ROOM	No more core memory.

MALCPY

FUNCTION: Makes a copy of a list.

FORMAT: MALCPY(KEY1,KEY2,IRC)

INPUT:
KEY1 : LISTKEY
A list key whose entries will be copied.

OUTPUT:
KEY2 : LISTKEY
The new list that will receive a copy of KEY1.

IRC : INTEGER
The return code.

DESCRIPTION: KEY2 will be created. The elements of KEY1 will be copied into KEY2.

ERRORS:

Message	Description
BAD_LIST_REFERENCE	Given key nil or not a list.
NO_MORE_ROOM	No more core memory.

MALFND

FUNCTION: Find the position of an entity in a list. If KEY1 is an entity then find its position in the constituent list of that entity.

FORMAT: MALFND(KEY1,KEY2,IFIRST,IPOS,IRC)

INPUT:

KEY1 : ANYKEY
The entity or list of entities in which KEY2 is to be found.

KEY2 : ENTKEY
The entity to be found in KEY1.

IFIRST : INTEGER
The position in KEY1 where the find operation is to start.

OUTPUT:

IPOS : INTEGER
The position in KEY1 where KEY2 is found.

IRC : INTEGER
The return code.

DESCRIPTION: KEY1 may be either an entity key or a list key. If KEY1 is a list then KEY2 is found in the list. If KEY1 is an entity, then KEY2 is found in the constituent list of KEY1. KEY2 must be an entity key. The find starts at position IFIRST. Each entity in KEY1 is examined for equality with KEY2 starting with the specified position. If a match is found, then the position is returned in IPOS. If there is no match, then IPOS is returned as zero and IRC signals an error. If there are multiple matches, then only the first (leftmost) match is returned in IPOS.

ERRORS:

Message	Description
NO_MATCH_FOUND	Entity not on list.
BAD_LIST_REFERENCE	Given key(s) not an entity or a list.
BAD_ENT_KEY	Given key(s) is nil.
NO_MORE_ROOM	No more core memory.

MALNO

FUNCTION: Count the entities in a list.

FORMAT: MALNO(KEY1,KOUNT,IRC)

INPUT:
KEY1 : ENTKEY
The entity or list of entities to be counted

OUTPUT:
KOUNT: INTEGER
The number of entities in the list.

IRC : INTEGER
The return code.

DESCRIPTION: KEY1 may be either an entity key or a list key. If KEY1 is an entity the number of constituents is returned. If KEY1 is a list the number of entities on the list is returned.

EXAMPLE: See Sample Programs Section.

ERRORS:

Message	Description
BAD_LIST_REFERENCE	Given key(s) is nil or is not an entity or a list.
NO_MORE_ROOM	No more core memory.

MALGTK

FUNCTION: Get the Nth Key from a list.

FORMAT: MALGTK(KEY1,IPOS,KEY2,IRC)

INPUT:
KEY1 : ANYKEY
The entity or list of entities to be processed.

IPOS : INTEGER
The position in the list of the target entity.

OUTPUT:
KEY2 : ENTKEY
The requested key.

IRC : INTEGER
The return code.

DESCRIPTION: If KEY1 is a list, get the IPOS entry from the list. If KEY1 is an entity, get the IPOS entry from the constituent list of KEY1.

EXAMPLE: See Sample Programs Section

ERRORS:

Message	Description
BAD_LIST_POSITION	Given position beyond the length of list.
BAD_LIST_REFERENCE	Given key(s) is nil or is not an entity or a list.
NO_MORE_ROOM	No more core memory.

4.4.4 DELETE OPERATIONS

The following table presents the delete routines:

DESCRIPTION	ROUTINE
Delete an application list.	MALD
Delete all application lists.	MALDA
Delete an application list and all lists created after it.	MALDI
Set or unset the application list lock flag.	MALOCK

MALD

FUNCTION: Delete an application list.

FORMAT: MALD(KEY1,IRC)

INPUT:
KEY1 : LISTKEY
The list to be deleted.

OUTPUT:
IRC : INTEGER
The return code.

DESCRIPTION: KEY1 must not be an entity key. KEY1 is deleted. KEY1 cannot be recovered.

ERRORS:

Message	Description
BAD_DELETE_KEY	Given key not a root, entity, or list.
NO_MORE_ROOM	No more core memory.

MALDA

FUNCTION: Delete all application lists.

FORMAT: MALDA(IRC)

INPUT:
None

OUTPUT:
IRC : INTEGER
The return code.

DESCRIPTION: All application lists will be deleted. They cannot be recovered. If an application list is locked, then it will not be deleted.

ERRORS:

Message	Description
BAD_LIST_POSITION	Error in processing lists.
BAD_LIST_REFERENCE	Found nil list pointer.
NO_MORE_ROOM	No more core memory.

MALDI

FUNCTION: Delete an application list and all lists created after it.

FORMAT: MALDI(KEY1,IRC)

INPUT:
KEY1 : LISTKEY
The list to be deleted.

OUTPUT:
IRC : INTEGER
The return code.

DESCRIPTION: KEY1 must not be an entity key. The list identified by KEY1 and all lists created after it will be deleted. Deleted lists cannot be recovered. If an application list is locked, then it will not be deleted.

ERRORS:

Message	Description
BAD_LIST_POSITION	Error in processing lists.
BAD_LIST_REFERENCE	Given key is nil or not in stack of lists or is not a list.
BAD_DELETE_LIST	Given key is nil.
BAD_ENT_KEY	Found a nil list.
NO_MORE_ROOM	No more core memory.

MALOCK

FUNCTION: Set or unset the application list lock flag.

FORMAT: MALOCK(KEY1,LOCK,IRC)

INPUT:
KEY1 : LISTKEY
The list to be set.

LOCK : INTEGER
The lock setting
=0 unlocked
=1 locked

OUTPUT:
IRC : INTEGER
The return code

DESCRIPTION: A list that is locked will not be deleted by the interface functions MALDA or MALDI. All other functions that delete lists will delete a locked list.

ERRORS:

Message	Description
BAD_LIST_REFERENCE	Given key is not a list or is nil.
NO_MORE_ROOM	No more core memory.

4.4.5 EDIT OPERATIONS

The following table presents the edit routines:

DESCRIPTION	ROUTINE
Attach an entity or list of entities to a list.	MALATC
Insert an entity or list of entities into a list.	MALINS
Remove duplicate entries in a list.	MALRDE
Replace a list.	MALREP
Remove an entity from a list.	MALRMV
Reorder list of entities in user to constituent order.	MALROR
Replace an entity in a list.	MALRPL
Reverse the order of a list	MALRVS
Sorts a list using order provided by a user defined function	MALSRT

MALATC

FUNCTION: Attach an entity or list of entities to a list. If KEY1 is an entity then attach to the constituent list of that entity.

FORMAT: MALATC(KEY1,KEY2,IRC)

INPUT:
KEY1 : ANYKEY
The entity or list of entities to which KEY2 is to be attached.

KEY2 : ANYKEY
The entity or list to be attached to KEY1.

OUTPUT:
IRC : INTEGER
The return code.

DESCRIPTION: KEY1 may be either an entity key or a list key. If KEY1 is a list, then KEY2 is attached to the list. If KEY1 is an entity, then KEY2 is attached to the constituent list of KEY1. This will make KEY2 a constituent of KEY1. KEY2 may be either an entity key or a list key. If KEY2 is a list, then the entire list is attached to KEY1. This is the same as doing multiple attaches of an entity. If KEY2 is an entity, then the entity is attached to KEY1.

EXAMPLE: See Sample Programs Section.

ERRORS:

Message	Description
INVALID_CONNECTION	Given key is nil.
CANT_CONNECT	Given key is not an entity or list.
BAD_ENT_KEY	Given key(s) is nil.
NO_MORE_ROOM	No more core memory.

MALINS

FUNCTION: Insert an entity or list of entities into a list. If KEY1 is an entity, then insert into the constituent list of that entity.

FORMAT: MALINS(KEY1,KEY2,IPOS,IRC)

INPUT:
KEY1 : ANYKEY
The entity or list of entities in which KEY2 is to be inserted.

KEY2 : ANYKEY
The entity or list to be inserted in KEY1.

IPOS : INTEGER
The position in KEY1 where the insert is to take place.

OUTPUT:
IRC : INTEGER
The return code.

DESCRIPTION: KEY1 may be either an entity key or a list key. If KEY1 is a list, then KEY2 is inserted in the list. If KEY1 is an entity, then KEY2 is inserted in the constituent list of KEY1. KEY2 may be either an entity key or a list key. If KEY2 is a list, then the entire list is inserted in KEY1. If KEY2 is an entity, then the entity is inserted in KEY1.

The insert takes place before IPOS. That is, the entity at IPOS is moved by one position if KEY2 is an entity or by the number of elements in the list if KEY2 is a list. Then the elements are moved into the vacated positions.

ERRORS:

Message	Description
BAD_LIST_POSITION	Given position less than 1 or greater than length.
BAD_LIST_REFERENCE	Given key is nil.
INVALID_CRB_POSITION	Pointer to position of last read at constituent list is inconsistent.
CRB_POSITION_NOT_FOUND	No pointer to read position found.
NO_MORE_ROOM	No more core memory.

MALRDE

FUNCTION: Remove duplicate entries in a list.

FORMAT: MALRDE(KEY1,IRC)

INPUT:
KEY1 : LISTKEY
The input/output list.

OUTPUT:
IRC : INTEGER
The return code.

DESCRIPTION: Any duplicate entities found in the input list will be removed. The change is made in-place. The first instance of each entity will be kept.

ERRORS:

Message	Description
BAD_LIST_REFERENCE	Given key is not a list.
DUPLICATES_NOT_REMOVED	
NO_MORE_ROOM	No more core memory.

MALREP

FUNCTION: Replace a list. If KEY1 is an entity then replace the constituent list of that entity.

FORMAT: MALREP(KEY1,KEY2,IRC)

INPUT:
KEY1 : ANYKEY
The entity or list of entities to be replaced.

KEY2 : ANYKEY
The entity or list to replace KEY1.

OUTPUT:
IRC : INTEGER
The return code.

DESCRIPTION: KEY1 may be either an entity key or a list key. If KEY1 is a list then KEY2 replaces KEY1. If KEY1 is an entity then the constituent list of KEY1 is replaced by KEY2. KEY2 may be either an entity or a list key.

ERRORS:

Message	Description
BAD_LIST_REFERENCE	Given key(s) is nil or not an entity or a list.
INVALID_CRB_POSITION	Pointer to position of last read of constituent list is inconsistent.
CRB_POSITION_NOT_FOUND	No pointer to read position found.
BAD_ENT_KEY	Given key(s) is nil.
NO_MORE_ROOM	No more core memory.

MALRMV

FUNCTION: Remove an entity from a list. If KEY1 is an entity, then remove it from the constituent list of that entity.

FORMAT: MALRMV(KEY1,IPOS,IRC)

INPUT:
KEY1 : ANYKEY
The entity or list of entities from which an entity is to be removed.

IPOS : INTEGER
The position, in the list, of the entity to be removed.

OUTPUT:
IRC : INTEGER
The return code.

DESCRIPTION: KEY1 may be either an entity key or a list key. If KEY1 is a list then an entity is removed from the list. If KEY1 is an entity then an entity is removed from the constituent list of KEY1. IPOS is the position number of the entity to be removed. The MAS delete rules are used to see if the entity can be removed from the constituent list.

ERRORS:

Message	Description
BAD_LIST_POSITION	Remove position = 0 or is greater than length.
BAD_LIST_REFERENCE	Given key is not an entity or a list.
INVALID_DELETE	Delete rule prohibits delete.
INVALID_CRB_POSITION	Pointer to position of last read of constituent list is inconsistent.
CRB_ENTRY_NOT_FOUND	Pointer to read position not found.
RULE_DOES_NOT_MATCH	Rules incorrectly defined.
NO_MORE_ROOM	No more core memory.

MALROR

FUNCTION: Reorder a list of entities so that the users appear at the head of the list.

FORMAT: MALROR(KEYL, IRC)

INPUT:
KEYL : LISTKEY
Key of an application list.

OUTPUT:
RC : INTEGER
Return code
0 = Good return
<0 Critical error
>0 Warning

DESCRIPTION: For each member of the list, search each of the remaining members for its users; put users at the head of the list.

MALRPL

FUNCTION: Replace an entity in a list. If KEY1 is an entity then replace in the constituent list of that entity.

FORMAT: MALRPL(KEY1,KEY2,IPOS,IRC)

INPUT:
KEY1 : ANYKEY
The entity or list of entities in which an entity is to be replaced.

KEY2 : ENTKEY
The entity that will replace an entity in KEY1.

IPOS : INTEGER
The position of the entity in KEY1 to be replaced.

OUTPUT:
IRC : INTEGER
The return code.

DESCRIPTION: KEY1 may be either an entity key or a list key. If KEY1 is a list, then an entity is replaced in the list. If KEY1 is an entity, then an entity is replaced in the constituent list of KEY1. KEY2 must be an entity key. The entity at position IPOS in KEY1 will be replaced by KEY2. If the entity being replaced is "MARKED FOR DELETE," then an attempt is made to delete the entity.

ERRORS:

Message	Description
BAD_LIST_POSITION	Remove position = 0 or is greater than length.
BAD_LIST_REFERENCE	Given key is not an entity or a list.
INVALID_DELETE	Delete rule prohibits delete.
INVALID_CRB_POSITION	Pointer to position of last read of constituent list is inconsistent.
CRB_ENTRY_NOT_FOUND	Pointer to read position not found.
RULE_DOES_NOT_MATCH	Rules incorrectly defined.
NO_MORE_ROOM	No more core memory.

MALRVS

FUNCTION: Reverse the order of the entities in a list.

FORMAT: MALRVS(KEY1,IRC)

INPUT:
KEY1 : ANYKEY
The entity or list of entities in which the order of the entities is to be reversed.

OUTPUT:
IRC : INTEGER
The return code.

DESCRIPTION: KEY1 may be either an entity key or a list key. If KEY1 is a list, then the list is reversed. If KEY1 is an entity, then the constituent list is reversed.

ERRORS:

Message	Description
BAD_LIST_REFERENCE	Given key is nil or not an entity or a list.
NO_MORE_ROOM	No more core memory.

WARNING:

NO_LIST_CREATED	Given list is empty.

MALSRT

FUNCTION: Sorts an entity list using the order given in a user defined function.

FORMAT: MALSRT(KEY1,KEY2,IRC)

INPUT:
KEY1 : ANYKEY
The list of entity or applications to be sorted.

KEY2 : The name of the user defined function for ordering the list

OUTPUT:
IRC : INTEGER
The return code.

DESCRIPTION: This routine references a user defined function which provides the order sequence to be applied to the list to be sorted.

	Message	Description
ERRORS:	BAD_LIST_REFERENCE	Given key is nil or not an entity or a list.
	NO_MORE_ROOM	No more core memory.
WARNING:	NO_LIST_CREATED	Given list is empty.

4.4.6 SEQUENTIAL READ AND EXECUTE OPERATIONS

The following table shows routines that process a list sequentially (as if it were a file):

DESCRIPTION	ROUTINE
Read the next entry in a list.	MALRD
Setup for reading in a forward direction.	MALSTF
Setup for reading in reverse direction.	MALSTR
Execute a procedure on an entity or a list of entities.	MAEXEQ
Execute a procedure on all entities of a specified KIND.	MAKXEQ
Execute a procedure on an entity or a list of entities.	MALXEQ
Execute a given procedure on constituents of entity.	MAECXQ
Execute a procedure on the users of an entity.	MAEUXQ

The MALSTF and MALSTR set up a list for forward or reverse reading of an application list. Forward reading is assumed and need not be called explicitly before a read or an execute function is used. However, after an end-of-list is signaled, the list is disabled. An explicit setup must be done to enable the list.

MALRD

FUNCTION: Read the next entry in a list.

FORMAT: MALRD(KEY1,KEY2,IRC)

INPUT:
KEY1 : ANYKEY
The entity or list of entities to be read.

OUTPUT:
KEY2 : ENTKEY
The entity of the next list entry. Next depends on the direction of the read set by MALSTF or MALSTR.

IRC : INTEGER
The return code.

DESCRIPTION: The next entity in the list is returned. Always set the direction by using MALSTF or MALSTR before the first time this routine is used to read a list.

ERRORS:

Message	Description
BAD_LIST_REFERENCE	Given key is nil or not an entity or a list.
INVALID_CRB_POSITION	Pointer to position of last read of constituent list is inconsistent.
CRB_ENTRY_NOT_FOUND	Pointer to read position not found.
NO_MORE_ROOM	No more core memory.

MALSTF

FUNCTION: Setup for reading in forward direction.

FORMAT: MALSTF(KEY1,IRC)

INPUT:
KEY1 : ANYKEY
The entity or list of entities to be processed in a forward direction.

OUTPUT:
IRC : INTEGER
The return code.

DESCRIPTION: If KEY1 is an entity, then the constituent list of KEY1 will be set up.

ERRORS:

Message	Description
BAD_LIST_REFERENCE	Given key is not an entity or a list.
BAD_ENT_KEY	Given key is nil.
INVALID_CRB_POSITION	Pointer to position of last read of constituent list is inconsistent.
CRB_ENTRY_NOT_FOUND	Pointer to direction of read not found.
NO_MORE_ROOM	No more core memory.

MALSTR

FUNCTION: Setup for reading in reverse direction.

FORMAT: MALSTR(KEY1,IRC)

INPUT:
KEY1 : ANYKEY
The entity or list of entities to be processed in the reverse direction.

OUTPUT:
IRC : INTEGER
The return code.

DESCRIPTION: If KEY1 is an entity then the constituent list of KEY1 will be setup.

ERRORS:

Message	Description
BAD_LIST_REFERENCE	Given key is not an entity or a list.
BAD_ENT_KEY	Given key is nil.
INVALID_CRB_POSITION	Pointer to position of last read of constituent list is inconsistent.
CRB_ENTRY_NOT_FOUND	Pointer to direction of read not found.
NO_MORE_ROOM	No more core memory.

The application-supplied procedure invoked by the "execute" functions must conform to the declaration shown below:

```
Procedure PROC(KEY,ENTDEF,DATA,IRC)

     INPUT:
          1) KEY is an entity key.
          2) ENTDEF is the entity ADB declaration.
          3) DATA is a variant data structure used as needed by the
             procedure.  DATA is the input data structure passed originally
             to an EXECUTE function.

     OUTPUT:
          1) IRC is the return code produced by the "PROC".
```

The application procedure called from MAEXEQ and MAKXEQ have the following return code values:

```
          RCC >=0  and  RCC <=7
               processing OK
     The EXECUTE routine continues processing.

          RCC >=8  and  RCC <=15
               procedure_code_error
     The EXECUTE routine halts processing.

          RCC < 0  or   RCC > 15
               procedure_out_of_range
     The EXECUTE routine halts processing.
```

The application procedure called from MALXEQ has the following return code values:

```
          RCC = 0   or   RCC = 1
               processing OK
     The EXECUTE routine adds an entity to the output list and
     continues processing.

          RCC >=2  and  RCC <=7
               procedure_warning_code
     The EXECUTE routine continues processing.

          RCC >=8  and  RCC <=15
               procedure_code_error
     The EXECUTE routine halts processing.
```

MAEXEQ

FUNCTION: Execute a procedure on a entity or a list of entities.

FORMAT: MAEXEQ(KEY1,DATA,PROC,RCC,IRC)

INPUT:

KEY1 : ANYKEY
The entity or list of entities on which the application procedure should be performed.

DATA : VARIANT
The application defined data structure which either supplies or receives the values operated on by the application defined procedure.

PROC : ENTRY POINT
The entry point of an application defined procedure.

OUTPUT:

RCC : INTEGER
The procedure PROC return code.

IRC : INTEGER
The MAS return code.

DESCRIPTION: The entity, or each entity in a list, is passed to the application-defined procedure. The operation performed on the entity is determined by the application-defined procedure.

EXAMPLE: See Sample Programs Section.

ERRORS:

Message	Description
BAD_LIST_REFERENCE	Given key is nil or not an entity or a list.
PROC_CODE_ERROR PROC_OUT_OF_RANGE	Return error code greater than 15.
NO_MORE_ROOM	No more core memory.

MAKXEQ

FUNCTION: Execute a procedure on all entities of a specified kind.

FORMAT: MAKXEQ(KIND,DATA,PROC,RCC,IRC)

INPUT:

KIND : INTEGER
The KIND value of the entities to be processed.

DATA : VARIANT
The application-defined data structure, which either supplies or receives the values operated on by the application-defined procedure.

PROC : ENTRY POINT
The entry point of an application-defined procedure.

OUTPUT:

RCC : INTEGER
The procedure PROC return code.

IRC : INTEGER
The MAS return code.

DESCRIPTION: Each entity of the specified kind is passed to the application-defined procedure. The operation performed on the entity is determined by the application-defined procedure.

ERRORS:

Message	Description
BAD_LIST_POSITION	Schema inconsistent.
PROC_CODE_ERROR	
PROC_OUT_OF_RANGE	Returned error code greater than 15.
NO_MORE_ROOM	No more core memory.

WARNING:

NO_SUCH_SCHEMA	No definition for given kind.

MALXEQ

FUNCTION: Execute a procedure on a entity or a list of entities. Construct an output list of entities as determined by the application procedure.

FORMAT: MALXEQ(KEY1,DATA,PROC,KEY2,RCC,IRC)

INPUT:

KEY1 : ANYKEY
The entity or list of entities to be processed.

DATA : VARIANT
The application-defined data structure, which either supplies or receives the values operated on by the application-defined procedure.

PROC : ENTRY POINT
The entry point of an application-defined procedure.

OUTPUT:

KEY2 : LISTKEY
The list created by this function.

RCC : INTEGER
The procedure PROC return code.

IRC : INTEGER
The return code produced by this operation.

DESCRIPTION: An empty list (KEY2) is created. The entity, or each entity in sequence if a list is supplied, is passed to the application-defined procedure. The operation performed on the entity is determined by the application-defined procedure. When the application return code of "success," (0 or 1), is returned from the application procedure, the entity just processed is added to the result list. When an application error return code (less than 0 or greater than 7) is returned from the application procedure, MALXEQ is terminated. When an application warning return code (2 through 7) is returned from the application procedure, the entity just processed is not placed on the result list, but processing continues.

MALXEQ (Cont.)

	Message	Description
ERRORS:	BAD_LIST_REFERENCE	Given key is not an entity or a list.
	BAD_ENT_KEY	Given key is nil.
	PROC_CODE_ERROR	
	PROC_OUT_OF_RANGE	Returned error code greater than 15.
	INVALID_CRB_POSITION	Pointer to position of read of the constituent list inconsistent.
	CRB_POS_NOT_FOUND	Pointer to position of read not found.
	NO_MORE_ROOM	No more core memory.
WARNING:	PROC_WARNING_CODE	
	NO_LIST_CREATED	No entities executed sucessfully.

MAECXQ

FUNCTION: Given a user-defined procedure, perform this procedure on the constituents of an entity or list of entities.

FORMAT: MAECXQ(KEY1, DATAREC, PROCNM, KEY2, RRC, IRC)

INPUT:

KEY1 : ANYKEY
Key of an entity or an application list thats constituent(s) are to be processed.

DATAREC : BLKDATA
Data to be supplied to the procedure.

PROCNM : ROUTINE
Routine supplied by caller that processes one entity at a time.

OUTPUT:

KEY2 : LISTKEY
Key to the list of constituents that processed without error.

RRC : INTEGER
Return code of the user-defined procedure.

IRC : INTEGER
Return code
0 = Good return
<0 Critical error
>0 Warning

DESCRIPTION: For each constituent of an entity read from the position and in the direction indicated in its user constituent list, process by the user-defined procedure. For each entity processed without error, add to the output list.

MAEUXQ

FUNCTION: Given a user-defined procedure, perform this procedure on the users of an entity or list of entities.

FORMAT: MAEUXQ(KEY1, DATAREC, PROCNM, KEY2, RRC, IRC)

INPUT:

KEY1 : ANYKEY
Key of an entity or an application list thats user(s) are to be processed.

DATAREC : BLKDATA
Data to be supplied to the procedure.

PROCNM : ROUTINE
Routine supplied by the caller that processes one entity at a time.

OUTPUT:

KEY2 : LISTKEY
Key to the list of users that processed without error.

RCC : INTEGER
Return code of the user-defined procedure.

IRC : INTEGER
Return code
0 = Good return
<0 Critical error
>0 Warning

DESCRIPTION: For each user of an entity or an entity on the list of entities, process by the user-defined procedure. For each user processed without error, add to the output list.

SECTION 5

GENERAL UTILITIES

This section contains descriptions of available general utility routines, as shown in the table below.

DESCRIPTION	ROUTINE
Get number of different KIND values in the working-form model.	MAECTK
Get KIND value stored at specific position in KIND list.	MAEKND
Determine if an entity has any users.	MAEUSR
Get actual model space used and amount of model free space.	MASMSZ
Determine the number of entities in the model of a specified KIND.	MAKCNT

MAECTK

FUNCTION: Get the number of different KIND values in the working-form model.

FORMAT: MAECTK(KNDCNT,IRC)

INPUT:
NONE

OUTPUT:
KNDCNT: INTEGER
The number of different KIND values in the working-form model.

IRC : INTEGER
The return code.

DESCRIPTION: Get the number of KIND values in the working-form model from the KIND list.

NOTE: Works in conjunction with MAEKND.

MAEKND

FUNCTION: Get KIND value at specified position in the KIND list.

FORMAT: MAEKND(KNDPOS,KNDVAL,IRC)

INPUT:
KNDPOS: INTEGER
The position in the standard array of where to get the KIND value

OUTPUT:
KNDVAL: INTEGER
The KIND value retrieved from the KIND list

IRC : INTEGER
The return code.

DESCRIPTION: Get the KIND value at KNDPOS in the KIND list.

NOTE: Works in conjunction with MAECTK.

MAEUSR

FUNCTION: Determine if an entity has any users.

FORMAT: MAEUSR(KEY1,UEXIST,IRC)

INPUT:
KEY1 : ENTKEY
The entity whose user existence is to be determined.

OUTPUT:
UEXIST: INTEGER
The value indicating if the entity has users or not.
=0 No users exist
=1 Users exist

IRC : INTEGER
The return code.

DESCRIPTION: Determines if an entity has any users.

MASMSZ

FUNCTION: Determine actual model used space and model free space (in bytes).

FORMAT: MASMSZ(MODSIZ,FRESIZ,IRC)

OUTPUT:

MODSIZ : INTEGER
The total number of bytes used by the model.

FRESIZ : INTEGER
The total number of bytes of free space.

IRC : INTEGER
The return code.

DESCRIPTION: The used model space is calculated by taking the difference of allocated model space and free model space. This routine can only be used where the MAS memory manager is used.

MAKCNT

FUNCTION: Determine the number of entities in the model of a specified KIND.

FORMAT: MAKCNT(KIND,COUNT,IRC)

INPUT:
- KIND : INTEGER
  The KIND value for which a count is to be determined.

OUTPUT:
- COUNT : INTEGER
  The number of entities in the model of the specified KIND.
- IRC : INTEGER
  The return code.

DESCRIPTION: If the KIND specified is in the model, determine the number of entities with that KIND.

SECTION 6

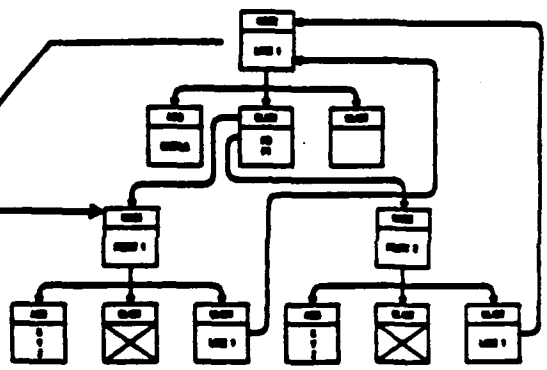
SAMPLE PROGRAMS

The following pages illustrate uses of the Access Software. These examples show Create and Get operations for a line.

DESCRIPTION	MAS ROUTINES USED
Create a Line	MAL, MALATC, MAECR, MALD
Get Constituents	MALNO, MALGTK
Get Users	MAEU, MALNO, MALGTK

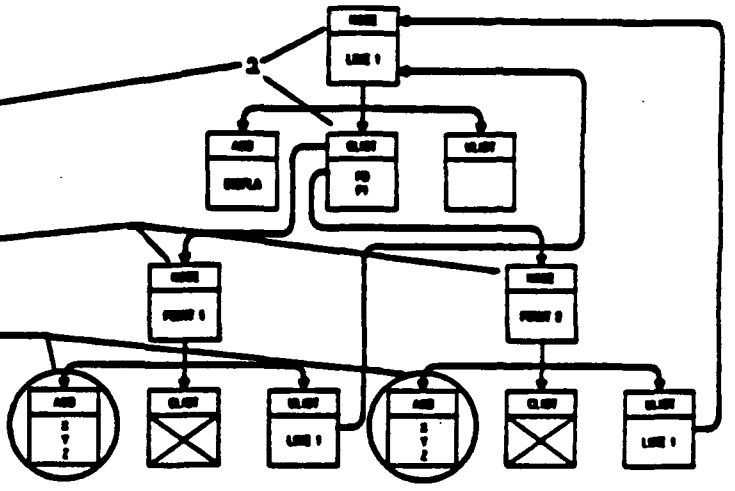
Line
Get Users

```
PROCEDURE USERS  ;
VAR
  BUFFER          : ENTBLOCK ;
  IRC             : EXT_RET_CODE ;
  KEYE_SMS        : ENTKEY ;
  KEYLC           : LISTKEY ;
  NEXT_USER       : INTEGER ;
  NUM_OF_USERS    : INTEGER ;
BEGIN
    .
    .  SELECT ENTITY
    .
(*  GET USER LIST *)
    MAEU (KEYE_SMS,KEYLC,IRC) ;

(*  GET NUMBER IN LIST *)
    MALNO (KEYLC,NUM_OF_USERS,IRC) ;

    WHILE NUM_OF_USERS > 0 DO BEGIN
      (* GET ENTITY FROM LIST*)
      MALSTK (KEYLC,NEXT_USER, KEYE_SMS,IRC) ;

      (* GET ADB FROM ENTITY*)
      MAESTK (KEYE_SMS,BUFFER,IRC) ;
      .
      .  DISPLAY ENTITY INFORMATION
      .
      NEXT_USER := NEXT_USER + 1 ;
      NUM_OF_USERS := NUM_OF_USERS - 1 ;
      END ;
END ;
```



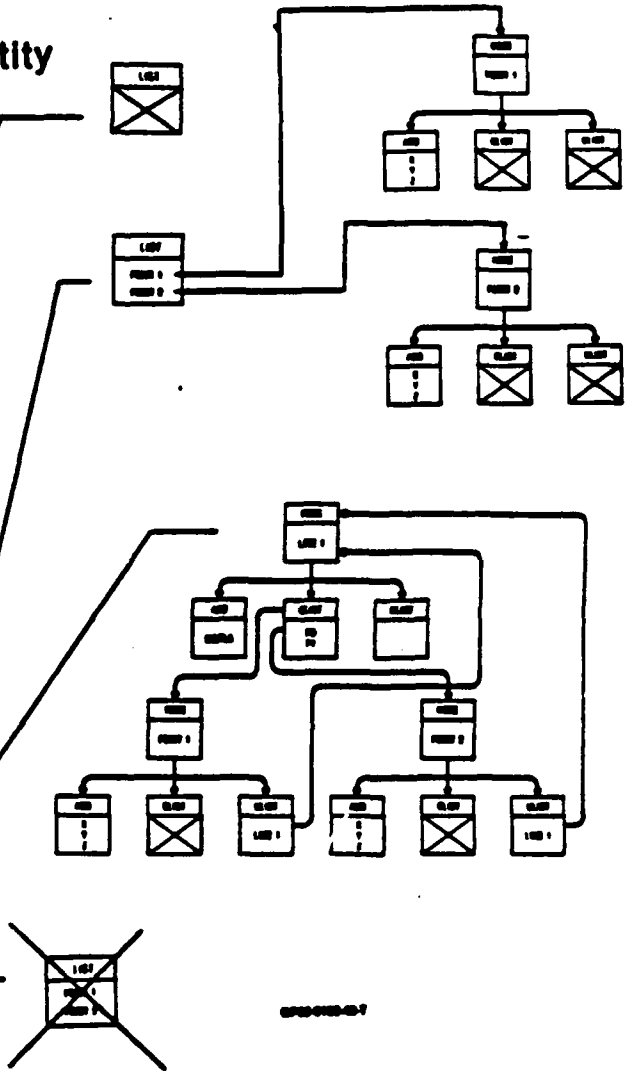
Line
Get Constituents

```
  EXAMP.DATA(CNSTNTS)
PROCEDURE CNSTNTS;
VAR
  BUFFER          : ENTBLOCK ;
  IRC             : EXT_RET_CODE ;
  CNSTNT_KEY      : ENTKEY ;
  KEYLC           : LISTKEY ;
  NEXT_CNSTNT_NO  : INTEGER ;
  NUM_OF_CONSTITUENTS : INTEGER ;
  NUM_OF_DATA_ENT : INTEGER ;
  RESPONSE        : OSRESPONSE ;
BEGIN

  VERIFY INPUT AND INITIALIZE

      NEXT_CNSTNT_NO := 1 ;
(*    DETERMINE NUMBER OF CONSTITS *)
      MALNO (INPUTKEY,NUM_OF_CONSTITUENTS, IRC) ;

        WHILE NUM_OF_CONSTITUENTS > 0
        DO BEGIN
(*        GET ENTITY KEY FROM LIST *)
          MALSTX (INPUTKEY,NEXT_CNSTNT_NO,
                  CNSTNT_KEY,IRC) ;
(*        GET ENTITY ADB *)
          MAESTX (CNSTNT_KEY,BUFFER,IRC) ;
          .
          USE THE DATA IN THE ADB
          .
          NEXT_CNSTNT_NO := NEXT_CNSTNT_NO + 1;
          NUM_OF_CONSTITUENTS :=
                  NUM_OF_CONSTITUENTS - 1 ;
        END ;
END ;
```



Line
Create an Entity

```
EXAMP.DATA(CRETLIN)
CC
        KIND   = KLINE
        LENGTH = LLINE
        SYSUSE = 0
        VERSUN = 0
        SYSID  = KIDENT
        IDENT  = JDENT
        DISPLA = DISPLY
        RGB(1) = 0
        RGB(2) = 0
        RGB(3) = 0
        INTENS = 0
        SYMBOL = DISTYP
C
C         CREATE AN EMPTY LIST
C
        CALL MAL (LIST,IRC)
        IF(IRC .NE. 0) GOTO 900
C
C   CREATE CONSTITUENT LIST OF LINE
C
          DO 100 I = 1,MLINE
          CALL MALATC(LIST,KEYPNT(I),IRC)
  100   CONTINUE
C
C         CREATE A LINE ENTITY
C
        CALL MAECR(ADB, LIST, KEY, IRC)
C
        IF(IRC .NE. 0) GOTO 900
C
C   DELETE LIST
        CALL MALD(LIST,IRC)
C
```



APPENDICES

INTRODUCTION

Valuable supplementary information not included earlier in this manual is included in this section.

ACCESS SOFTWARE CALLING PARAMETER INDEX

ACCESS SOFTWARE CALLING PARAMETER INDEX

ACCESS SOFTWARE CALLING PARAMETER INDEX

ACCESS SOFTWARE CALLING PARAMETER INDEX

ALPHABETICAL ACCESS SOFTWARE ROUTINE INDEX

ALPHABETICAL ACCESS SOFTWARE ROUTINE INDEX

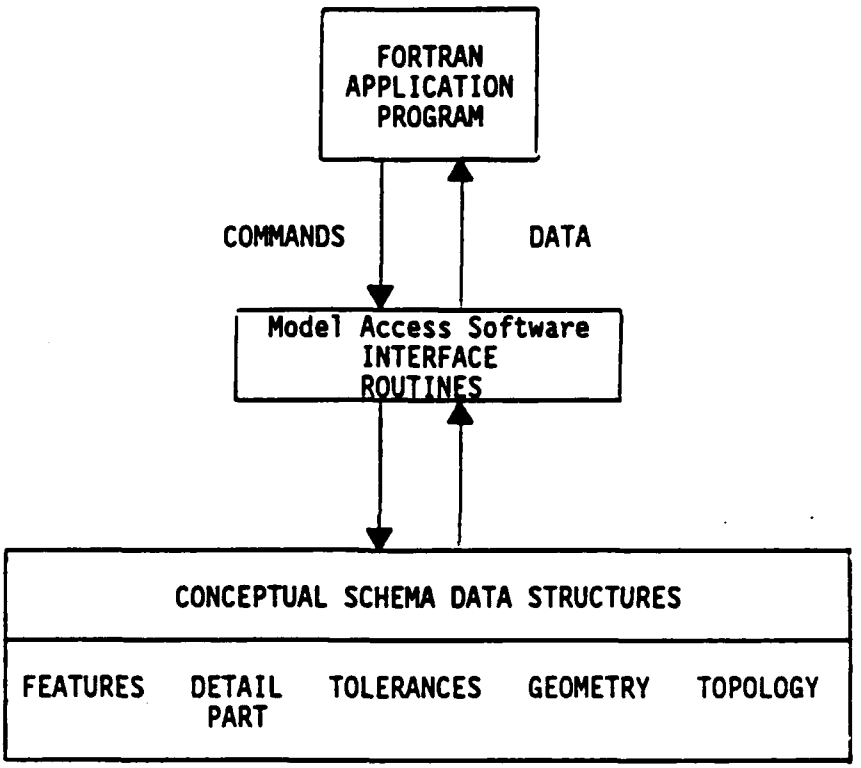
ACCESS SOFTWARE RETURN CODE INDEX

Error type	Code
NO_ERRORS_DETECTED	0
BAD_ENT_KIND	1
INVALID_CREATE	2
CANT_CREATE_LIST	3
MAS_INIT_FAILED	4
INVALID_UPDATE	5
CANT_UPDATE_ENT	6
CANT_CREATE_ENT	7
CANT_VERIFY_CONNECT	8
INVALID_CONNECTION	9
CANT_CONNECT	10
ABSENT_INPUT	11
INVALID_GET	12
NDS_OP_COMPLETE	13
BAD_LIST_POSITION	14
MAXIMUM_LIST_SIZE	15
BAD_LIST_MOVE_COUNT	16
BAD_LIST_REFERENCE	17
BAD_ENT_KEY	18
DUPLICATE_SCH	19
DUMP_ERROR	20
BAD_ENT_SIZE	21
BAD_SCH_KIND	22
PROC_CODE_ERROR	23
PROC_OUT_OF_RANGE	24
NO_MATCH_FOUND	25
DUPS_NOT_REMOVED	26
INVALID_DELETE	27
BAD_ENTITY_ON_USER_LIST	28
BAD_DELETE_KEY	29
EMPTY_MODEL	30
ARG_OUT_OF_RANGE	31
INVALID_CRB_POSITION	32
CRB_ENTRY_NOT_FOUND	33
INVALID_FLAG_NAME	34
CANT_MARK_ENTITY_DELETE	35
SIZE_NOT_CARE_ENOUGH	36
RTS_NOT_IN_WORKING_FORM	37
CORE_NOT_AVAILABLE	38
NOT_ENOUGH_CORE_FOR_INIT	39
ABSOLUTELY_NO_MORE_CORE	40

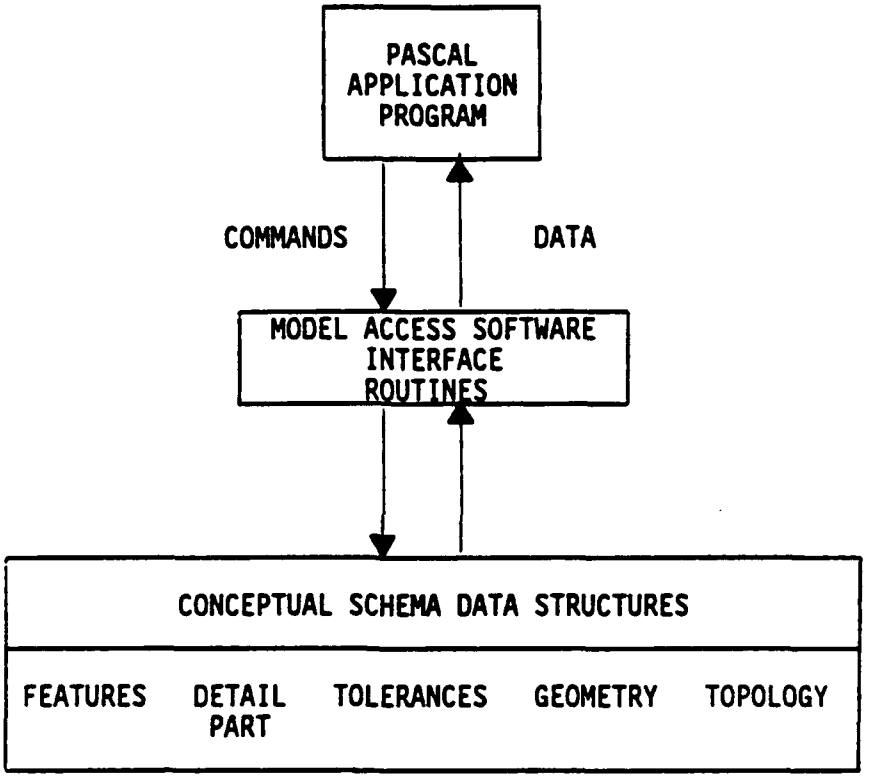
ACCESS SOFTWARE RETURN CODE INDEX

Warning type	Code
OKW	0
NO_SUCH_SCH	-1
PROC_WARNING_CODE	-2
EMPTY_DELETE_LIST	-3
EMPTY_EXCEPTION_LIST	-4
END_OF_LIST	-5
NO_LIST_CREATED	-6
EMPTY_MARK_LIST	-7

ACCESS SOFTWARE FORTRAN SCHEMA DIAGRAM



ACCESS SOFTWARE PASCAL SCHEMA DIAGRAM



GENERAL TECHNIQUES/GUIDELINES

- Avoid creating long lists of entities:
  - -Lists are processed sequentially
  - -Lists use model space

- Do not use ENTKEY as a memory address:
  - -ENTKEY does not address the attribute data block of the entity

- Avoid "nil" keys:
  - -Abend or nil pointer checking errors may be caused

- Delete application lists when no longer needed:
  - -Application lists use memory
  - -Application lists slow deletion of entities

- Always test the MAS interface return code:
  - -RC = 0 normal return
  - -RC < 0 warning message
  - -RC > 0 critical error

- Reset the process bit to "off" when it is no longer needed.

- Define the KIND and LENGTH fields in the ADB.

- When MALRD is used in conjunction with one of the following interface routines:

  MAED MALINS
  MAEDI MALRMV
  MAL

  the position of sequential reading is incremented/decremented if an interface function modifies the list.

  Do not use MALGTK and one of the above routines because the local variable position cannot be adjusted by the MAS package.

For example:

```
VAR NUM_IN_LIST: = INTEGER

BEGIN

    FOR I = 1 TO NUM_IN_LIST     DO

        MALGTK (LISTKEY, NUM_IN_LIST, ENTKEY1):

        MAED (ENTKEY1, LISTX):

END:
```

As each entity is deleted, it is removed from the LISTKEY list, but I is not adjusted.

- With the exception of MAL and MALK, empty lists will not be created. If an interface function has an output LISTKEY and the list is empty, the list will not be created and the LISTKEY will be NIL. A warning return code will indicate this situation.

RUN-TIME ENVIRONMENT

INTRODUCTION

The Access Software consists of a set of Pascal procedures that provides an interface to the working form model for application programs. When the application programs are written in a language other than Pascal, the run-time environment must satisfy the interlanguage communication requirements of all the languages involved. This appendix discusses the MAS interlanguage environment conventions and the composition of the Pascal dynamic storage areas. Examples are given for a FORTRAN program that uses MAS routines.

INTERLANGUAGE CONVENTIONS

When the MAS subprograms were compiled, they were defined as PROCEDUREs using SUBPROGRAM declarations. The subprogram declaration is an extension to IBM Pascal that allows a Pascal procedure to be called from any language. The subprogram declaration supplies special code at compile time. At run-time, this code determines the nature of the calling program. For non-Pascal calls, two macros are invoked: Prolog and Epilog. Before the procedure executes, Prolog locates the Pascal Communication Work Area (PCWA) as well as the main and local Dynamic Storage Areas (DSA) and establishes the Pascal register conventions. On exit, the Epilog macro restores the register conventions of the calling program.

The effect of this method is that no special action is required by the calling program, regardless of its language.

The SUBPROGRAM declaration may also be applied to application procedures, which may then be called from, and make calls to, routines of any language. This method is limited to Pascal PROCEDURES and does not apply to Pascal FUNCTIONS.

ESTABLISHING INTERLANGUAGE ENVIRONMENT

The preferred (and easiest) approach is to insert the entire application into a Pascal program. This method assures correct error handling.

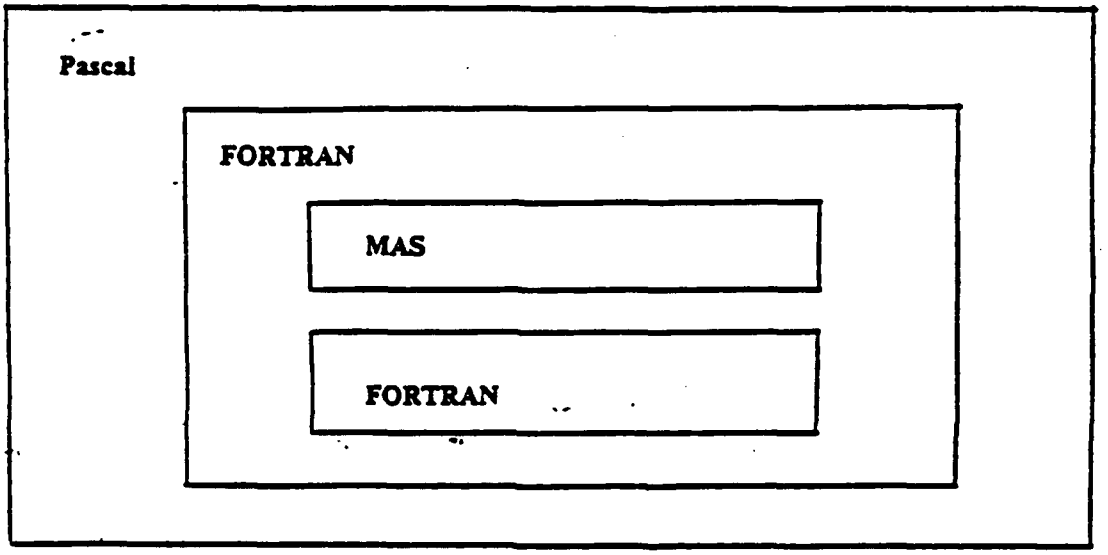


Figure G-1

An alternate approach is to insert the portion of the application that makes the MAS calls into a Pascal procedure that is declared MAIN. The error handling capability, however, may be limited in this method. Note that the model created within the scope of the MAIN Pascal procedure is active only during the execution of the MAIN procedure; new models may be created in subsequent calls to a similarly declared MAIN procedure. Upon termination of the last call to a Pascal MAIN, the procedure PSCLHX should be called to terminate the Pascal run-time environment.

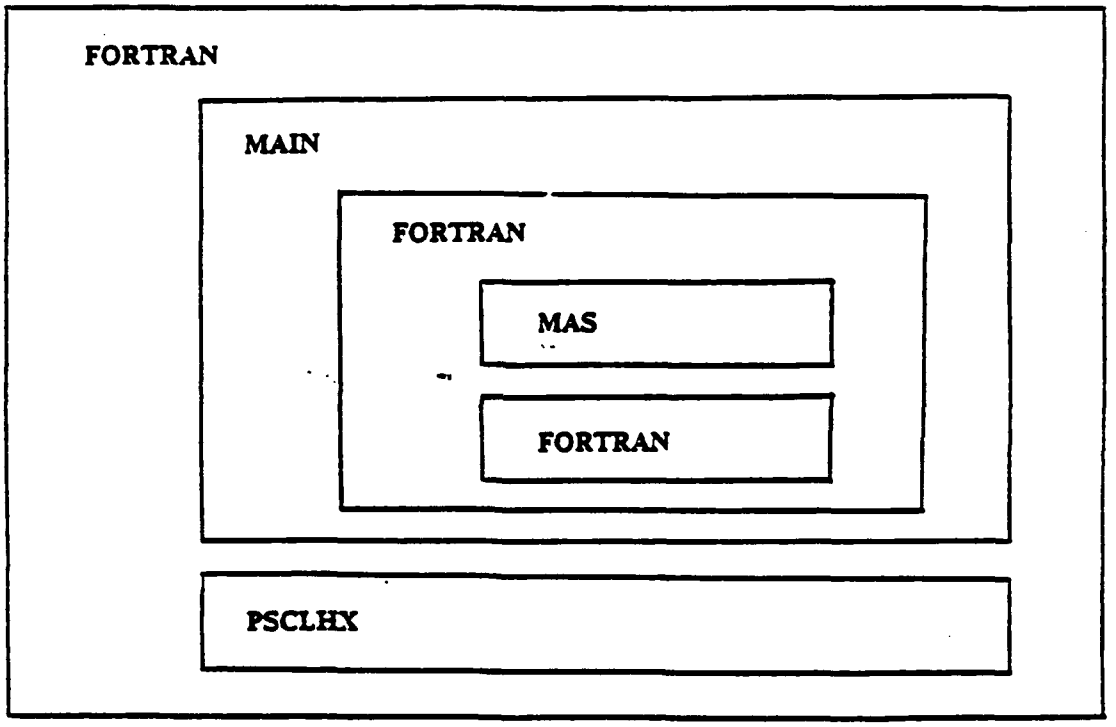


Figure G-2

Examples of the Pascal source and link-edit instructions are included at the end of this appendix.

REGISTER CONVENTIONS

The interlanguage environment establishes the correct register conventions automatically. The following information is included for use from the IBM TEST mode.

Register	Pascal	Non-Pascal
15	Branch address	Branch address
14	Return address	Return address
13	Local DSA address (1)	Save area address
12	PCWA address	
11	Main DSA address	
1	Address of parameter list (2) (3)	Address of parameter list
0	(2)	Function value

NOTES: (1) The save area is the first entry in the local DSA, which is established by a Pascal caller.

(2) The function value for Pascal is referred to by the first entry in the parameter list. Pascal input parameters for a function are referred to as starting with the second entry in the parameter list.

(3) The parameter list contains addresses of parameters except for pass-by-value of scalars, pointers, or sets, in which case the parameter list contains the actual value.

PASCAL DYNAMIC STORAGE AREA

The dynamic storage area of the Pascal main program contains global variables (including any commons). Each Pascal procedure invoked has a local dynamic storage area containing local variables. The dynamic storage areas are contained in a LIFO stack.

In general, the DSA of a routine consists of five sections:

(1) The local save area (144).

(2) Parameters passed in by the caller.

(3) Local variables required by the routine.

(4) A save area required by any routine that will be called.

(5) Storage for the largest parameter list to be built for a call.

Sections 1 and 2 are allocated by the calling routine; Sections 3, 4, and 5 are allocated by the Prolog of the called routine.

Every DSA is at least 144 bytes long. This is the storage required by Pascal/VS for a save area. The local variables and parameters of the routine are mapped within the DSA starting at offset 144.

Upon entering a routine, Register 1 points 144 bytes into the DSA of the routine, which is where the parameters passed in by the caller reside.

Upon invocation, Register 13 points to the base of the DSA of the caller, which is where the save area of the caller is located. Figure 3 illustrates the condition of the stack and relevant registers immediately upon the start of the routine.

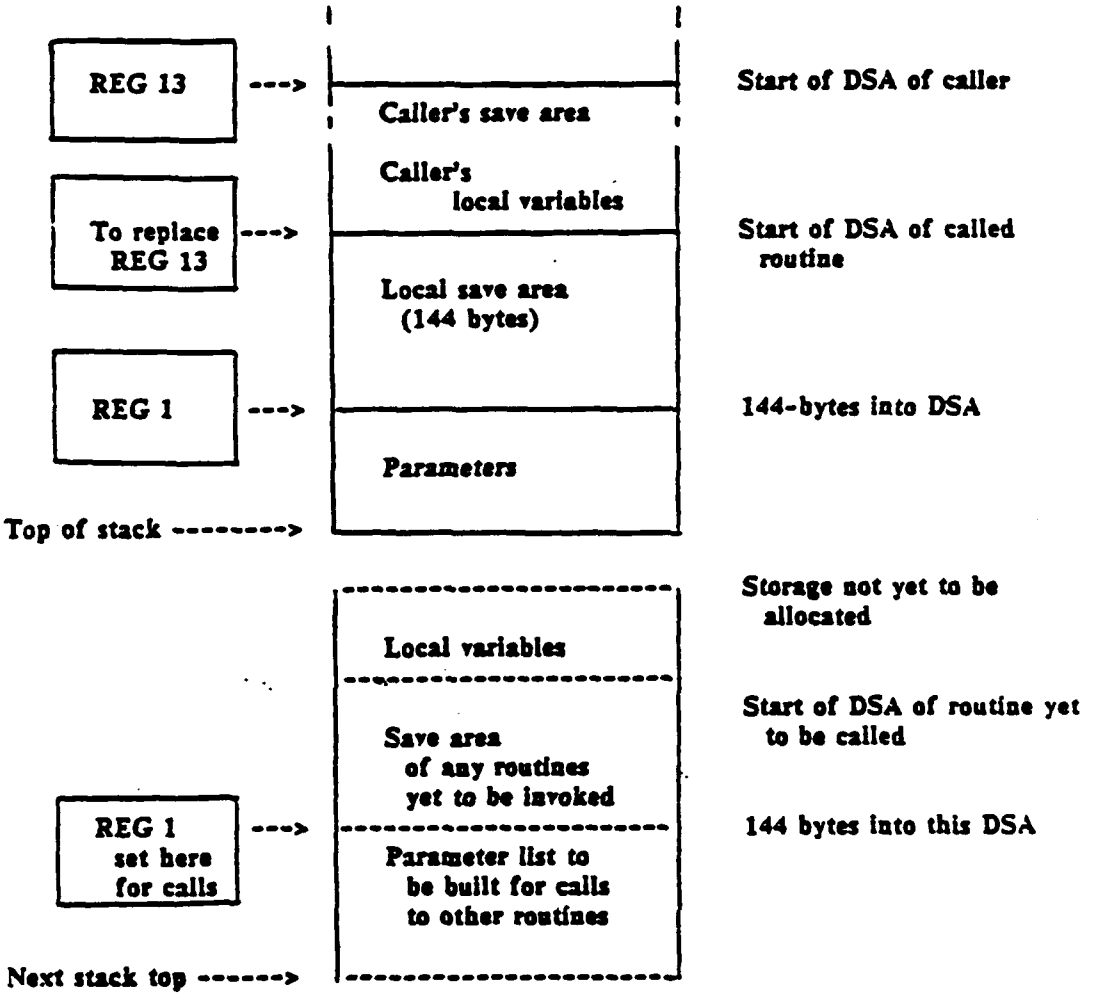

REG 13
--->
Caller's save area
Start of DSA of caller
Caller's
local variables
To replace
REG 13
--->
Start of DSA of called
routine
Local save area
(144 bytes)
REG 1
--->
144-bytes into DSA
Parameters
Top of stack -------->
Storage not yet to be
allocated
Local variables
Start of DSA of routine yet
to be called
Save area
of any routines
yet to be invoked
REG 1
set here
for calls
--->
144 bytes into this DSA
Parameter list to
be built for calls
to other routines
Next stack top ------>

Figure G-3

EXAMPLES

EXAMPLE 1: PASCAL PROGRAM (PASMAIN) THAT INVOKES FORTRAN MAIN

PASCAL PROGRAM

```
PROGRAM PASMAIN;
PROCEDURE MAIN; FORTRAN;
BEGIN
MAIN;                          Invoke FORTRAN main.
END.
```

LINKEDIT INSTRUCTIONS

```
INCLUDE APLLIB(PASMAIN)
INCLUDE APLLIB(APL    )        FORTRAN main object,
                               list of objects including FORTRAN main,
                               or LOAD module including FORTRAN main.
INCLUDE MASLIB(MAS    )
ENTRY   PASMAIN
```

where SYSLIB allocation includes SYS1.PASCLIB.

EXAMPLE 2: PASCAL PROCEDURE (PASSUB) INVOKED BY FORTRAN MAIN THAT INVOKES FORTRAN SUBROUTINE (FORSUB)

PASCAL PROCEDURE

```
SEGMENT PASSUB;
PROCEDURE PASSUB (....);MAIN;        FORTRAN MAIN may pass parameters to the
                                     PASCAL subroutine.
PROCEDURE PASSUB;
PROCEDURE FORSUB(....);FORTRAN;      PASCAL MAIN may pass parameters to the
                                     FORTRAN MAIN.
BEGIN
FORSUB(....);                        Invokes FORTRAN subroutine that calls
                                     MAS.
end;
```

FORTRAN MAIN PROGRAM

```
      .
      .
      .
CALL PASSUB(....)
CALL PSCLHX
      .
      .
      .
```

LINKEDIT INSTRUCTIONS

```
INCLUDE APLLIB(APL    )              List of objects including FORTRAN MAIN
                                     or LOAD module including FORTRAN MAIN.
INCLUDE APLLIB(PASSUB)
INCLUDE MASLIB(MAS    )
ENTRY APL
NAME APL
```

where SYSLIB allocation includes SYS1.PASCLIB.

MAS ERROR AND WARNING RETURN CODE INDEX

ERROR TYPE	CODE
NO_ERRORS_DETECTED	0
BAD_ENT_KIND	1
INVALID_CREATE	2
CANT_CREATE_LIST	3
MAS_INIT_FAILED	4
INVALID_UPDATE	5
CANT_UPDATE_ENT	6
CANT_CREATE_ENT	7
CANT_VERIFY_CONNECT	8
INVALID_CONNECTION	9
CANT_CONNECT	10
ABSENT_INPUT	11
INVALID_GET	12
NDS_OP_COMPLETE	13
BAD_LIST_POSITION	14
MAXIMUM_LIST_SIZE	15
BAD_LIST_MOVE_COUNT	16
BAD_LIST_REFERENCE	17
BAD_ENT_KEY	18
DUPLICATE_SCH	19
DUMP_ERROR	20
BAD_ENT_SIZE	21
BAD_SCH_KIND	22
PROC_CODE_ERROR	23
PROC_OUT_OF_RANGE	24
NO_MATCH_FOUND	25
DUPS_NOT_REMOVED	26
INVALID_DELETE	27
BAD_ENTITY_ON_USER_LIST	28
BAD_DELETE_KEY	29
EMPTY_MODEL	30
ARG_OUT_OF_RANGE	31
INVALID_CRB_POSITION	32
CRB_ENTRY_NOT_FOUND	33
INVALID_FLAG_NAME	34
CANT_MARK_ENTITY_DELETE	35
SIZE_NOT_LARGE_ENOUGH	36
RTS_NOT_IN_WORKING_FORM	37
CORE_NOT_AVAILABLE	38
NOT_ENOUGH_CORE_FOR_INIT	39
ABSOLUTELY_NO_MORE_CORE	40
MAINIT_ALREADY_DONE	41
RULE_DOES_NOT_MATCH	42
ENTITY_NOT_FOUND_LIST	43

WARNING TYPE	CODE
OKW	0
NO_SUCH_SCH	-1
PROC_WARNING_CODE	-2
EMPTY_DELETE_LIST	-3
EMPTY_EXCEPTION_LIST	-4
END_OF_LIST	-5
NO_LIST_CREATED	-6
EMPTY_MARK_LIST	-7
EMPTY_MARK_N_EXCEPTION	-8
EMPTY_DELETE_N_EXCEPTION	-9
EMPTY_MARK_N_DELETE	-10