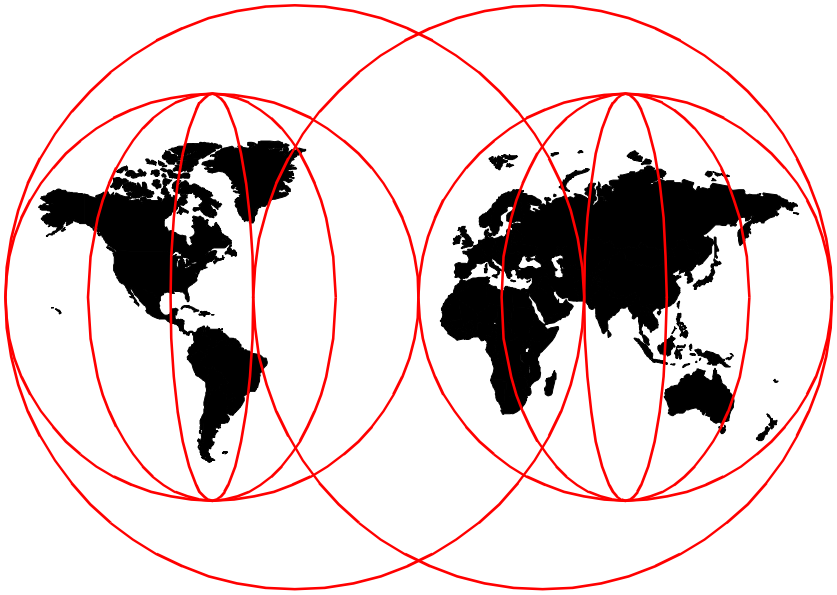
Getting Started with Data Warehouse and Business Intelligence

Maria Sueli Almeida, Missao Ishikawa, Joerg Reinschmidt, Torsten Roeber



International Technical Support Organization

www.redbooks.ibm.com

SG24-5415-00

SG24-5415-00

International Technical Support Organization

Getting Started with Data Warehouse and Business Intelligence

August 1999

Take Note!

Before using this information and the product it supports, be sure to read the general information in Appendix B, “Special Notices” on page 225.

First Edition (August 1999)

This edition applies to Version 5, Release 1of DB2 Server for VSE & VM Program Number 5648-158, Version 5, Release 1of DB2 Server for OS/390 Program Number 5655-DB2, Version 5.2 of IBM Visual Warehouse, Version 1.0.1 of IBM DB2 OLAP Server, Version 2.1.2 of IBM Intelligent Miner for Data, Version 5.2 of IBM DB2 UDB for NT, Version 2.1.1of IBM DB2 DataJoiner Classic Connect, Version 2.1.3 of IBM DB2 Datajoiner for use with the Windows NT operating system, and Version 5.2 of IBM DB2 UDB for AIX, Version 2.1.2 of IBM Intelligent MIner for Data, Version 2.1.3 of IBM DB2 DataJoiner, Version 2.1.1 of IBM DB2 DataJoiner Classic Connect for use with the AIX Version 4.3.1 Operating System, CrossAccess VSE V4.1.

Comments may be addressed to:
IBM Corporation, International Technical Support Organization
Dept. QXXE Building 80-E2
650 Harry Road
San Jose, California 95120-6099

When you send information to IBM, you grant IBM a non-exclusive right to use or distribute the information in any way it believes appropriate without incurring any obligation to you.

Contents

Figures

Tables

Preface

This redbook describes an operating environment that supports Data Warehousing and BI solutions on all available platforms. The book describes how this environment was established. This project was carried out at the ITSO San Jose Center. DRDA over TCP/IP, DataJoiner Classic Connect, Cross Access for VSE, and Datajoiner are used to create this environment.

The objective of creating this environment was to have a base BI environment to support Data Warehouse, OLAP, and Data Mining solutions. This book is not intended to show how to set up and configure the different products used; some of these have been covered in previous product-specific redbooks.

This redbook is intended to be used in conjunction with the redbooks: *Intelligent Miner for Data: Enhance Your Business Intelligence*, SG24-5422 and *My Mother Thinks I'm a DBA! Cross-Platform, Multi-Vendor, Distributed Relational Data Replication with IBM DB2 DataPropagator and IBM DataJoiner Made Easy!,* SG24-5463*.* Future redbooks will enhance and exploit this environment.

The Team That Wrote This Redbook

This redbook was produced by a team of specialists from around the world working at the International Technical Support Organization San Jose Center.

Maria Sueli Almeida is a Certified I/T Specialist - Systems Enterprise Data, and is currently a specialist in DB2 for OS/390 and Distributed Relational Database System (DRDS) at the International Technical Support Organization, San Jose Center. Before joining the ITSO in 1998, Maria Sueli worked at IBM Brazil assisting customers and IBM technical professionals on DB2, data sharing, database design, performance, and DRDA connectivity.

Missao Ishikawa is an Advisory I/T Specialist, supporting Intelligent Miner for OS/390 and Domino for S/390 in IBM Japan. He joined IBM in 1987 and has been working in various areas of technical support. He has worked for 1998 Nagano Olympics as a DB2 specialist, supporting all aspects of DB2 for OS/390.

Joerg Reinschmidt is an Information Mining Specialist at the International Technical Support Organization, San Jose Center. He writes extensively and teaches IBM classes worldwide on all areas of DB2 Universal Database, Internet access to legacy data, Information Mining, and Knowledge Management. Before joining the ITSO in 1998, Joerg worked in the Solution

Partnership Center in Germany as a DB2 Specialist, supporting independent software vendors (ISVs) to port their applications to use the IBM data management products.

Torsten Roeber is a Software Service Specialist with IBM Germany. He has several years of experience with VSE/ESA and DB2 (SQL/DS) for VSE and VM. During the last two years he has focused on distributed database issues in the VM/VSE and workstation environment.

Thanks to the following people for their invaluable contributions to this project:

Paolo Bruni
International Technical Support Organization, San Jose Center

Scott Chen
International Technical Support Organization, San Jose Center

Thomas Groh
International Technical Support Organization, San Jose Center

Rick Long
International Technical Support Organization, San Jose Center

Wiliam Tomio Kanegae
IBM Brazil

Wilhelm Mild
IBM Germany

Thanks also to the professionals from Cross Access Corporation, for supporting and writing about the CrossAccess product.

Comments Welcome

Your comments are important to us!

We want our redbooks to be as helpful as possible. Please send us your comments about this or other redbooks in one of the following ways:

- Fax the evaluation form found in “ITSO Redbook Evaluation” on page 243 to the fax number shown on the form.
- Use the electronic evaluation form found on the Redbooks Web sites:

  For Internet users `http://www.redbooks.ibm.com/`
  For IBM Intranet users `http://w3.itso.ibm.com`

- Send us a note at the following address:

  `redbook@us.ibm.com`

Chapter 1. What is BI ?

When reading about business intelligence (BI), one of the global definitions you may see is the one found on the IBM Business Intelligence Web page:

> "Business intelligence means using your data assets to make better business decisions. It is about access, analysis, and uncovering new opportunities."

Many of the concepts of business intelligence are not new, but have evolved and been refined based on experience gained from early host-based corporate information systems, and more recently, from data warehousing applications.

Given the increasing competition in today's tough business climate, it is vital that organizations provide cost-effective and rapid access to business information for a wide range of business users, if these organizations are to survive into the new millennium. The solution to this issue is a business intelligence system, which provides a set of technologies and products for supplying users with the information they need to answer business questions, and make tactical and strategic business decisions.

1.1 The Evolution of Business Information Systems

Inevitably the first question that arises when describing the objectives of a business intelligence system is, "Does a data warehouse have the same objectives and provide the same capabilities as a business intelligence system?" A similar question arose when data warehouses were first introduced, "Is a data warehouse similar to the corporate information systems and information centers we built in the past?" Although a quick and simple answer to both questions is "yes", closer examination shows that, just as there are important differences between a warehouse and early corporate information systems and information centers, there are also important differences between a business intelligence system and a data warehouse.

1.1.1 First-Generation: Host-Based Query and Reporting

Early business information systems employed batch applications to provide business users with the information they needed. The output from these applications typically involved huge volumes of paper that users had to wade through to get the answers they needed to business questions. The advent of terminal-driven time-sharing applications provided more rapid access to information, but these systems were still cumbersome to use, and required access to complex operational databases.

This first generation of business information systems could, therefore, only be used by information providers, such as business analysts, who had an intimate knowledge of the data and extensive computer experience. Information consumers, like business executives and business managers, could rarely use these early systems, and instead had to rely on information providers to answer their questions and supply them with the information they needed.

1.1.2 Second-Generation: Data Warehousing

The second generation of business information systems came with data warehousing, which provided a giant leap forward in capability. Data warehouses have several advantages over first-generation systems:

- Data warehouses are designed to satisfy the needs of business users and not day-to-day operational applications.
- Data warehouse information is clean and consistent, and is stored in a form business users can understand.
- Unlike operational systems, which contain only detailed current data, the data warehouses can supply both historical and summarized information.
- The use of client/server computing provides data warehouse users with improved user interfaces and more powerful decision support tools.

1.1.3 Third-Generation: Business Intelligence

A data warehouse is still not a complete solution to the needs of business users. One weakness of many data warehouse solutions is that the vendors often focus on technology, rather than business solutions. While there is no doubt that data warehouse vendors provide powerful products for building and accessing a data warehouse, these products can require a significant amount of implementation effort.

The issue here is that warehouse products rarely come prepackaged for specific industries or application areas, or address particular business problems. This is very much like the situation in the early days of client/server computing, when vendors initially provided the technology for developing operational applications, but then quickly realized that organizations were looking for application and business solutions, and not yet more technology. Vendors fixed this problem, with the result that today many operational client/server applications are built using application packages, rather than being handcrafted by developers.

The same evolution has to happen in business information systems – vendors must provide application packages, and not just more technology. One distinguishing factor of business intelligence systems is that they focus on providing prepackaged application solutions in addition to improved technology.

Another issue with data warehousing is that much of the focus is still on building the data warehouse, rather than accessing it. Many organizations seem to think that if they build a data warehouse and provide users with the right tools, the job is done. In fact, it is just beginning. Unless the information in the warehouse is thoroughly documented and easy to access, complexity will limit warehouse usage to the same information providers as first-generation systems.

Business intelligence systems focus on improving the access and delivery of business information to both information providers and information consumers. They achieve this by providing advanced graphical- and Web-based online analytical processing (OLAP) and information mining tools, and prepackaged applications that exploit the power of those tools. These applications may need to process and analyze large volumes of information using a variety of different tools. A business intelligence system must, therefore, provide scalability and be able to support and integrate products from multiple vendors.

A business intelligence system may also simplify access to business information through the use an information catalog that documents decision support objects that can be employed by information consumers to answer the main business questions that arise in everyday business operations. Some also reduce the need for information consumers to access the warehouse at all. Instead, information consumers subscribe to the information they require, and the system delivers it to them at predefined intervals through a corporate intranet or e-mail.

The information stored in a data warehouse is typically sourced from operational databases (and in some cases external information providers). There is, however, also a considerable amount of business information kept in office and workgroup systems, on Web servers on corporate intranets and the public Internet, and in paper form on people's desks. To solve this issue, business intelligence systems are designed to support access to all forms of business information, not only the data stored in a data warehouse. Having a business intelligence system does not negate the need for a data warehouse – a data warehouse is simply one of the data sources that can be handled by a business intelligence system.

We see, then, that a business intelligence system is a third-generation business information system that has three key advantages:

1. Business intelligence systems not only support the latest information technologies, but also provide prepackaged application solutions.
2. Business intelligence systems focus on the access and delivery of business information to end users, and support both information providers and information consumers.
3. Business intelligence systems support access to all forms of business information, and not just the information stored in a data warehouse.

Figure 1 gives an overall view of the IBM business intelligence structure.

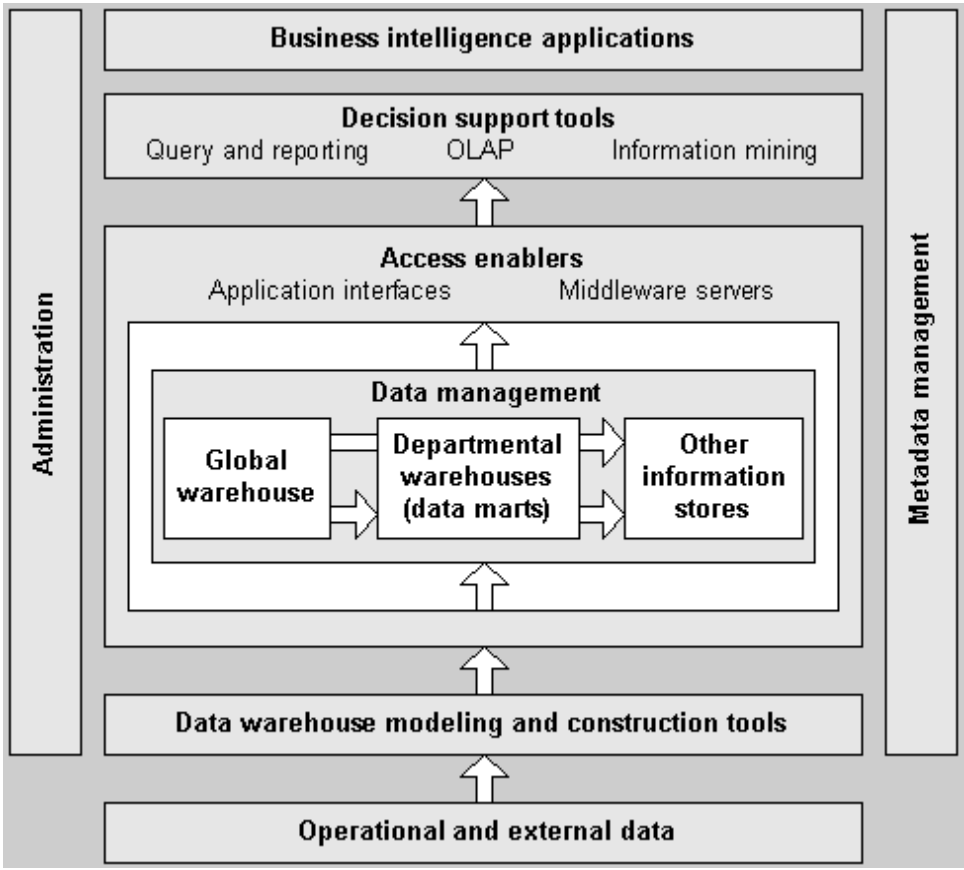


Figure 1. IBM Business Intelligence Structure

1.2 Why Do You Need Business Intelligence ?

Businesses collect large quantities of data in their day-to-day operations: data about orders, inventory, accounts payable, point-of-sale transactions, and of course, customers. In addition, businesses often acquire data, such as demographics and mailing lists, from outside sources. Being able to consolidate and analyze this data for better business decisions can often lead to a competitive advantage, and learning to uncover and leverage those advantages is what business intelligence is all about.

Some examples are:

- Achieving growth in sales, reduction in operating costs, and improved supply management and development.
- Using OLAP to reduce the burden on the IT staff, improve information access for business processing, uncover new sources of revenue, and improve allocation of costs.
- Using data mining to extract key purchase behaviors from customer survey data. NBA Coaches use IBM's Advance Scout to analyze game situations and gain a competitive advantage over other teams.

All of this is possible if you have the right applications and tools to analyze data, and more importantly, if the data is prepared in a format suitable for analysis. For a business person, it is most important to have applications and tools for data analysis, while for the IT community, having the tools to build and manage the environment for business intelligence is key.

1.3 What Do You Need for Business Intelligence ?

Business decision-makers have vastly different levels of expertise, and different needs for data analysis.

A wide range of approaches and tools are available, to meet their varied needs:

- Applications such as IBM's DecisionEdge for customer relationship management, and IBM's Business Discovery Series for data mining
- Query tools such as Impromptu and PowerPlay from Cognos, BusinessObjects from Business Objects, Approach from Lotus Development Corp., and IBM's Query Management Facility

- OLAP tools for multidimensional analysis such as Essbase from Arbor Software, and IBM's DB2 OLAP Server (developed in conjunction with Arbor)
- Statistical analysis tools such as the SAS System from SAS Institute Inc.
- Data Mining tools such as IBM's Intelligent Miner

Many of these applications and tools feature built-in support for Web browsers and Lotus Notes, enabling users to get the information they need from within a familiar desktop environment.

Most businesses do not want informal access to their operational computer systems, either for security or performance reasons. Rather, they prefer to build a separate system for business intelligence applications. To build these systems, tools are needed to extract, cleanse, and transform data from source systems which may be on a variety of hardware platforms, using a variety of databases. Once the data is prepared for business intelligence applications, the data is stored in a database system and must be refreshed and managed. These systems are called data warehouses or data marts, and the process of building and maintaining them is called data warehouse or data mart generation and management.

IBM's principal solution for generating and managing these systems is Visual Warehouse. Other IBM offerings such as the Data Replication Family and DataJoiner (for multi-vendor database access) can complement Visual Warehouse as data is moved from source to target systems. IBM also partners with companies such as Evolutionary Technologies International for more complex extract capabilities and Vality Technology Inc. for data cleansing technology.

For the warehouse database, IBM offers the industry leader: DB2. The DB2 family spans AS/400 systems, RISC System/6000 hardware, IBM mainframes, non-IBM machines from Hewlett-Packard and Sun Microsystems, and operating systems such as OS/2, Windows (95 & NT), AIX, HP-UX, SINIX, SCO OpenServer, and Solaris Operating Environment. When DataJoiner is used in conjunction with Visual Warehouse, non-IBM databases such as those from Oracle, Sybase, and Informix can be used as the warehouse database.

1.4 Business Driving Forces

So far we have seen that many of the driving forces behind business intelligence come from the need to improve ease-of-use and reduce the resources required to implement and use new information technologies. There are, however, three additional important business driving forces behind business intelligence:

1. The need to increase revenues, reduce costs, and compete more effectively. Gone are the days when end users could manage and plan business operations using monthly batch reports, and IT organizations had months to implement new applications. Today companies need to deploy informational applications rapidly, and provide business users with easy and fast access to business information that reflects the rapidly changing business environment. Business intelligence systems are focused towards end-user information access and delivery, and provide packaged business solutions in addition to supporting the sophisticated information technologies required for the processing of today's business information.
2. The need to manage and model the complexity of today's business environment. Corporate mergers and deregulation means that companies today are providing and supporting a wider range of products and services to a broader and more diverse audience than ever before. Understanding and managing such a complex business environment and maximizing business investment is becoming increasingly more difficult. Business intelligence systems provide more than just basic query and reporting mechanisms, they also offer sophisticated information analysis and information discovery tools that are designed to handle and process the complex business information associated with today's business environment.
3. The need to reduce IT costs and leverage existing corporate business information. The investment in IT systems today is usually a significant percentage of corporate expenses, and there is a need not only to reduce this overhead, but also to gain the maximum business benefits from the information managed by IT systems. New information technologies like corporate intranets and thin-client computing help reduce the cost of deploying business intelligence systems to a wider user audience, especially information consumers like executives and business managers. Business intelligence systems also broaden the scope of the information that can be processed to include not only operational and warehouse data, but also information managed by office systems and corporate Web servers.

1.5 Business Intelligence Requirements

Summarizing the two previous sections, we see that the main requirements of a business intelligence system are:

- Support for prepackaged application solutions.
- A cost-effective solution that provides a quick payback to the business and enables an organization to compete more effectively.
- Fast and easy access to an organization's business information for a wide range of end users, including both information providers and information consumers.
- Support for modern information technologies, including information analysis and discovery techniques like online analytical processing (OLAP) and information mining.
- An open and scalable operating environment.

Now that we have defined what a business intelligence system is, and have also identified its key requirements, we can move on to look at IBM's business intelligence strategy and products.

1.6 The IBM Business Intelligence Product Set

This part of the paper reviews the products and tools provided by IBM (and its key partners) for supporting a business intelligence software environment — these products are listed in Figure 2.

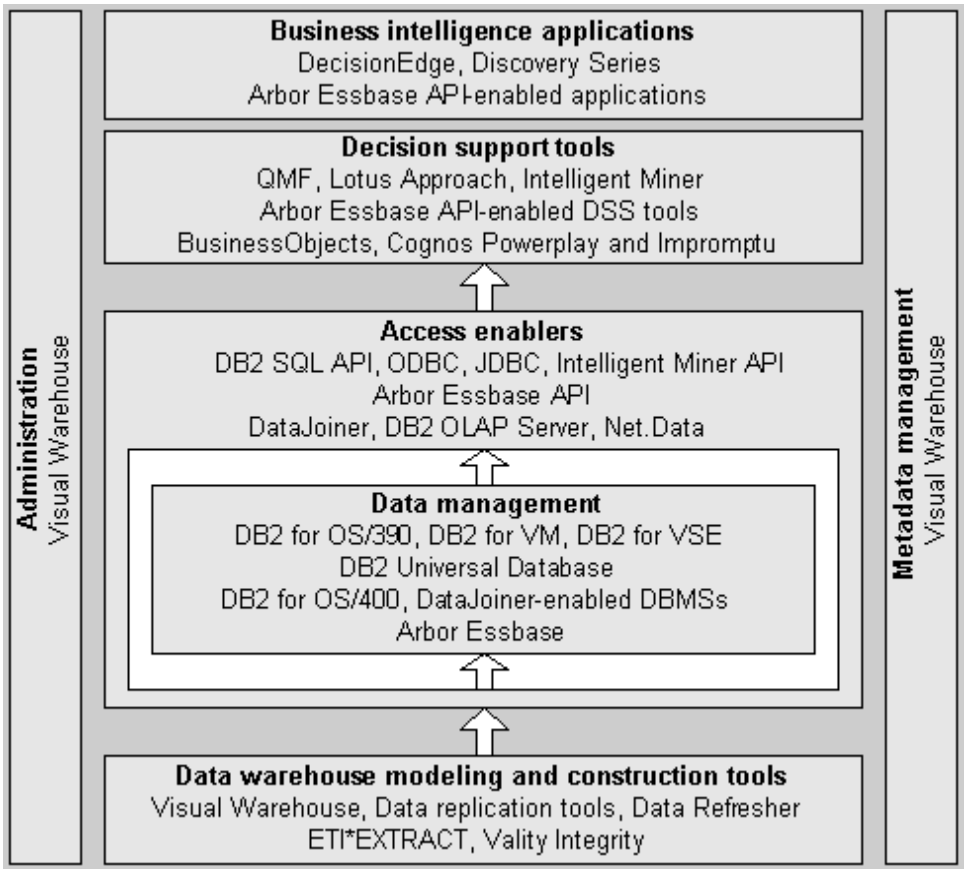


Figure 2. IBM Business Intelligence Product Set

1.6.1 Business Intelligence Applications

IBM's business intelligence applications are marketed under the DecisionEdge and Discovery Series brand names. DecisionEdge is a set of customer relationship management applications currently available for the telecommunications and utility industries. Each DecisionEdge offering provides integrated business applications, hardware, software, and consulting services. DecisionEdge for Telecommunications, for example, analyzes customer information (measuring profitability, predicting customer behavior, analyzing attrition, and so forth) and assists in the creation of tailored customer marketing programs. The product is used to design and deploy a customer information data warehouse on an IBM System/390, RS/6000 or AS/400 server using either an IBM DB2, Informix, Oracle or Sybase relational DBMS. Business users then employ DecisionEdge packaged and customized

applications to analyze customer information, and develop and monitor marketing programs.

Discovery Series is a set of applications and services that enable organizations to harness the power of IBM's Intelligent Data Miner product for customer relationship management. Included with the Discovery Series is the software, installation support, consulting, and training required to develop the data models, application-specific templates, and customized graphical output for an information mining application. The combination of services and prebuilt applications makes it easier for organizations to see quick results from information mining.

Business intelligence applications are also available for the DB2 OLAP Server (see description below). This product (which was developed by IBM and Arbor Software) employs the same API as Arbor Essbase, and can, therefore, be used with the many industry-specific third-party application packages available for Essbase.

1.6.2 Decision Support Tools

Business intelligence DSS tools can be broken down into three categories: query and reporting, online analytical processing (OLAP), and information mining.

1.6.2.1 Query and Reporting

The two main IBM query and reporting products are the Query Management Facility (QMF) and Lotus Approach. The System/390 version of QMF has been used for many years as a host-based query and reporting tool by DB2 for S/390 users (MVS, OS/390, VM, VSE). More recently, IBM introduced a native Windows version of QMF. Both versions support access not only to DB2 for S/390, but also any relational and non-relational data source supported by its DataJoiner middleware product (see description below). QMF host objects are compatible with QMF for Windows, extending the enterprise query environment to Windows and the Web. Output from QMF can be passed to other Windows applications like Lotus 1-2-3, Microsoft Excel, Lotus Approach, and many other desktop products via Windows OLE.

Lotus Approach is a desktop relational DBMS that has gained popularity due to its easy-to-use query and reporting capabilities. Approach can act as a client to a DB2 family database server, and, therefore, its query and reporting capabilities can be used to query and process DB2 data.

To increase the scope of its query and reporting offerings, IBM recently forged relationships with Business Objects (for its BusinessObjects product)

and Cognos (for its Impromptu and PowerPlay products). Like its key relationships with Evolutionary Technology International, Vality Technology, and Arbor Software, IBM intends the relationships with Business Objects and Cognos to be more than mere joint marketing deals — they also involve agreements to integrate the products from these companies with IBM's business intelligence offerings, for example, in the area of meta data interchange.

1.6.2.2 Online Analytical Processing (OLAP)

IBM's key product in the OLAP marketplace is the DB2 OLAP Server, which implements a three-tier client/server architecture for performing complex multidimensional data analysis. The middle tier of this architecture consists of an OLAP analytical server developed in conjunction with Arbor Software, which is responsible for handling interactive analytical processing and automatically generating an optimal relational star schema based on the dimensional design the user specifies. This analytical server runs on Windows NT, OS/2, or UNIX and can be used to analyze data managed by a DB2 Universal Database engine, or any relational database supported by DataJoiner. The DB2 OLAP Server supports the same client API and calculation engine as Arbor Essbase, and any of the many third-party GUI or Web-based tools that support Essbase can act as clients to the DB2 OLAP Server.

The value of the DB2 OLAP server lies in its ability to generate and manage relational tables that contain multidimensional data, in the available Essbase applications that support the product, and features within Visual Warehouse for automating the loading of the relational star schema with information from external data sources such as DB2, Oracle, Informix, IMS, and VSAM.

1.6.2.3 Information Mining

IBM has put significant research effort into its Intelligent Miner for Data product, which runs on Windows NT, OS/400, UNIX and OS/390, and can process data stored in DB2 family databases, any relational database supported by DataJoiner, and flat files. Intelligent Miner Version 1, released in 1996, enabled users to mine structured data stored in relational databases and flat files, and offered a wide range of different mining algorithms. Intelligent Miner Version 2 features a new graphical interface, additional mining algorithms, DB2 Universal Database exploitation, and improved parallel processing.

Intelligent Miner is one of the few products on the market to support an external API, allowing result data to be collected by other products for further analysis (by an OLAP tool, for example). Intelligent Miner has good data

visualization capabilities, and unlike many other mining tools, supports several information mining algorithms. IBM is also preparing to introduce its Intelligent Miner for Text product, which will provide the ability to extract, index, and analyze information from text sources such as documents, Web pages, survey forms, etc.

1.6.2.4 Access Enablers

Client access to warehouse and operational data from business intelligence tools requires a client database API. IBM and third-party business intelligence tools support the native DB2 SQL API (provided by IBM's Client Application Enablers) and/or industry APIs like ODBC, X/Open CLI, and the Arbor Essbase API.

Often, business information may be managed by more than one database server, and IBM's strategic product for providing access to this data is its DataJoiner middleware server, which allows one or more clients to transparently access data managed by multiple back-end database servers. This federated database server capability runs on Windows NT and UNIX, and can handle back-end servers running IBM or non-IBM data products, for example, IBM DB2 family, Informix, Microsoft SQL Server, Oracle, Sybase, VSAM, IMS, plus any ODBC, IBI EDA/SQL or Cross Access supported data source. Features of this product that are worthy of note include:

- Transparent and heterogeneous database access using a single dialect of SQL.
- Global optimization of distributed queries with query rewrite capability for poorly coded queries.
- Stored procedure feature that allows a global DataJoiner procedure to transparently access data or invoke a local procedure on any DataJoiner-supported database. This feature includes support for Java and Java Database Connectivity (JDBC).
- Heterogeneous data replication (using IBM DataPropagator, which is now integrated with DataJoiner) between DB2, Informix, Oracle, Sybase and Microsoft relational database products.
- Support for Web-based clients (using IBM's Net.Data product).

IBM's Net.Data Web server middleware tool (which is included with DB2) supports Web access to relational and flat file data on a variety of platforms, including the DB2 family, DataJoiner-enabled databases, and ODBC data sources. Net.Data tightly integrates with Web server interfaces, and supports client-side and server-side processing using applications written in Java, REXX, Perl, C++, or its own macro language.

1.6.2.5 Data Warehouse Modeling and Construction

IBM supports the design and construction of a data warehouse using its Visual Warehouse product family and data replication tools, and through third-party relationships with Evolutionary Technologies International (for its ETI*EXTRACT Tool Suite) and Vality Technology (for its Integrity Data Reengineering tool).

The Visual Warehouse product family is a set of integrated tools for building a data warehouse, and includes components for defining the relationships between the source data and warehouse information, transforming and cleansing acquired source data, automating the warehouse load process, and managing warehouse maintenance. Built on a DB2 core platform, Visual Warehouse can acquire source data from any of the DB2 family of database products, Informix, Microsoft, Oracle, Sybase, IMS databases, VSAM and flat files, and DataJoiner-supported sources.

Organizations have the choice of two Visual Warehouse packages, both of which are available with either Business Objects or Cognos add-ins for information access. The base package, Visual Warehouse, includes:

- DB2 Universal Database for meta data storage.
- A Visual Warehouse Manager for defining, scheduling, and monitoring source data acquisition and warehouse loading operations.
- A Visual Warehouse agent for performing the data capture, transformation and load tasks.
- The Visual Warehouse Information Catalog (formerly known as DataGuide) for exchanging meta data between administrators and business users.
- Lotus Approach for information access.

The second package, Visual Warehouse OLAP, adds the DB2 OLAP Server to the mix, allowing users to define and load a star schema relational database, as well as to perform automatic precalculation and aggregation of information as a part of the load process.

1.6.2.6 Data Management

Data management in the business intelligence environment is provided by IBM's DB2 family of relational DBMSs, which offers intelligent data partitioning and parallel query and utility processing on a range of multiprocessor hardware platforms. DB2 Universal Database on UNIX and Windows NT additionally supports both partition and pipeline parallelism, SQL CUBE and ROLLUP OLAP operations, integrated data replication,

dynamic bit-mapped indexing, user-defined types, and user-defined functions (which can be written in object-oriented programming languages such as Java).

1.7 The Challenge of Data Diversity

Rarely do medium- to large-sized organizations store all their enterprise and departmental data in a single database management system (DBMS) or file system. Instead, key business data is managed by multiple products (such as DB2, Oracle, Sybase, Informix, IMS, and others) running on different operating systems (MVS, UNIX, and Windows NT), often at widely separated locations. For business intelligence systems, the heterogeneity of most computing environments presents several challenges:

1. Providing users with an integrated view of the business is a key requirement for many business intelligence systems. Therefore, business intelligence software must be flexible enough to support diverse data sources.
2. Similarly, a robust business intelligence solution should support heterogeneous databases as target stores. Many companies are adopting a multi-tiered or distributed implementations, resulting in multiple data marts within a single company. With the increased adoption of distributed, client/server and departmental computing, it is common for different divisions of a company to use different database systems.
3. The foundation of an effective business intelligence solution is making it easy for the end user to access relevant business information. A user might need to consult the enterprise data warehouse for an answer to one question, but for a different question, query a local data mart — or for another, a correlation of data across a data mart and an external data source. Making the user aware of data location adds unneeded complexity, and discourages use of all available information.

IBM's business intelligence offerings meet the challenges of today's heterogeneous environments. For example, IBM's DataJoiner enables easy integration of diverse application, platform, and database environments. Introduced in 1995 and now in its second version, DataJoiner offers features to enable:

- **Transparent heterogeneous data access:** With DataJoiner, business users need not know that they are connecting to multiple databases. DataJoiner provides a single SQL interface that can read from and write to diverse data sources. DataJoiner manages the complexity of establishing connections to different data sources, translating requests into the native

interfaces of these data sources, coping with differences in data types, and determining an efficient data access strategy to satisfy any request. DataJoiner allows you to treat your data marts, external data, enterprise warehouse, and operational data store as a single, federated warehouse.

- **Simpler, more powerful queries:** DataJoiner makes queries in mixed and distributed data warehouse environments simpler and more powerful than ever. The ability to send a single query to access and join data stored in many IBM or non-IBM, relational or non-relational, local or remote data stores, combined with the power to employ global stored procedures, simplifies the creation of complex business intelligence applications. Further, DataJoiner features built-in support for Java and Java Database Connectivity (JDBC) for Java developers.
- **Optimized data access:** Fast response time to queries is important to all business users. But many of today's popular tools generate poorly structured queries, resulting in poor performance. DataJoiner includes sophisticated global query optimization processing, that rewrites queries automatically — transforming poorly structured queries into an efficient, logically equivalent form. The result? Queries perform better and are less costly to execute. From Web browsers or classic client, DataJoiner speeds results to demanding end users.
- **Heterogeneous replication:** Replication capability is vital in many data warehouse implementations. By enabling data warehouses to be continuously updated with changed and new operational data, business users are given access to the latest data. And, for companies that run their business systems 24x7, replication minimizes the reliance on batch windows for moving data from operational systems to data warehouses. IBM has integrated advanced replication capability into DataJoiner, enabling heterogeneous replication between DB2, Informix, Oracle, Sybase and Microsoft databases.

Chapter 2. ITSO Scenario

In this chapter we describe the network and systems setup for the IBM ITSO San Jose center where this project was conducted. We also describe the software and hardware that was used for the project.

2.1 The Environment

The ITSO network environment includes OS/390, VM and VSE host servers systems, and AIX and Windows NT workstations servers. The integration of an AS/400 system into this environment is planned for later this year.

The OS/390 and VSE systems are running as guest systems on different VM systems located in Poughkeepsie.

On the workstation side, we used two AIX systems and three Windows NT Server systems, one of them installed on a Netfinity server.

Figure 3 provides an overview of the BI environment we set up at the ITSO center while running this project.

The systems are named by their TCP/IP hostname (workstations) or their VTAM SSCP-name (hosts).

As you can see, this environment has all the software installed on all platforms it is available for. Our intent was to show all the possible options for the product installation. Therefore, we made no assumptions regarding where to install each product for best performance, accessibility, and so on. In a real BI environment, you will have to carefully consider which product to install on which system, depending on the systems available for the implementation, available products, connectivity and performance.

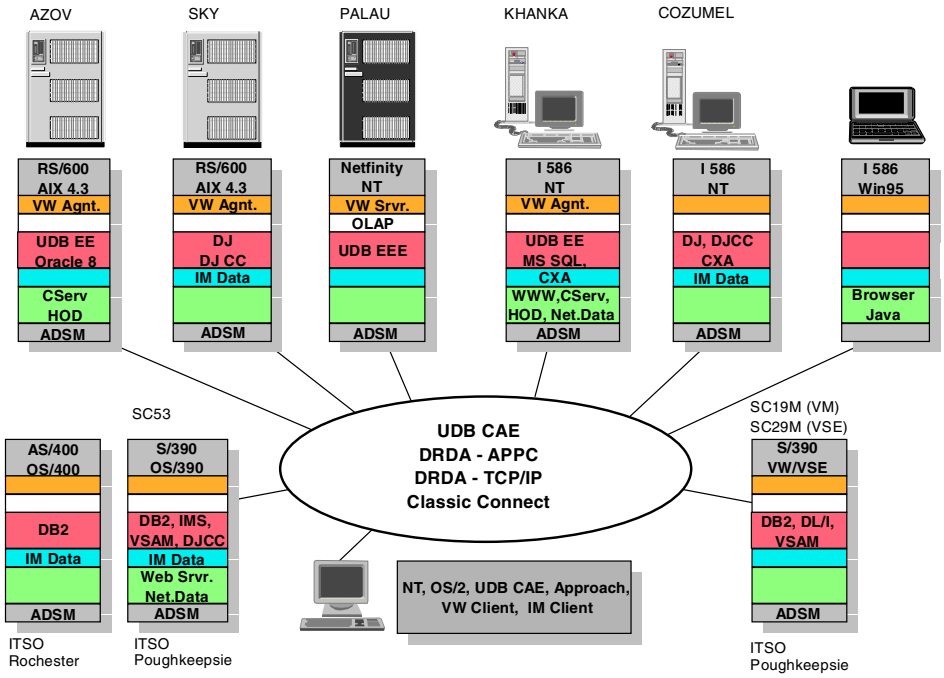


Figure 3. The ITSO Environment

The following sections briefly describe the installed hardware and software according to their main functionality in the environment.

2.1.1 Database Server

The following types of relational database management systems (RDBMSs) have been installed in the environment:

- DB2 UDB Enterprise Edition Version 5.2 on the AZOV RS/6000 system to hold the Visual Warehouse database on AIX. The same version of DB2 UDB has been installed on the KHANKA system running under Windows NT version 4.0.
- DB2 UDB Extended Enterprise Edition V 5.2 on the PALAU Netfinity system to hold the Visual Warehouse database on Windows NT.
- DB2 DataJoiner Version 2.1.2 on SKY and COZUMEL for access to non-IBM databases. These two systems also host the Classic Connect and CrossAccess software for access to the nonrelational data sources on the OS/390 and VSE host systems.

- DB2 for OS/390 Version 5 on the SC53 S/390 system at the ITSO in Poughkeepsie. This system is the one that holds most of the operational data.
- DB2 for VM Version 5.1 on the SC19M S/390 system at the ITSO center in Poughkeepsie.
- DB2 for VSE Version 5.1 on the SC29M S/390 system at the ITSO center in Poughkeepsie.
- VSAM and DL/I data sources residing on SC53 and SC29M.
- IMS data located on the SC53 system.
- DB2 for OS/400 on an AS/400 system located in Rochester.
- Oracle Version 8.0.4 on the AZOV AIX system.
- Microsoft SQL Server Version 7 on the KHANKA Windows NT system.

2.1.2 Visual Warehouse

The PALAU Netfinity server running under Windows NT Version 4.0 was installed with the IBM Visual Warehouse Version 5.2 Server.

On all other systems that are intended to either hold the warehouse database or that are used as communication gateways, we installed the Visual Warehouse Agent.

2.1.3 Communication Gateways

In the current configuration of this environment, we used TCP/IP as the main underlaying communication protocol. As the support for TCP/IP is usually included with the operating system, there is no additional software to install.

To enhance the communication abilities of the environment, we installed the following additional software:

- IBM Communication Server Version 5 on AIX (AZOV) and Windows NT (KHANKA) for the APPC communication protocol support.
- IBM Host on Demand on AIX (AZOV) and Windows NT (KHANKA) for Web-based 3270 data access.
- The World Wide Web Server has been configured on AIX (AZOV), Windows NT (KHANKA), and S/390 (SC53). Whereas the http deamon on AIX only has to be configured and comes with the base operating system, we had to install a Web server software on the Windows NT server to achieve this. We used the Lotus Domino Go Version 4.6.1 Web server.

- Net.Data Version 2.0.3 has been installed on the KHANKA Windows NT server and the SC53 OS/390 system to provide World Wide Web access to the databases.

2.1.4 Data Analysis Tools

To have the ability to go beyond the standard database query capability and achieve real data exploration of the data, in the data warehouse or in the operational data sources, we installed the following software:

- DB2 OLAP Server Version 1.0.1 has been installed on the Netfinity system (PALAU) running under Windows NT Version 4.0 to allow Online Analytical Processing (OLAP) of the data.
- IBM Intelligent Miner for Data Version 2.1.3 Server for data mining capability has been installed on AIX (SKY), Windows NT (COZUMEL), OS/390 (SC53), and OS/400. The Intelligent Miner for Data client code has been installed on AIX (AZOV) and Windows NT (COZUMEL).

2.2 The Data

One major part of this scenario consists of the data and the data sources. We have been provided with quite a large database, and its data has been stored on the OS/390 system into DB2, VSAM, and IMS databases; and on the VSE system into DB2, VSAM, and DL/I database.

To give you an idea of the amount of data, here some figures:

The largest DB2 table has a rowcount of more than 3,500,000 with an average rowlength of about 80 bytes. All DB2 tables together occupy about 700 MB of disk space.

The VSAM KSDS cluster has more than 740,000 636-byte records, which is more than 450 MB of data. Due to the VSAM specifications, there are no more than 2 records in one 2048-byte control interval. So the file occupies more than 727 MB of disk space.

The following is a description of the data provided. As mentioned above, we have three different kinds of data sources: DB2, DL/I and VSAM. But all data ends up in DB2 tables on the workstation side. Even the VSAM and DL/I data is already referenced on the host side as relational tables through CrossAccess. Therefore, the data description does not follow the data sources, but rather the usage of the data.

2.2.1 Sales Information

The sales information is contained in one DB2 table called SALE_DAY_003, which holds data from the stores scanner cashiers. The '003' in the name identifies this data being captured for the company stores belonging to the product segment group '3' ('PRODNO = 3.' in the other tables), which means that only data belonging to that product segment group is to be populated to the data warehouse.

This table contains sales information, such as:

- Basic article number
- Product grouping number
- Supplier identification
- Sales per store and article on a daily basis
- Date, the article was sold
- Number of sold units
- Retail price including tax
- Sales tax

2.2.2 Article Information

The article information tables have all the data about the articles, their structuring, relation to suppliers and supplier data. These tables are mostly from DB2 except the supplier data, which is derived from VSAM. The main table content and table names are listed below.

The table called BASART holds basic article information, such as:

- Basic article number
- Article description
- Creation date of the database entry
- Color

The table called ARTTXT contains more data on the article description, such as:

- Basic article number
- Product segment grouping
- Company number
- Store number

The table called STRUCTART holds article structuring information, such as:

- Basic article number
- Product segment grouping
- Price range number

The table called STRARTDAT contains additional article structuring information, such as:

- Basic article number
- Product segment grouping
- Store number
- Date until the article is valid
- Date since the article is available
- Units for retail
- Product group

The table called WGRARTST003 contains article grouping data for PRODNO=3, such as:

- Company number
- Product group number
- Product group description
- Creation date of entry
- Changing date of entry

The table called DEPOT holds the information about the relationship to the product line, brand, and supplier, such as:

- Product segment grouping
- Company number
- Price range number
- Depot number
- Depot description
- Creation date of entry

The table called SUPPLART contains information about the relationship to the suppliers and order information, such as:

- Base article number
- Supplier number
- Price range number
- Store number
- Creation date of entry
- Deletion marker
- Account to be billed
- Delivery unit
- Supply unit
- Delivery time

The table called SUPPLIER holds detailed information about the suppliers, such as:

- Supplier number
- Supplier name
- Company number
- Supplier address

2.2.3 Organization Information

The organization information consists of data from all data sources. The information about the business lines is taken from a new DB2 table, the company data is derived from the DL/I database, and the information about the stores comes from the VSAM data set. The organization structure table (ORGA_STRUC) from DB2 is not used in this project, because the available sales data relates to one product segment group (3) only. The following describes the tables and their organization.

The ORGSTRUCT table holds data such as:

- Product segment grouping
- Company number
- Price range number
- Store number

The table called STORES is derived from the VTAM data set, and describes the different stores with information, such as:

- Company number
- Store number
- Store address
- Sales space in square meter
- Sales manager ID
- Date store was opened

The COMPANY_DB is taken from DL/I and contains information, such as:

- Company number
- Company name
- Business line
- Company group ID

2.3 Data Warehouse for OLAP

To build up the data warehouse for OLAP with three different dimensions (article, organization, and time) a large amount of this data has to be replicated to the workstation databases.

Here we provide a little description of the databases and tables we used.

Because the data warehousing and OLAP are based on relational data sources, we had to transform the DL/I (IMS) and VSAM data into DB2 tables.

We describe only the tables and columns used to build the data warehouse sources for OLAP, starting with the DB2 tables contained in the VSE database as shown in Table 1.

Table 1. DB2 Tables on SC19M

Table Name	Column Name	Description
STRUC_ARTICLE	Structure of articles	
	BASARTNO	Basic article number
	DEL_MARK	delete marker
	DELETE_DATE	date entry was marked 'deleted'
	PRODNO	product segment number (**= 3.0**)

Table Name	Column Name	Description
SUPPLIERS_ARTICLE	Article to supplier relation	
	BASARTNO	basic article number
	SUPPLNO	supplier number
	DEPOTNO	product line number
	PRODNO	product segment number (**= 3.0**)
	DEL_MARK	delete marker (**^= 'L'** to avoid duplicate article numbers)
ARTICLE_TXT	Article description	
	BASARTNO	basic article number
	ARTICLE_TEXT	article description
	TXTTYPNO	type of ARTICLE_TEXT (1.0 = name / 2.0 = content)
	PRODNO	product segment number (**= 3.0**)
DEPOT	Depot (brand) and product line description	
	BASARTNO	basic article number
	TEXT_DEPOT	product brand (supplier) description
	TEXT_LINE	product line description
	SUPPLNO	supplier number
	DEPOTNO	DEPTNO (6:7) = 00 --> brand ID DEPTNO (6:7) > 00 --> line ID
	PRODNO	product segment number (**= 3.0**)

Table Name	Column Name	Description
SALE_DAY_003	Sold articles per day and per store	
	BASARTNO	Basic article number
	STORENO	Store number *
	COMPNO	Company number *
	NO_UNITS	Number of sold units
	IN_PRC	Price for buying the article (DM)
	OUT_PRC	Price the article was sold for multiplied by NO_UNITS (DM)
	TAX	Amount of tax (DM)
	NO_CUST	Number of customers

* STORENO is only unique together with COMPNO!

The data about the organization and the suppliers is derived from the DL/I and VSAM data. By using CrossAccess and the appropriate meta data definitions, we created Table 2 and Table 3:

Table 2. DL/I 'Tables' derived through CrossAccess

Table Name	Column Name	Description
COMPANY_DB	Base of companies belonging to the organization	
	COMPNO	Company number
	NAME	Company name
	B_LINE	Business line for this company

Table 3. VSAM 'Tables' derived through CrossAccess

Table Name	Column Name	Description
STORES	Base of stores belonging to the companies	
	STORENO	Store number
	NAME	Store name
	COMPNO	Company number
	STREET	Address of store
	ZIP	
	CITY	
	REGION_MGR	Region (manager) ID

For the organization information, we needed an additional data source providing the data for the business lines. So we generated an additional database 'SJNTADD' on the Windows NT Server workstation 'KHANKA'. See Table 4 below.

Table 4. DB2 Table in Windows NT database SJNTADD

Table Name	Column Name	Description
BUSINESS_LINES	business line definitions	
	BL_NO	business line ID
	BL_NAME	business line name

Chapter 3. The Products and Their Construction

In this chapter we describe briefly the products that were used for the IBM ITSO project. Detailed information about each product can be found in their own manuals.

3.1 The DataJoiner Product

DataJoiner is a multidatabase server that provides access to data in multiple heterogeneous sources, including IBM and non-IBM, relational and nonrelational, and local and remote sources. DataJoiner includes integrated replication administration, support for Java applications, query optimization technology, industry-standard SQL (across all data source types), and both synchronous and asynchronous data access. DataJoiner allows you to access all data in your enterprise as if it were local. It is currently available for Windows NT and UNIX.

DataJoiner provides all the major functional enhancements provided by DB2. Also, Datajoiner supports geographic information system (GIS) data.

3.1.1 DataJoiner Classic Connect Component

DataJoiner Classic Connect is a separately-orderable component of DataJoiner that provides access to nonrelational data stored in Information Management Systems (IMS) databases and Virtual Storage Access Method (VSAM) data sets on OS/390. It provides communication, data access, and data mapping functions so you can access nonrelational data using relational queries.

DataJoiner Classic Connect requires the DataJoiner software product in order to allow you to connect to DataJoiner databases, and DataJoiner instances. A solution with DataJoiner Classic Connect and a DataJoiner instance together, allows users from several different platforms to submit an SQL query that accesses nonrelational data.

DataJoiner Classic Connect provides read-only relational access to IMS databases and VSAM data sets. It creates a logical, relational database, complete with logical tables that are mapped to actual data in IMS or VSAM databases. Using this relational structure, Classic Connect interprets relational queries that are submitted by users against IMS and VSAM data sets.

3.1.2 DataJoiner Classic Connect Architecture

Figure 4 on page 33 shows the Classic Connect architecture, which consists of the following major components:

- **Client Interface Module:**

  The client interface module is used to establish and maintain connections with data servers and Enterprise Servers. It performs the following functions:

  - Determines and loads the appopiate transport layer module, based on configuration parameters
  - Establishes communications with data servers and Enterprise Servers
  - De-references host variables in SQL statements
  - Stores and retrieves data in the application storage areas
  - Presents error and feedback information to the application

  The client interface module can establish multiple connections to a data server or Enterprise Server on behalf of a single application program.

- **Classic Connect Data Server:**

  Classic Connect data server is responsible for all data access. It performs the following functions:

  - Accepting SQL queries from DataJoiner or the sample applications (DJXSAMP).
  - Determining the type of data to be accessed.
  - Rewriting the SQL query into the native file or database access language needed. A single SQL access could translate into multiple native requests.
  - Optimizing queries based on generic SQL query rewrite and file — or database-specific optimization.
  - Querying multiple data sources for JOINs.
  - Translating result sets into a consistent relational format, which involves restructuring non-relational data into columns and rows.
  - Sorting result sets as needed; such as ORDER BY.
  - Issuing all client catalog queries to the Classic Connect meta data catalog.

  The following components run in the data server:

  - Region Controller Services — This data server component is responsible for starting, stopping, and monitoring all of the other

components of the data server. It determines which services to start based on SERVICE INFO ENTRY parameters at the Data Server Master configuration file on OS/390.

- Initialization Services — This data server component is responsible for initializing and terminating different types of interfaces to underlying database management systems or MVS systems components such as IMS BMP/DBB initialization service, IMS DRA initialization service, and WLM initialization service.
- Connection Handler Services — This data server component is responsible for listening for connection requests from DataJoiner. Connection requests are routed to the appropriate query processor task for subsequent processing.
- Query Processor Services — This data server component is responsible for translating client SQL into database and file-specific data access requests.
- Logger Services — This data serve component is used for system monitoring and trouble shooting. A single logger task can be running within a data server. During normal operations, you will not need to be concerned with the logger service.

- **Enterprise Server:**

  The Enterprise Server is an optional component that you can use to manage a large number of concurrent users across multiple data sources (see Figure 5 on page 34). Like a data server, the Enterprise Server's connection handler is responsible for listening for client connection requests. However, when a connection request is received, the Enterprise Server does not forward the request to a query processor task for processing. Instead, the connection request is forwarded to a data source handler (DSH) and then to a data server for processing. The Enterprise Server maintains the end-to-end connection between the client application and the target data server. It is responsible for sending and receiving messages between the client application and the data server.

  The Enterprise Server determines the locations of the data servers that it will be communicating with through the configuration parameters. Also, it determines whether those data servers are running on the platform as the Enterprise Server.

  The Enterprise Server can automatically start a local data server if there are no instances active. It can also start additional instances of a local data server when the currently active instances have reached the maximum number of concurrent users they can service, or the currently active instances are all busy.

- **Data Mapper:**

  The Classic Connect nonrelational data mapper is a Microsoft Windows-based application that automates many of the tasks required to create logical table definitions for nonrelational data structures. The data mapper interprets existing physical data definitions that define both the content and the structure of nonrelational data.

  The data mapper accomplishes the creation of logical table definitions for nonrelational data structures, by creating meta data grammar from existing nonrelational data definitions. The meta data grammar is used as input to the Classic Connect meta data utility to create a meta data catalog that defines how the nonrelational data structure is mapped to an equivalent logical table. The meta data catalogs are used by query processor tasks to facilitate both the access and translation of the data from the nonrelational data structure into relational result sets.

  The data mapper import utilities create initial logical tables from COBOL copybooks. A visual point-and-click environment is used to refine these initial logical tables to match site- and user-specific requirements. You can utilize the initial table definitions automatically created by data mapper, or customize those definitions as needed.

  It is possible to create multiple logical tables that map to a single physical file or database. With this facility you can customize these table definitions to the needs of the user. The data mapper contains embedded FTP support of facilitate file transfer from and to the mainframe.

  Figure 6 on page 35 shows the Data Mapper workflow.

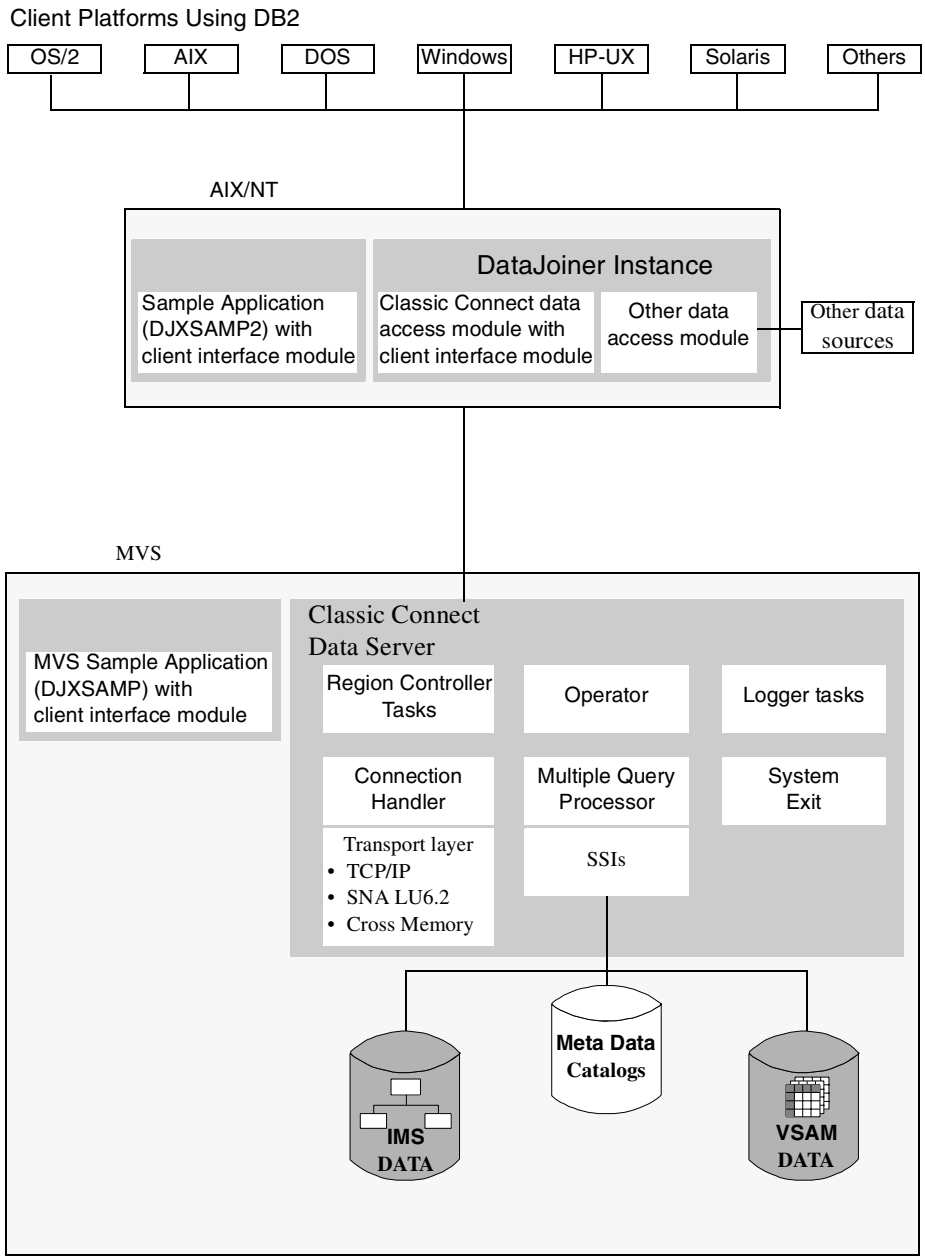


Figure 4. Classic Connect Architecture

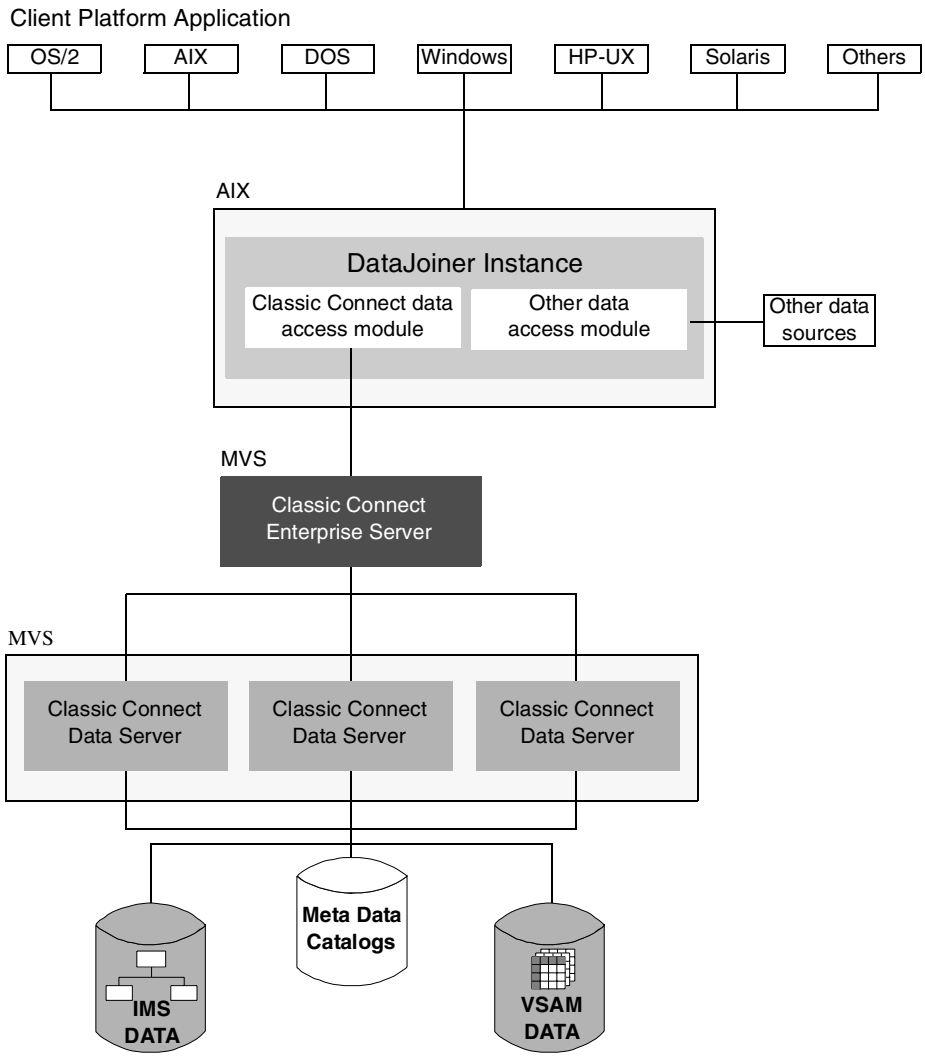


Figure 5. Classic Connect Architecture with Enterprise Server

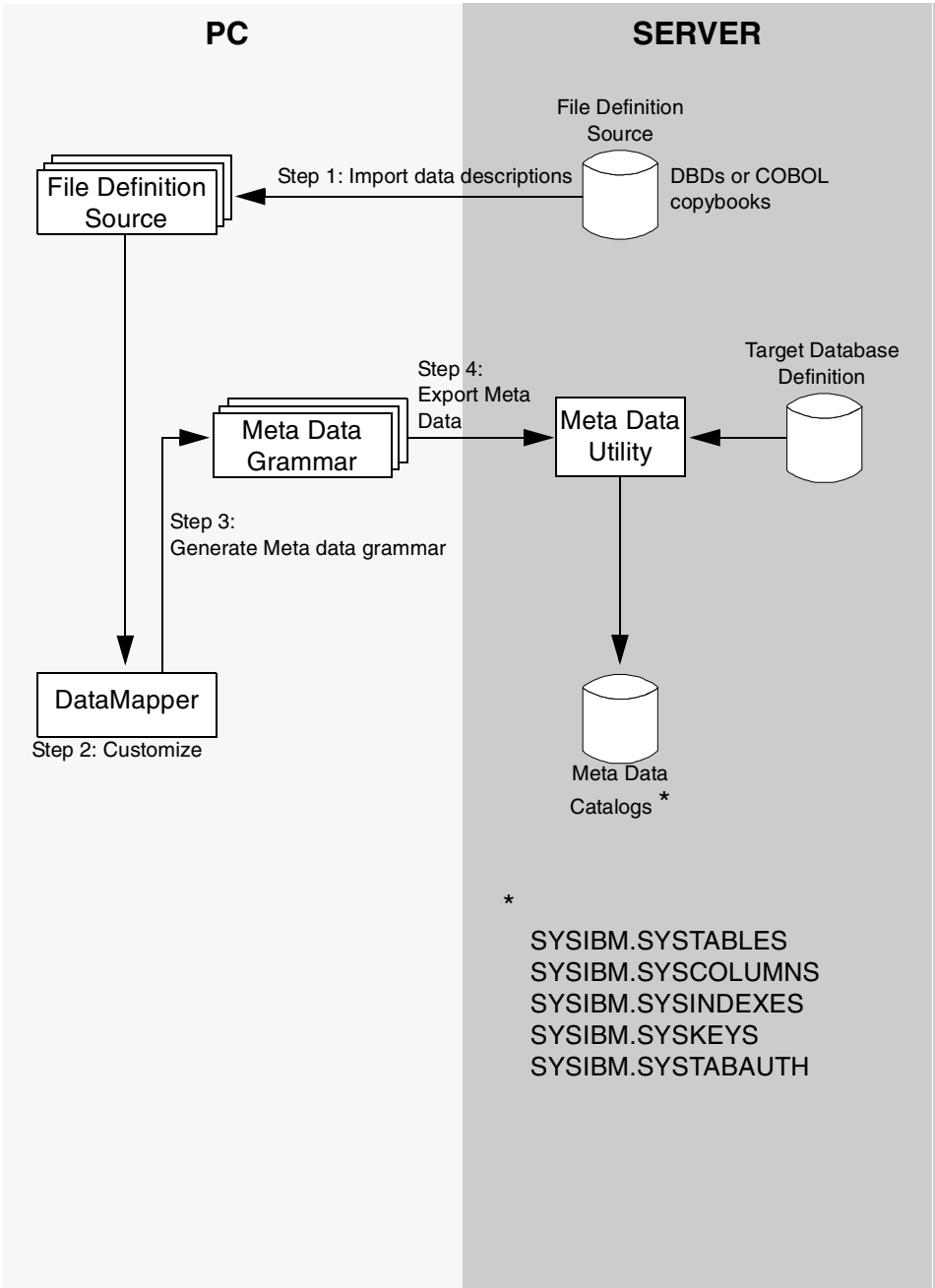


Figure 6. Data Mapper Workflow

3.2 CrossAccess

CrossAccess from CROSS ACCESS Corporation (www.crossaccess.com) provides relational access to nonrelational data stored in VSAM, DL/I, sequential, ADABAS, Datacom and IDMS. It provides communication, data access, and data mapping functions so you can access nonrelational data using relational queries.

3.2.1 CrossAccess Architecture

Figure 7 on page 39 shows the CrossAccess architecture, which consists of the following major components:

- **CrossAccess Data Server:**

  CrossAccess data server is responsible for all data access. It performs the following functions:

  - Accepting SQL queries from ODBC clients or the sample applications (CXASAMP).
  - Determining the type of data to be accessed.
  - Rewriting the SQL query into the native file or database access language needed. A single SQL access could translate into multiple native requests.
  - Optimizing queries based on generic SQL query rewrite and file—or database-specific optimization.
  - Querying multiple data sources for JOINs.
  - Translating result sets into a consistent relational format, which involves restructuring non-relational data into columns and rows.
  - Sorting result sets as needed; such as ORDER BY.
  - Issuing all client catalog queries to the CrossAccess meta data catalog.
  - Stored procedure interface, which allows an Assembler, COBOL, or PLI application program to be invoked.

  The following components run on the data server:

  Region Controller Services—This data server component is responsible for starting, stopping, and monitoring all of the other components of the data server. It determines which services to start based on SERVICE INFO ENTRY parameters in the Data Server Master configuration file.

  Initialization Services—This data server component is responsible for initializing and terminating different types of interfaces to underlying

database management systems or systems components such as Language Environment (LE) or WLM initialization service.

Connection Handler Services—This data server component is responsible for listening for connection requests from ODBC clients. Connection requests are routed to the appropriate query processor task for subsequent processing.

Query Processor Services—This data server component is responsible for translating client SQL into database and file-specific data access requests.

Logger Services—This data serve component is used for system monitoring and trouble shooting. A single logger task can be running within a data server. During normal operations, you will not be concerned with the logger service.

- **Enterprise Server:**

  The Enterprise Server is an optional component that you can use to manage a large number of concurrent users across multiple data sources (see Figure 8 on page 40). Like a data server, the Enterprise Server's connection handler is responsible for listening for client connection requests. However, when a connection request is received, the Enterprise Server does not forward the request to a query processor task for processing. Instead, the connection request is forwarded to a data source handler (DSH) and then to a Data Server for processing. The Enterprise Server maintains the end-to-end connection between the client application and the target data server. It is responsible for sending and receiving messages between the client application and the data server.

  The Enterprise Server determines the locations of the data servers that it will be communicating with through the configuration parameters. Also, it determines whether those data servers are running on the same platform as the Enterprise Server.

  The Enterprise Server can automatically start a local Data Server if there are no instances active. It can also start additional instances of a local data server when the currently active instances have reached the maximum number of concurrent users they can service, or the currently active instances are all busy.

- **Data Mapper:**

  The CrossAccess nonrelational Data Mapper is a Microsoft Windows-based application that automates many of the tasks required to create logical table definitions for nonrelational data structures. The Data

Mapper interprets existing physical data definitions that define both the content and the structure of nonrelational data.

The Data Mapper accomplishes the creation of logical table definitions for nonrelational data structures by creating meta data grammar from existing nonrelational data definitions. The meta data grammar is used as input to the CrossAccess meta data utility to create a meta data catalog that defines how the nonrelational data structure is mapped to an equivalent logical table. The meta data catalogs are used by query processor tasks to facilitate both the access and translation of the data from the nonrelational data structure into relational result sets.

The Data Mapper import utilities create initial logical tables from COBOL copybooks. A visual point-and-click environment is used to refine these initial logical tables to match site- and user-specific requirements. You can utilize the initial table definitions automatically created by Data Mapper, or customize those definitions as needed.

It is possible to create multiple logical tables that map to a single physical file or database. With this facility you can customize these table definitions to the needs of the user. Figure 9 on page 41 shows the Data Mapper workflow.

- **Client Interface Module:**

  The client interface module is used to establish and maintain connections with Data Servers and Enterprise Servers. It performs the following functions:

  - Determines and loads the appropriate transport layer module, based on configuration parameters
  - Establishes communications with Data Servers and Enterprise Servers
  - De-references host variables in SQL statements
  - Stores and retrieves data in the application storage areas
  - Presents error and feedback information to the application

  The Client Interface Module can establish multiple connections to a Data Server or Enterprise server on behalf of a single application program.

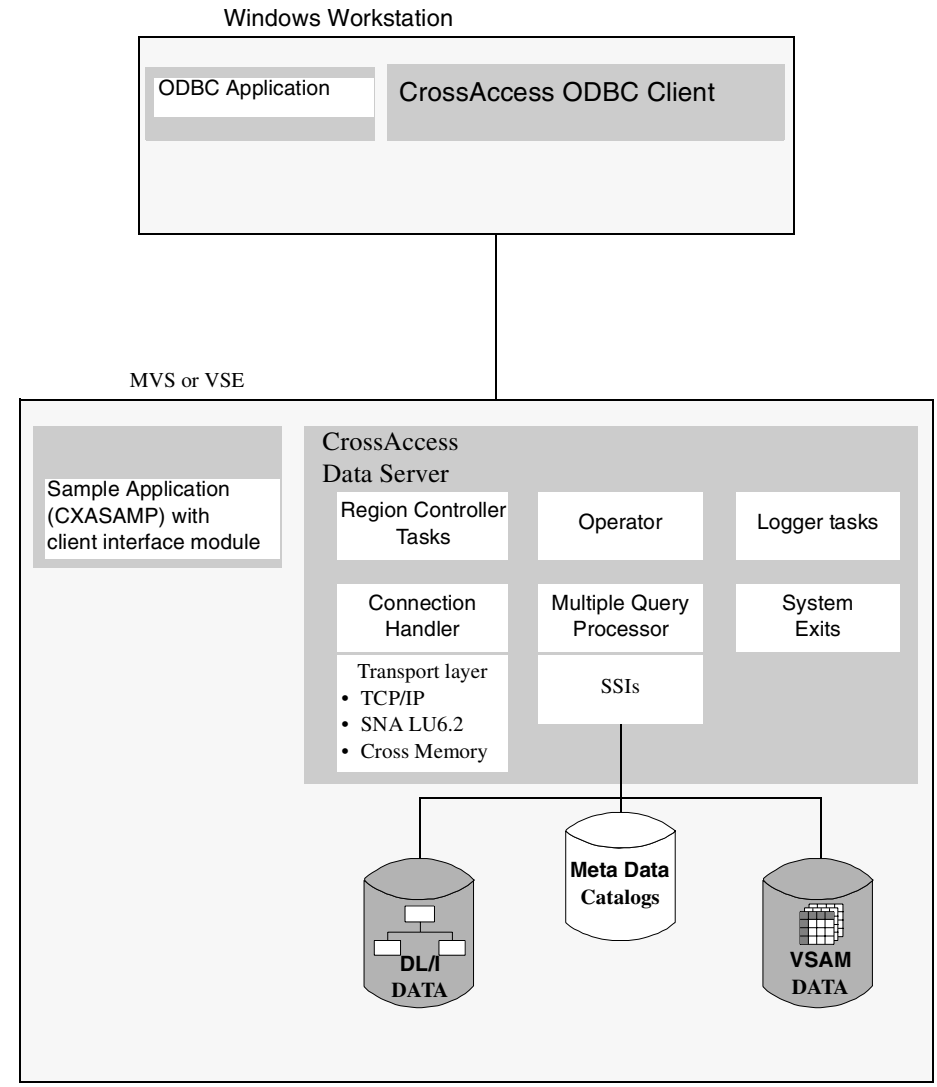


Figure 7. CrossAccess Architecture

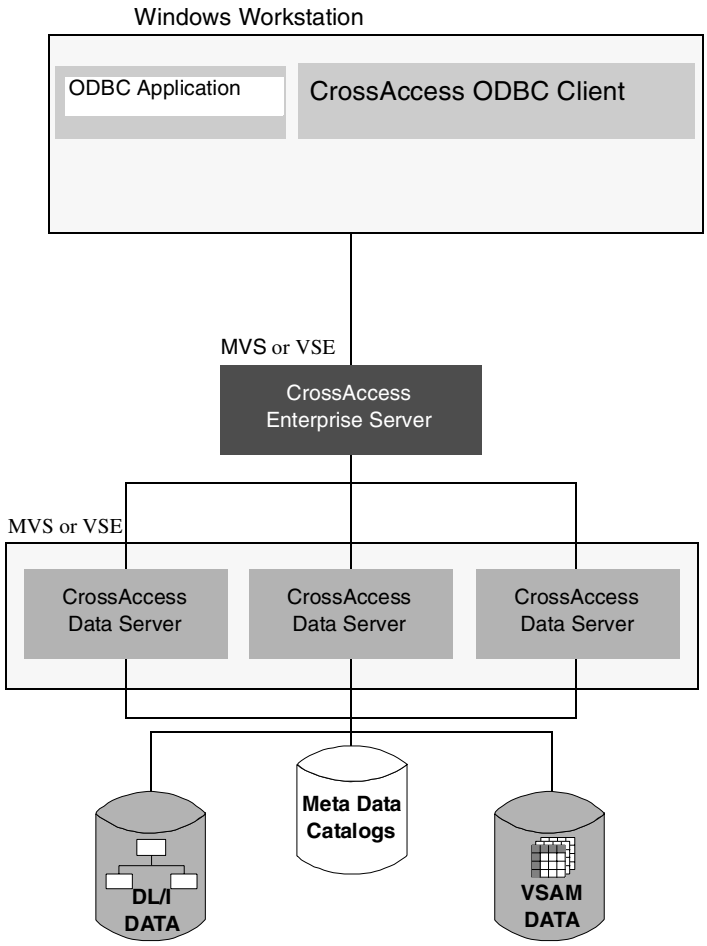


Figure 8. CrossAccess Architecture with Enterprise Server

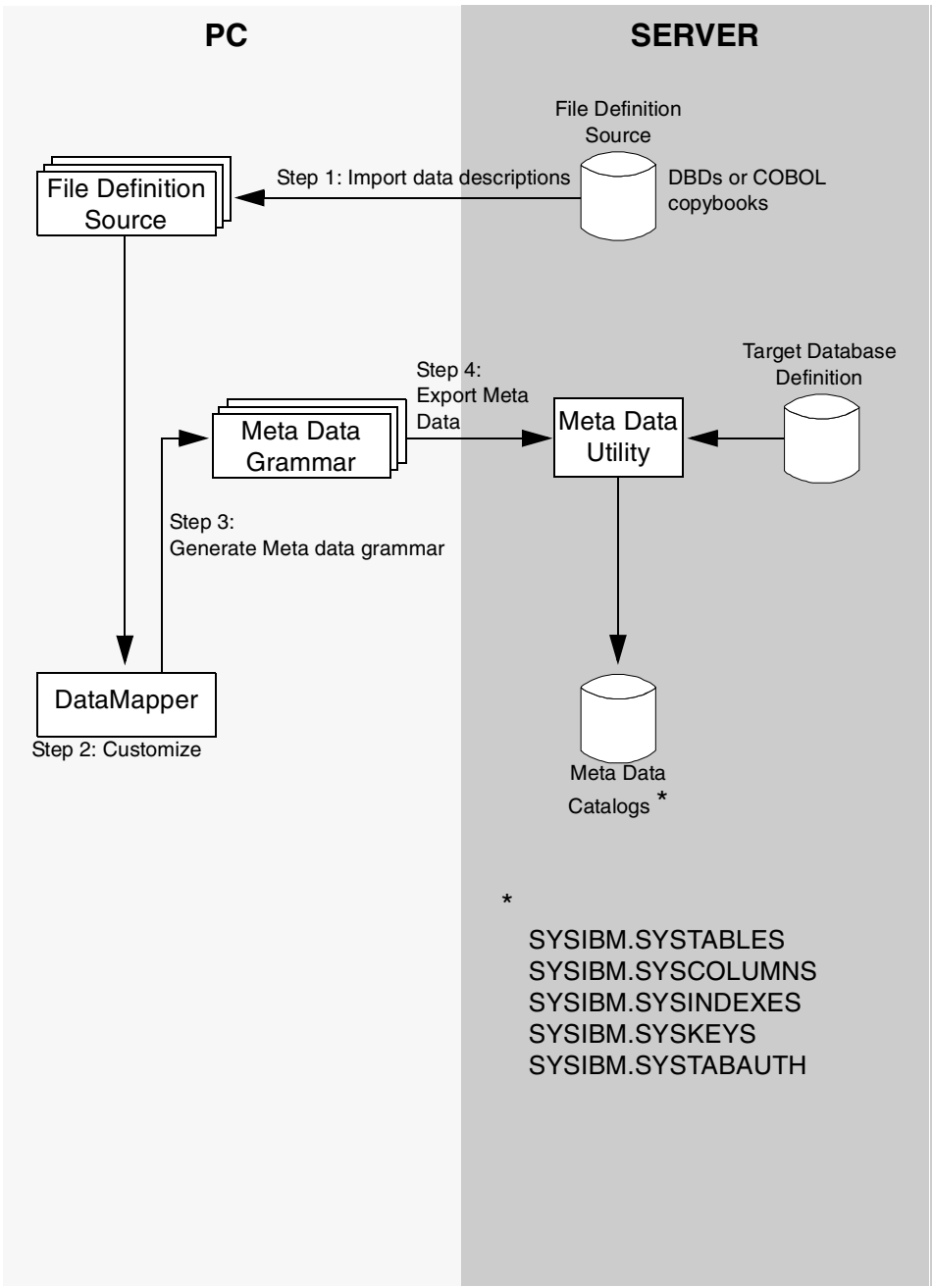


Figure 9. CrossAccess Data Mapper Workflow

The Data Mapper contains embedded FTP support to facilitate file transfer from and to the mainframe.

3.3 Visual Warehouse: Server and Agent

Visual Warehouse is an integrated product for building and maintaining a data warehouse or data mart in a LAN environment. Visual Warehouse does not simply create a data warehouse or an informational database; it provides the processes to define, build, manage, monitor, and maintain an informational environment. It integrates many of the business intelligence component functions into a single product. It can be used to automate the process of bringing data together from heterogeneous sources into a central, integrated, informational environment.

Visual Warehouse can be managed either centrally or from the workgroup environment. Therefore, business groups can meet and manage their own information needs without burdening information systems resources, thus enjoying the autonomy of their own data mart without compromising overall data integrity and security in the enterprise.

3.3.1 Data Sources Supported

Visual Warehouse provides the capability to extract and transform data from a wide range of heterogeneous data sources, either internal or external to the enterprise, such as the DB2 family, Oracle, Sybase, Informix, Microsoft SQL Server, VSAM, IMS, and flat files (for example, from spreadsheets). Data from these sources is extracted and transformed based on meta data defined by the administrative component of Visual Warehouse. The extract process, which supports full refreshes of data, can run on demand or on an automated scheduled basis.

3.3.2 Data Stores Supported

The transformed data can be placed in a data warehouse built on any of the DB2 UDB platforms, including DB2 for Windows NT, DB2 for AIX, DB2 for HP-UX, DB2 for Sun Solaris, DB2 for SCO, DB2 for SINIX, DB2 for OS/2, DB2 for OS/400, and DB2 for OS/390, or on flat files. Visual Warehouse provides the flexibility and scalability to populate any combination of the supported databases.

Visual Warehouse also supports Oracle, Sybase, Informix, and Microsoft SQL Server using IBM DataJoiner.

3.3.3 End User Query Tools

Once the data is in the target data warehouse, it is accessible by a variety of end user query tools. Those tools can be from IBM, such as Lotus Approach, or QMF for Windows, or from any other vendors whose products comply with the DB2 Client Application Enabler (CAE) or the Open Database Connectivity (ODBC) interface, such as Business Objects, Cognos Impromptu, and Brio Query. The data can also be accessed using a popular Web browser with additional Web infrastructure components.

3.3.4 Meta Data Management

Visual Warehouse stores all the meta data in its control database and is integrated with DataGuide, IBM's meta data management tool, which is part of the Visual Warehouse solution. The data warehouse model, which defines the structure and contents of the data warehouse, is stored in the meta data repository. For each data source to be accessed, Visual Warehouse first extracts the meta data that describes the contents of the data source and places it in the meta data repository. This meta data is then used to extract, filter, transform, and map the source data to the data warehouse.

The meta data of Visual Warehouse can then be transferred to the Information Catalog managed by DataGuide. With DataGuide, users can create an Information Catalog, which contains graphical representations of the meta data. DataGuide can be integrated with DB2 CAE entitled decision support tools, which can be used to view the meta data specific to an object of interest in the DataGuide Information Catalog.

3.3.5 The Architecture of Visual Warehouse

The Visual Warehouse architecture provides a fully distributed Client/Server system that lets users reap the benefits of network computing. The architecture consists of the following major components:

- Server
- Administrative Clients
- Agents
- Control Database
- Target Databases

3.3.5.1 Visual Warehouse Server

Visual Warehouse Server, which runs on a Windows NT workstation or server, controls the interaction of the various data warehouse components and provides for automation of data warehousing processes by a powerful

scheduling facility, which allows calendar-based scheduling as well as event-based scheduling. The server component monitors and manages the data warehousing processes. It also controls the activities performed by the Visual Warehouse agents.

3.3.5.2 Visual Warehouse Administrative Clients

The Administrative Client, which also runs on a Windows NT workstation or server, provides an interface for administrative functions, such as defining the business views, registering data resources, filtering source data, defining the target data warehouse databases, managing security, determining the data refresh schedules, and monitoring the execution of the data warehouse processes. Visual Warehouse can support an unlimited number of administrative clients and provides comprehensive security facilities to control and manage client access to the administrative functions.

3.3.5.3 Visual Warehouse Agents

Visual Warehouse agents handle access to the source data, filtering, transformation, subsetting, and delivery of transformed data to the target warehouse under the direction of the Visual Warehouse Server.

Visual Warehouse agents run on Windows NT, OS/2, AS/400, AIX, and Sun Solaris. Visual Warehouse supports an unlimited number of agents. Because multiple agents can participate in the population of a data warehouse, the throughput can significantly increase when multiple agents act simultaneously. The agents primarily use ODBC drivers as the means of communicating with different data sources and targets.

The Visual Warehouse agents architecture is a key enabler for scalable business intelligence solutions.

3.3.5.4 Visual Warehouse Control Database

A control database must be set up in DB2 to be used by Visual Warehouse to store control information used by the Visual Warehouse Server. The control database stores all the meta data necessary to build and manage the warehouse. The information in the control database includes the mappings between the source and target data, the schedules for data refresh, the Business Views, and operational logs. The control database is managed by the Visual Warehouse Administrator and used by the Visual Warehouse agents. When a request for service is made to the Visual Warehouse Server, the control information pertinent to that request is retrieved from the control database and sent to the appropriate agent that actually provides the service. Note that different warehouses could use different control databases.

Advanced DB2 features, such as triggers and stored procedures, can be used in conjunction with the Visual Warehouse control data to provide an advanced operating environment. For instance, DB2 triggers can be used to monitor log inserts and to send out alert signals through DB2 stored procedures when a certain event occurs.

3.3.5.5 Visual Warehouse Target Databases

Target databases in a data warehouse contain the Visual Warehouse data stored in structures defined as *Business Views* (BVs). When Visual Warehouse populates a BV, data is extracted from the source, transformed according to the rules defined in the BV, and then stored in the target database. Multiple databases could be used as target databases for a data warehouse.

3.4 Intelligent Miner for Data

Data mining can be defined as the process of automatically extracting valid, useful, previously unknown, and ultimately comprehensible information from large databases and using it to make crucial business decisions.

The Intelligent Miner (IM) helps us perform data mining tasks. Through an intuitive graphical user interface (GUI) you can visually design data mining operations. You can choose tools and customize them to meet your requirements. The available tools cover the whole spectrum of data mining functions. In addition IM selects data, explores it, transforms it, and visually interprets the results for productive and efficient knowledge discovery.

3.4.1 Overview of the Intelligent Miner

The IM is based on a client-server architecture. The server executes mining and processing functions and can host historical data and mining results. The client is powered with administrative and visualization tools and can be used to visually build a data mining operation, execute it on the server, and have the results returned for visualization and further analysis. In addition, the IM application programing interface (API) provides C++ classes and methods as well as C structures and functions for application programers.

3.4.2 Working with Databases

Most functions of the IM can use input data from either flat files or database tables. If you want to access DB2 tables, you only require authorization to access that database and the permission to query the appropriate tables. If you want to access files in Oracle, SPSS, or SAS format, DataJoiner may be installed as a middleware product.

There are two ways to access database management systems:

- Connect through the Intelligent Miner server without installing any database software in the client.
- Connect directly from the client to the table, letting the IM client access the database without using the IM communication interface.

3.4.3 The User Interface

The IM helps businesses reduce the cost of data mining and maximize the return on investment (ROI), providing an administrative user interface based on Java. The IM user interface is simple and intuitive and provides consistency across all operations. The interface's state-of-the-art GUI facilities include online help, task guides, and a graphical representation of the mining operations and its functions.

3.4.4 Data Preparation Functions

Once the desired database tables have been selected and the data to be mined has been identified, it is usually necessary to perform certain transformations on the data. IM provides a wide range of data preparation functions which help to optimize the performance of the data mining functions. Depending on the data mining technique, you can select, sample, aggregate, filter, cleanse, and/or transform data in preparation for mining.

The data preparation functions are:

- Aggregate values
- Calculate values
- Clean up data sources
- Convert to lower or upper case
- Copy records to file
- Discard records with missing values
- Discretize into quantiles
- Discretize using ranges
- Encode missing values
- Encode nonvalid values
- Filter fields
- Filter records
- Filter records using a value set

- Get random sample
- Group records
- Join data sources
- Map values
- Pivot fields to records
- Run SQL statements

Data preparation functions are performed through the GUI, reducing the time and complexity of data mining operations. You can transform variables, impute missing values, and create new fields through the touch of a button. This automation of the most typical data preparation tasks is aimed at improving your productivity by eliminating the need for programming specialized routines.

3.4.5 Statistical and Mining Functions

After transforming the data we use one or more data mining functions in order to extract the desired type of information. IM provides both statistical analysis tools and state of the art machine learning algorithms for successful data mining.

Statistical functions facilitate the analysis and preparation of data, as well as providing forecasting capabilities. For example, you can apply statistical functions like regression to understand hidden relationships in the data or use factor analysis to reduce the number of input variables. Statistical functions include:

- Factor analysis
- Linear regression
- Principal component analysis
- Univariate curve fitting
- Univariate and bivariate statistics

Based on IBM research, validated through real-world applications, IM has incorporated a number of data mining algorithms as the critical suite to address a wide range of business problems. The algorithms are categorized as follows:

- Association discovery:

  Given a collection of items and a set of records, each of which contains some number of items from the given collection, an association discovery

function is an operation against this set of records which returns affinities that exist.

- Sequential pattern discovery:

  A sequence discovery function will analyze collections of related records and will detect frequently occurring patterns of products bought over time among the collection of items.

- Clustering:

  Clustering is used to segment a database into subsets, the clusters, with the members of each cluster sharing a number of interesting properties.

- Classification:

  Classification is the process of automatically creating a model of classes from a set of records. The induced model consists of patterns, essentially generalizations over the records, that are useful for distinguishing the classes. Once a model is induced it can be used to automatically predict the class of other unclassified records.

- Value prediction:

  As in classification, the goal is to build a data model as a generalization over the records. However, the difference is that the target is not a class membership but an actual value.

- Similar time sequences:

  The purpose of this process is to discover all occurrences of similar subsequences in a database of time sequences.

Clustering, classification, and value prediction can be covered by a number of different algorithms. For instance, you can perform clustering by using either the demographic or the neural network algorithm, depending on the properties of the input data set and the requirements of the data mining operation.

3.4.6 Processing IM Functions

All IM functions can be customized using two levels of expertise. Users who are not experts can accept the defaults and suppress advanced settings. However, experienced users who want to fine-tune their application have the ability to customize all settings according to their requirements.

You can additionally define the mode of your statistical and mining functions. Possible modes are:

- Training mode. In training mode a mining function builds a model based on the selected input data.
- Clustering mode. In clustering mode, the clustering functions build a model based on the selected input data.
- Test mode. In test mode, a mining function uses new data with known results to verify that the model created in training mode produces consistent results.
- Application mode. In application mode, a mining function uses a model created in training mode to predict the specified fields for every record in the new input data.

3.4.7 Creating and Visualizing the Results

Information that has been created using statistical or mining functions can be saved for further analysis in the form of result objects. Figure 10 illustrates some of the results generated by the clustering function.

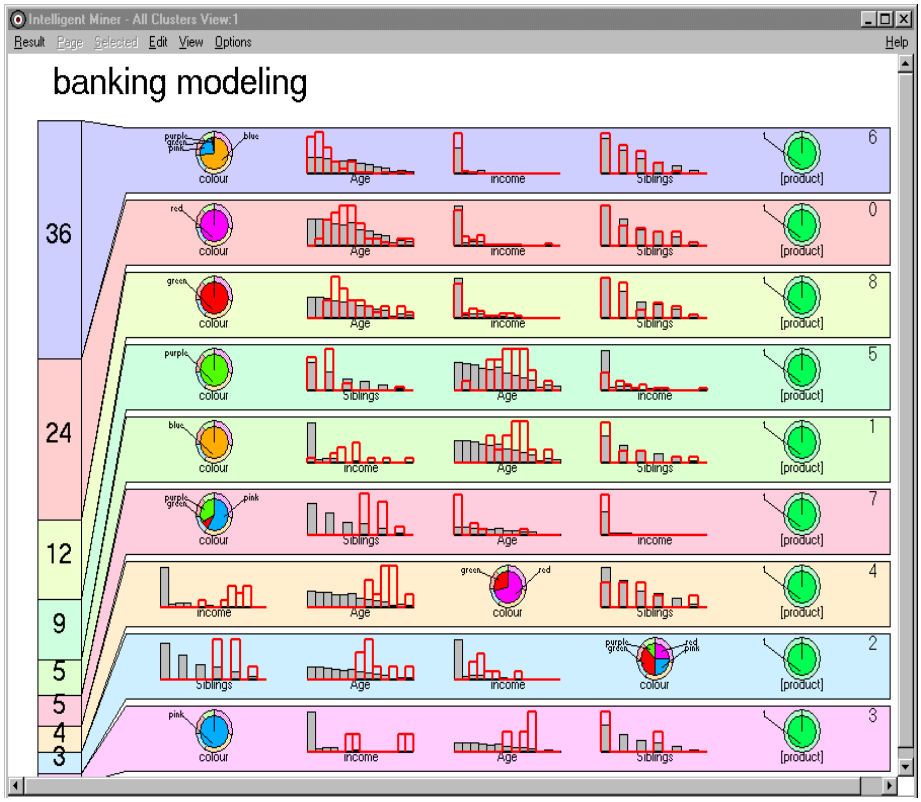


Figure 10. Sample Clustering Visualization

Result objects can be used in several ways:

- To visualize or access the results of a mining or statistical function
- To determine what resulting information you want to write to an output data object
- As input when running a mining function in test mode to validate the predictive model representation by the result
- As input when running a mining function in application mode to apply the model to new data

3.4.8 Creating Data Mining Operations

The IM provides a means to construct data mining operations as a sequential series of related data preparation, statistical, and mining functions. IM will execute the objects in the order in which they have been specified. A

sequence can contain other sequences. You can construct standard sequences that can be reused in similar data mining operations forming part of a more complex sequence.

In IM, sequence setting objects are created through the sequence task guide. You can select objects from the mining database and place them in the sequence work area setting in the order in which they are to run. In addition you can specify whether the sequence should continue if any of the setting objects fails. Figure 11 illustrates a sequence-settings window.

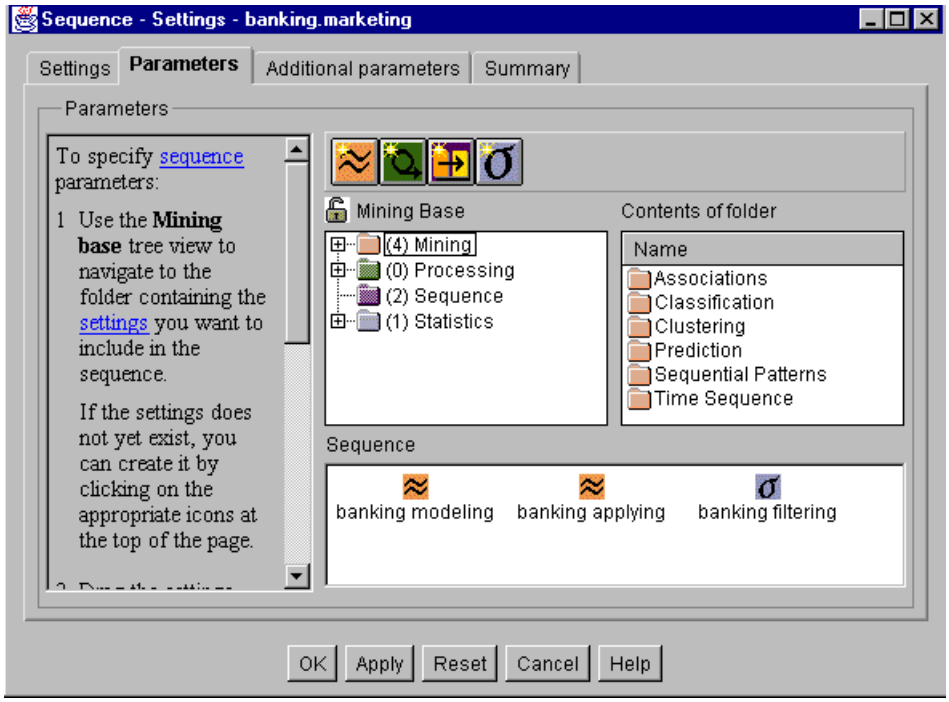


Figure 11. Sequence-Settings Window

3.5 DB2 OLAP Server

The IBM DB2 OLAP Server is an online analytical processing (OLAP) server that you can use to create a wide range of multidimensional planning, analysis, and reporting applications. DB2 OLAP Server uses the Essbase OLAP engine developed by Arbor Software Corporation. The OLAP Server uses the Essbase engine for application design and management, data

access and navigation, data load, data calculation, and application programming interfaces (APIs).

DB2 OLAP Server is compatible with Essbase, and can be used with all Essbase-ready front-end tools and applications developed by Arbor and Essbase partners.

DB2 OLAP Server allows you to:

- Perform multidimensional analyses on large volumes of relational data
- Manage data using relational database management system tools
- Access and query data in the star schema using standard SQL statements.

DB2 OLAP Server replaces the integrated, multidimensional data storage used by Arbor with a relational storage manager, and stores data in relational data storage using a star schema.

The Relational Storage Manager (RSM) separates the OLAP engine from database and provides support for DB2 and other relational databases.You can manage the data stored by your Essbase applications using familiar relational database management system (RDBMS) management, backup and recovery tools.

Using the RSM, DB2 OLAP Server stores data in a relational database using a star schema data structure, which means a fact table and a set of dimension tables. The fact table holds the actual data values for the database, and the dimension tables hold data about members and their relationship.

You can access your data using Essbase clients, and you can access the multidimensional data stored in the star schema using standard SQL statements.

The RSM creates and manages automatically the necessary relational tables, views and indices within the star schema, and the start schema can be populated with calculated data to improve the performance of queries.

You can use DB2 OLAP Server with a new or existing DB2 database system. If you plan to install a new DB2 database system, you can install DB2 OLAP Server before or after you install DB2. You will need to collect specific information about your DB2 system, such as database name, database user ID, database password, and tablespace name, before you install DB2 OLAP Server. This information can be collected from your DB2 database

administrator, or you can configure the database information for DB2 OLAP Server and then configure DB2 to match this configuration.

3.5.1 The General Architecture

In general, the architecture of an OLAP solution consists of the building blocks depicted in Figure 12.

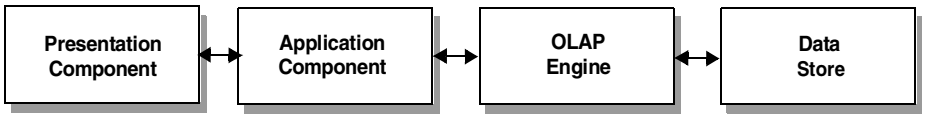


Figure 12. Architecture Building Blocks of an OLAP Solution

The *Presentation Component* provides a rich set of easy-to-use visualization, navigation, and reporting capabilities that have contributed to the success of OLAP tools in the marketplace.

The *OLAP Engine* is responsible for the multidimensional representation of the model, the complex calculations, and the aggregations along the paths of the dimension hierarchies.

The *Data Store* takes care of the persistency of the data represented in the multidimensional model. It arranges the data elements of the model in a physical structure for fast and efficient storage and retrieval.

Some solutions include an additional layer, the *Application Component*, which typically resides between the presentation component and the multidimensional calculation component. The application component provides business logic that is targeted to a specific subject area (for example, financial consolidation, marketing and sales support) and makes use of the general functions provided by the multidimensional calculation component.

3.5.2 Architecture and Concepts of DB2 OLAP Server and Essbase

Whereas Hyperion Essbase clearly belongs to the thin-client, two-tier, M-OLAP category of available architectures, the positioning of the DB2 OLAP Server within the defined categories is not so straightforward.

Both products shield the complexity of managing the data storage (that is, the physical representation of the multidimensional model) from administrators and users. The OLAP engine takes care of building and managing the actual data store, based on the definition of the multidimensional model. Remember, this is not the case for three-tier R-OLAP solutions, where the complex,

time-consuming, and error-prone tasks of managing the data store and defining the mapping information for the multidimensional calculation component must be done by the administrator!

Whereas Hyperion Essbase is a pure M-OLAP solution (that is, it utilizes the file system of the underlying operating system to store the data), DB2 OLAP Server uses a standard DB2 Universal Database (UDB) to manage the persistent model, and is, in this sense, an M-OLAP solution with relational storage.

DB2 OLAP Server structures the data in a relational *Star-Schema* within DB2 UDB. The table structure in a star-schema is especially well suited for multidimensional analysis of relational data. A star-schema consists of a so-called *fact table*, which holds the numerical measures and key figures of the business subject area. The fact table relates these measures to a number of *dimension tables*, which contain the information to establish a context for the recorded facts and hold the aggregation hierarchies to enable drill-down and roll-up operations.

The elements of the dimensions are called *members*. They provide the meaning for the numerical facts in the model and enable analysts to select certain areas of interest by putting constraints on the attributes of the dimension members. The members of a *Market* dimension are, for example, all cities, where a company has sales outlets, such as *Phoenix, San Francisco, Los Angeles, San Diego*. Members of the *Market* dimension belonging to higher aggregation levels, such as states and sales regions are, for example, *California, Arizona* and *East, West*. The members of these higher levels summarize the facts related to the lower level members of the dimension hierarchy.

Both Hyperion Essbase and DB2 OLAP Server share the exact same OLAP engine, originally developed by Arbor Software Corporation. The OLAP engine is accessed through an API, the *Essbase API*, which is also identical between the two products. The Essbase API has established itself as a common standard in the business intelligence industry. Many vendors (more than 30, including Cognos and Business Objects, and Brio) have implemented this API to provide access from their OLAP query products to Hyperion Essbase and of course to DB2 OLAP Server.

The multidimensional calculation component retrieves and returns data blocks from or to the data store component to satisfy the requests from the client application. Therefore, in order to be able to use the same calculation component for DB2 OLAP Server, the storage management component of Hyperion Essbase, which deals with data blocks, had to be replaced by a

component to map the data blocks to the relational tables of the star-schema and vice versa. This component is called the *Relational Storage Manager* (RSM) in DB2 OLAP Server. It is also responsible for creating and maintaining the tables, views, and indexes of the star-schema in DB2 UDB.

The architecture of DB2 OLAP Server combines the advantages of DB2 UDB, the industrial-strength relational database management system, with the power of the widely accepted Essbase OLAP engine, without putting the burden of building and maintaining the relational data store on the administrator. Furthermore, it enables database administrators to manage the multidimensional data in the same way they manage relational data in the data warehouse and in operational systems, thereby leveraging the skills, utilities, and procedures already in place. The solution also integrates smoothly into the existing backup strategy for relational data without additional effort — for example, using ADSTAR Distributed Storage Manager (ADSM).

Because the multidimensional data is stored in relational tables, it is also very easy to do analysis across traditional relational data marts or data warehouses and OLAP data marts, enabling a staged transition to OLAP technology without losing analysis capabilities or introducing unnecessary duplication of data.

Many standard reporting requirements can be solved with traditional SQL-based decision support tools by directly accessing the star-schema of DB2 OLAP Server without having to go through the Essbase calculation engine.

Typically, in large business intelligence environments, both Hyperion Essbase and DB2 OLAP Server are utilized. Consistency of the models, data, and meta data exchange are managed by Visual Warehouse, which integrates with both OLAP solutions.

Figure 13 compares the architectures of Hyperion Essbase and DB2 OLAP Server.

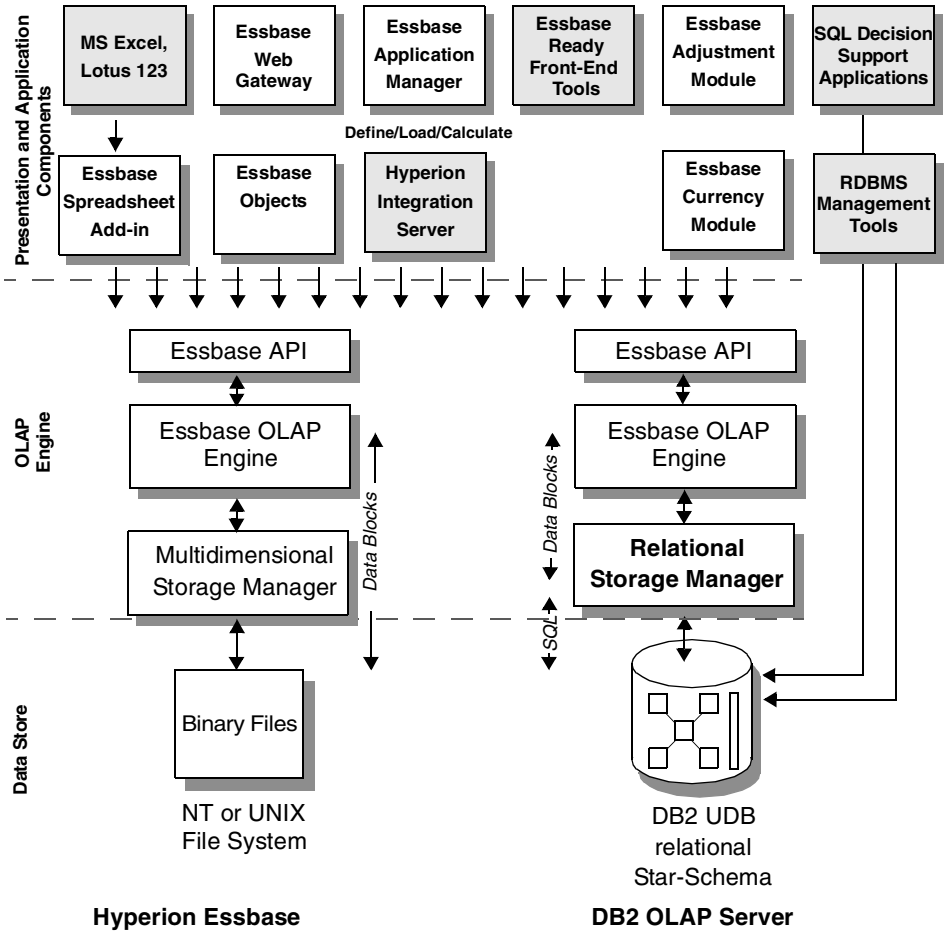


Figure 13. Hyperion Essbase and DB2 OLAP Server Architectures

As you can see in Figure 13, the OLAP Server functions can be accessed by Essbase ready front-end tools that implement the Essbase API (such as Hyperion Wired for OLAP or Cognos PowerPlay) and seamlessly integrated in standard spreadsheets, such as Microsoft Excel and Lotus 1-2-3.

The administration interface for the OLAP Server is provided by the Essbase Application Manager, which allows the definition of the models and the initiation of the load and calculation processes.

Note that Figure 13 also includes the optional Essbase modules: Essbase Adjustment Module, Essbase Currency Module, and Essbase Objects in the Presentation and Application Components section. The Essbase Adjustment

Module provides a complete application for financial consolidation. The Essbase Currency Module contains the functions for currency conversions. The Essbase Objects provide ActiveX components for all major Essbase functions, which can easily be integrated in custom applications, implemented in, for example, Visual Basic or C++.

3.5.3 Supported Platforms and RDBMSs

You can run DB2 OLAP Server on the following platforms:

- OS/2 Warp Version 4.0 or later
- Windows NT Version 4.0 or later
- AIX Version 4.2 or later.

DB2 OLAP Server supports these RDBMSs:

- DB2 Universal Database (UDB) Version 5 Workgroup Edition or later
- DB2 Universal Database (UDB) Version 5 Enterprise Edition or later
- DB2 Database Server Version 4.0.1
- DB2 Common Server Version 2.1.2
- DB2 for OS/390 Version 4.1 or later

3.5.4 Wired for OLAP Server

The OLAP database can be used from end user tools such as Wired to work with the multidimensional database and initiate analytical queries using drag-and-drop.

Wired for OLAP is an OLAP-centric analysis and presenting tool that operates in both client/server and Web-based computing architectures.

Wired for OLAP delivers:

- Highly graphical displays
- Intuitive OLAP navigation
- Robust analytics
- Analytical collaboration
- Easy customize and extend

3.6 DB2 Connect

DB2 Connect, a member of IBM's industry-leading DB2 Universal Database family of products, is IBM's successor to IBM's Distributed Database Connection Services (DDCS).

DB2 Connect provides extremely fast and robust connectivity to IBM mainframe databases for E-business and other applications running under the following Intel and UNIX operating systems:

- AIX
- HP-UX
- Microsoft Windows (all variants)
- OS/2
- Sun Solaris

DB2 Connect is supported by the following IBM database products when running as DRDA Application Servers:

- DB2 for AS/400 Version 2.1.1 or higher
- DB2 for MVS/ESA Version 3.1 and Version 4
- DB2 for OS/390 Version 5 or higher
- DB2 Common Server Version 2
- DB2 Universal Database Version 5 or higher
- SQL/DS Version 3.5
- DB2 for VSE & VM Version 5 or higher

Connectivity to host databases is provided over Systems Network Architecture (SNA) connections using IBM's Advanced Peer-to-Peer Connection (APPC) network protocol for DB for AS/400, DB2 for MVS, DB2 for OS/390, DB2 for VM & VSE, and SQL/DS. DB2 for OS/390 also supports database connections over TCP/IP.

DB2 Connect is available in two forms:

1. DB2 Connect Enterprise Edition (see Figure 14).

   DB2 Connect Enterprise Edition supports Intel and UNIX workstations in a workgroup, department or LAN setting.

   Operating systems supported:

   - AIX

- HP-UX
- OS/2
- SCO UnixWare
- Solaris
- Windows NT

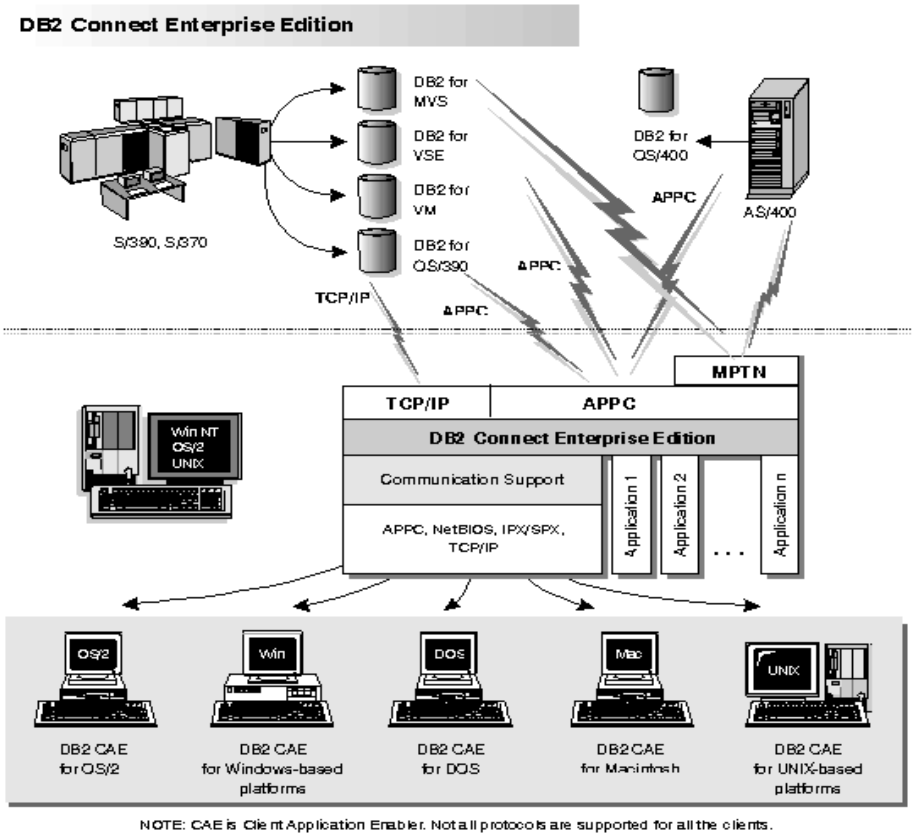


Figure 14. DB2 Connect Enterprise Edition

2. DB2 Connect Personal Edition (see Figure 15).

   DB2 Connect Personal Edition is intended for single-users on Intel workstations.

   Operating systems supported:

   - OS/2
   - Windows 3.1
   - Windows 3.11 for Workgroup

- Windows 95
- Windows 98
- Windows NT

DB2 Connect Personal Edition includes Integrated SNA Support for use on Windows 3.1, Windows 3.11 for Workgroup, and Windows 95. Users of OS/2 also require IBM Communications Server for OS/2. Users of Windows NT also require IBM Communications Server for Windows NT, or Microsoft SNA Server Version 2.11 or higher.

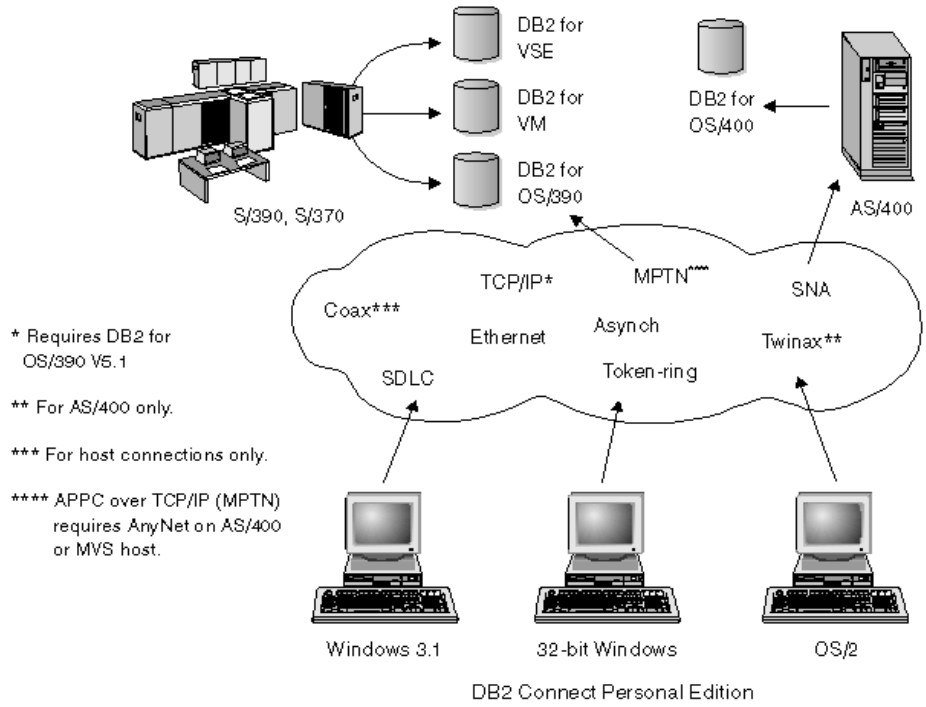


Figure 15. DB2 Connect Personal Edition

DB2 Connect Version 5.2 includes the following enhancements for the host and AS/400 DRDA functions.

- DCE Cell Directory support

  Users working with host and AS/400 databases servers now have additional options for providing database location information when using DCE Cell Directory support for implementations from IBM and Gradient. Refer to the Administration Guide for additional information.

- Enhanced password management

DB2 Connect now permits users to change their passwords without having to log on to their database server. Users can now change their passwords in any one of four ways: by using the SQL CONNECT statement from the DB2 Command Line Processor, by requesting a password change from within the ODBC login dialog, by using the password change option of the Client Configuration Assistant, or by using the ATTACH command.

In addition, application programmers can now take advantage of DB2 Connect enhanced password management to deliver more robust security mechanisms for their applications. The ability to change user passwords is provided for Embedded SQL, ODBC, and DB2 CLI, as well as for Java using both JDBC and SQLJ.

For example, with this support, a user connected to a DB2 for OS/390 database server no longer has to sign on to TSO in order to change his or her password when it expires. Through DRDA, DB2 for OS/390 can change the password for you. The old password along with the new password and the verify password must be supplied by the user.

If the security specified at the DB2 Connect EE gateway is DCS, then a request to change the password is sent to the DRDA server. If the authentication specified is SERVER, then the password on the gateway machine is changed.

An additional benefit is that, with TCP/IP connections to the host, a separate LU definition is no longer required, as was the case with DB2 Connect Version 5.0. Refer to the manual, *DB2 Connect Enterprise Edition Quick Beginnings*, S10J-7888, for additional information.

- Enhanced security failure notification

  Users connecting to host and AS/400 databases can now get additional information on the cause of security failures when they occur, for example as the result of an expired password. Refer to the manual, *DB2 Connect Quick Beginnings*, S10J-7888, for further information.

  In addition, password change support is now supported through DRDA (see Enhanced password management above).

- Enhanced System/390 SYSPLEX exploitation

  DB2 Connect Enterprise Edition (EE), and the DB2 Connect component that is included in both DB2 UDB EE and DB2 UDB Extended - Enterprise Edition (EEE), can now provide enhanced load balancing and fault tolerance by routing connections to different nodes on a System/390 SYSPLEX. Some additional configuration considerations apply, and these are documented in the manual, *DB2 Connect Enterprise Edition Quick Beginnings*, S10J-7888.

- Optimized Catalog Access for ODBC and JDBC Applications

  A new tool db2ocat is provided on Windows 32-bit operating systems in order to assist customers to optimize system catalog searches for ODBC applications.

  DB2 Connect now offers a way to dramatically improve the performance of ODBC and JDBC applications that make extensive use of the system catalog. This improvement is provided using the CLISCHEMA parameter in the DB2CLI.INI file, which allows applications to use an ODBC-optimized catalog instead of the regular system catalog tables. In addition, a point-and-click utility that greatly simplifies the creation and maintenance of ODBC-optimized catalogs can be obtained by downloading db2ocat.zip from:

  ```
  ftp://ftp.softwre.ibm.com/ps/products/db2/tools
  ```

- Microsoft Transaction Server support

  DB2 family databases including host and AS/400 databases can now fully participate in distributed transactions managed by the Microsoft Transaction Server (MTS). Refer to the *DB2 Connect Enterprise Edition Quick Beginnings,* S10J-7888 for additional information.

- New BIND options (DYNAMICRULES)

  There are two new enumerated values for the DYNAMICRULES option of the BIND command. These two values: DEFINE, and INVOKE, are defined to specify the authorization identity to be used for the execution of a dynamic SQL statement in a user defined function (UDF) or in a stored procedure:

  - DEFINE

    Indicates that the authorization identifier used for the execution of dynamic SQL is the definer of the UDF or stored procedure.

  - INVOKE

    Indicates that the authorization identifier used for the execution of dynamic SQL is the invoker of the UDF or stored procedure. Refer to the *IBM DB2 Universal Database Command Reference*, S10J-8166, for further information.

- Set Client Information API enhancements

  A new Set Client Information API allows three-tier client/server or TP monitor applications to pass more specific information about the application end user to DB2 for OS/390.

The new information includes the end user name supplied by server application, the workstation name, the application name, and the accounting string. This information can now be reported by the DB2 for OS/390 DISPLAY THREAD command, and it is available in DB2 for OS/390 accounting records. Previously, in three-tier environments, DB2 for OS/390 could only provide information about the server application and the individual authentication user ID, and not about the numerous end users who multiplex SQL queries on long-running connections. For additional information, refer to the *IBM DB2 Universal Database API Reference*, S10J-8167.

- SQLDescribeParam support for DB2 Connect

  With this enhancement, an application is now able to issue the SQLDescribeParam API call to retrieve parameter descriptions from a DB2 for OS/390 data source.

- Support for Bidirectional Languages

  DB2 Connect now provides support for bidirectional languages such as Arabic and Hebrew. Refer to the *IBM DB2 Universal Database Administration Guide*, S10J-8157, for more information about the nature of this support.

  For information on configuring DB2 Connect Version 5.2 for bidirectional languages please refer to the Release Notes for DB2 Connect Version 5.2, provided with the product.

- System Monitor enhancements

  The following System Monitor enhancements for DB2 Connect are provided in Version 5.2:

  - Enhancements to the sqlmonss API call and the LIST DCS APPLICATIONS command provide for the listing of seven new data elements: DCS application status, client login ID, client platform, client protocol, host CCSID, process ID of client application, and status change time.
  - New GET SNAPSHOT support for DB2 Connect at the database manager and application levels, where the application level reporting includes statement and transaction levels.
  - New SNAPSHOT support for DB2 Connect at the database level.

  Information about detailed updates to the *System Monitor Guide and Reference*, S10J-8164, is contained in What's New.

- Two-phase commit support enhancements

In DB2 Connect Enterprise Edition Version 5.0, two-phase commit support over SNA connections using the DB2 Syncpoint Manager (SPM) was only available on AIX and OS/2. With DB2 Connect Enterprise Edition Version 5.2, this support is now extended to Windows NT. This support requires IBM eNetwork Communications Server for Windows NT Version 5.01 or higher.

Two-phase commit for XA applications was previously only supported over SNA connections, using the SPM. It is now also supported over TCP/IP connections using the SPM.

Applications executed by Transaction Processing Monitors such as IBM TXSeries, CICS for Open Systems, Encina Monitor, and Microsoft Transaction Server previously had to access host systems such as DB2 for OS/390 using SNA. With DB2 Connect Version 5.2, TCP/IP can now be used by these same applications. The DB2 Syncpoint Manager must be used to enable this new feature.

For further information refer to the manual, *DB2 Connect Quick Beginnings*, S10J-7888.

- Simplified DB2 Syncpoint Manager Configuration

  DB2 Syncpoint Manager configuration has been simplified. Many steps are now automated or eliminated compared to previous releases. Please refer to the manual, *DB2 Connect Quick Beginnings*, S10J-7888.

- Support for the SCO** operating system

  DB2 Connect Enterprise Edition Version 5.2 is available for the SCO operating system.

- Support for Big Integer, Large Object, Row ID, and User Defined Distinct data types.

  DB2 Connect Version 5.2 now provides support for Big Integer, Large Object, Row ID, and User Defined Distinct data types. Refer to the *IBM DB2 Universal Database SQL Reference*, S10J-8165, for more details.

- Enhancements to the Client Configuration Assistant

  In V5.2 you can use the Client Configuration Assistant (CCA) to configure TCP/IP connections to DB2 for VM and DB2 for AS/400 database servers. You can also use the CCA to configure IBM Communications Server for NT (CS/NT) and IBM Personal Communications (PComm) SNA stacks if you are using an SNA network.

3.7 IBM e-Network Communication Server Host-on Demand

This section describes the IBM e-Network Communication Server product that has to be used when the connectivity between the workstation platforms and the host system must be established using the APPC networking protocol rather than the TCP/IP protocol.

3.7.1 Communication Server

The solution for a changing environment IBM Communications Server, part of the IBM Software Servers line, meets the challenge of today's changing business environment. Communications Server offers Internet and intranet solutions that allow your company to take advantage of network computing advances—like information access, electronic commerce, and collaboration.

With Communications Server, you choose applications based on your business needs, not on your network. With various local area networks (LANS), mergers, consolidations, and changes to organizational structure, is your network still able to connect applications, data, and people-regardless of where they are? Communications Server brings you true networking, interconnecting people and applications, even when platforms and network configurations are diverse.

Communications Server brings you the reliability, open standards, scalability, and security you've come to expect from IBM. Communications Server is the solution to meet your needs, today and tomorrow.

The Communications Server is designed to meet your networking requirements, so you can concentrate on making your business a success. Communications Server lets workstation users and applications communicate with other workstations and large-computer applications, enabling commerce, encouraging collaboration, and managing your content. The Communications Server provides easy access to the information and people you need in today's diverse multiprotocol network computing environment.

It belongs to the IBM Software Server products, that also include:

- IBM DATABASE 2 (DB2) Database Server
- IBM Directory and Security Server
- IBM Internet Connection Server
- Tivoli Management Server
- IBM Transaction Server
- Lotus Domino Server

3.7.1.1 Highlights

- Make application decisions based on business needs, not network protocols
- Access the information you need—when you need it—from a large computer or LAN, whether you are in the office or on the road
- Discover a powerful gateway server for SNA and TCP/IP clients
- Improve your network systems management through consolidated traffic and reduced need for parallel networks
- Enable remote, integrated cross-server administration capability through the Web
- Get the widest range of connectivity in the industry
- Provide TCP/IP users access to 3270 central computer applications through TN3270E server
- Provide easy SNA 3270 application access from any Java-enabled Web browser

3.7.1.2 Web-Based Server Administration

Communications Server provides a new Web-based tool that gives you remote integrated cross-server administration capability. IBM takes Web-based server administration to a new dimension. A simple graphical user interface provides a convenient, at-a-glance status of Communications Server, while a user interface that is consistent across server platforms preserves a common look and feel.

3.7.1.3 A Solution

Communications Server is the solution for companies that:

- Need to expand the use of applications, yet protect current network investments
- Need to reduce operation and management costs by connecting networks without impacting existing applications
- Must reduce costs of central computer systems and peer-to-peer connectivity by sharing communication resources
- Want to improve network availability and response time by assigning priority to short, interactive data transmissions rather than to batch-oriented bulk data traffic

3.7.1.4 Protocol Independence

The Communications Server opens the door to protocol-independent networking, with seamless support for workstations communicating across SNA, IPX, NetBIOS, and TCP/IP networks. This interoperability gives you the freedom to be responsive to changing business applications, without disrupting your network. Delivering data where it is needed, when it is needed, is a fundamental challenge in today's networked environment. Communications Server lets you exploit the newest technology to maintain your competitive edge.

The Communications Server provides powerful, multiprotocol gateway support for SNA, TCP/IP, IPX, and NetBIOS networks. Communications Server connects applications on many platforms across heterogeneous networks. AnyNet technology, based on open standards, provides the capability to run sockets TCP/IP applications over SNA; SNA applications over TCP/IP; and, with Communications Server for OS/2, you can run IPX- or NetBIOS-applications over TCP/IP and SNA networks. You can mix and match SNA and TCP/IP-based network protocols as you expand or combine networks.

Applications written for SNA, sockets, IPX, or NetBIOS can run without change on mixed network backbones. For diverse networks, Communications Server gives you the breadth of function, connectivity, and capacity to support future needs.

Communications Server also provides TN3270E server function. This allows TCP/IP users easy access to 3270 applications. With the standard extensions, users can print to their workstations or to printers in the TCP/IP network. Also, requesting a resource (LU or pool of LUs), responses, and Attn and SysReq keys are supported. TN3270E support is compliant with industry standard Request For Comment (RFC) 1576, RFC 1646, and RFC 1647. This function is integrated as part of the Communications Server for OS/2 and Windows NT. For Communications Server for AIX, this function is provided by SNA Client Access for AIX (an optional licensed program). SNA Client Access also includes TN5250 server support and dynamic load-balancing capabilities.

3.7.1.5 Mobile Computing

With the IBM Communications Server and a laptop computer, you can take your applications on the road. In addition, remote personal computers can easily access information on central computer systems and other personal computers attached to a LAN. Either way, you gain productivity by staying connected in today's mobile work environment.

3.7.1.6 SNA Services

The Communications Server provides all-in-one SNA communication services from workstations to an S/390 system, an AS/400 system, or other workstations. Its capabilities include a full-function SNA gateway, the most Advanced Peer-to-Peer Networking in the industry, support for many types of connections, and a rich set of application programming interfaces (APIs). Of particular significance is the support of SNA, which is based on IBM's long experience as the architect and developer of this important networking protocol.

3.7.1.7 Advanced Peer-to-Peer Networking

Communications Server acts as a subarea node and an Advanced Peer-to-Peer Networking (APPN) node (both network node and end node). Communications Server APPN support includes SNA networking facilities that connect distributed computing applications, peer applications, and client applications to their servers.

The Communications Server also includes support for High-Performance Routing (HPR), which improves availability and throughput for network communication. It provides error recovery, connection awareness, sophisticated flow control, and segmentation at the end points of a connection, freeing intermediate nodes to move data.

On the Communications Server for OS/2 or Windows NT, if an intermediate link or node in a connection route fails, HPR can Determine a new connection route and resume transmission without disrupting your users' sessions.

3.7.1.8 Supported Platforms and Functions

IBM Communication Server is available for the following operating systems:

- OS/390
- AIX
- DOS
- OS/2

  The IBM Communications Server for OS/2 Warp provides two freestanding components that can be licensed and installed separately to support application development in OS/2 or Windows environments. These components provide SNA services and application programming interfaces for LAN-attached workstations and can function independently from the Communications Server for OS/2 Warp gateway server.

  OS/2 Access Feature consists of 32-bit and 16-bit APIs, LAN and WAN connectivity, APPN end node, and multiprotocol support for the desktop.

This allows Sockets applications over SNA and SNA applications over TCP/IP to communicate with each other through the multiprotocol gateway.

- Windows 3.1, Windows95, Windows NT

  Windows Access Feature consists of the APPC Networking Services for Windows product (NS/Windows) and the multiprotocol support, which lets APPC and CPI-C applications communicate through the SNA over TCP/IP gateway to IBM and other computers. NS/Windows provides the CPI-C application programming interface and APPC support for APPN low-entry network (LEN) end node.

The Communication Server provides the following functions:

- SNA over TCP/IP and Sockets over SNA network communication
- Features APPN network node, end node, including support for HPR and dependent LU requester (DLUR)
- Delivers a rich set of APIs to develop applications for distributed computing, including support for APPC, Common Programming Interface for Communications (CPI-C), and LUA
- Supports TN3270E server functions
- Enables easy 3270 SNA access to any Java-enabled Web browser with Host On-Demand
- Accommodates a broad range of LAN and wide area network (WAN) protocols, including Fiber Distributed Data Interface (FDDI), Synchronous Data Link Control (SDLC), asynchronous transfer mode (ATM), and X.25. The OS/2 and Windows NT Servers also support integrated services digital network (ISDN), integrated data link control (IDLC), and frame relay
- Provides S/390 channel and ESCON support with efficient, high-capacity access to multiple large computers (available for AIX and Windows NT)
- Offers remote access to SNA applications over asynchronous, synchronous, Hayes AutoSync, digital, and cellular connections
- Supports a wide range of IBM and OEM adapters and modems
- Remote installation and configuration
- Allows easy-to-use Web-based, remote cross-server administration

Communications Server for Windows NT allows TCP/IP-attached clients to access SNA APIs, without requiring SNA protocols to flow between the clients and the server. This allows most SNA configuration to take place at the central server. Communications Server supports SNA API clients on Windows

95, Windows NT, Windows 3.1, or higher, and OS/2. With this configuration the server handles the processing while reducing the storage and workload at the client PCs.

3.7.1.9 Benefits

Everyone benefits from the Communications Server:

- Users have a wider choice of new applications, because the Communications Server expands the reach of existing applications. Applications can be deployed to all users quickly and economically.
- Administrators can focus on optimizing the network environment for availability and response time, confident they are always ready to support new application requirements and can still manage costs.
- Application writers can select the APIs they use, based on functions the API provides, without regard to the underlying network. Existing applications can be run over additional network types, expanding the market for those applications. In this way, application providers can concentrate on improving their products rather than on developing different versions to run on different protocols.

3.7.2 Host-on Demand

IBM eNetwork Host On-Demand is an Internet-to-host interconnectivity solution that provides host application access through the Web.

Web users needing host applications, such as public catalogs, databases, and other resources, can use eNetwork Host On-Demand from inside their Java-enabled Web browsers to access central computer data.

eNetwork Host On-Demand delivers network computing to the Web by enabling Web browser users seamless access to non-Internet-based 3270, 5250, ASCII, and CICS Gateway for Java applications, content, and services.This product, available in a single package, can run in any Java-enabled environment. Thus you have simple and consistent access to your enterprise data, and the need for user installation, user configuration, and costly software upgrade administration is eliminated.

eNetwork Host On-Demand is Java-based, so users in different operating environments—whether they are using network computers, traditional personal computers, or advanced workstations—get the same look and feel. This consistency reduces retraining costs when users change operating environments, and it reduces service costs, because each user is on the

same version of the code. You can extend the reach of your enterprise data and applications by using eNetwork Host On-Demand's SSL authentication and encryption to gain secure access across the Internet.

eNetwork Host On-Demand Version 2.0 also provides many features that enable users to customize the interface and to transfer data to other desktop applications. File transfer, cut and paste, and print screen are included to increase user productivity. A Java-based API for application development is available to customize desktops. National language versions are also available, including versions for double-byte character sets and file transfers.

Host On-Demand includes the following components:

- Server

  The server must be installed on a Web server. It includes a client that can be downloaded to workstations, and an administration function that can be used, through a browser, on the server itself or on a client workstation.

- Redirector

  The Redirector allows a client to connect to multiple Telnet servers (or host systems) even if it is using a browser that does not support signed Java applets. It also allows the use of SSL Version 3 security between clients and the server. The Redirector is part of a server installation.

- Express Server

  The Express Server, together with the Express Client, provides enhanced performance on slower connections, such as telephone lines. It also provides redirection function and SSL support. The Express Server is part of a server installation.

- Download client

  The Host On-Demand emulator applet is downloaded to a workstation from a Host On-Demand server, through a Web browser. Most common browsers can be used. No program files are installed on the workstation.

  Unless the browser supports signed Java applets, the client can connect to host systems only through the server from which it was downloaded. The client supports SSL security. It is part of a server installation.

  The user of a download client has three possible ways of working:

  - As a defined user, with an ID and password, and a host-session profile that is unique to that user. The user account and session profile are saved on the server.
  - As a guest user, who uses the default host-session profile.

- With the simple user interface (SUI). The SUI is similar to the interface provided with Host On-Demand Release 1, and has minimal configuration capability.

- Locally installed client

  This client supports SSL security. The user of a local client has two possible ways of working:

  - Full-function

    All four types of host sessions can be used concurrently, and session definitions are saved on the local disk.

  - SUI

    Again, the SUI is similar to the interface provided with Host On-Demand Release 1.

Both the download client and the locally installed client can use the Host Access Class Library API. Message logging and tracing are provided on clients and the server.

More information on eNetwork Host On-Demand is available at:

`http://www.software.ibm.com/enetwork/hostondemand`

3.8 Net.Data and Its Architecture

Net.Data is a Web server gateway that application developers can use to create Internet applications that access data from IBM's DB2 family databases. It enables an application developer to build Web applications that access DB2 databases by using HTML forms and dynamic SQL. These applications are then stored on the Web server, and the end user can use any Web browser to access the HTML forms returning DB2 data.

Net.Data builds on the strengths of its predecessor product, DB2 World Wide Web Connection (DB2WWW), in enabling interactive, data-rich sites. As such, IBM Net.Data delivers a powerful framework for Web applications. In addition to connecting to diverse data sources, Net.Data provides for high performance, robust application development function, and exploitation of existing business logic.

Net.Data provides native access to the data you need in your business environment: DB2, as well as Oracle, IMS, and file data. In addition, through ODBC you can access many other relational data sources. And, Net.Data optimizes access to advanced objects in the DB2 family such as DB2 stored procedures.

By tightly integrating with specific Web server interfaces (such as GWAPI), Net.Data can operate as an extension of the Web server, delivering improved performance over CGI applications. Net.Data provides high-performance access to all of your data sources, including hot connectivity to your DB2 data sources.

Net.Data has extensive application development functionality. A rich macro language, conditional logic, HTML and Virtual Reality Modeling Language (VRML) support, HTML variable substitution, a JDBC interface to DB2 data, and support for multiple data sources result in flexible yet robust Web applications.

You can repurpose your existing client/server applications to the Web, using your existing business logic, embed dynamic SQL, Java applets and JavaScripts, Perl and REXX in your Net.Data application, or call DLLs written in C or C++. By leveraging your existing business applications, you can get your Web applications up and running quickly with Net.Data.

Net.Data is architected as a program that is called by a Web server through either the CGI, ICAPI, or GWAPI (see Figure 16). The Net.Data application uses macro file containing sections, text, HTML, SQL to be executed, programs and scripts to be called, and application control logic. It uses these directives in the macro file to interpret the input from the browser and the Web server, access the specified data sources, and generate the requested output to the browser.

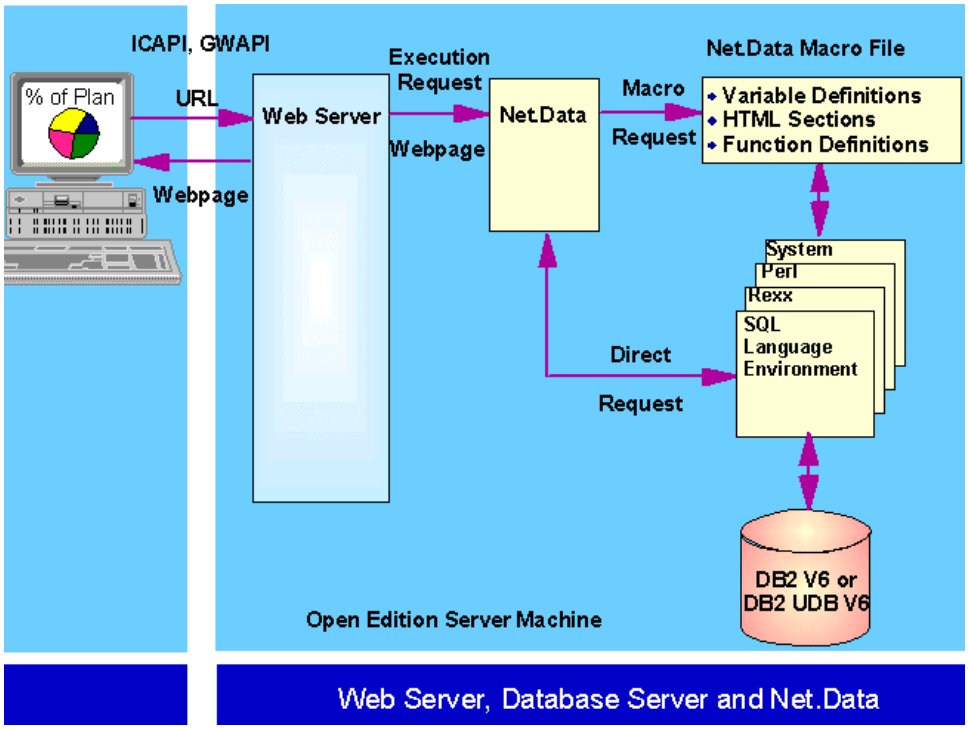


Figure 16. Net.Data Architecture

3.9 Web Server

Web content is what you provide your users from your Web server. Content could include general information about your enterprise, advertising, descriptions of products and services, and order entry facilities.

Two interface options are available for Web programming:

- CGI—where a process is created and destroyed on each Web click.This option is much too expensive to consider for high volume applications.
- All other interfaces (for example, GWAPI, servlets, and FastCGI)—These interfaces provide better performance. However, there is a price to pay: You have to do more of the work. For example, with servlets, FastCGI, or GWAPI, none of the system components is responsible for data integrity or SQL state on your behalf. Typically, these interfaces allow you to establish a database connection and then reuse the connection over multiple Web requests.

However, if you make a mistake in your application, there is no automatic cleanup mechanism. For example:

- You might run your program to completion, but forget to issue COMMIT.
- You might take an exception and then fail to catch the error (that is, you did not retry out of the exception).
- You might set the SQL special registers to some unexpected values during one Web request. If you do not remember to reset the registers, the next Web request will inherit whatever you have left behind.

The basic problem here is that the Web does not behave like IMS, CICS, or DB2 stored procedures, where the system watches for application errors and cleans up as needed. The Web does not do anything special for SQL access, so you have to manage the cleanup on your own. Net.Data provides some of this "safety net" function for your application.

Chapter 4. Data Communication

In data communication, several layers of communication are used in a very complex environment connecting different operating systems and data sources of completely different architectures.

From the application point of view, the base for all communication and data transfer consists of the *communication protocols*. Several protocols are available for inter-system communication. Especially in the workstation area, you have several options.

- The connectivity between the workstation environment and the host systems is based, for example, on Ethernet or on Token Ring.
- The communication protocols mostly used in the workstation environment are NetBIOS and TCP/IP. TCP/IP is used for communication to the host systems as well.
- The most common protocol in the host environment is still APPC (Advanced Program to Program Communication) based on SNA (Shared Network Architecture). The usage of APPN (Advanced Peer to Peer Networking) simplifies the configuration.
- Whether APPC or TCP/IP is used for the communication with the host systems depends on the capabilities of the communication partner on the host side. For example, Cross Access for VSE can use both protocols, whether DB2 Server for VSE V 5.1 uses APPC only.

The next layer is the protocol or architecture supplying the base for the *data exchange* between the data sources and targets.

- For the data transfer between DB2 family products and other relational database software in different operating environments (host and workstation) it is DRDA (Distributed Relational Database Architecture).
- But between like platforms (workstations or VM and VSE) there are so-called private protocols available as well. For example, between the Universal Databases (UDBs) on the workstations, there is a private data exchange protocol available, which has the same functionality as DRDA.
- For the nonrelational data sources, there exist special 'private' solutions (like CrossAccess or Classic Connect) used to provide these sources in a relational view.

4.1 Communication Protocols

The following sections provide a description of the possible communication protocols you can choose for your implementation. Understanding how they work and what they need, you can identify which solution fits best in your environment.

4.1.1 TCP/IP

The need to interconnect networks that use different protocols was recognized early in the 1970s during a period when both the use and development of networking technology were increasing. Even though the rapid growth in networking over the past three decades has allowed users much greater access to resources and information, it has caused significant problems with merging, or interconnecting, different types of networks. Open protocols and common applications were required, leading to the development of a protocol suite known as *Transmission Control Protocol/Internet Protocol* (TCP/IP), which originated with the U.S. Department of Defense (DoD) in the mid-1960s and took its current form around 1978.

An interesting article about the history of the Internet can be found at:

`http://www.isoc.org/internet-history/`

In the early 1980s, TCP/IP became the backbone protocol in multivendor in networks such as ARPANET, NFSNET, and regional networks. The protocol suite was integrated into the University of California at Berkeley's UNIX operating system and became available to the public for a nominal fee. From that point TCP/IP became widely used. Its spread to other operating systems resulted in increasing use in both local area network (LAN) and wide area network (WAN) environments.

Today, TCP/IP enables corporations to merge differing physical networks while giving users a common suite of functions. It allows interoperability between equipment supplied by multiple vendors on multiple platforms, and it provides access to the Internet. In fact, the Internet, which has become the largest computer network in the world, is based on TCP/IP.

So why has the use of TCP/IP grown at such a rate? The reasons include the availability of common application functions across differing platforms and the ability to access the Internet, but the primary reason is that of interoperability. The open standards of TCP/IP allow corporations to interconnect or merge different platforms. An example is the simple case of allowing file transfer

capability between an MVS/ESA host and, perhaps, a Hewlett Packard workstation.

TCP/IP also provides for the routing of multiple protocols to and from diverse networks. For example, a requirement to connect isolated networks using IPX, AppleTalk, and TCP/IP protocols using a single physical connection can be accomplished with routers using TCP/IP protocols.

One further reason for the growth of TCP/IP is the popularity of the socket programming interface between the TCP/IP transport protocol layer and TCP/IP applications. A large number of applications today have been written for the TCP/IP socket interface.

4.1.1.1 TCP/IP Architecture

TCP/IP, as a set of communications protocols, is based on layers. Unlike System Network Architecture (SNA) or Open Systems Interconnection (OSI), which distinguish seven layers of communication, TCP/IP has only four layers. See Figure 17. The layers enable heterogeneous systems to communicate by performing network-related processing such as message routing, network control, and error detection and correction.

- Application Layer

  The application layer is provided by the program that uses TCP/IP for communication. Examples of applications are Telnet, File Transfer Protocol (FTP), e-mail, Gopher and SMTP. The interface between the application and transport layers is defined by port numbers and sockets.

- Transport Layer

  The transport layer provides communication between application programs. The applications may be on the same host or on different hosts. Multiple applications can be supported simultaneously. The transport layer is responsible for providing a reliable exchange of information. The main transport layer protocol is TCP. Another is User Datagram Protocol (UDP), which provides a connectionless service in comparison to TCP, which provides a connection-oriented service. That means that applications using UDP as the transport protocol have to provide their own end-to-end flow control. Usually, UDP is used by applications that need a fast transport mechanism.

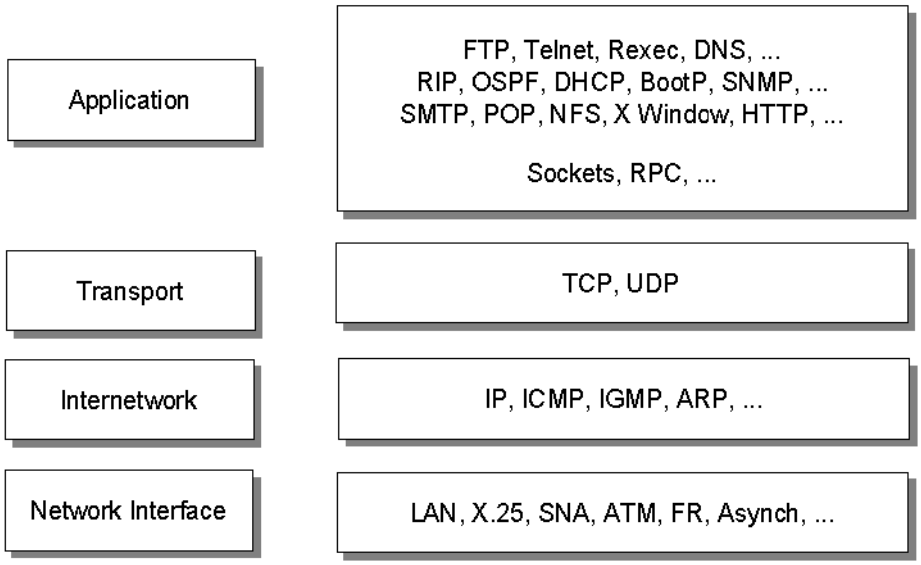


Figure 17. TCP/IP Architecture Model: Layers and Protocols

- Internet Layer

  The Internet layer provides communication between computers. Part of communicating messages between computers is a routing function that ensures that messages will be correctly delivered to their destination. The Internet Protocol (IP) provides this routing function. Examples of Internet layer protocols are IP, ICMP, IGMP, ARP and RARP.

- Network Interface Layer

  The network interface layer, sometimes also referred to as link layer, data link layer or network layer, is implemented by the physical network that connects the computers. Examples are LAN (IEEE 802.x standards), Ethernet, X.25, ISDN, ATM, Frame Relay, or asynch.

  Note that the RFCs actually do not describe or standardize any network layer protocols by themselves, they only standardize ways of accessing those protocols from the Internet layer.

4.1.1.2 IP Addressing

IP uses *IP addresses* to specify source and target hosts on the Internet. (For example, we can contrast an IP address in TCP/IP with a fully qualified NETID.LUNAME in SNA). An IP address consists of 32 bits and is usually

represented in the form of four decimal numbers, one decimal number for each byte (or octet). For example:

```
00001001 01000011 00100110 00000001     a 32-bit address
    9        67        38        1      decimal notation
```

An IP address consists of two logical parts: a network address and a host address. An IP address belongs to one of four classes. The class to which an IP address belongs is determined by the value of its first four bits. See Figure 18.

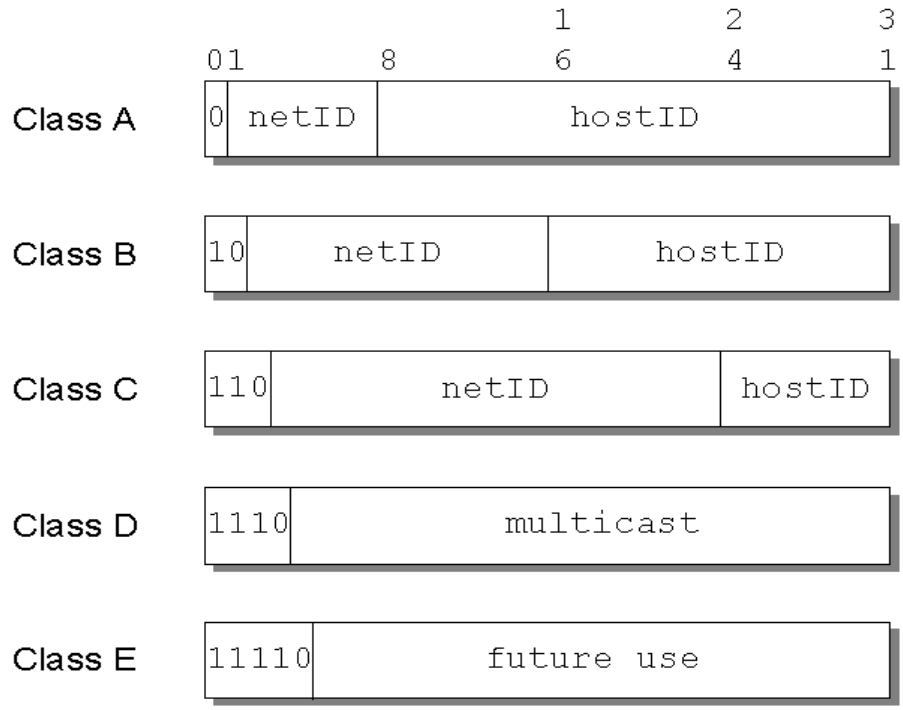


Figure 18. Assigned Classes of IP Addresses

- Class A addresses use 7 bits for the <network> and 24 bits for the host portion of the IP address. That allows for 126 (2**7-2) networks with 16777214 (2**24-2) hosts each; a total of more than 2 billion addresses.
- Class B addresses use 14 bits for the network and 16 bits for the host portion of the IP address. That allows for 16382 (2**14) networks with 65534 (2**16-2) hosts each; a total of more than 1 billion addresses.

- Class C addresses use 21 bits for the network and 8 bits for the host portion of the IP address. That allows for 2097150 (2**21) networks with 254 (2**8-2) hosts each; a total of more than half a billion addresses.
- Class D addresses are reserved for multicasting (a sort of broadcasting, but in a limited area, and only to hosts using the same class D address).
- Class E addresses are reserved for future use.

Some values for these host IDs and network IDs are preassigned and cannot be used for actual network or host addressing:

- All bits 0

  Stands for *this*: this host (IP address with <host address>=0) or this network (IP address with <network address>=0). When a host wants to communicate over a network, but does not know the network IP address, it may send packets with <network address>=0. Other hosts on the network interpret the address as meaning *this network*. Their reply contains the fully qualified network address, which the sender records for future use.

- All bits 1

  Stands for *all*: all networks or all hosts. For example:

  128.2.255.255

  Means all hosts on network 128.2 (class B address).

  This is called a directed broadcast address because it contains both a valid <network address> and a broadcast <host address>.

- Loopback

  Class A network 127.0.0.0 is defined as the loopback network. Addresses from that network are assigned to interfaces that process data inside the local system and never access a physical network (loopback interfaces).

4.1.1.3 Subnets

Because of the explosive growth of the Internet, the principle of assigned IP addresses became too inflexible to facilitate changes to local network configurations. Such changes might occur when:

- A new type of physical network is installed at a location.
- Growth of the number of hosts requires splitting the local network into two or more separate networks.
- Growing distances require splitting a network into smaller networks, with gateways between them.

To avoid having to request additional IP network addresses in these cases, the concept of subnets was introduced. The assignment of subnets can be done locally, as the whole network still appears to be one IP network to the outside world.

Recall that an IP address consists of a pair <network address> and <host address>. For example, let us take a class A network; the address format is shown in Figure 19.

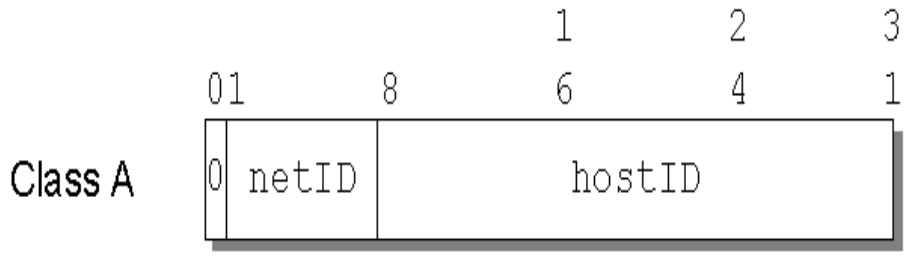


Figure 19. Class A Address without Subnets

Let us use the following IP address:

```
00001001 01000011 00100110 00000001        a 32-bit address
    9       67       38       1            decimal notation (9.67.38.1)

         9.67.38.1          is an IP address  (class A)  having

         9                  as the <network address>
           67.38.1          as the <host address>
```

Subnets are an extension to this by considering a part of the <host address> to be a subnetwork address. IP addresses are then interpreted as <network address><subnetwork address><host address>.

We may, for example, want to choose the bits from 8 to 25 of a class A IP address to indicate the subnet addresses, and the bits from 26 to 31 to indicate the actual host addresses. Figure 20 shows the subnetted address that has thus been derived from the original class A address.

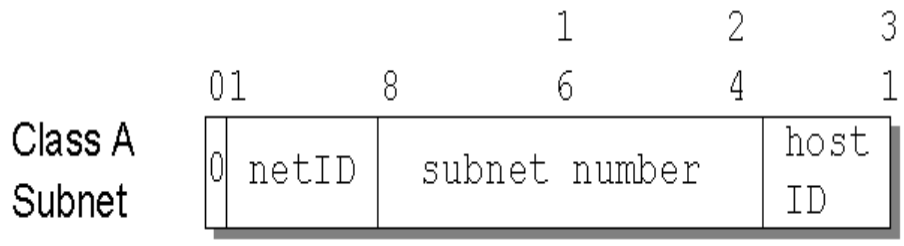


Figure 20. Class A Address with Subnet Mask and Subnet Address

We usually use a bit mask, known as the *subnet mask*, to identify which bits of the original host address field to indicate the subnet number. In the above example, the subnet mask is 255.255.255.192 in decimal notation (or 11111111 11111111 11111111 11000000 in bit notation). Note that, by convention, the <network address> is masked as well.

For each of these subnet values, only (2**18)-2 addresses (from 1 to 262143) are valid because of the all bits 0 and all bits 1 number restrictions. This split will therefore give 262142 subnets, each with a maximum of (2**6)-2 or 62 hosts.

The value applied to the subnet number takes the value of the full byte, with nonsignificant bits set to zero. For example, the hexadecimal value 01 in this subnet mask assumes an 8-bit value, 01000000, and gives a subnet value of 64 (and not 1 as it might seem).

Applying this mask to our sample class A address 9.67.38.1 would break the address down as follows:

```
 00001001 01000011 00100110 00000001 = 9.67.38.1 (class A address)
 11111111 11111111 11111111 11------   255.255.255.192 (subnet mask)
==================================== logical_AND
 00001001 01000011 00100110 00------ = 9.67.38  (subnet base address)
```

and leaves a host address of:

```
-------- -------- -------- --000001 = 1        (host address)
```

IP recognizes all host addresses as being on the local network for which the logical_AND operation described above produces the same result. This is important for routing IP datagrams in subnet environments (see “IP Routing” on page 86).

The actual number would be:

```
-------- 01000011 00100110 00------ = 68760    (subnet number)
```

The subnet number shown above is a relative number, that is, it is the 68760th subnet of network 9 with the given subnet mask. This number bears no resemblance to the actual IP address that this host has been assigned (9.67.38.1) and has no meaning in terms of IP routing.

The division of the original <host address> part into <subnet> and <host> parts can be chosen freely by the local administrator; except that the values of all zeros and all ones in the <subnet> field are reserved for special addresses.

4.1.1.4 IP Datagram

The unit of transfer of a data packet in TCP/IP is called an *IP datagram.* It is made up of a header containing information for IP and data that is only relevant to the higher-level protocols. IP can handle fragmentation and reassembly of IP datagrams. The maximum length of an IP datagram is 65,535 bytes (or octets). There is also a requirement for all TCP/IP hosts to support IP datagrams of up to 576 bytes without fragmentation.

The IP datagram header is a minimum of 20 bytes long (see Figure 21).

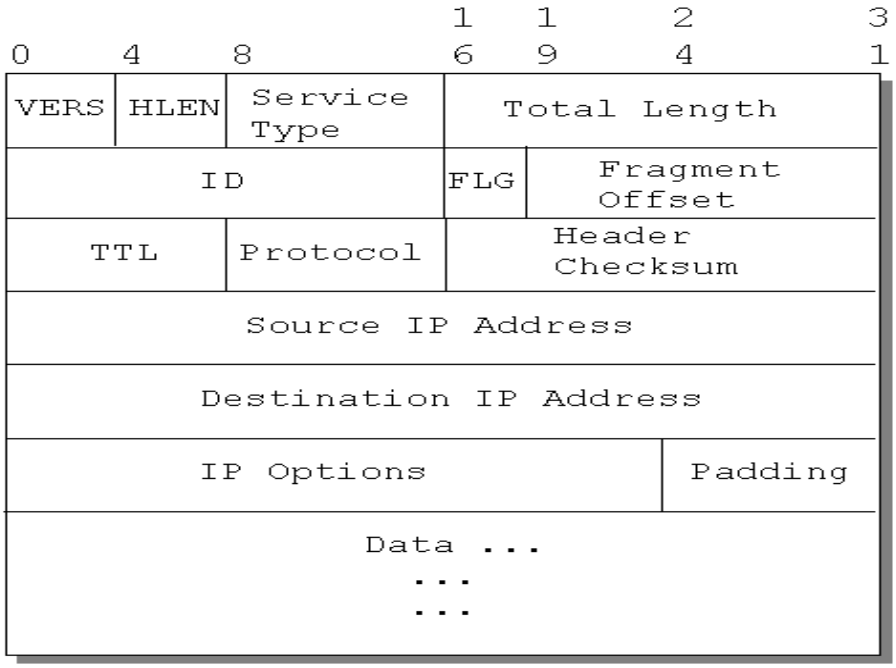


Figure 21. Format of an IP Datagram Header

4.1.1.5 IP Routing

There are two types of IP routing: direct and indirect. For example, Figure 22 shows that the host C has a direct route to hosts B and D, and an indirect route to host A through gateway B.

Direct Routing

If the destination host is attached to a physical network to which the source host is also attached, an IP datagram can be sent directly, simply by encapsulating the IP datagram in the physical network frame. This is called *direct delivery* and is referred to as *direct routing*.

Indirect Routing

Indirect routing occurs when the destination host is not on a network directly attached to the source host. The only way to reach the destination is through one or more IP gateways. In TCP/IP terminology, the terms *gateway* and *router* are used interchangeably for a system that actually performs the duties of a router. The address of the first of these gateways (the first hop) is called an indirect route in the context of the IP routing algorithm. The address of the first gateway is the only information needed by the source host.

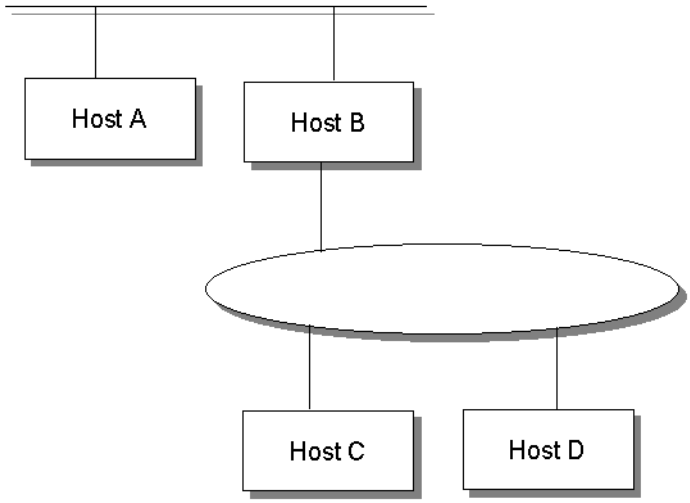


Figure 22. Direct and Indirect Routing

IP Routing Table

The determination of available direct routes is derived from the list of local interfaces available to IP and is composed by IP automatically at initialization. A list of networks and associated gateways (indirect routes) must be configured to be used with IP routing if required.

Each host keeps the set of mappings between the:

- Destination IP network addresses
- Routes to next gateways

The mappings are stored in the IP routing table (see Figure 23). Three types of mappings can be found in this table:

- Direct routes, for locally attached networks
- Indirect routes, for networks reachable through one or more gateways
- Default route, which contains the (direct or indirect) route to be used if the destination IP network is not found in the mappings of type 1 and 2 above.

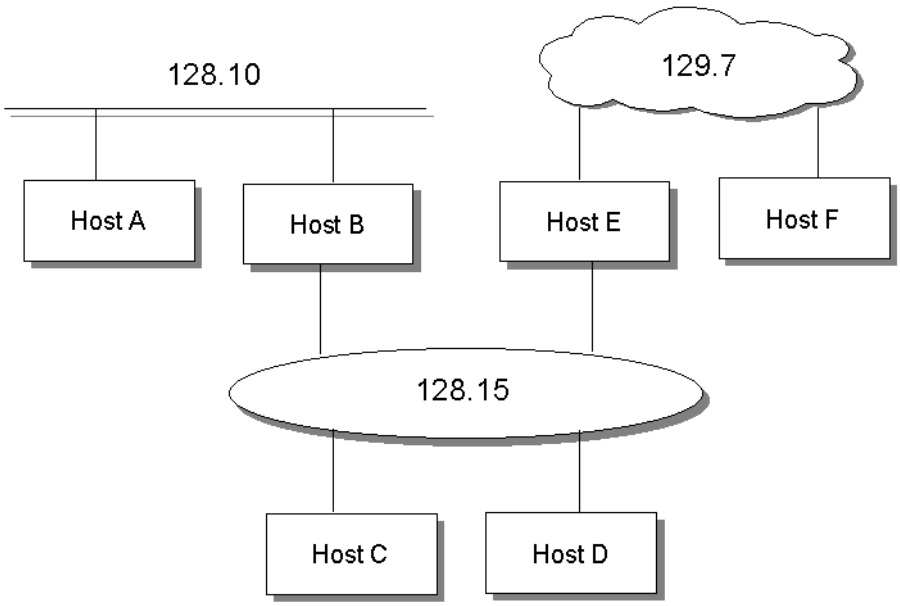


Figure 23. Routing Table Scenario

The routing table of host F might contain the symbolic entries shown in the Figure 24.

```
destination      router       interface
129.7.0.0        F              lan0
128.15.0.0       E              lan0
128.10.0.0       E              lan0
default          B              lan0
127.0.0.1        loopback       lo
```

Figure 24. IP Routing Table Entries Example

IP Routing Algorithm

IP uses a unique algorithm to route an IP datagram. Figure 25 shows an IP routing algorithm with subnets.

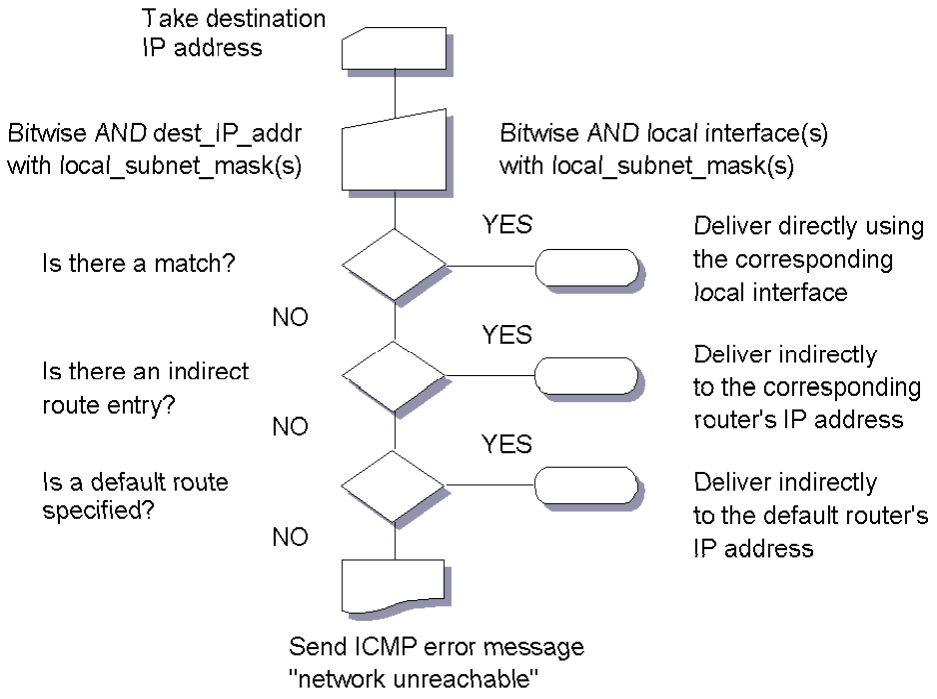


Figure 25. IP Routing Algorithm (with Subnets)

Notes:

- IP routing is an iterative process. It is applied by every host handling a datagram, except for the host to which the datagram is finally delivered.
- Routing tables and the routing algorithm are local to any host in an IP network. To forward IP datagrams on behalf of other hosts, routers must exchange their routing table information with other routers in the network, using special routing protocols.

4.1.2 APPC

The following sections provide information about the advanced program-to-program communication (APPC) protocol.

4.1.2.1 SNA Basis

SNA is a communications architecture that was originally designed to address the increasing complexity of data processing and communications needs as technology advanced. SNA is not a product, it is an architecture that provides a blueprint or specification of how diverse products can connect

and communicate with each other. It defines a set of rules that describe the transport of data and specify, for example, what the data looks like, how it is to be packaged and who the sender and receiver are.

SNA Layers

SNA is a structured architecture that consists of seven well-defined layers, each of which performs a specific network function. As a result of this structure, SNA products have compatible interfaces that facilitate interconnection and communication. Their new functions and technologies can be added to the network with no disruption to the flow of data. The layers defined in SNA are:

- Transaction services

  Provides application services, such as distributed database access or distributed file management.

- Presentation services

  In general, formats the data for different media and sharing of devices.

- Data flow control

  Synchronizes the flow of data within a network, correlates data exchanges, and groups related data into units.

- Transmission control

  Regulates the rate at which data is exchanged to fit within the processing capacity of the participants to avoid congestion in the transport network. This layer is also responsible for encryption, if required.

- Path control

  Routes data between source and destination and controls data traffic within the network.

- Data link control

  Transmits data between adjacent network nodes.

- Physical control

  Connects adjacent nodes physically and electrically and is the hardware part of the connection.

SNA provides function subsetting at a logical unit (LU) level. Thus the architecture provides standard option sets, in the form of profiles, which are defined in the transmission control, data flow control, and presentation services levels. A specific LU supports a subset of architected profiles that reduces the number of options specific network products have to implement. End users (for example, terminal users, applications) access the network

through the LU component of a network product. The LU manages the exchange of data and acts as the intermediary between the end user and the network.

Network products only need to implement the rules or protocols that support the type of communication appropriate to the product. Therefore, printers implement printer protocols, (for example, LU1), and display devices implement LU2.

With the advent of personal computers, programmable workstations, and LANs, SNA has led the move toward peer-to-peer networking. Within SNA, the LU 6.2 protocol is the defined standard for communications between functionally equivalent LUs. It provides a standard set of formats and communication rules that allow programs to directly communicate across multiple hardware and software environments.

4.1.2.2 APPC Basics and Terminology

LU 6.2 describes the standard functions that programs can use to communicate with each other. The implementation of this protocol is called APPC. Sometimes LU 6.2 and APPC are used synonymously.

The LU 6.2 Protocol

The LU 6.2 protocol provides a consistent method for programs to:

- Identify and negotiate the communications options to be used by each partner program
- Provide the name of the partner destination and program
- Supply end-user security parameters to be associated with the request on the remote platform
- Control the transmission of messages
- Synchronize the processing between the partner programs
- Perform coordinated commit processing

The actual functions that can be used may vary from one APPC implementation to another. Programs communicate using options that are supported and agreed to by the APPC support on either side.

Logical Units

The APPC LU implements the LU 6.2 protocol and provides the means by which transaction programs (TPs) access the network. The SNA software accepts requests from the TPs, executes them, and routes the data packet while hiding the physical details of the underlying network. The term *local* LU

refers to the LU to which a TP issues its APPC calls. The Local LU then communicates with a *partner* LU on either the same or a different node.

Transaction Programs

When an APPC application establishes a connection with another LU in the network, the application must identify the name of the TP it wants to execute. The TP name is the logical network name that is used by a program to communicate over the network and can be up to 64 bytes long.

There are two basic types of TPs:

- Application TPs, which perform tasks for end users
- Service TPs, which perform tasks related to system services, such as changing passwords.

Sessions

The logical connection between LUs is called a *session*. Sessions are established when one LU sends another LU the request to BIND. During this BIND process, both partners exchange information about the characteristics of the connection to be established. The LU that starts the session, the initiator, is known as the primary LU, and the recipient of the session is known as the secondary LU.

LUs have either single-session capability, that is, they allow only one active LU-to-LU session with a partner LU at a time; or they have parallel-session capability. With parallel-session support it is possible to have more than one session with the same partner LU at the same time. Most LUs have parallel-session capability.

Conversations

To avoid the overhead of session setup every time two LUs want to communicate, another concept, that of a conversation, has been defined. A conversation is the logical connection between TPs and is carried out over a session. Conversations serially reuse a session to exchange end user information. When a conversation ends, another conversation can be allocated and use the same session. Sessions are typically long-lived links, whereas conversations exist for the duration of the exchange of information, for example, the time it takes to process a transaction.

The basic elements of a conversation are:

- **Starting a conversation**. When a program wants to start an LU 6.2 conversation with another program, it issues an allocate request. The ALLOCATE identifies the partner and requests a connection. The APPC LU makes the connection, if possible, and attempts to reuse a session that

was previously established. If none exists, it creates a session. The partner can accept or reject the conversation request. If the request is accepted and the conversation established, the caller is put into send state, the partner is put into receive state, and information can now be exchanged between the two.

- **Exchange of information**. The program that is in send state sends information to its partner, using the SEND_DATA verb. This action causes the data to be put into the LU's buffer (the LU that is local to the program). The LU does not actually send the data until either the buffer is full (max RU for the session on which the conversation is allocated) or the program explicitly issues a verb (that is, FLUSH, CONFIRM, or one that changes state) that explicitly causes the LU to transmit the buffered data. The partner LU accepts the data and buffers it. The TP gets the data and/or status indicators as a result of issuing a verb such as RECEIVE_AND_WAIT or RECEIVE_IMMEDIATE.
- **Requesting confirmation**. TPs can optionally request synchronization of communications by requesting and granting confirmations, so that they can determine whether their partners have successfully received data that they have sent. Requesting confirmation allows programs to agree that processing completed without error. The level of synchronization (in this case, CONFIRM) is specified during allocation with the SYNC_LEVEL parameter. When a TP issues the CONFIRM verb after a SEND_DATA, the TP actually waits (is suspended) until it receives the response from the partner. The partner responds that it has either received the data (CONFIRMED) or that an error has occurred.
- **Sending an error notification**. When an error occurs, either partner may inform the other of the condition by issuing a SEND_ERROR or DEALLOCATE_ABEND.
- **Ending conversations**. A conversation is ended by issuing a DEALLOCATE verb. The partner receives both a deallocate indicator and any remaining data and then may be asked to confirm the deallocation or just terminate. The partner is put into reset state and completes its own processing. When a conversation is ended, the session is then available for use by another conversation.

When TPs communicate over an LU 6.2 conversation, there are a few areas that they both agree on for compatibility.

Synchronization level provides a means by which two TPs (if they choose to do so) reach a consistent state of processing with respect to the data exchanged. The programs on either end synchronize their actions by requesting and granting confirmations. Confirmation could be used, for

example, when one program wants to ensure that its partner received the data it sent before deleting the source of the transmitted data. There are three possible SYNC_LEVELs.

- **NONE** — specifies no synchronization.
- **CONFIRM** — allows a TP to request specific acknowledgment from a partner that it has received a message. This SYNC_LEVEL enforces confirmation exchanges and error reporting. There are two flavors of confirmation. The first is one wherein a TP issues a CONFIRM verb, to which the partner replies either positively with CONFIRMED, or reports an error condition with SEND_ERROR. The second one is where a TP requests confirmation from its partner by issuing a verb such as DEALLOCATE with type=SYNC_LEVEL.
- **SYNCPOINT** — allows all transaction programs in a distributed environment to commit or back out changes to protected resources (that is, databases). The LU takes responsibility for syncpoint processing.

A synchronous conversation is characterized by a transaction program issuing an ALLOCATE of a conversation, a SEND of data, and a RECEIVE for the reply. When the partner detects that the input message is complete, that is, the partner program enters the RECEIVE state, the conversation is considered to be synchronous. Replies are sent back on the same conversation.

An asynchronous conversation is characterized by a transaction program issuing an ALLOCATE of a conversation, a SEND of data, and a DEALLOCATE. This conversation allows the originating TP to do other work while the partner processes the request. The conversation is in RESET state. If an output reply is to be sent back, a new conversation to send the reply is allocated.

The choice of a MAPPED or BASIC conversation type affects the format of data transmission. An APPC logical record is a sequence of length "LL" (2 bytes) and "data" fields. A typical pattern is "LLdataLLdata..." where the LL fields define how much data follows before the next length field. The choices for preparing the data for transmission in this manner are:

- **MAPPED** — Lets APPC format the data into and out of this pattern for each transmission. The handling of the details of the underlying data stream is the responsibility of the APPC LU and not the application. Thus applications are easier to code because they only need to prepare the data in the format that the partner expects.

- **BASIC** — Requires the TPs to be responsible for formatting the data and including the LL field. This puts the burden on the TP rather than the APPC LU.

Common Programming Interface for Communications

Because the LU 6.2 architecture provides freedom of syntax, products such as APPC/MVS, OS/400, and OS/2 have the option of creating unique implementations of the APPC API as long as they adhere to the semantics (services) as defined by the architecture. As a result of this freedom, the different products have in fact done so. This makes it very complicated for APPC programmers who have to program in different environments, because they are faced with having to learn the unique API appropriate to an implementation. For example, to issue an allocate verb in the APPC/MVS environment, a programmer codes ATBALLC; in an OS/2 environment, a programmer would use the MC_ALLOCATE verb, and in an OS/400 environment, a programmer would use the ACQUIRE and EVOKE verbs.

To alleviate this problem, a standard and consistent API has been defined for applications that need to communicate in the APPC arena. The Common Programming Interface for Communications (CPIC) is common across multiple environments and differs from the product-specific APIs in that it provides an exact common syntax to specify the function calls and parameters. CPIC is designed to eliminate the mismatch of the verb specifications in the different environments. This capability allows an application programmer to learn the syntax on one platform and port the knowledge or even part of the program to another supporting platform. Application programs can use CPIC calls in the major languages such as COBOL, C, FORTRAN, and PL/I. Pseudonym files are provided in the different operating environments (in MVS, check SYS1.SAMPLIB). The files can be "included" or "copied" into programs that call CPIC.

It is up to an application programmer to decide whether to use CPIC or the native interface unique to the specific APPC implementation.

Advanced Program to Program Communication (APPC) is the System Network Architecture (SNA) protocol, on which Distributed Relational Data Architecture (DRDA) is based. APPC is used for the communication between the host system and the workstation servers. The necessary definitions for the APPC protocol are much easier to handle using VTAM/Advanced Peer to Peer Networking (APPN) on the host side. That means some of the definitions are made automatically during startup of communication.

For the time being, TCP/IP is not supported by DB2 for VSE V5, one of the host data servers for this project, just having support for APPC protocol.

To set up DRDA in VM, we need APPC/VM VTAM Support (AVS), which handles the communications between VM and non-VM systems in the network. DB2 communicates by using Inter User Communication Vehicle (IUCV) with the AVS virtual machine. Coordinated Resource Recovery (CRR) provides the synchronization services for two-phase commit processing. A VM CMS application can act as a DRDA client to access any DRDA server.

On VSE, CICS handles the DRDA connectivity and also supports the two-phase commit processing. VSE itself uses Cross Partition Communication (XPCC) to talk to CICS.

APPC communication can be used for communication with CrossAccess Servers as well. CrossAccess is able to work as a VTAM application, not requiring use of the CICS. This allows the possibility of using native TCP/IP for VSE with this products. Details about this configuration will be described later in this book.

4.2 Data Exchange Protocols

This heading discusses the different options and capabilities for accessing and transferring data between different systems. More detailed information about the following headings can be found in *From Multiplatform Operational Data to Data Warehousing and Business Intelligence*, SG24-5174.

4.2.1 DRDA Remote Unit of Work (RUW)

The remote unit of work, also referred to as DRDA level 1, offers remote data access from an *Application Requester* (AR) to an *Application Server* (AS).

RUW means one *Database Management Subsystem* (DBMS) is accessed with one logical unit of work. After changed data has been committed, the application might switch to another DBMS, even on another platform.

The AR functionality is available not only on the workstation side. An application running on OS/390 or VM might access a workstation DBMS as well. The way to define the remote access is different on the different platforms. On OS/390 all definitions are held in DB2 tables, whereas the VM side requires some definitions on the operating system side as well. The PC systems (Windows and OS/2) offer a GUI for all required definitions.

4.2.2 DRDA Distributed Unit of Work (DUW)

The distributed unit of work represents the DRDA level 2, giving access to more than one DBMS within one logical unit of work. That is, the application

might switch to another DBMS before committing the data on all sites in parallel. A funds transfer from one DBMS to another is the best sample for such an application. If the update on one side fails, the changes on the other side are rolled back as well. So there is no risk of an inconsistency in between. The DUW requires a *Two Phase Commit* functionality on all participating DBMSs.

4.2.3 Distributed Request (DR)

The two phase commit function is the base for the distributed request as well. DR means access to several DBMS within one *select* statement. With this functionality, a join of data from multiple systems is possible. The IBM DataJoiner (DJ) offers this function when providing several (remote) data sources as one single database image. The SELECT SQL statement (join of two or more tables) is issued against the DJ database, and the middleware splits it up to several DUW requests or transfers the data and performs the join locally.

4.2.4 Private Protocols

Private protocols are used within the DB2 family for communication between the *Universal Database* (UDB) products on the workstation side. This private protocol provides same functionality as DRDA.

The SQLDS private protocol is used for communication between DB2 Server for VM and DB2 Server for VSE through *Guest Sharing* only. It provides no DRDA functionality. With the setting of the DB2 for VSE or VM start-up parameter 'PROTOCOL' to either 'AUTO' or 'SQLDS', you may decided whether the database server accepts a DRDA request or private protocol only. See the 'Operation' or 'System Administration' manual for more details.

4.2.5 Nonrelational Access

For the access to nonrelational data from a "relational" requester, there are no specific protocols to be named; only products.

OS/390

A feature of DataJoiner called Classic Connect provides access to IMS and VSAM data on OS/390 in a relational view. A server application running on the host, maps the nonrelational data to the specified table image using *meta data*. This meta data is generated from the COBOL copy books or the database descriptor block (DBD for IMS), which describe the format of the data records.

VSE/ESA

A similar function is provided for access to VSAM, DL/I, and sequential files on VSE by CrossAccess. The Server is running permanently on the host to be accessed either through TCP/IP or APPC. For every request, a Database Management System Interface (DMSI) is started in another (dynamic) partition. The DMSI accesses the nonrelational data, while the server maps it to the relational table image by using the meta data, as described for Classic Connect.

So far, the access to the nonrelational data is read-only. Joining of *tables* is possible for "like" data; that means, for example, two VSAM tables.

Chapter 5. Implementation

This chapter describes how the host servers were implemented in the ITSO scenario, providing samples that can help you in your implementation.

5.1 OS/390 Environment

This section explains how to configure the environment to access IMS databases, VSAM files, and DB2 databases under the OS/390 environment from a client workstation through the DataJoiner and DataJoiner Classic Connect products.

The following steps are required to configure this environment under the OS/390 by using the DataJoiner and DataJoiner Classic Connect.

1. Section 5.1.1, “IMS/ESA Environment Configuration” on page 99, shows you how to configure the IMS Database control (DBCTL) environment if you use the database resource adapter (DRA).
2. Section 5.1.2, “DataJoiner Classic Connect Configuration” on page 100, shows you how to configure DataJoiner Classic Connect.
3. Section 5.1.8, “DataJoiner Connectivity” on page 123, shows you how to configure DataJoiner.

See Appendix A, “The OS/390 Environment” on page 177, for detailed information about how all the source databases were created for this project, on the OS/390 system.

5.1.1 IMS/ESA Environment Configuration

This section describes how to prepare the IMS/ESA environment to access the IMS Database from the DataJoiner through the DataJoiner Classic Connect (DJCC). The following paragraph gives a short introduction to the IMS system.

IMS consists of two licensed programs: the IMS Database Manager (DM) and the IMS Transaction Manager (TM). With the Database Manager, you can generate the batch environment and the database control (DBCTL) environment. With both the Database Manager and the Transaction Manager, you can generate the DB/DC environment. With the Transaction Manager, you can generate the data communication control (DCCTL) environment.

The greatest dissimilarity between DBCTL and DB/DC is that DB/DC is a complete on-line transaction and database management system. DBCTL is a

database management system only. No communication facility, such as VTAM or TCP/IP, is available on DBCTL. Also, DBCTL supports part of the Fast Path database. No IMS remote site recovery and share queue address spaces exist. The Batch Message Processing (BMP) region is used only by batch applications and utilities. External program subsystems can, however, use an interface that does handle messages—a coordinator controller (CCTL). The interface between the CCTL and the control region is the database resource adapter (DRA).

The DRA is provided by IMS, but does not reside in any IMS on-line or associated address spaces. Instead, it resides in "client" address space. For example, when CICS connects to DBCTL, DRA resides in CICS address space, and communicates with DBCTL's partition support table (PST) control block.

The DJCC allows you to access IMS data using either its DRA interface or its BMP/DB Batch (DBB) interface. The DJCC is a VTAM application; it uses IMS CCTL modules, but resides in DJCC address space, not in IMS.

Using the DRA interface, you must use the IMS DBCTL control region, you must configure the DRA interface in your DJCC data server configuration file, and you must start the DJCC data server using the DRA interface parameters. If you have to configure the IMS DBCTL control region in your IMS environment, as we did for this project, see Appendix A, "The OS/390 Environment" on page 177, for help in configuring it.

Using the BMP/DBB interface, you can use the IMS control region from either DBCTL or DB/DC. You must configure the BMP/DBB interface in your DJCC data server configuration file, and you start the DJCC data server using the BMP/DBB interface parameters.

We describe how to configure the DJCC data server under "Establish Connectivity between IMS and DJ through DJCC" on page 123 in this redbook.

For more detail information about configuring IMS DBCTL, see the manual *IMS/ESA V6 Admin Guide: System*, SC26-8730.

5.1.2 DataJoiner Classic Connect Configuration

This section describes how to configure the DJCC configuration files.

5.1.2.1 Data Server Installation Verification

After you have finished the installation, and before you continue with the configuration, we strongly recommend that you go through the installation verification program.

The OS/390 Sample Application (DJXIVP) is available in the installation IVP sample library (djxhlq.DJXSAMP). Make sure that this JOB correctly generates the same output as the sample output (DSXIVOUT) in djxhlq.DJXSAMP. The return code is 0, even if the queries from the sample application failed. You have to check the output file carefully.

5.1.2.2 Data Server Setup for IMS Access

This section describes the Data Server setup for IMS Access by the DRA interface. You do not need this setup for the BMP/DBB interface.

A coordinator controller (CCTL) provides communications and transaction management services for a DBCTL environment, which has no transaction management facilities of its own.

1. Make DFSPRRC0 accessible:

   The Classic Connect uses the CCTL. The CCTL must load the DRA start-up/router (load module DFSPRRC0). Although the DRA is shipped with the IMS product, it executes in the CCTL address space, that is the Classic Connect data server.

   Make the DFSPRRC0 accessible to the Classic Connect data server using either of the following methods:

   - Copy DFSPRRC0 from the imshlq.RESLIB library into the djxhlq.SDJXLOAD load library.
   - Concatenate the imshlq.RESLIB library to the SDJXLOAD STEPLIB.

2. Create DFSPZPxx:

   The DRA start-up table (load module DFSPZPxx) contains default values for the DRA initialization parameters. If the system programmer wants to specify values other than the defaults, write your own module (naming it DFSPZPxx), assemble it, and load it in the CCTL load library. Use the supplied module, DFSPZP00, as an example. See the following example:

```
EJECT
        DFSPRP DSECT=NO,                                              X
              FUNCLV=1,          X        CCTL FUNCTION LEVEL         X
              DDNAME=CCTLDD,     XXXXXXXX DDN FOR CCTL RESLIB DYNALOC X
              DSNAME=IMS610D.RESLIB,                                  X
              DBCTLID=IMSD,      NAME OF DBCTL REGION                 X
              USERID=YOURID,     XXXXXXXX NAME OF USER REGION         X
              MINTHRD=001,       XXX      MINIMUM THREADS             X
              MAXTHRD=005,       XXX      MAXIMUM THREADS             X
              TIMER=60,          XX       IDENTIFY TIMER VALUE - SECS X
              SOD=T,     X        SNAP DUMP CLASS                     X
              TIMEOUT=060        XXX      DRATERM TIMEOUT IN SECONDS
             END
```

Set "DSECT=NO".

Set "DSNAME" to imshlq.RESLIB. In our example, "DSNAME=IMS610D.RESLIB".

Set "DBCTLID" to your IMS subsystem id. In our example, "DBCTLID=IMSD".

Make the load module DFSPZPxx accessible to the Classic Connect data server. In our example, "SJ" is used for the suffix, and it is stored into IMS610D.RESLIB and is specified in STEPLIB of the data server started JCL.

The SERVICE INFO ENTRY parameter for DRA specifies the suffix xx for the start-up tables name. You specify it in Data Server Configuration file.

An example follows:

```
*
* IMS DRA INTERFACE SERVICE INFO ENTRY
*   REFER TO CLASSIC CONNECT DOCUMENTATION FOR DETAILED
*   INFORMATION ON LAST SUBPARAMETER
 SERVICE INFO ENTRY = DJXDRA IMS  2 1 1 10 4 5M 5M SJ,YOURDID,PFIRDB
```

5.1.3 Network Communication Protocol Configurations

This section describes the steps you must perform, both on your OS/390 system and on your AIX system, to configure a TCP/IP communications interface (CI) for DJCC.

5.1.3.1 Configuring TCP/IP on OS/390

DJCC's TCP/IP is compatible with both IBM's and Interlink's Berkeley Socket TCP/IP. This section describes how to configure Classic Connect using IBM's TCP/IP.

Berkeley sockets is supported by IBM and Interlink. The Berkeley Sockets version requires an additional parameter in the DJXDSCF member called TASK PARAMETER, which identifies the Interlink subsystem name and identifies the location of the configuration data sets for IBM. Within the configuration data sets, users must specify the name of the started-task procedure used to start the TCP/IP address space name and can also specify the TCP/IP DNS IP addresses. If no environment variables are passed, then the default value TCP/IP is used for both the address space name and as the high-level qualifier (hlq) of the standard configuration files:

- hlq.TCPIP.DATA
- hlq.ETC.HOSTS
- hlq.ETC.PROTOCOLS
- hlq.ETC.SERVICES
- hlq.ETC.RESOLV.CONF

DJCC uses a search order to locate the data sets, regardless of whether DJCC sets the hlq or not.

Determine the following values for the OS/390 system on which DJCC is being installed, and enter these values in the worksheet portion of Figure 26:

- IP Address (or hostname)

  is specified in the hlq.PROFILE file under the parameter of HOME.

- Port Number (or service name)

  is not specified in the hlq.PROFILE file under PORT parameters for another application.

- TCP/IP address space name

  is specified in subparameter TCPIP_MACH of TASK PARAMETER, which must be the same name in the hlq.TCPIP.DATA file under the parameter of TCPIPJOBNAME.

- High level qualifier of TCP/IP standard configuration files

  is specified in subparameter TCPIP_PREFIX of TASK PARAMETER.

5.1.3.2 Configuring TCP/IP on AIX

You must configure your AIX machine to locate the DJCC data server on OS/390.

1. Update the Names server or /etc/hosts file on the AIX machine with the hostname value. If you are using an IP address, no action is required.

2. On the AIX machine, you can configure either a port number or service name to access a particular data server. If you are using a service name, it must be defined in the /etc/services file on the AIX machine. If you are using a port number, no action is required.

5.1.3.3 TCP/IP Communications Template and Worksheet

Figure 26 provides you with an example set of TCP/IP values for both your OS/390 configuration. The values will be used during DJCC Data Server and client configuration in a later step.

```
TCP/IP-MVS

MVS hostname              not used (*)
or IP address             9.12.14.223
subsystem name            tcp
port number or service    3500
name for data server


(*)This example uses IP address instead of the hostname
```

Figure 26. TCP/IP Communications Template and Worksheet

5.1.4 Configuring Data Server Communications on OS/390

DJCC data server can accept communication connections from both local and remote client applications.

Three parameters are involved in configuring a client application to DJCC data server connection:

- The DATASOURCE parameter in the client

  The client's DATASOURCE parameter specifies two subparameters:

  - The data source name
  - A communications compound address field
- A SERVICE INFO ENTRY parameter in the data server for a query processor (DJXQP)
- A SERVICE INFO ENTRY parameter in the data server for a connection handler service (DJXINIT)

Figure 27 shows the relationship of the DJCC configuration files and other related parameters.

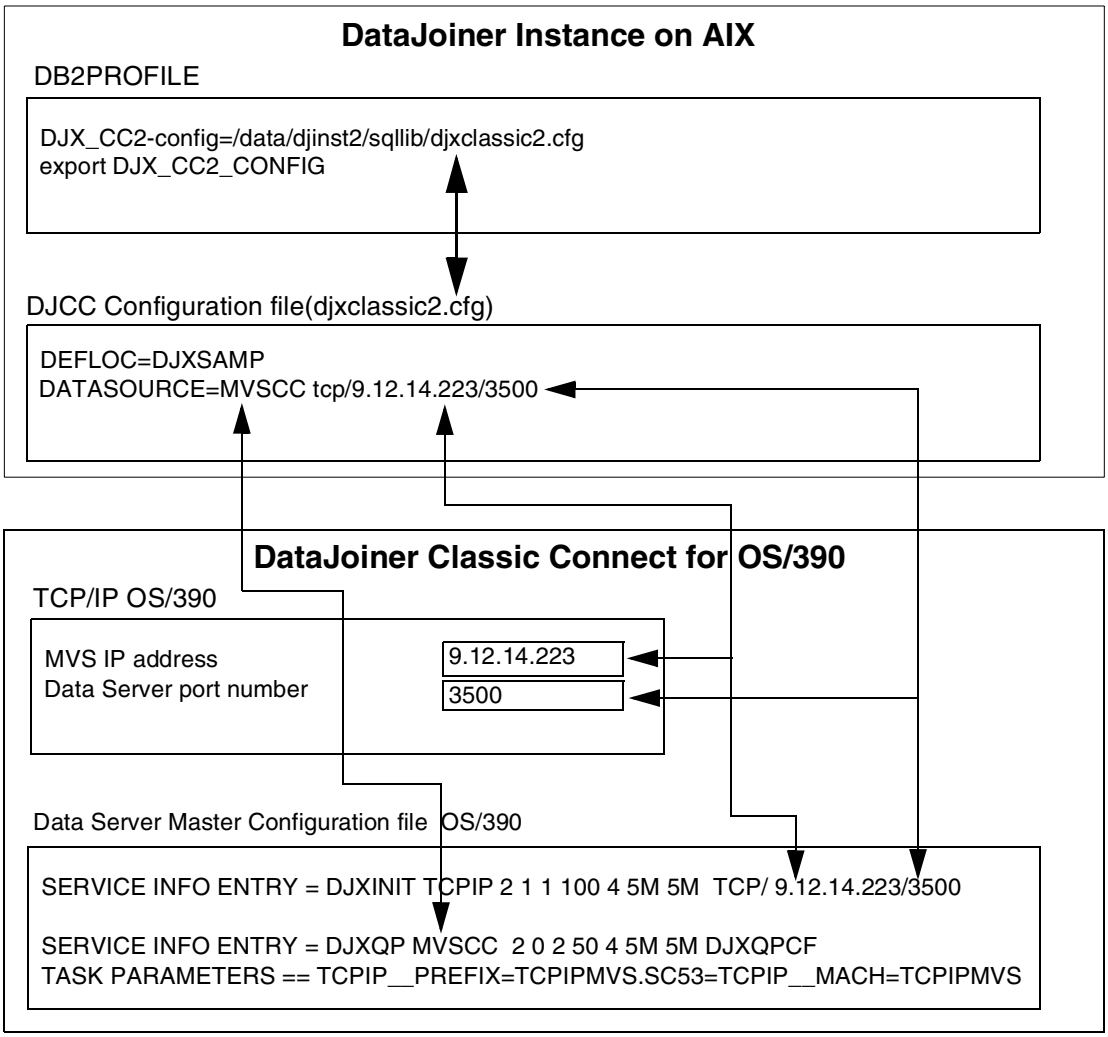


Figure 27. Relationship of DJCC Parameters

5.1.5 Configuring an AIX Classic Connect Client

The following steps describe how to configure a DJCC instance to access a DJCC data server.

1. Edit the DJCC configuration file, djxclassic2.cfg.

   The configuration file, djxclassic2.cfg, shown in Figure 28, is located in the DataJoiner instance owner's sqllib directory; for example, /home/djinst/sqllib/djxclassic2.cfg. Each instance has its own configuration file.

```
************************************************************************
*  Classic Connect Sample Application Configuration File              *
************************************************************************/
* national language for messages
NL                = US English
* resource file master file
NL CAT = /data/djinst2/sqllib/msg/En_US/djxengcat2
FETCH BUFFER SIZE = 32000
DECODE BUFFER SIZE = 4096
DEFLOC = MVSCC
USERID = yourid
USERPASSWORD = password
DATASOURCE = MVSCC tcp/9.12.14.223/3500
*DATASOURCE = SFVTAM appc/sideprofile1/remote1tpname
HOST CODEPAGE = IBM-850
NETWORK CODEPAGE = IBM-037
RESPONSE TIME OUT = 20S
COMPRESSION = 0
```

Figure 28. Example of Classic Connect Configuration file, djxclassic2.cfg

2. Configure DATASOURCE parameter for TCP/IP.

   Modify the DJXSAMP DATASOURCE parameter to include the IP address (or hostname) and port number (or service name) of the data server.

   While configuring the data server in "Configuring Data Server Communications on OS/390" on page 104, you may have added additional query processor SERVIVE INFO ENTRYs. Add DATASOURCE statements for any additional query processors to be accessed using TCP/IP.

   The sample configuration file contains an entry for the SFVTAM query processor. If you are not using APPC to configure a data server, comment this DATASOURCE statement out by adding an asterisk (*) as the first character of the line.

3. Uncomment the DEFLOC configuration parameter.
4. Save the file to disk.

5. Set environment variables.

   The DJX_CC2_CONFIG environment variable must be set to point to the DJCC configuration file on AIX, djxclassic2.cfg. For example:

   export DJX_CC2_CONFIG=/home/djinst2/sqllib/djxclassic2.cfg

   This variable must be set for each DataJoiner instance or user running DJXSAMP2 to access DJCC. Set DJX_CC2_CONFIG from your AIX command prompt, from the shell initialization file (see Figure 29), or from the instance profile scripts (see Figure 30).

```
export LIBPATH=\home\djinst2\sqllib\bin;
export DJX_CC2_CONFIG=\home\djinst2\sqllib\djxclassic2.cfg
```

Figure 29. Example of .profile

```
:
#------------------------------------------------------------------------
# DJX_CC2_CONFIG [Default= null, Value: name of the CC V2.1.1 config file]
# specifies the complete path and file name of the configuration file
# for the DataJoiner Classic Connect (CC)V2.1.1 interface.  If set
# and the file exists, support for the CC is enabled.  If null, not
# set, or DataJoiner cannot find the file, the CC interface cannot be
# used.  The CC interface is used to access data sources defined to
# DataJoiner Classic Connect V2.1.1 for MVS.  A sample setting is:
#    DJX_CC2_CONFIG=/data/djinst2/sqllib/djxclassic2.cfg
#------------------------------------------------------------------------
DJX_CC2_CONFIG=/data/djinst2/sqllib/djxclassic2.cfg
export DJX_CC2_CONFIG
:
```

Figure 30. Example of db2profile

Access from DataJoiner will be available only after the instance is restarted using the DB2 start command.

5.1.6 Mapping Non-Relational Data (VSAM)

5.1.6.1 Data Mapper

This section explains how to use the Data Mapper.

Creating a Repository

The first step in mapping your non-relational data to a relational view is to create a repository.

A repository stores information (data catalogs, tables, columns, and owners) about the legacy data DataMapper is mapping.

To create a repository:

1. Select **File** -> **New Repository** from the DataMapper main menu.
2. Enter a File Name and location for your repository in the **Create a New Repository** dialog box. A file extension of .mdb must be assigned to all DataMapper repository files.
3. Click **Save** to create the repository. The repository you created is displayed. This is an empty repository. You will add data catalogs to the repository in “Creating a Data Catalog” on page 108.

Creating a Data Catalog

This step describes how to create a data catalog for the newly-created repository.

1. With the repository window open, select **Edit** -> **Create a New Data Catalog**... from the DataMapper main menu, or click the **Create a New Data Catalog** icon on the toolbar.

   The **Create Data Catalog** dialog box opens.
2. Enter the data catalog **Name**, **Type**, and any **Remarks**. To select from a list of data catalog types, click the arrow next to the **Types** box.
3. Click **OK** to create the data catalog.

   The data catalog is now displayed on your repository screen.

Creating a Table

The following steps describe how to add tables to a data catalog.

A Classic Connect table is equivalent to a DB2 table and is created by mapping one or more record types from a non-relational database into a single Classic Connect table.

Be sure to have a repository open before starting this section.

1. Select a data catalog by clicking the number to the left of the data catalog name. This will highlight the selected row.
2. Double-click the **Table** icon to bring up the **Tables** window, or select **Window** -> **List Tables** to list tables for the data catalog.

3. From the **Tables** window, select **Edit** -> **Create a new table**..., or click the **Create a New Table** icon on the toolbar.

   The **Create a VSAM Table** window opens.

4. Enter the table Name in the **Name** box.
5. Choose an Owner from the pulldown list.
6. Enter the data set name or the DDname of the data set for a VSAM DMSI:
   - For a data set name, select the **DS** radio button. Enter a 1- to 44-character MVS data set name, such as SYS1.VSAMKSDS, in the **Name** field.

     The DS option users MVS dynamic allocation services to access the associated VSAM data set.

   - For a DD name, select the **DD** radio button. Enter a 1- to 8-character alphanumeric DDname in the **Name** field.

     The DD option requires a DD statement with that DDname in the VSAM DMSI start-up procedure JCL.

7. (Optional) Select **Reference Only** by clicking the box to the left of the **Reference Only** field.

   This selection specifies that the table you are creating will be used for reference purposes only. The reference table is used to build large column lists to populate other tables. These reference tables are not generated into the data catalog's meta data input when meta data generation is requested. This option is particularly useful when creating tables with hundreds of columns, as you can use the drag-and-drop feature of DataMapper to copy columns between windows.

8. Enter any remarks in the **Remarks** box.
9. Press **Enter**, and the table is added to the data catalog.
10. Click **OK** to create the table.

    The table is added to the **VSAM Tables for Data Catalog** window for this data catalog.

Importing a Copybook

This section describes how to import a COBOL copybook. Copybooks are transferred from the mainframe to the workstation and must be given a file extension of .fd.

1. Open the **VSAM Tables for Data Catalog** window by double-clicking the **Table** icon, or selecting **Window** -> **List Tables**.

2. Select the table into which you want to import the copybook by clicking the number to the left of the table name.
3. Select **File** -> **Import External File...**, or press the **Import an External File** icon.

   The **Import File** dialog box opens.
4. Select a copybook to import from the C:\cxa32\dm\samples directory and then click **Open**.

   The **Import Copybook** window opens.
5. Select the table into which you which you want to import the copybook, and select the appropriate import options, which include:

   Import Group Level Data Items

   Creates a column for each COBOL data item that is a group level item. Group level items are items without picture clauses that contain subordinate data items with higher level numbers.

   Import Selected Structure Only

   Since most copybooks contain more than one record or field definition, you can select a particular structure to import from an existing copybook by clicking on the data item at which to start the import, then selecting the **Import Selected Structure Only** check box. When structure selection is used, the selected data item and all subordinate data items (following data items with higher level numbers) are imported. The data item selected can exist at any level in the structure.

   OCCURS Clauses

   - **Create Record Array**: defines a record array for data items within OCCURS clauses in the copybook.
   - **Expand each occurrence**: creates a column for each occurrence of a data item within the copybook. Data item names within the OCCURS clause are suffixed with _1, _2, ..._n.
   - **Map first occurrence only**: create a column for the first occurrence of a data item within the OCCURS clause only.

   Append to Existing Columns

   Adds the copybook columns to the bottom of the list of existing columns in that table. Not selecting this option deletes any existing columns and replaces them with the columns you are now importing.

Calculate Starting Offset

Use this option to append to existing columns in a table. This allows the starting offset of the first appended column to be calculated based on the columns already defined in the table. When selected, the first appended column will be positioned at the first character position after the last column (based on offset and length already defined for the table).

Use Offset

When you have an explicit offset to be used for the first column imported and it does not match the field's offset in the copybook structure, enter an offset in this field to override the default calculation based on the COBOL structure. If you do not override the default, the offset for the first imported column is determined by the COBOL field's offset in the structure you are importing.

Note: By default, the offset of the first COBOL data item imported is based on the data item's position in all of the structures defined in the import file. This offset will always be zero unless you are importing a selected structure from the copybook. In that case, the offset for the first column imported from the structure will be the COBOL data item's position based on all structures that precede it in the import file. If the default offset is not correct, then the **Calculate Starting Offset** or **Use Offset** options can be used to override the default.

6. Select **Import** to import the copybook to your table.

   The **Columns for VSAM Table** window opens with the newly-imported columns.

Creating VSAM Index

Note: Be sure to have the **VSAM Tables** window open and a table selected before starting this section.

1. Select **Window** -> **List Indexes**, or click the **Index** icon on the toolbar to list the indexes of the table.
2. Select **Edit** -> **Create a new Index...**, or select the **Create a New Index** icon on the toolbar.

   The **Create VSAM Index** window opens.
3. Enter the following information:

   Name

   Specifies the name of the index (required).

   Owner

   Specifies the authorization ID to be assigned to the index (optional).

Index is Unique

If checked, every key in the index has a unique value.

VSAM Alternate Index

Select either DD or DS and enter 1- to 8-character DD Name or 1- to 44-character VSAM PATH name (optional).

If alternate index information is not defined, the index is assumed to be the primary index of a VSAM KSDS.

Included Columns

Contains the columns comprising the index and their physical order in the index. At least one column must be defined in the included columns list.

Remarks

Description of the VSAM index (optional).

4. Click **OK** to add the index.

   The **Indexes for VSAM Table** window opens with your new index added.

Generate VSAM Meta Data Grammar

This section describes the steps required to create *meta data grammar*. Meta data grammar, also known as *USE grammar*, is generated by the DataMapper for all of the tables in a specific data catalog. When meta data grammar has been created, it is subsequently transferred from the workstation to the mainframe. It is required as input to the Classic Connect Meta data Utilities that are run on the mainframe to create tables and used as relational-equivalent data maps for their corresponding non-relational files.

1. From the **Data Catalog** window, select a data catalog.
2. Select **Generate USE Statements...** from the **File** menu or select the **Generate USE** icon on the toolbar.

   The **Generate USE Statements** window opens.
3. Give the file a name, using .use as the file extension, for example, generate.use.
4. If you click **Yes**, the following screen appears asking if you want to view the newly-created script.

   Click **Yes**, and the USE statement script displays.

   Note: If you define duplicate table names, the DROP table statement deletes the old table and creates the new table with the newly-generated USE statement.

If necessary, you can edit this file directly from the notepad where it appears.

5.1.6.2 Meta Data Utility

The meta data utility is used to complete the process of mapping nonrelational data into a relational logical table that Classic Connect is capable of accessing. The meta data utility accepts meta data grammar as input, which contains the nonrelational-to-relational mapping information. The meta data utility reads the meta data grammar and populates meta data catalogs for use by the Query Processor. The meta data catalogs are stored in two files referenced by the DJXCAT and DJXINDX DD statements in both the meta data utility, and the Data Server JCL streams. The meta data utility supports incremental updates to the meta data catalogs, and can be run while data servers are active.

1. Edit the meta data utility JCL.

   Sample meta data utility JCL is found in SDJXSAMP member METAUTL. The contents of the METAUTL member are shown in A.4.4.3, “Meta Data Utility” on page 221.

   Sample meta data utility JCL is found in SDJXSAMP member METAUTL. The contents of the METAUTL member is shown in A.4.4.3, “Meta Data Utility” on page 221.

2. Basic Customization.

   Supply a valid jobcard and modify the DJX high-level qualifier to reference the high-level qualifier for the Classic Connect-supplied data sets. At this point you may want to save the member, since the DJX high-level qualifier is not likely to change from run-to-run of the meta data utility.

3. Customize VSAM mappings.

   When mapping VSAM data, the meta data grammar can reference the VSAM file to be accessed by the logical table, either by its data set name or using a DD name. When referenced by a data set name, the meta data utility dynamically allocates the data set name referenced, by checking for its existence and gathering physical attributes about the file.

   If you are referencing a file by DD name, then you need to add DD statements with the same DD names in the meta data utility JCL. You should specify a DISP=SHR for these data sets. The meta data utility will open these files during processing in order to obtain physical information about the files.

4. Determine whether you need to create the meta data catalogs.

   The first time you run the meta data utility, you must create the meta data catalog files. For the installation verification process, you must create a new set of meta data catalogs.

   To create a new set of meta data catalogs, uncomment the IEFBR14 job step and the associated DD statements in order to allocate the DJXCAT and DJXINDX data sets. Also uncomment the DISKU and DISKVOL parameters in the PROC statement and specify the DASD unit and VOLSER where the catalogs will be created.

5. Identify the meta data grammar to be used as input to the meta data utility.

   Specify the name of the meta data grammar file to use as input. For mapping the Classic Connect-supplied meta data grammar, uncomment the MEMBER name for the sample database, or file that you wish to map.

   When mapping your own data, modify the MEMBER parameter to specify the name of the PDS member that contains the meta data grammar to map. You may also need to change the SYSIN data set name to reference the name of the data set where the meta data grammar is located.

6. Verify access, and execute authority for the data sets referenced in the meta data utility JCL.

   Contact your security administrator, and verify that the user ID used when the meta data utility is executed, has been granted access and execute authority for the data sets reference in the METAUTL JCL. Also, ensure that the user ID has update authority for the meta data catalogs referenced by the DJXCAT and DJXINDX DD statements.

7. Submit the METAUTIL JCL for execution.

8. Review the output.

   After the meta data utility has completed executing, review the output listing. The meta data utility should complete with a COND CODE of 0 or 4. A COND CODE of 4 indicates that an attempt to DROP a logical table was made, but the table does not exist. This is merely a warning message that you may receive the first time you map a logical table.

   A condition code higher than 4 indicates that the meta data utility encountered an error. Review the listing to determine what the error is.

   Note: Before the physical databases or files that you have mapped can be accessed by a data server, the data server requires authority to read these databases or files. Contact your security administrator and inform them of the user ID(s) that the data server(s) will be using, so that the security administrator can grant the proper authority.

5.1.7 Mapping Non-Relational Data (IMS)

This section explains how to use the Data Mapper.

5.1.7.1 Data Mapper

Creating a Repository

The first step in mapping your non-relational data to a relational view is to create a repository.

A repository stores information (data catalogs, tables, columns, and owners) about the legacy data DataMapper is mapping.

To create a repository:

1. Select **File** -> **New Repository** from the DataMapper main menu.
2. Enter a File Name and location for your repository in the **Create a New Repository** dialog box. A file extension of .mdb must be assigned to all DataMapper repository files.

Click **Save** to create the repository. The repository you created is displayed. This is an empty repository. You will add data catalogs to the repository in “Creating a Data Catalog” on page 115.

Creating a Data Catalog

This step describes how to create a data catalog for the newly-created repository.

1. With the repository window open, select **Edit** -> **Create a New Data Catalog**... from the DataMapper main menu, or click the **Create a New Data Catalog** icon on the toolbar.

   The **Create Data Catalog** dialog box opens.
2. Enter the data catalog **Name**, **Type**, and any **Remarks**. To select from a list of data catalog types, click the arrow next to the **Types** box.
3. Click **OK** to create the data catalog.

   The data catalog is now displayed on your repository screen.

   Repeat steps 1 through 3 to add additional data catalogs.

Loading IMS DBDs for Reference

This section describes how to load IMS Database definitions (DBDs) for reference. IMS DBDs are transferred from the mainframe to the workstation and given a file extension of .dbd.

The DBDs are used as reference for building table and column information. DBD information is also used to provide lists of segment names and field names when creating and updating the table and column information.

1. Select the data catalog you created in previous step by clicking the number to the left of the data catalog name. This highlights the selected row.
2. Select **File** --> **Load DL/I DBD for Reference...**.

   The **Load DBD File** window opens.
3. Select a DBD from the C:\djx32\dm\sample directory, or enter the name and location of the DBD to be loaded and click **OK**.

   Note: DataMapper requires a file extension of **.dbd** for all DBD files and will not recognize other file extensions.

   The DBD reference is created. An IMS or DL/I DBD file folder icon is displayed in the window indicating that the DBD is loaded for reference by subsequent DataMapper functions.

   Repeat Steps 1 though 3 to add additional DBDs from your hard drive.

   Note: You must load the DBD each time you open the repository. DataMapper does not store DBD references between sessions. Only one DBD may be loaded for reference at a time. However, you may switch DBDs at any time during the mapping process.

   This completes loading a DBD from the hard drive.

Creating a Table

In this section, you will create a table for the data catalog you created in “Creating a Data Catalog” on page 115.

A Classic Connect table is equivalent to a DB2 table, and is created by mapping one or more record types from a non-relational database into a single Classic Connect table.

Note: Be sure to have a repository open before starting this section.

1. Select a data catalog.
2. Select **Window** -> **List Tables**.
3. Select **Edit** -> **Create a new table**..., or select the **Create a New Table** icon on the toolbar.

   The **Create an IMS Table** window opens.
4. To create an IMS Table:
   1. Enter the table name in the **Name** field.

2. Select an owner from the **Owner** pull-down list.
3. Confirm that a name exists in the **DBD Name** field.

   The name should have been automatically added to the field based on the DBD that was loaded for reference. If you did not load a DBD, you must manually enter a name. This is a required field.
4. (Optional) Enter or select an index root from the **Index Root** pull-down list. The index root name must be a 1- to 8-character alphanumeric string.
5. Enter or select a leaf segment from the **Leaf Seg** pull-down list.

   If you loaded a DBD, this pull-down list box contains the segment names defined in the DBD. This value defines the path in the IMS database to include in the table. You can map information from any segments in this path to columns in the table you are creating.

   Note: The DBD Name is automatically added based on the DBD that was loaded for reference in Chapter , “Loading IMS DBDs for Reference” on page 115. If you did not load a DBD, you are required to manually enter a name.
6. (Optional) Enter a PSB name in **PSB Name** field. The PSB Name defines the PSB to be scheduled when accessing this table. The PSB name must be a 1- to 8- character alphanumeric string.
7. (Optional) Enter a PSB name in **JOIN PSB Name** field. The JOIN PSB Name defines the PSB to be scheduled when accessing this table as part of an SQL JOIN with other tables. The JOIN PSB name must be a 1- to 8- character alphanumeric string.
8. (Optional) Enter the PCB Prefix in the **PCB Prefix** field.

   The prefix must be a 1- to 7-character alphanumeric string. The PCB Prefix is used by the DMSI to identify the PCB used in all IMS queries for the table. The prefix value specified is suffixed by the DMSI with a character 0 through 9 prior to looking up the PCB name using the DLI’s AIB interface. If no PCB Prefix is specified, the DMSI searches the PCB list for a valid PCB by issuing GU calls for the necessary path to the leaf segment.
9. (Optional) Check the **Reference Only** box if the table will be used for reference only.

   Reference tables allow you to build large column lists that can be used to populate other tables using drag-and-drop between column windows. Reference tables are not generated into the data catalog’s meta data input when meta data generation is requested.

10. Enter any remarks in the **Remarks** box.

5. Click **OK** to create the table.

   The table is now added to the **IMS Tables for Data Catalog** window.

   Repeat steps 1 through 5 to add additional tables to a data catalog.

Importing a Copybook

This section describes how to import a COBOL copybook. Copybooks are transferred from the mainframe to the workstation and must be given a file extension of .fd.

1. Open the **IMS Tables for Data Catalog** window by double-clicking the **Table** icon, or selecting **Window** -> **List Tables...**.
2. Select the table into which you want to import the copybook by clicking the number to the left of the table name. This will highlight the row.
3. Select **File** -> **Import External File...**, or press the **Import an External File** icon.

   The **Import File** dialog box opens.

   Note: When transferring IMS copybooks to the workstation, be sure to include a file extension of **.fd**, for example, boxes.fd, or the DataMapper will not recognize the file.
4. Select a copybook to import from the C:\cxa\dm\samples directory and then click **Open**.

   The **Import Copybook** window opens.
5. Select the table into which you which you want to import the copybook, and select the appropriate import options, which include:

   Import Group Level Data Items

   Creates a column for each COBOL data item that is a group level item. Group level items are items without picture clauses that contain subordinate data items with higher level numbers.

   Import Selected Structure Only

   Since most copybooks contain more than one record or field definition, you can select a particular structure to import from an existing copybook by clicking on the data item at which to start the import, then selecting the **Import Selected Structure Only** check box. When structure selection is used, the selected data item and all subordinate data items (following data items with higher level numbers) are imported. The data item selected can exist at any level in the structure.

OCCURS Clauses

- **Create Record Array**: defines a record array for data items within OCCURS clauses in the copybook.
- **Expand each occurrence**: creates a column for each occurrence of a data item within the copybook. Data item names within the OCCURS clause are suffixed with _1, _2, ..._n.
- **Map first occurrence only**: create a column for the first occurrence of a data item within the OCCURS clause only.

Append to Existing Columns

Adds the copybook columns to the bottom of the list of existing columns in that table. Not selecting this option deletes any existing columns and replaces them with the columns you are now importing.

Calculate Starting Offset

Use this option to append to existing columns in a table. This allows the starting offset of the first appended column to be calculated based on the columns already defined in the table. When selected, the first appended column will be positioned at the first character position after the last column (based on offset and length already defined for the table).

Use Offset

When you have an explicit offset to be used for the first column imported and it does not match the field's offset in the copybook structure, enter an offset in this field to override the default calculation based on the COBOL structure. If you do not override the default, the other offset for the first imported column is determined by the COBOL field's offset in the structure you are importing.

Note: By default, the offset of the first COBOL data item imported is based on the data item's position in all of the structures defined in the import file. This offset will always be zero unless you are importing a selected structure from the copybook. In that case, the offset for the first column imported from the structure will be the COBOL data item's position based on all structures that precede it in the import file. If the default offset is not correct, then the **Calculate Starting Offset** or **Use Offset** options can be used to override the default.

Seg Name

This is the segment name and is selectable, using the DBD previously loaded for reference. The segment name defaults to the leaf segment name selected when the table is defined.

6. Click **Import** to import the copybook to your table.

   The **Columns for IMS Table** window opens with the newly-imported columns.

Creating IMS Index

1. Select **Window** --> **List Indexes** or select the **Index** icon on the toolbar to list the indexes of the table.
2. Select **Edit** --> **Create a new Index...** or select the **Create a new Index** icon on the toolbar.

   The **Create IMS Index** window opens.
3. Enter the following information:

   Name

   Specifies the name of the *relational* index (this name is required, and need not be the same as the IMS index name).

   Owner

   Specifies the authorization ID to be assigned to the index (optional).

   Index is Unique

   If checked, every key in the index has a unique value.

   PCB Prefix

   A character string used by the Data Server to identify by name the PCB to be used in all IMS queries for the index (optional).

   Include Columns

   Contains the columns comprising the index and their physical order in the index. At least one column must be defined in the included columns list.

   Remarks

   Description of the IMS index (optional).
4. Click **OK** to add the index.

   The **Indexes for IMS Table** window opens.

Generate IMS Meta Data Grammar

This section describes the steps required to create *meta data grammar*. Meta data grammar, also known as *USE grammar*, is generated by the DataMapper for all of the tables in a specific data catalog. When meta data grammar has been created, it is subsequently transferred from the workstation to the mainframe. It is required as input to the Classic Connect Meta data Utilities that are run on the mainframe to create tables and used as relational-equivalent data maps for their corresponding non-relational files.

1. From the **Data Catalog** window, select a data catalog.
2. Select **Generate USE Statements...** from the **File** menu or select the **Generate USE** icon on the toolbar.

   The **Generate USE Statements** window opens.
3. Give the file a name, using .use as the file extension, for example, generate.use.
4. If you click **Yes**, the following screen appears asking if you want to view the newly-created script.

   Click **Yes**, and the USE statement script displays.

   Note: If you define duplicate table names, the DROP table statement deletes the old table and creates the new table with the newly-generated USE statement.

   If necessary, you can edit this file directly from the notepad where it appears.

5.1.7.2 Meta Data Utility

The meta data utility is used to complete the process of mapping nonrelational data into a relational logical table that Classic Connect is capable of accessing. The meta data utility accepts as input meta data grammar, which contains the nonrelational-to-relational mapping information. The meta data utility reads the meta data grammar and populates meta data catalogs for use by the Query Processor. The meta data catalogs are stored in two files referenced by the DJXCAT and DJXINDX DD statements in both the meta data utility and the Data Server JCL streams. The meta data utility supports incremental updates to the meta data catalogs and can be run while data servers are active.

1. Edit the meta data utility JCL.

   Sample meta data utility JCL is found in SDJXSAMP member METAUTL. The contents of the METAUTL member is shown in A.4.4.3, “Meta Data Utility” on page 221.

2. Basic customization.

   Supply a valid jobcard and modify the DJX high-level qualifier to reference the high-level qualifier for5 the Classic Connect-supplied data sets. At this point you may want to save the member, since the DJX high-level qualifier is not likely to change from run-to-run of the meta data utility.

3. Customize IMS mappings.

   If you are planning to map IMS data, then you must modify the IMS high-level qualifier to reference the IMS high-level qualifier where the DBDs referenced in the meta data grammar are located. You must also uncomment the DBDLIB DD statement. Save the member, since the IMS high-level qualifier is not likely to change from run-to-run of the meta data utility.

4. Determine whether you need to create the meta data catalogs.

   The first time you run the meta data utility you must create the meta data catalog files. For the installation verification process, you must create a new set of meta data catalogs.

   To create a new set of meta data catalogs uncomment the IEFBR14 job step and the associated DD statements in order to allocate the DJXCAT and DJXINDX data sets. Also uncomment the DISKU and DISKVOL parameters in the PROC statement and specify the DASD unit and VOLSER where the catalogs will be created.

5. Identify the meta data grammar to be used as input to the meta data utility.

   Specify the name of the meta data grammar file to use as input. For mapping the Classic Connect-supplied meta data grammar, uncomment the MEMBER name for the sample database or file that you want to map.

   When mapping your own data, modify the MEMBER parameter to specify the name of the PDS member that contains the meta data grammar to map. You may also need to change the SYSIN data set name to reference the name of the data set where the meta data grammar is located.

6. Verify access and execute authority for the data sets referenced in the meta data utility JCL.

   Contact your security administrator and verify that the user ID used when the meta data utility is executed has been granted access and execute authority for the data sets reference in the METAUTL JCL. Also ensure that the user ID has update authority for the meta data catalogs referenced by the DJXCAT and DJXINDX DD statements.

7. Submit the METAUTIL JCL for execution.

8. Review the output.

   After the meta data utility has completed executing, review the output listing. The meta data utility should complete with a COND CODE of 0 or 4. A COND CODE of 4 indicates that an attempt to DROP a logical table was made, but the table does not exist. This is merely a warning message that you may receive the first time you map a logical table.

   A condition code higher than 4 indicates that the meta data utility encountered an error. Review the listing to determine what the error is.

   Note: Before the physical databases or files that you have mapped can be accessed by a data server, the data server requires authority to read these databases or files. Contact your security administrator and inform them of the user ID(s) that the data server(s) will be using, so that the security administrator can grant the proper authority.

5.1.8 DataJoiner Connectivity

The following sections show how to configure DataJoiner to allow remote users and applications to communicate with the DB2 instance.

5.1.8.1 Establish Connectivity between IMS and DJ through DJCC

DataJoiner uses nicknames to allow users and applications to map a two or three part table or view name (*data-source-name.remote-authorization-name.remote-table-name*) to a data source. The nickname can be used consequently in an SQL statement whenever the remote table, or view, is referenced.

There are several tasks that need to be performed before you create the nicknames. This section lists the various commands used for establishing connectivity between IMS and DJ through DJCC.

Create Server Mapping for DJCC

Using the CREATE SERVER MAPPING statement, you define the access to each classic connect data source, in this case IMS. The mapping corresponds to a DATASOURCE parameter defined in the djxclassic2.cfg configuration file. For example:

```
create server mapping from MVSCC to node MVSCC type CLASSIC version 2.1.1
protocol "djxclassic2" authid yourid password password;
```

Where:

- The *server name* MVSCC should be a unique name and it is a DataJoiner name for a particular classic connect data source.

- The *node name* MVSCC is the data source name in the DATASOURCE parameter in the djxclassic2.cfg configuration file.
- The *type* must be CLASSIC, and you have to specify the version, in our case, 2.1.1 or just 2.1.
- The *protocol* must be djxclassic2.

Create User Mapping for DJCC

Once you have defined the data source server mapping, you can use additional DataJoiner DDL statements to refine access to these data sources.

Using the CREATE USER MAPPING statement, you can create a mapping between the authorization ID under which a user accesses the DataJoiner database and the authorization ID under which this user accesses a data source. For example:

```
create user mapping from djinst2 to server MVSCC authid "YOURID"
password "PASSWORD";
```

Where:

- djinst2 is the local authorization ID.
- MVSCC is the data server name.
- YOURID is the remote authorization ID.

Create Nickname

You must create nicknames for all tables in the meta data utility to allow DataJoiner to access them. For example:

```
create nickname OS390_IMS_FIRDB for MVSCC.yourid.firma_db;
create nickname OS390_IMS_FILSTAM for MVSCC.yourid.filstam;
create nickname OS390_IMS_LIFSTAM for MVSCC.yourid.lifstam;
```

Note: When the CREATE NICKNAME statement is executed, DataJoiner accesses the remote server, so the remote table must be an existing table or view on the remote server.

5.1.8.2 Establish Connectivity between VSAM and DJ through DJCC

DataJoiner uses nicknames to allow users and applications to map a two or three part table or view name (*data-source-name.remote-authorization-name.remote-table-name*) to a data source. The nickname can be used consequently in an SQL statement whenever the remote table, or view, is referenced.

There are several tasks that need to be performed before you create the nicknames. This section lists the various commands used for establishing connectivity between VSAM and DJ through DJCC.

Create Server Mapping for DJCC

Using the CREATE SERVER MAPPING statement, you define the access to each classic connect data source, in this case VSAM. The mapping corresponds to a DATASOURCE parameter defined in the djxclassic2.cfg configuration file. For example:

```
create server mapping from MVSCC to node MVSCC type CLASSIC version 2.1.1
protocol "djxclassic2" authid yourid password password;
```

Where:

- The *server name* MVSCC should be a unique name, and it is a DataJoiner name for a particular classic connect data source.
- The *node name* MVSCC is the data source name in the DATASOURCE parameter in the djxclassic2.cfg configuration file.
- The *type* must be CLASSIC connect, and you have to specify the version, in our case, 2.1.1 or just 2.1.
- The *protocol* must be djxclassic2.

Create User Mapping for DJCC

Once you have defined the data source server mapping, you can use additional DataJoiner DDL statements to refine access to these data sources.

Using the CREATE USER MAPPING statement, you can create a mapping between the authorization ID under which a user accesses the DataJoiner database and the authorization ID under which this user accesses a data source. For example:

```
create user mapping from djinst2 to server MVSCC authid "YOURID"
password "PASSWORD";
```

Where:

- djinst2 is the local authorization ID.
- MVSCC is the data server name.
- YOURID is the remote authorization ID.

Create Nickname

You must create nicknames for all tables in the meta data utility to allow DataJoiner to access them. For example:

```
create nickname OS390_VSM_FILSTAM for MVSCC.yourid.filstam;
```

```
create nickname OS390_VSM_LIFSTAM for MVSCC.yourid.lifstam;
```

Note: When the CREATE NICKNAME statement is executed, DataJoiner accesses the remote server, so the remote table must be an existing table or view on the remote server.

5.1.8.3 Establish Connectivity between DB2 and DJ

This section lists the various commands used for establishing connectivity between DB2 and DJ.

Catalog tcpip node for DB2

```
catalog TCPIP node WTSV53 remote 9.12.14.223 server 33320;
```

Create Server Mapping for DB2

```
create server mapping from MVSCC to node WTSC53 database
"DB2I" type "db2/mvs" version 5.1 protocol "DRDAIP"
authid "YOURID" password "PASSWORD";
```

Create User Mapping for DB2

```
create user mapping from djinst2 to server MVSCC
authid "YOURID" password "PASSWORD";
```

Where:

- djinst2 is the local authorization ID.
- MVSCC is the data server name.
- YOURID is the remote authorization ID.

Create Nickname

You must create nicknames for all tables that DataJoiner has to access. For example:

```
create nickname OS390_DB2_WGRARTST003 for MVSCC.YOURID.WGRARTST003;
create nickname OS390_DB2_ORGSTRUC for MVSCC.YOURID.ORGSTRUCT;
create nickname OS390_DB2_DEPOT for MVSCC.YOURID.DEPOT;
create nickname OS390_DB2_ARTTXT for MVSCC.YOURID.ARTTXT;
create nickname OS390_DB2_BASART for MVSCC.YOURID.BASART;
create nickname OS390_DB2_SUPPLART for MVSCC.YOURID.SUPPLART;
create nickname OS390_DB2_STRARTDAT for MVSCC.YOURID.STRARTDAT;
create nickname OS390_DB2_STRUCART for MVSCC.YOURID.STRUCART;
create nickname OS390_DB2_SELLDAY3 for MVSCC.YOURID.SELLDAY03;
```

Note: When the CREATE NICKNAME statement is executed, DataJoiner accesses the remote server, so the remote table must be an existing table or view on the remote server.

5.1.9 Accessing Your Data

This section describes how to access your tables. It includes DB2, IMS, and VSAM data step-by-step instructions.

5.1.9.1 Start IMS at the OS/390 Side

1. Issue the following command from an SDSF console: `/S IVP61CR3`.
2. Check that the message `*DFS989I IMS (DBCTL) READY (CRC=/) - IMSD` appears on an SDSF console.
3. Issue the following command from an SDSF console: //NRE.
4. Check that the message `DFS994I WARM START COMPLETED.` appears on an SDSF console.

If you have trouble starting IMS, see 5.1.1, “IMS/ESA Environment Configuration” on page 99. You need to check if you set up IMS correctly, according to this section.

5.1.9.2 Start Data Server at the OS/390 Side

1. Submit the JOB ’DJX.V2R1M01.SDJXSAMP(DJXDRA)’.
2. Check that there are no error messages in the joblog (see Figure 31).

```
05.16.51 JOB14853  Log: Started.
05.16.51 JOB14853  Controller: Logging!
05.16.52 JOB14853  Query Processor: Started.
05.16.52 JOB14853  Controller: Started DJXQP!
05.16.53 JOB14853  Query Processor: Started.
05.16.53 JOB14853  Controller: Started DJXQP!
05.16.53 JOB14853  Controller: Started DJXDRA!
05.16.53 JOB14853  DRA: Started.
05.16.55 JOB14853  Initiator: Started.
05.16.55 JOB14853  Controller: Started DJXINIT!
05.16.55 JOB14853  Initiator: Started.
05.16.55 JOB14853  Controller: Started DJXINIT!
05.16.55 JOB14853  Data Server: Ready.
```

Figure 31. Output of JOBLOG for JDXDRA

5.1.9.3 Start DB2 at the OS/390 Side

Issue the DB2 start command, for example: `-START DB2` .

5.1.9.4 Start DB2 at the AIX Side

Issue the DB2 start command, for example: `db2start` .

5.1.9.5 Accessing DB2 Tables

Issue the command `db2 -vtf orgstruc.sql` to verify access to DB2 tables in OS/390 system.

Your results should look like those in Figure 32.

```
select * from os390_db2_orgstruc

GRPNO  COMPNO PRCRNGNO LOCNO
------ ------ -------- -----
    0.     0.       0.    0.
    3.     0.       0.    0.
   58.     0.       0.    0.
   58.     0.       1.    0.
   58.     0.       2.    0.
   58.     0.       3.    0.
   58.     0.       4.    0.
   58.     0.       5.    0.
   58.     0.       6.    0.
   58.     0.       7.    0.
   58.     0.       8.    0.
   58.     0.       9.    0.
   58.     0.      10.    0.
   58.     0.      11.    0.
   58.     0.      12.    0.
   70.     0.       0.    0.

  16 record(s) selected.
```

Figure 32. Result of 'db2 -vtf orgstruc.sql'

5.1.9.6 Accessing IMS tables

Issue the command `db2 -vtf firfb.sql` to verify access to an IMS table on an OS/390 system. Your results should look like those in Figure 33.

```
select fast_firma, fast_name from os390_ims_firdb where fast_firma < 10

FAST_FIRMA FAST_NAME
---------- -------------------------
         1. AAAAAAAAAAAAAAAAAAAA
         3. BBBBBBBBBBBBBBBBBBBB
         4. CCCCCCCCCCCCCCCCCCCC
         5. DDDDDDDDDDDDDDDDDDDD
         6. EEEEEEEEEEEEEEEEEEEE
         7. FFFFFFFFFFFFFFFFFFFF
         8. GGGGGGGGGGGGGGGGGGGG
         9. HHHHHHHHHHHHHHHHHHHH

  8 record(s) selected.
```

Figure 33. Result of 'db2 -vtf firdb.sql'

5.1.9.7 Accessing VSAM tables

Issue the command 'db2 -vtf filstam.sql' to verify to access a VSAM table on OS/390 system. Your results should look like those in Figure 34.

```
select fs_dateinr, fs_filiale from os390_vsm_filstam where fs_dateinr = '05'

FS_DATEINR FS_FILIALE
---------- ----------

  0 record(s) selected.
```

Figure 34. Result of 'db2 -vtf filstam.sql'

5.2 VM/VSE

The VSE/ESA 2.3.1 system is installed as a guest on VM/ESA. The following sections describe the VSE environment. The detailed information about how to provide access to non-relational data stored under the VSE system through CrossAccess can be found in the redbook *From Multiplatform Operational Data to Data Warehousing and Business Intelligence*, SG24-5174.

Note: The redbook *From Multiplatform Operational Data to Data Warehousing and Business Intelligence*, SG24-5174, was based on a previous release of the CrossAccess product. We recommend that you contact the Cross Access Corporation and follow their recent manuals for this product.

5.2.1 Installation

The VSE system has been installed as a guest system under an existing VM/ESA system (WTSCVMXA) running on a CPU in Poughkeepsie. The VM user ID for VSE is SJVMVSE. The automatic installation process was used to install the VSE/ESA 2.3.1 base system.
The following optional products have been installed using the appropriate installation process:

- DB2 Server for VSE V 5.1
- DataPropagator Relational Capture for VSE V 5.1
- Control Center for VSE V 5.1
- Data Restore Feature for VSE V 5.1
- DL/I V 1.10
- CrossAccess VSE V4.1 from CROSS ACCESS Corporation

Other products used, like VSE/VSAM V 6.3.0, VTAM V 4.2, TCP/IP for VSE V 1.3, or Language Environment Runtime Services are part of the VSE/ESA V 2.3.1 base system.

For the system installation, we used two 3380 DASDs as system residences with the volume IDs 'DOSRES' and 'SYSWK1' as volume identifiers.

The data is loaded into two separate VSAM user catalogs, which we defined beside the required VSAM.MASTER.CATALOG (IJSYSCT) and the default VSESP.USER.CATALOG (VSESPUC):

- The DLIVSAM.DATA.CATALOG (DLICAT) owns one 3390 disk and contains the VSAM and DL/I data.
- The DB2.DATA.CATALOG (DB2CAT) holds all the DB2 data on two 3390 DASDs.

We defined several VSE/ICCF user IDs with system administrator authority to hold the configuration files and jobs for the different products in separate ICCF libraries. See Table 5 below.

Table 5. VSE User IDs and ICCF Libraries

User ID	Product	Library No.	Remarks
SYSA	VSE/ESA Base and CICS	10	Basic installation and configuration of CICSICCF
CXA1	Cross Access VSE	11	

User ID	Product	Library No.	Remarks
DB2A	DB2 Server for VSE and CICS	12	DB2 and CICSDB2
TCPA	TCP/IP for VSE	13	
VTMA	VTAM	14	SC19M configuration
VSMA	VSAM and DL/I	15	Jobs related to DLICAT and DB2CAT

These ICCF libraries are available at the SCADMCIC (CICSICCF) only. This CICS system is used for the system administration tasks.

Access to the DB2 for VSE database SJVSEDB1 is available through the production CICS system SCDB2CIC (CICSDB2).

We decided to install the predefined environment B using the automatic installation process. This environment definition offers the most capabilities of all three predefined environments (A,B and C).

- A is the smallest environment, with a limited number of partitions and limited system storage size.
- B is the full-size system, with 12 static partitions, dynamic partitions, and expandable storage size.
- C is intended for 'unattended node support' only!

For more details, see the VSE/ESA product library for specific manual.

Due to the number of software products having the need of a larger partition size, we had to adjust the partition allocation. The partitions F9 and FA have been expanded to 10 MB in size. Table 6 lists the partition allocation and usage for our VSE system.

Table 6. VSE Partition Allocation and Usage

Partition Id or Class	Product	Size	Remarks
BG		6 MB	default batch partition
F1	POWER	1600 KB	
F2	CICS (SCADMCIC)	30 MB	expanding across 16 MB line
F3	VTAM	6 MB	
F4	CICS (SCDB2CIC)	30 MB	expanding across 16 MB line

Partition Id or Class	Product	Size	Remarks
F5		1 MB	default
F6		256 KB	default
F7	DB2 Server	12 MB	default
F8	TCP/IP	12 MB	default
F9		10 MB	default
FA		10 MB	large DB2 batch jobs
FB		5 MB	default
C (9) *	Cross Access Server	10 MB	recommended min.size: 8MB
P (32) *		1 MB	default
Y (8) *		2 MB	default
Z (3) *		5 MB	default

* the number given in ( ) is the number of available partitions of one class.

5.2.2 Product Installation and Configuration

This chapter describes the Installation and Configuration of the used base and optional products:

- VSE/VTAM V 4.2
- TCP/IP for VSE V 1.3
- VSE/VSAM V 6.3
- CICS/VSE V 2.3
- DL/I V 1.10
- DB2 Server for VSE V 5.1
- DB2 Control Center, Data Restore and DataPropagator V 5.1
- CrossAccess VSE V 4.1

Some hints on installation planning are included here as well.

5.2.2.1 VSE/VTAM

VTAM provides the Advanced Program to Program Communication (APPC) between VSE and various host and workstation systems. The Distributed Relational Database Architecture (DRDA), concerning the VSE Application

Server, is based on APPC. The configuration of our environment defines the VSE system as a subarea node. That means no Advanced Peer-to-Peer Networking (APPN) capabilities are defined on the VSE side, although the adjacent nodes might be APPN capable. Even if the configuration of a subarea node requires more definitions than an APPN End-Node, it is still used in lot of customer installations.

The VSE System operates as a guest system under VM/ESA and has no direct (dedicated) access to the communication controller, Open Systems Adapter (OSA). That is why we defined a virtual channel to channel (VCTC) connection to the VM/VTAM system running on WTSCVMXA. The VCTC is coupled to the VM/VTAM user ID 'VTAM' using the address 'C20' (only one address is needed for send and receive!). The CTC was defined to VSE/VTAM in the CTC major node SCVCTCA.

All the configuration jobs are available in the primary library of user 'VTMA', and the members are cataloged into VSE library PRD2.CONFIG, known as B-books (for example, SCVCTCA.B).

Table 7 lists the member names and their purposes.

Table 7. VTAM Configuration Members

ATCSTR00	VTAM start list (start-up parameters)
ATCCON00	List containing all configuration members
SCVADJS	Adjacent SSCP major node
SCVAPPL	Application major node
SCVCDRM	Cross domain resource manager major node
SCVCDRS	Cross domain resource major node
SCVCTCA	CTC major node
SCVMDL	Logmode model entry list
SCVNSNA	Non SNA major node
SCVPATH	Path definition major node
SCVUSS	USSTAB created using SKVTMUSS from ICCF library 59

The VTAM System Services Control Program (SSCP) name of the VSE system is 'SC29M', and it is defined as subarea 29. The directly adjacent SSCP is 'SC19M', which is the VM/VTAM system of WTSVMXA (user ID 'VTAM'). All connections to other Systems (hosts or workstations)

are provided through VTAM SSCP 'SCG20', which resides on another VM system named WTSCPOK.

Note: You need to remember this, when configuring the workstations for APPC to the VSE system, because the SCG20 is the *adjacent node* for all the workstations!

VTAM Configuration Members

These listings have been captured from the ICCF library 14. The surrounding 'CATALOG' and '/+' statements are not part of the configuration member; they are only needed to catalog this member into the VSE library.

ATCSTR00.B

```
CATALOG ATCSTR00.B                      REPLACE=YES
SSCPID=29,                                                      *
SSCPNAME=SC29M,                                                 *
NETID=USIBMSC,                                                  *
HOSTSA=29,                                                      *
HOSTPU=SCVMPU,                                                  *
MAXSUBA=255,                                                    *
CONFIG=00,                                                      *
NOPROMPT,                                                       *
IOINT=0,                                                        *
SGALIMIT=0,                                                     *
BSBUF=(28,,,,1),                                                *
CRPLBUF=(60,,,,1),                                              *
LFBUF=(70,,,,11),                                               *
IOBUF=(70,288,,,11),                                            *
LPBUF=(12,,,,6),                                                *
SFBUF=(20,,,,20),                                               *
SPBUF=(210,,,,32),                                              *
DBUF=(6,,,,1)
/+
```

ATCCON00.B

```
CATALOG ATCCON00.B                      REPLACE=YES
         SCVAPPL,                                               *
         SCVNSNA,                                               *
         SCVADJS,                                               *
         SCVCTCA,                                               *
         SCVPATH,                                               *
         SCVCDRM,                                               *
         SCVCDRS
/+
```

SCVADJS.B

```
CATALOG SCVADJS.B                       REPLACE=YES
SCVADJS  VBUILD  TYPE=ADJSSCP
USIBMSC  NETWORK NETID=USIBMSC
SCG20    ADJCDRM
SC19M    ADJCDRM
/+
```

SVCAPPL.B

```
CATALOG SCVAPPL.B                       REPLACE=YES
SCVAPPL  VBUILD TYPE=APPL
```

```
SCADMCIC APPL  AUTH=(PASS,ACQ),MODETAB=IESINCLM,PARSESS=YES
SCDB2CIC APPL  AUTH=(PASS,ACQ),MODETAB=IESINCLM,PARSESS=YES
IESWAITT APPL  AUTH=(NOACQ)
TELADM01 APPL  AUTH=(ACQ)
TELADM02 APPL  AUTH=(ACQ)
TELDBC01 APPL  AUTH=(ACQ)
TELDBC02 APPL  AUTH=(ACQ)
/+
```

SCVCDRM.B

```
CATALOG SCVCDRM.B                          REPLACE=YES
*  MEMBER FOR CROSS DOMAIN RESOURCE MANAGERS
SCVCDRM  VBUILD TYPE=CDRM
USIBMSC  NETWORK NETID=USIBMSC
SCG20    CDRM  SUBAREA=20,CDRDYN=YES,CDRSC=OPT
SC19M    CDRM  SUBAREA=19,CDRDYN=YES,CDRSC=OPT
SC38M    CDRM  SUBAREA=38,CDRDYN=YES,CDRSC=OPT
SC29M    CDRM  SUBAREA=29,CDRDYN=YES,CDRSC=OPT
/+
```

SCVCDRS.B

```
CATALOG SCVCDRS.B                          REPLACE=YES
*  MEMBER FOR CROSS DOMAIN RESOURCES
SCVCDRS  VBUILD TYPE=CDRSC
USIBMSC  NETWORK NETID=USIBMSC
SCPCMS05 CDRSC  CDRM=SCG20
SC19VSCS CDRSC  CDRM=SC19M
SC53TS   CDRSC  CDRM=SC38M
/+
```

SCVCTCA.B

```
CATALOG SCVCTCA.B                          REPLACE=YES
SCVCTCA  VBUILD TYPE=CA
SCVGC20  GROUP LNCTL=CTCA,MAXBFRU=5,ISTATUS=ACTIVE
SCVLC20  LINE  ADDRESS=C20
SCVPC20  PU    PUTYPE=4
/+
```

SCVMDL.B (default entry as in VTMMDL.B)

```
CATALOG SCVMDL.B                           REPLACE=YES
SCVMDL   MDLTAB
VSE3278Q MDLENT MODEL=VSE3278Q
/+
```

SCVNSNA.B

```
CATALOG SCVNSNA.B                          REPLACE=YES
SCVNSNA  LBUILD
D08001   LOCAL CUADDR=080,TERM=3277,                                  *
               USSTAB=SCVUSSTB,                                       *
               DLOGMOD=SP3272QN,                                      *
               MODETAB=IESINCLM,                                      *
               MDLTAB=SCVMDL,                                         *
               MDLENT=VSE3278Q,                                       *
               FEATUR2=(MODEL2)
D08101   LOCAL CUADDR=081,TERM=3277,                                  *
               USSTAB=SCVUSSTB,                                       *
               DLOGMOD=SP3272QN,                                      *
               MODETAB=IESINCLM,                                      *
               MDLTAB=SCVMDL,                                         *
               MDLENT=VSE3278Q,                                       *
               FEATUR2=(MODEL2)
.
.
.
.

D09401   LOCAL CUADDR=094,TERM=3277,                                  *
               USSTAB=SCVUSSTB,                                       *
               DLOGMOD=SP3272QN,                                      *
               MODETAB=IESINCLM,                                      *
               MDLTAB=SCVMDL,                                         *
               MDLENT=VSE3278Q,                                       *
               FEATUR2=(MODEL2)
D09501   LOCAL CUADDR=095,TERM=3277,                                  *
               USSTAB=SCVUSSTB,                                       *
               DLOGMOD=SP3272QN,                                      *
               MODETAB=IESINCLM,                                      *
               MDLTAB=SCVMDL,                                         *
               MDLENT=VSE3278Q,                                       *
               FEATUR2=(MODEL2)
/+
```

SCVPATH.B

```
CATALOG SCVPATH.B                          REPLACE=YES
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
*                                                                       *
*   PATH DEFINITIONS FOR SJVMVSE  (SUBAREA 29).                         *
*                                                                       *
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
*
PATH2919 PATH  DESTSA=19,             WTSCVMXA                        *
               ER0=(19,1),                                            *
               VR0=0
*
PATH2920 PATH  DESTSA=20,             WTSCVMXA                        *
               ER0=(19,1),                                            *
               VR0=0
*
PATH2938 PATH  DESTSA=38,             WTSCVMXA                        *
               ER0=(19,1),                                            *
               VR0=0
*
/+
```

SCVUSS

The VTAM Unformatted System Services Table (USSTAB) 'SCVUSS' is generated using the provided skeleton 'SKVTMUSS' from ICCF library 59. We defined the USSTAB to provide logon access to two VTAM applications, SCADMCIC (administration CICS with ICCF) and SCDB2CIC (DB2 production CICS).

5.2.2.2 TCP/IP for VSE

TCP/IP for VSE is delivered with the VSE/ESA package as a base product, so it is installed with the base installation process. But the product is usable in **demo** mode only until you obtain a Licence Key from IBM. You may use the demo mode for testing, but there are some restrictions concerning the number of available daemons. If you start TCP/IP without a licence key, the server will terminate itself after one hour.

The ICCF user ID 'TCPA' was used for the TCP/IP configuration, so all jobs to catalog the configuration files are contained in ICCF library 13.

The product resides in the VSE library PRD1.BASE, but all the configured members have been cataloged into the PRD2.CONFIG library.

The main configuration member is the IPINITnn file where nn is the numeric suffix referenced by the start-up job named 'TCPSTART'.

Because VSE has no direct access to the communication controller, TCP/IP has to be customized using a CTC connection to TCP/IP on VM side similar to the VTAM connectivity. For TCP/IP we had to define two adjacent CTC addresses and it has to be an even/odd pair. In our environment we used C22 and C23.

Another even/odd pair of addresses have to be defined for the VM user 'TCPIP', where the TCP/IP for VM is running. We used the same pair of addresses here. These addresses had to be 'cross coupled'. That means C22 of user SJVMVSE is coupled to C23 of user TCPIP and vice versa.

The CTC can be defined either in the CP directory or through the user profile, which is executed when the user ID (SJVMVSE, TCPIP, VTAM) is logged on, or within an exec, which is used to start (IPL) the system running in that specific user.

The following listing shows the START EXEC of user SJVMVSE used to IPL the VSE system. The define and couple commands for the CTCs are contained in this exec:

START EXEC A of User ID SJVMVSE

```
/* */
'CP DEFINE CTCA C20'
'CP DEFINE CTCA C21' /* not used */
'CP DEFINE CTCA C22'
'CP DEFINE CTCA C23'
'CP DEFINE 251E AS 80E'
'CP DEFINE 251F AS 80F'
'CP COUPLE C20 VTAM C20'
'CP COUPLE C22 TCPIP C23'
'CP COUPLE C23 TCPIP C22'
DEF STOR 120M
TERM CON 3270
I 650       /* IPL from 'DOSRES' */
```

TCP/IP for VSE provides lot of different daemons; for example, for FTP, for access to VSE Libraries or TELNET connections, or just for communication with applications like CrossAccess VSE.

For every application, you must define a port, where TCP/IP listens for requests coming to or from the application. For CrossAccess, we used '5111' in our configuration.

The following listing shows the IPINIT00 configuration member used in our environment:

IPINIT00.L

```
CATALOG IPINIT00.L                        REPLACE=YES
*-----------------------------------------*
*                                         *
*        Define the constants             *
*                                         *
*-----------------------------------------*
SET IPADDR   = 9.12.13.29
SET MASK     = 000.255.255.000
*
SET ALL_BOUND        = 30000
SET WINDOW           = 4096
SET TRANSFER_BUFFERS = 20
SET TELNETD_BUFFERS  = 20
SET RETRANSMIT       = 100
SET DISPATCH_TIME    = 30
SET REDISPATCH       = 10
*
SET GATEWAY          = ON
*-----------------------------------------*
*                                         *
*        Wait for VTAM Start-up            *
*                                         *
*-----------------------------------------*
WAIT     VTAM
*-----------------------------------------*
*                                         *
*        Define the Communication Links   *
*                                         *
*-----------------------------------------*
*
```

```
DEFINE LINK,ID=LINK01,TYPE=CTCA,DEV=C22,MTU=2000
*
*-----------------------------------------*
*                                         *
*        Define Routine Information       *
*                                         *
*-----------------------------------------*
DEFINE ROUTE,ID=VMESA,     LINKID=LINK01,     IPADDR=0.0.0.0
* DEFINE ROUTE,ID=MVSESA,    LINKID=MVS_TCPIP,    IPADDR=100.100.80.80
* DEFINE ROUTE,ID=VSETCPIP,  LINKID=VSE_PART_F8,  IPADDR=100.50.0.0
*-----------------------------------------*
*                                         *
*        Define Telnet Daemons            *
*                                         *
*-----------------------------------------*
DEFINE TELNETD,ID=LUADC,TERMNAME=TELADM,TARGET=SCADMCIC,PORT=23, -
       COUNT=2,LOGMODE=SP3272QN
*
DEFINE TELNETD,ID=LUDBC,TERMNAME=TELDBC,TARGET=SCDB2CIC,PORT=25, -
       COUNT=2,LOGMODE=SP3272QN
*-----------------------------------------*
*                                         *
*        Define FTP Daemons               *
*                                         *
*-----------------------------------------*
* DEFINE FTPD,ID=FTP,PORT=21,COUNT=2
* DEFINE FTPD,ID=FTP11,PORT=21
* DEFINE FTPD,ID=FTP12,PORT=21
*-----------------------------------------*
*                                         *
*        Line Printer Daemons             *
*                                         *
*-----------------------------------------*
* DEFINE LPD,PRINTER=FAST,QUEUE='POWER.LST.A'
* DEFINE LPD,PRINTER=FASTLIB,QUEUE='PRD2.SAVE'
* DEFINE LPD,PRINTER=LOCAL,QUEUE='POWER.LST.A',LIB=PRD2,SUBLIB=SAVE
*-----------------------------------------*
*                                         *
*        Automated Line Printer Client    *
*                                         *
*-----------------------------------------*
* DEFINE EVENT,ID=LST_LISTEN,TYPE=POWER,CLASS=X,QUEUE=LST,ACTION=LPR
*-----------------------------------------*
*                                         *
*        Setup the File System            *
*                                         *
*-----------------------------------------*
* DEFINE FILESYS,LOCATION=SYSTEM,TYPE=PERM
*
* DEFINE FILE,PUBLIC='IJSYSRS',DLBL=IJSYSRS,TYPE=LIBRARY
* DEFINE FILE,PUBLIC='PRD1',DLBL=PRD1,TYPE=LIBRARY
* DEFINE FILE,PUBLIC='PRD2',DLBL=PRD2,TYPE=LIBRARY
* DEFINE FILE,PUBLIC='POWER',DLBL=IJQFILE,TYPE=POWER
*
* MODIFY FILE,PUBLIC='VSE.SYSRES.LIBRARY',TYPE=LIBRARY
* MODIFY FILE,PUBLIC='VSE.PRD1.LIBRARY',TYPE=LIBRARY
* MODIFY FILE,PUBLIC='VSE.PRD2.LIBRARY',TYPE=LIBRARY
* MODIFY FILE,PUBLIC='VSE.DUMP.LIBRARY',TYPE=LIBRARY
* MODIFY FILE,PUBLIC='VSE.PRIMARY.LIBRARY',TYPE=LIBRARY
*
* MODIFY FILE,PUBLIC='ICCF.LIBRARY',TYPE=ICCF
* MODIFY FILE,PUBLIC='VSE.POWER.QUEUE.FILE',TYPE=POWER
*-----------------------------------------*
```

```
*                                       *
*       Setup member NETWORK.L to       *
*       execute once the engine has     *
*       been activated                  *
*                                       *
*---------------------------------------*
INCLUDE NETWORK,DELAY
/+
/*
```

5.2.2.3 VSE/VSAM

VSE/VSAM, as the major VSE DASD storage access method, does all the DASD handling for DL/I and DB2 databases and VSAM native files.

To physically separate the relational and nonrelational data, we defined two additional VSAM user catalogs:

1. The DLIVSAM.DATA.CATALOG, named DLICAT, used for DL/I databases and native VSAM files.
2. The DB2.DATA.CATALOG, named DB2CAT, which holds all the DB2 data.

The DLICAT owns one Volume of device type 3390, with the volume ID DLIVSM, and the DB2CAT owns all the space on another two other volumes of the same type, named SJDB21 and SJDB22.

These two CATALOGS hold the "productive" data only. All other data, like product files or sample data (for example, for CrossAccess) is placed in the default user catalog VSESPUC, or defined as sequential files on volume SYSWK1.

The native VSAM data is contained in data set BASE.FILE03, a KSDS cluster with a fixed record length of 636 bytes, which contains basic information about the articles, the company's organizational structure, and the suppliers.

5.2.2.4 CICS/VSE

We defined two partitions for CICS/VSE (F2 and F4) to run two CICS systems in parallel.

The standard 'DBDCCICS' (start-up job CICSICCF) has been renamed to 'SCADMCIC' and provides access to the ICCF primary libraries and all other functions that use ICCF. This CICS system is used for system administration tasks such as creating jobs, modifying control files, and managing the POWER queues.

The second CICS system is our DB2 production CICS named 'SCDB2CIC' (startup job CICSDB2). This system provides online access to the DB2 database SJVSEDB1 on the VSE system through ISQL and it is used as the

VTAM primary LU for the DRDA connection to VSE. So all user IDs used by the remote systems to connect to database SJVSEDB1 must be defined in the signon table (DFHSNT) for this CICS system. All the connection and session definitions are created through Resource Definition On-line (RDO) in a group named 'DRDA'. The program and transaction definitions for the DB2 and DRDA support are contained in the appropriate program control table (DFHPCT) and program processing table (DFHPPT).

We used the system administrator user ID SYSA to configure the SCADMCIC, so all definitions and modifications are contained in the ICCF library 10.

DFHSITSP

The following listing shows the IBM-supplied CICS system initialization table DFHSITSP, modified to change the APPLID to 'SCADMCIC'.

```
* $$ JOB JNM=DFHSITSP,CLASS=A,DISP=D,NTFY=YES
* $$ LST CLASS=Q,DISP=H
// JOB DFHSITSP ASSEMBLE
// LIBDEF *,CATALOG=PRD2.CONFIG
* IN CASE GENERATION FEATURE IS INSTALLED ACTIVATE THE FIRST LIBDEF
* // LIBDEF SOURCE,SEARCH=(PRD2.GEN1,PRD1.BASE,PRD1.MACLIB)
// LIBDEF SOURCE,SEARCH=(PRD1.BASE,PRD1.MACLIB)
// OPTION CATAL,LIST
// EXEC ASMA90,SIZE=(ASMA90,64K),PARM='EXIT(LIBEXIT(EDECKXIT)),SIZE(MAXC
               -200K,ABOVE)'
*****************************************************
*                                                   *
*   5686-066 (C) COPYRIGHT IBM CORP. 1984, 1995     *
*                                                   *
*****************************************************
         TITLE 'DFHSITSP  --  SUPPLIED BY VSE/ESA'
         PUNCH ' CATALOG DFHSITSP.OBJ REP=YES'
         DFHSIT TYPE=CSECT,                                        *
               ABDUMP=NO,              CICS SYSDMP ON ASRB TRANS ABEND*
               AKPFREQ=200,            ACTIVITY KEYPOINTING FREQUENCY *
               ALT=NO,                 NO APPLICATION LOAD TABLE      *
               AMXT=20,                MAX ACTIVE TASKS               *
               APPLID=SCADMCIC,        CICS APPLICATION NAME          *
               AUTINST=(100,IESZATDX,700,200), AUTO INSTALL TERMINALS  *
               BFP=NO,                 NO BUILT-IN FUNCTIONS          *
               BMS=FULL,               FULL BASIC MAPPING SUPPORT     *
               CMXT=(10,10,10,10,10,10,10,10,10,10), 10 TASKS/ TRANS CL*
               COBOL2=NO,              USAGE OF COBOL II APPL. PRGMS  *
               DATFORM=MMDDYY,         EXTERNAL DATE DISPLAY          *
               DBP=1$,                 DYN. BACKOUT (NO LOCAL DLI I/F)*
               DBUFSZ=2000,            DYN. ADJUSTED BY CICS          *
               DCT=SP,                 SUPPLIED WITH VSE/ESA          *
               DIP=NO,                 NO BATCH DATA INTERCHANGE      *
               DLI=NO,                 NO DL/I SUPPORT                *
               DTB=MAIN,               CHANGE TO AUX TO SAVE VIRT STOR*
               DUMP=YES,               IDUMP IN ABEND SITUATIONS      *
               DUMPDS=AUTO,            AUTO SWITCH DUMP DATA SETS     *
               EXEC=YES,               EXEC LEVEL SUPPORT             *
               EXITS=YES,              USER EXIT INTERFACE            *
               EXTSEC=YES,             CHECKING DONE BY VSE/ESA       *
               FCT=SP,                 SUPPLIED WITH VSE/ESA          *
```

```
                    GMTEXT='VSE/ESA ONLINE', GOOD MORNING MESSAGE TEXT      *
                    GMTRAN=IEGM,            LOGON TRANSACTION ID            *
                    ICP=COLD,               INTERVAL CONTROL PGM            *
                    ICV=1000,               INTERVAL CONTROL EXIT TIME-MS   *
                    ICVR=20000,             RUNAWAY TASK TIME               *
                    ICVS=1000,              DELAY BEFORE STALL PURGE =ICV   *
                    ICVTSD=200,             TERMINAL SCAN DELAY             *
                    IRCSTRT=NO,             NO INTERREGION COMMUNICATION    *
                    ISC=NO,                 INTERSYSTEM COMMUNICATION       *
                    JCT=NO,                 NO JOURNALLING                  *
                    LESTG=NO,               CHANGE TO 1000 IF ENV B         *
                    LGNMSG=YES,             VTAM LOGON DATA                 *
                    MCT=NO,                 NO MONITOR CONTROL TABLE        *
                    MSGLVL=2,               MESSAGES ON BOTH SYSLST/SYSLOG *
                    MXT=999,                MAX NO. OF ALL CONCURRENT TASKS*
                    NLT=NO,                 DEFAULT LOAD ORDER FOR NUCLEUS *
                    OPNDLIM=10,             OPEN/CLOSE DESTINATION LIMIT    *
                    PCDUMP=NO,              CICS SYSDMP ON ASRA TRANS ABEND*
                    PCT=SP,                 SUPPLIED WITH VSE/ESA           *
                    PGCHAIN=X/,             BMS CHAINING COMMAND            *
                    PGCOPY=COPY/,           BMS COPY COMMAND                *
                    PGPURGE=T/,             BMS PURGE COMMAND               *
                    PGRET=P/,               BMS RETRIEVAL COMMAND           *
                    PGSIZE=2048,            SIZE OF VIRTUAL PAGING AREA     *
                    PLTPI=PI,               POST-INITIALIZATION PLT         *
                    PLTSD=SD,               SHUTDOWN PLT                    *
                    PL1=NO,                 NO PL/1 SUPPORT                 *
                    PPT=SP,                 SUPPLIED WITH VSE/ESA           *
                    PRGDLAY=100,            ONE HOUR PURGE DELAY            *
                    PRINT=PA1,              PRINT WITH PA1 AND TCP PRINT    *
                    RAMAX=256,              SIZE OF I/O AREA FOR RA         *
                    RAPOOL=10,              NUMBER OF FIXED RPLS            *
                    SCS=16384,              STORAGE CUSHION-MIN OF 4 PAGES *
                    SPOOL=(YES,A,A),        CICS SPOOLER ACTIVE             *
                    SRT=1$,                 DEFAULT SRT                     *
                    START=AUTO,             LET CICS DETERMINE STARTUP      *
                    SUFFIX=SP,              SUPPLIED WITH VSE/ESA           *
                    SVD=YES,                STORAGE VIOLATION DUMP&RECOVERY*
                    TCP=S$,                 TERMINAL CONTROL PROGRAM        *
                    TCT=SP,                 BUILT AFTER CONFIGURATION       *
                    TD=(3,3),               THREE BUFFERS & THREE STRINGS   *
                    TRACE=(800,ON),         TRACE TABLE (FOR PROD. SET OFF)*
                    TS=(,8,8),              EIGHT BUFFERS & EIGHT STRINGS   *
                    TSMGSET=4,              4 MESSAGE SET ENTRIES           *
                    TST=NO,                 NO TEMP STORAGE TABLE INCLUDED *
                    VTAM=YES,               SUPPORT FOR VTAM TERMINALS      *
                    VTPRFX=\,               CICS CLIENT TERMINAL PREFIX@LTA*
                    WRKAREA=512,            COMMON WORK AREA OF THE CSA     *
                    XLT=SP,                 SUPPLIED WITH VSE/ESA           *
                    XRF=NO,                 NO XRF SUPPORT INCLUDED         *
                    ZCP=S$,                 ALL ACCESS METHODS              *
                    DUMMY=DUMMY             TO END MACRO
            END     DFHSITBA
/*
// IF $MRC GT 4 THEN
// GOTO NOLINK
// EXEC LNKEDT
/. NOLINK
/*
/&
* $$ EOJ
```

The user ID 'DB2A' was used to set up the production CICS 'SCDB2CIC', so all the definitions are held in library 12.

DFHSITD2

The following is a listing of 'DFHSITD2', the system initialization table for SCDB2CIC. All definitions (CICS tables) for this system have the suffix 'D2', if they have been modified. Unchanged default tables keep the default suffix.

```
* $$ JOB JNM=DFHSITD2,CLASS=A,DISP=D,NTFY=YES
* $$ LST CLASS=Q,DISP=H
// JOB DFHSITD2 ASSEMBLE
// LIBDEF *,CATALOG=PRD2.CONFIG
// LIBDEF SOURCE,SEARCH=(PRD2.GEN1,PRD1.BASE,PRD1.MACLIB)
// OPTION CATAL,LIST
// EXEC ASMA90,SIZE=(ASMA90,64K),PARM='EXIT(LIBEXIT(EDECKXIT)),SIZE(MAXC
              -200K,ABOVE)'
*****************************************************
*                                                   *
*   5686-066 (C) COPYRIGHT IBM CORP. 1984, 1995     *
*                                                   *
*****************************************************
         TITLE 'DFHSITD2  --  SUPPLIED BY VSE/ESA'
         PUNCH ' CATALOG DFHSITD2.OBJ REP=YES'
         DFHSIT TYPE=CSECT,                                          *
               AKPFREQ=200,             ACTIVITY KEYPOINTING FREQUENCY *
               ALT=NO,                  NO APPLICATION LOAD TABLE      *
               AMXT=20,                 MAX ACTIVE TASKS               *
               APPLID=SCDB2CIC,         CICS APPLICATION NAME          *
               AUTINST=(100,IESZATDX,700,200), AUTO INSTALL TERMINALS  *
               BFP=NO,                  NO BUILT-IN FUNCTIONS          *
               BMS=FULL,                FULL BASIC MAPPING SUPPORT     *
               CMXT=(10,10,10,10,10,10,10,10,10,10), 10 TASKS/ TRANS CL*
               COBOL2=NO,               USAGE OF COBOL II APPL. PRGMS  *
               DATFORM=MMDDYY,          EXTERNAL DATE DISPLAY          *
               DBP=1$,                  DYN. BACKOUT (NO LOCAL DLI I/F)*
               DBUFSZ=2000,             DYN. ADJUSTED BY CICS          *
               DCT=C2,                  FOR SECOND CICS                *
               DIP=NO,                  NO BATCH DATA INTERCHANGE      *
               DLI=NO,                  NO DL/I SUPPORT                *
               DTB=MAIN,                CHANGE TO AUX TO SAVE VIRT STOR*
               DUMP=YES,                IDUMP IN ABEND SITUATIONS      *
               DUMPDS=AUTO,             AUTO SWITCH DUMP DATA SETS     *
               EXEC=YES,                EXEC LEVEL SUPPORT             *
               EXITS=YES,               USER EXIT INTERFACE            *
               EXTSEC=YES,              CHECKING DONE BY VSE/ESA       *
               FCT=C2,                  FOR SECOND CICS                *
               GMTEXT='VSE/ESA CICS2',  GOOD MORNING MESSAGE TEXT      *
               GMTRAN=IEGM,             LOGON TRANSACTION ID           *
               GRPLIST=VSELIST,         AUTOINST. TERMINALS. AND MRO   *
               ICP=COLD,                INTERVAL CONTROL PGM           *
               ICV=1000,                INTERVAL CONTROL EXIT TIME-MS  *
               ICVR=20000,              RUNAWAY TASK TIME              *
               ICVS=1000,               DELAY BEFORE STALL PURGE = ICV *
               ICVTSD=200,              TERMINAL SCAN DELAY            *
               IRCSTRT=YES,             START IRC DURING INITIALIZATION*
               ISC=YES,                 INTERSYSTEM COMMUNICATION      *
               JCT=D2,                  JOURNALLING                    *
               LESTG=1000,              LE SUPPORT                     *
               LGNMSG=YES,              VTAM LOGON DATA                *
               MCT=NO,                  NO MONITOR CONTROL TABLE       *
               MSGLVL=2,                MESSAGES ON BOTH SYSLST/SYSLOG *
```

```
                MXT=999,                MAX NO. OF ALL CONCURRENT TASKS*
                NLT=NO,                 DEFAULT LOAD ORDER FOR NUCLEUS *
                OPNDLIM=10,             OPEN/CLOSE DESTINATION LIMIT   *
                PCT=D2,                 FOR SECOND CICS                *
                PGCHAIN=X/,             BMS CHAINING COMMAND           *
                PGCOPY=COPY/,           BMS COPY COMMAND               *
                PGPURGE=T/,             BMS PURGE COMMAND              *
                PGRET=P/,               BMS RETRIEVAL COMMAND          *
                PGSIZE=2048,            SIZE OF VIRTUAL BLOCKS         *
                PLTPI=P2,               POST-INITIALIZATION PLT        *
                PLTSD=S2,               SHUTDOWN PLT                   *
                PL1=NO,                 NO PL/1 SUPPORT                *
                PPT=D2,                 FOR SECOND CICS                *
                PRGDLAY=100,            ONE HOUR PURGE DELAY           *
                PRINT=PA1,              PRINT WITH PA1 AND TCP PRINT   *
                RAMAX=256,              SIZE OF I/O AREA FOR RA        *
                RAPOOL=10,              NUMBER OF FIXED RPLS           *
                SCS=16384,              STORAGE CUSHION-MIN OF 4 PAGES *
                SPOOL=(YES,B,A),        CICS SPOOLER ACTIVE            *
                SRT=1$,                 DEFAULT SRT                    *
                START=AUTO,             LET CICS DETERMINE STARTUP     *
                SUFFIX=D2,              FOR SECOND CICS                *
                SVD=YES,                STORAGE VIOLATION DUMP&RECOVERY*
                SYSIDNT=CIC2,           IDENTIFIER OF THIS CICS        *
                TCP=S$,                 TERMINAL CONTROL PROGRAM       *
                TCT=CC,                 FOR AUTOINSTALLED TERMINALS    *
                TD=(3,3),               THREE BUFFERS & THREE STRINGS  *
                TRACE=(800,OFF),        TRACE OFF FOR PRODUCTION       *
                TS=(,8,8),              EIGHT BUFFERS & EIGHT STRINGS  *
                TSMGSET=4,              4 MESSAGE SET ENTRIES          *
                TST=NO,                 NO TEMP STORAGE TABLE INCLUDED *
                VTAM=YES,               SUPPORT FOR VTAM TERMINALS     *
                VTPRFX=\,               CICS CLIENT TERMINAL PREFIX@LTA*
                WRKAREA=512,            COMMON WORK AREA OF THE CSA    *
                XLT=SP,                 SUPPLIED WITH VSE/ESA          *
                XRF=NO,                 NO XRF SUPPORT INCLUDED        *
                ZCP=S$,                 ALL ACCESS METHODS             *
                DUMMY=DUMMY             TO END MACRO
        END     DFHSITBA
/*
// IF $MRC GT 4 THEN
// GOTO NOLINK
// EXEC LNKEDT
/. NOLINK
/*
/&
* $$ EOJ
```

DFHPCTD2

The following is a listing of the program control table (PCT) for 'SCDB2CIC', defining the DB2 transactions for ISQL and DRDA.

```
* $$ JOB JNM=DFHPCTD2,CLASS=A,DISP=D,NTFY=YES
* $$ LST CLASS=Q,DISP=H
// JOB DFHPCTD2 ASSEMBLE
// LIBDEF *,CATALOG=PRD2.CONFIG
// LIBDEF SOURCE,SEARCH=(PRD2.GEN1,PRD1.BASE,PRD1.MACLIB,PRD2.DB2510)
// OPTION CATAL,LIST
// EXEC ASMA90,SIZE=(ASMA90,64K),PARM='EXIT(LIBEXIT(EDECKXIT)),SIZE(MAXC
              -200K,ABOVE)'
*****************************************************
*                                                   *
*   5686-028 (C) COPYRIGHT IBM CORP. 1984, 1990     *
*                                                   *
*****************************************************
         TITLE 'DFHPCTD2 -- SUPPLIED WITH VSE/ESA'
         PUNCH ' CATALOG DFHPCTD2.OBJ REP=YES'
         DFHPCT TYPE=INITIAL,SUFFIX=D2,                                *
               TRANSEC=(EDF(60),      EXEC DEBUG            FACILITIES *
               FE(62),                FIELD ENGINEERING     FACILITIES *
               INTERPRETER(60),       COMMAND INTERPRETER   FACILITIES *
               MASTER(64),            MASTER TERMINAL       FACILITIES *
               MIRROR(1),             MIRROR TRANSACTION    FACILITIES *
               ROUTING(1),            ROUTING TRANSACTION   FACILITIES *
               SPI(64),               RESOURCE DEFINITION   FACILITIES *
               SVR(63))               SUPERVISOR TERMINAL   FACILITIES
*-------------------------------------------------------------------------*
         SPACE 3
         COPY  IESZPCT      -- VSE/ESA PCT ENTRIES MUST BE BEFORE CICS
         COPY  IESZPCTI     -- VSE/ESA PCT ICCF RELATED ENTRIES
         COPY  IESWPCT      -- WORKSTATION FILE TRANSFER SUPPORT
         COPY  DFH$PCT      -- BASIC CICS/VSE FACILITIES
         COPY  DFHPSPCT     -- CICS SPOOLER ENTRIES
         COPY  DFHCLPCT     -- CICS EPI                      PN90783
         SPACE 3
*-------------------------------------------------------------------------*
*          LOCAL ENTRIES SHOULD BE PLACED BELOW THIS BOX                  *
*-------------------------------------------------------------------------*

* ------------------------------------------------------------ *
*      ENTRIES FOR DB2 FOR VSE
* ------------------------------------------------------------ *
* ------------------------------------------------------------ *
*           ONLINE RESOURCE MANAGER
* ------------------------------------------------------------ *
CIRA     DFHPCT TYPE=ENTRY,             ADD CONNECTION                X
               TRANSID=CIRA,                                           X
               PROGRAM=ARIRCONT,                                       X
               TWASIZE=0,                                              X
               DTB=YES,                                                X
               SPURGE=YES,                                             X
               TPURGE=YES
CIRB     DFHPCT TYPE=ENTRY,             ESTABLISH CONNECTION          X
               TRANSID=CIRB,                                           X
               PROGRAM=ARIRCONT,                                       X
               TWASIZE=0,                                              X
               DTB=YES,                                                X
               SPURGE=YES,                                             X
               TPURGE=YES
CIRC     DFHPCT TYPE=ENTRY,             CHANGE DEFAULT DB             X
```

```
                TRANSID=CIRC,                                          X
                PROGRAM=ARIRCONT,                                      X
                TWASIZE=0,                                             X
                DTB=YES,                                               X
                SPURGE=YES,                                            X
                TPURGE=YES
CIRD    DFHPCT TYPE=ENTRY,             DISPLAY CONNECTION STATUS       X
                TRANSID=CIRD,                                          X
                PROGRAM=ARIRCONT,                                      X
                TWASIZE=0,                                             X
                DTB=YES,                                               X
                SPURGE=YES,                                            X
                TPURGE=YES
CIRR    DFHPCT TYPE=ENTRY,             REMOVE CONNECTION               X
                TRANSID=CIRR,                                          X
                PROGRAM=ARIRCONT,                                      X
                TWASIZE=0,                                             X
                DTB=YES,                                               X
                SPURGE=YES,                                            X
                TPURGE=YES
CIRT    DFHPCT TYPE=ENTRY,             TERMINATE CONNECTION            X
                TRANSID=CIRT,                                          X
                PROGRAM=ARIRCONT,                                      X
                TWASIZE=0,                                             X
                DTB=YES,                                               X
                SPURGE=YES,                                            X
                TPURGE=YES
* ------------------------------------------------------------- *
*            ISQL ENTRIES
* ------------------------------------------------------------- *
ISQL    DFHPCT TYPE=ENTRY,                                             X
                TRANSID=ISQL,                                          X
                PROGRAM=ARIITRM,                                       X
                TWASIZE=300,                                           X
                DTB=YES,                                               X
                SPURGE=NO,                                             X
                TPURGE=YES                                             X
                SCRNSZE=ALTERNATE
CISQ    DFHPCT TYPE=ENTRY,                                             X
                TRANSID=CISQ,                                          X
                PROGRAM=ARIISQL,                                       X
                TWASIZE=0,                                             X
                DTB=YES,                                               X
                SPURGE=NO,                                             X
                TPURGE=YES
*---------------------------------------------------------------------*
*          DRDA SERVER SUPPORT AXE ENTRIES                            *
*---------------------------------------------------------------------*
CAXE    DFHPCT TYPE=ENTRY,                                             X
                TRANSID=CAXE,                                          X
                PROGRAM=ARICAXED,                                      X
                TWASIZE=0,                                             X
                FDUMP=(ASRA,ASRB),                                     X
                SPURGE=YES,                                            X
                XTRANID=07F6C4C2,                                      X
                TPURGE=YES
SJD1    DFHPCT TYPE=ENTRY,                                             X
                TRANSID=SJD1,                                          X
                PROGRAM=ARICAXED,                                      X
                TWASIZE=0,                                             X
                FDUMP=(ASRA,ASRB),                                     X
                SPURGE=YES,                                            X
                TPURGE=YES
```

```
*--------------------------------------------------------------------*
*          DRDA SERVER SUPPORT PARM SETTING (DAXP) ENTRY              *
*--------------------------------------------------------------------*
RSQL7   DFHPCT TYPE=ENTRY,                                            X
               TRANSID=DAXP,                                          X
               PROGRAM=ARICDAXD,                                      X
               TWASIZE=0,                                             X
               DTB=YES,                                               X
               SPURGE=YES,                                            X
               TPURGE=YES
*--------------------------------------------------------------------*
*          DRDA SERVER SUPPORT DISABLE TRUE (DAXT) ENTRY              *
*--------------------------------------------------------------------*
RSQL8   DFHPCT TYPE=ENTRY,                                            X
               TRANSID=DAXT,                                          X
               PROGRAM=ARICDAXD,                                      X
               TWASIZE=0,                                             X
               DTB=YES,                                               X
               SPURGE=YES,                                            X
               TPURGE=YES
         SPACE 3
*--------------------------------------------------------------------*
*          LOCAL ENTRIES SHOULD BE PLACED ABOVE THIS BOX              *
*--------------------------------------------------------------------*
         SPACE 3
         DFHPCT TYPE=FINAL
         END   DFHPCTBA
/*
// IF $MRC GT 4 THEN
// GOTO NOLINK
// EXEC LNKEDT
/. NOLINK
/*
/&
* $$ EOJ
```

DFHPPTD2

The following is a listing of the program processing table (PPT) for 'SCDB2CIC', defining the programs called by the DB2 transactions for ISQL and DRDA.

```
* $$ JOB JNM=DFHPPTD2,CLASS=A,DISP=D,NTFY=YES
* $$ LST CLASS=Q,DISP=H
// JOB DFHPPTD2 ASSEMBLE
// LIBDEF *,CATALOG=PRD2.CONFIG
// LIBDEF SOURCE,SEARCH=(PRD2.GEN1,PRD1.BASE,PRD1.MACLIB,PRD2.DB2510)
// OPTION CATAL,LIST
// EXEC ASMA90,SIZE=(ASMA90,64K),PARM='EXIT(LIBEXIT(EDECKXIT)),SIZE(MAXC
               -200K,ABOVE)'
*****************************************************
*                                                   *
*   5686-066 (C) COPYRIGHT IBM CORP. 1984, 1995     *
*                                                   *
*****************************************************
         TITLE 'DFHPPTD2 -- SUPPLIED WITH VSE/ESA'
         PUNCH ' CATALOG DFHPPTD2.OBJ REP=YES'
         DFHPPT TYPE=INITIAL,SUFFIX=D2
         COPY  IESZPPT            - VSE/ESA PROGRAMS
         COPY  IESZPPTI           - VSE/ESA ICCF RELATED ENTRIES
         COPY  IESZPPTL           - VSE/ESA MAPSETS AND OTHERS
```

```
         COPY  IESWPPT            - WORKST. FILE TRANSFER SUPP. PRGMS
         COPY  IESWPPTL           - WORKST. FILE TRANSFER SUPP. MAPSETS
         COPY  DFH$PPT            - BASIC CICS/VSE FACILITIES
         COPY  DFHPSPPT           - CICS SPOOLER ENTRIES
         COPY  DFHCLPPT           - CICS EPI                   PN90783
         SPACE 3
*------------------------------------------------------------------------*
*        ACTIVATE FOLLOWING ENTRY TO SUPPRESS DUMPS FOR INVALID          *
*        SECURITY PARAMETERS - MESSAGE DFH2024 - XFFDSUP EXIT,           *
*        LABEL ACPFFD24 FOR EXAMPLE WHEN USING APPC                      *
*------------------------------------------------------------------------*
*        DFHPPT TYPE=ENTRY,PROGRAM=IESFFSP,RSL=PUBLIC
         SPACE 3
*------------------------------------------------------------------------*
*          LOCAL ENTRIES SHOULD BE PLACED BELOW THIS BOX                 *
*------------------------------------------------------------------------*
* ---------------------------------------------------------- *
*      DB2 FOR VSE ONLINE RESOURCE MANAGER
* ---------------------------------------------------------- *
        DFHPPT TYPE=ENTRY,PROGRAM=ARIRCONT,RES=YES,PGMLANG=ASSEMBLER
        DFHPPT TYPE=ENTRY,PROGRAM=ARI0OLRM,PGMLANG=ASSEMBLER
        DFHPPT TYPE=ENTRY,PROGRAM=ARICMOD,PGMLANG=ASSEMBLER
        DFHPPT TYPE=ENTRY,PROGRAM=ARIMS001,RES=YES,PGMLANG=ASSEMBLER
* ---------------------------------------------------------- *
*      ISQL ENTRIES
* ---------------------------------------------------------- *
        DFHPPT TYPE=ENTRY,PROGRAM=ARIISQL,RES=YES,PGMLANG=ASSEMBLER
        DFHPPT TYPE=ENTRY,PROGRAM=ARIITRM,RES=YES,PGMLANG=ASSEMBLER
        DFHPPT TYPE=ENTRY,PROGRAM=ARIITRX,RES=YES,PGMLANG=ASSEMBLER
* ---------------------------------------------------------- *
*      DBNAME DIRECTORY SERVICES ENTRY
* ---------------------------------------------------------- *
        DFHPPT TYPE=ENTRY,PROGRAM=ARICDIRD,PGMLANG=ASSEMBLER
* ---------------------------------------------------------- *
*  DRDA SERVER SUPPORT AXE ENTRY
* ---------------------------------------------------------- *
        DFHPPT TYPE=ENTRY,PROGRAM=ARICAXED,PGMLANG=ASSEMBLER
* ---------------------------------------------------------- *
*  DRDA SERVER SUPPORT DAXP AND DAXT ENTRY
* ---------------------------------------------------------- *
        DFHPPT TYPE=ENTRY,PROGRAM=ARICDAXD,RES=YES,PGMLANG=ASSEMBLER
* ---------------------------------------------------------- *
*  DRDA SERVER SUPPORT DRDA TRUE EXIT ENTRY
* ---------------------------------------------------------- *
        DFHPPT TYPE=ENTRY,PROGRAM=ARICDRAD,PGMLANG=ASSEMBLER
* ---------------------------------------------------------- *
*  DRDA SERVER SUPPORT DR2DFLT CONTROL BLOCK ENTRY
* ---------------------------------------------------------- *
        DFHPPT TYPE=ENTRY,PROGRAM=ARICDR2,PGMLANG=ASSEMBLER
* ---------------------------------------------------------- *
*  DRDA SERVER SUPPORT TRUE ENABLE ENTRY
* ---------------------------------------------------------- *
        DFHPPT TYPE=ENTRY,PROGRAM=ARICDEBD,PGMLANG=ASSEMBLER
         SPACE 3
*------------------------------------------------------------------------*
*          LOCAL ENTRIES SHOULD BE PLACED ABOVE THIS BOX                 *
*------------------------------------------------------------------------*
         SPACE 3
         DFHPPT TYPE=FINAL
         END   DFHPPTBA
/*
// IF $MRC GT 4 THEN
// GOTO NOLINK
```

```
// EXEC LNKEDT
/. NOLINK
/*
/&
* $$ EOJ
```

DFHSNTD2

The following listing shows the signon table (SNT) for 'SCDB2CIC', defining the user IDs to be used for DRDA connections from remote systems.

```
* $$ JOB JNM=DFHSNTD2,CLASS=A,DISP=D,NTFY=YES
* $$ LST CLASS=Q,DISP=H
// JOB DFHSNTMM ASSEMBLE
// LIBDEF *,CATALOG=PRD2.CONFIG
// LIBDEF SOURCE,SEARCH=(PRD2.GEN1,PRD1.BASE)
// OPTION CATAL,LIST
// EXEC ASMA90,SIZE=(ASMA90,64K),PARM='EXIT(LIBEXIT(EDECKXIT)),SIZE(MAXC
               -200K,ABOVE)'
*****************************************************
*                                                   *
*   5686-066 (C) COPYRIGHT IBM CORP. 1984, 1995     *
*                                                   *
*****************************************************
         PUNCH ' CATALOG DFHSNT.OBJ REP=YES'
         DFHSNT TYPE=INITIAL
         DFHSNT TYPE=ENTRY,USERID=DBADMIN,PASSWRD=ITSOSJ
         DFHSNT TYPE=ENTRY,USERID=SJDB2A1,PASSWRD=SJVSE
         DFHSNT TYPE=ENTRY,USERID=SJDB2A2,PASSWRD=SJVSE
         DFHSNT TYPE=ENTRY,USERID=SJDB2A3,PASSWRD=SJVSE
         DFHSNT TYPE=ENTRY,USERID=SJDB2CL1,PASSWRD=SJVSE
         DFHSNT TYPE=ENTRY,USERID=SJDB2CL2,PASSWRD=SJVSE
         DFHSNT TYPE=ENTRY,USERID=SJDB2CL3,PASSWRD=SJVSE
         DFHSNT TYPE=FINAL
         END DFHSNTBA
/*
// EXEC LNKEDT
/*
/&
* $$ EOJ
```

5.2.2.5 DL/I

To set up the VSAM and DL/I data sources, we used the administrator user ID 'VSMA', so all the definitions concerning DL/I are stored in VSMA's primary library 15. The phases (executable modules) created for the DL/I control blocks (DBDs and PSBs) are stored in VSE library PRD2.DLI.

The VSAM data sets for the DL/I database 'COMPDB' are defined in the 'DLIVSAM.USER.CATALOG' (DLICAT). It is a HIDAM database having one KSDS base cluster and two KSDS index data sets. The structure of this database is quite simple: It has a root segment named COBA and two child segments named COLI and COBO. There are three DBDs defined for that database, one for access through the root segment (COMPDBD) and the others for access through the secondary indexes (COMPDBS and

COMPDBI). The fields within the segments are defined just as a structure with FILLER fields. The naming of the fields and a more detailed structure is given through COBOL copy books. This database is used to derive some information about the multiple companies belonging to the organization.

The system is not set up for applications other than CrossAccess to access the DL/I database as a DL/I batch job (DLIDMSI). We have no DL/I-CICS defined yet.

One PCB and PSB (COMPPSB) has to be generated for CrossAccess. The Data Management System Interface (DMSI) for DL/I needs this control information to access the database like a normal DL/I batch job. For more information, please refer to the redbook, *From Multiplatform Operational Data to Data Warehousing and Business Intelligence*, SG24-5174.

In the following listings we show the JCL used to generate the database and the appropriate control blocks.

DEFCLDLI

This first listing shows IDCAMS define cluster job to generate the database data sets in the DLICAT:

```
* $$ JOB JNM=DEFCLUST,DISP=D,PRI=9,CLASS=S
// JOB DEFCLUST DEFINE VSAM CLUSTER FOR DOUGLAS DLI DATA
*
*  THIS JOB DEFINES THE VSAM CLUSTERS TO HOLD DOUGLAS DLI DATA
*
// DLBL IJSYSUC,'DLIVSAM.DATA.CATALOG',,VSAM
// EXEC IDCAMS,SIZE=AUTO
 DELETE  (DB.COMPANY.BASEDATA)              -
        CLUSTER                        -
        NOERASE                        -
        PURGE
 IF LASTCC EQ 8                         -
   THEN SET MAXCC EQ 0
 DELETE  (DB.COMPANY.BASEDATA.INDEX)     -
        CLUSTER                        -
        NOERASE                        -
        PURGE
 IF LASTCC EQ 8                         -
   THEN SET MAXCC EQ 0
 DELETE  (DB.COMPANY.BASEDATA.INDEX.LIST)        -
        CLUSTER                        -
        NOERASE                        -
        PURGE
 IF LASTCC EQ 8                         -
   THEN SET MAXCC EQ 0
 IF MAXCC GE 16                         -
   THEN SET MAXCC EQ 16
 DEFINE  CLUSTER                        -
        (NAME(DB.COMPANY.BASEDATA)          -
        SPEED                          -
        SUBAL                          -
        NONINDEXED                     -
        SHR(2,3)                       -
```

```
       CNVSZ(4096)                -
       RECSZ(4086,4086)           -
       CYL(2 1)                   -
       VOL(DLIVSM))
 IF LASTCC GT 0                    -
   THEN SET MAXCC EQ 16
 DEFINE  CLUSTER                   -
       (NAME(DB.COMPANY.BASEDATA.INDEX)         -
       SPEED                      -
       SUBAL                      -
       INDEXED                    -
       KEYS(2,10)                 -
       FSPC(0,0)                  -
       NOIMBED                    -
       SHR(2,3)                   -
       CNVSZ(4096)                -
       RECSZ(14,14)               -
       TRK(1 1)                   -
       VOL(DLIVSM))
 IF LASTCC GT 0                    -
   THEN SET MAXCC EQ 16
 DEFINE  CLUSTER                   -
       (NAME(DB.COMPANY.BASEDATA.INDEX.LIST) -
       SPEED                      -
       SUBAL                      -
       INDEXED                    -
       KEYS(10,10)                -
       FSPC(0,0)                  -
       NOIMBED                    -
       SHR(2,3)                   -
       CNVSZ(4096)                -
       RECSZ(22,22)               -
       TRK(1 1)                   -
       VOL(DLIVSM))
 IF LASTCC GT 0                    -
   THEN SET MAXCC EQ 16
/*
/&
* $$ EOJ
```

COMPDBDG

This next listing shows the JCL for the DBD Definition and Generation:

```
* $$ JOB JNM=DBDGEN,DISP=D,CLASS=S,PRI=9
// JOB DBDGEN FOR COMPDB DLI
// LIBDEF *,SEARCH=(PRD2.DBASE,PRD2.DLI1A0G)
// LIBDEF *,CATALOG=PRD2.DLI
// OPTION CATAL
// EXEC ASSEMBLY
        PRINT NOGEN
        DBD   NAME=COMPDBD,                                    *
              ACCESS=HIDAM
              DATASET DD1=COMPDB,                              *
              DEVICE=CKD,                                      *
              BLOCK=(4096),                                    *
              FRSPC=(0,0)
        SEGM  NAME=COBA,                                       *
              BYTES=130,PARENT=0,                              *
              RULES=(,LAST),POINTER=(TB)
        FIELD NAME=(COMPNO,SEQ,U),TYPE=P,                      *
              START=1,BYTES=2
```

```
         FIELD NAME=FILLER,TYPE=C,                                     *
               START=3,BYTES=128
         LCHILD NAME=(COMPDBI$,COMPDBI),                               *
               POINTER=INDX
         SEGM  NAME=COBO,                                              *
               BYTES=1500,PARENT=((COBA,SNGL)),                        *
               RULES=(,LAST),POINTER=(TB)
         FIELD NAME=(MK,SEQ,U),TYPE=C,                                 *
               START=1,BYTES=1
         FIELD NAME=FILLER1,TYPE=C,                                    *
               START=2,BYTES=255
         FIELD NAME=FILLER2,TYPE=C,                                    *
               START=257,BYTES=256
         FIELD NAME=FILLER3,TYPE=C,                                    *
               START=513,BYTES=256
         FIELD NAME=FILLER4,TYPE=C,                                    *
               START=769,BYTES=256
         FIELD NAME=FILLER5,TYPE=C,                                    *
               START=1025,BYTES=256
         FIELD NAME=FILLER6,TYPE=C,                                    *
               START=1281,BYTES=220
         SEGM  NAME=COLI,                                              *
               BYTES=500,PARENT=((COBA,SNGL)),                         *
               RULES=(,LAST),POINTER=(TB)
         FIELD NAME=(PROGNO,SEQ,U),TYPE=C,                             *
               START=1,BYTES=8
         FIELD NAME=PROGCO,TYPE=P,                                     *
               START=0009,BYTES=002
         FIELD NAME=FILLER1,TYPE=C,                                    *
               START=11,BYTES=246
         FIELD NAME=FILLER2,TYPE=C,                                    *
               START=257,BYTES=244
         LCHILD NAME=(COMPDBS$,COMPDBS),                               *
               POINTER=INDX
         XDFLD NAME=LISTNO,                                            *
               SEGMENT=COLI,                                           *
               SRCH=(PROGNO,PROGCO)
         DBDGEN
         FINISH
         END
/*
// EXEC LNKEDT
/*
// OPTION CATAL
// EXEC ASSEMBLY
         PRINT NOGEN
         DBD   NAME=COMPDBS,                                           *
               ACCESS=INDEX
         DATASET DD1=COMPDBS,                                          *
               DEVICE=CKD,                                             *
               BLOCK=185,RECORD=22
         SEGM  NAME=COMPDBS$,                                          *
               BYTES=10,PARENT=0,                                      *
               RULES=(,LAST)
         FIELD NAME=(LISTNO,SEQ,U),TYPE=C,                             *
               START=1,BYTES=10
         LCHILD NAME=(COLI,COMPDBD),                                   *
               INDEX=LISTNO,                                           *
               POINTER=SNGL
         DBDGEN
         FINISH
         END
/*
```

```
// EXEC LNKEDT
/*
// OPTION CATAL
// EXEC ASSEMBLY
         PRINT NOGEN
         DBD   NAME=COMPDBI,                                          *
               ACCESS=INDEX
         DATASET DD1=COMPDBI,                                         *
               DEVICE=CKD,                                            *
               BLOCK=291,RECORD=14
         SEGM  NAME=COMPDBI$,                                         *
               BYTES=2,PARENT=0,                                      *
               RULES=(,LAST)
         FIELD NAME=(COMPNO,SEQ,U),TYPE=C,                            *
               START=1,BYTES=2
         LCHILD NAME=(COBA,COMPDBD),                                  *
               INDEX=COMPNO,                                          *
               POINTER=SNGL
         DBDGEN
         FINISH
         END
/*
// EXEC LNKEDT
/*
/&
* $$ EOJ
```

COMPPCBG

This last listing shows the PCB definition and PSB generation for CrossAccess:

```
* $$ JOB JNM=PCBGEN,DISP=D,CLASS=S,PRI=9
// JOB PCBGEN FOR COMPDB DLI
// LIBDEF *,SEARCH=(PRD2.DLI,PRD2.DBASE,PRD2.DLI1A0G)
// LIBDEF *,CATALOG=PRD2.DLI
// OPTION CATAL
// EXEC ASSEMBLY
         PCB           TYPE=DB,DBDNAME=COMPDBD,                       *
               PROCOPT=GOTP,KEYLEN=10
         SENSEG        NAME=COBA,PARENT=0
         SENSEG        NAME=COBO,PARENT=COBA
         SENSEG        NAME=COLI,PARENT=COBA
         PSBGEN        LANG=COBOL,PSBNAME=COMPPSB
         END
/*
// EXEC LNKEDT
/*
// OPTION CATAL
// EXEC DLZUACB0,SIZE=200K
 BUILD PSB=(COMPPSB),OUT=LINK,DMB=YES
/*
// EXEC LNKEDT
/*
/&
* $$ EOJ
```

5.2.2.6 DB2 Server for VSE

The DB2 Server for VSE database is stored in the VSAM user catalog named 'DB2CAT'. We defined several DBEXTENTs (VSAM cluster), which made up 5 storage pools. Every table has its own DBSPACE defined in one of these pools. Storage pool # 1 holds the system catalog tables and the sample data coming with the initial installation. Pool # 5 is for internal dbspace usage only, and therefore is defined as nonrecoverable (no logging needed for internal dbspaces). The storage pools # 2 to 4 are used for the production data. Pool # 4 has two DBEXTENTs on two different physical volumes. See Table 8 for the relation between tables, dbspaces and storage pools:

Table 8. Table-Dbspace-Pool Relation

TABLE Name	DBSPACE Name	DBSPACE Size (Pages)	DBSPACE No.	POOL No.
ARTICLE_TXT	ARTTXT	10240	23	2
ORGA_STRUC	ORGSTRUC	256	25	2
PGR_ART_BASE03	PGRARTBASE03	256	26	2
DEPOT	DEPOT	512	27	2
SUPPLIERS_ARTICLE	SUPPLART	10240	34	2
BASE_ARTICLE	BASART	4096	30	3
STRUC_ARTICLE	STRUCART	8192	33	3
STRUC_ART_DATA	STRUCARTDAT	8192	35	3
SALE_DAY_003	SALEDAY03	204800	31	4

In the following listings we show the jobs used to define the dbextents, add them to the database, add the dbspaces of the required size, acquire them with the appropriate name, and define the tables and indexes. Finally we show the JCL used to reload the data.

This first listing is the job to define the DBEXTENTs using IDCAMS:

DEFEXTNT

```
// JOB DEFEXTNT              DB2 FOR VSE DB EXTENT DEFINITIONS
// LIBDEF PROC,SEARCH=(PRD2.DB2510)
// EXEC PROC=ARIS51DB        *-- DB2 FOR VSE DATABASE ID PROC
// EXEC IDCAMS,SIZE=AUTO
   DEFINE CLUSTER      /* DEFINE DB2    DATABASE EXTENT 2 */ -
          ( NAME  (SQL.DDSK2.DB) -
            CNVSZ (4096)         -
            CYL   (200)          -
            NONINDEXED          -
            VOL   (SJDB21)      -
            RECSZ (4089 4089)   -
            REUSE               -
            SHR   (2)         ) -
            DATA  (NAME(SQL.DDSK2.DB.DATA)) -
            CAT   (DB2.DATA.CATALOG)
   DEFINE CLUSTER      /* DEFINE DB2    DATABASE EXTENT 3 */ -
          ( NAME  (SQL.DDSK3.DB) -
            CNVSZ (4096)        -
            CYL   (100)          -
            NONINDEXED          -
            VOL   (SJDB21)      -
            RECSZ (4089 4089)   -
            REUSE               -
            SHR   (2)         ) -
            DATA  (NAME(SQL.DDSK3.DB.DATA)) -
            CAT   (DB2.DATA.CATALOG)
   DEFINE CLUSTER      /* DEFINE DB2    DATABASE EXTENT 4 */ -
          ( NAME  (SQL.DDSK4.DB) -
            CNVSZ (4096)        -
            CYL   (500)         -
            NONINDEXED          -
            VOL   (SJDB21)      -
            RECSZ (4089 4089)   -
            REUSE               -
            SHR   (2)         ) -
            DATA  (NAME(SQL.DDSK4.DB.DATA)) -
            CAT   (DB2.DATA.CATALOG)
   DEFINE CLUSTER      /* DEFINE DB2    DATABASE EXTENT 5 */ -
          ( NAME  (SQL.DDSK5.DB) -
            CNVSZ (4096)        -
            CYL   (1000)        -
            NONINDEXED          -
            VOL   (SJDB22)      -
            RECSZ (4089 4089)   -
            REUSE               -
            SHR   (2)         ) -
            DATA  (NAME(SQL.DDSK5.DB.DATA)) -
            CAT   (DB2.DATA.CATALOG)
   DEFINE CLUSTER      /* DEFINE DB2    DATABASE EXTENT 6 */ -
          ( NAME  (SQL.DDSK6.DB) -
            CNVSZ (4096)        -
            CYL   (500)         -
            NONINDEXED          -
            VOL   (SJDB22)      -
            RECSZ (4089 4089)   -
            REUSE               -
            SHR   (2)         ) -
            DATA  (NAME(SQL.DDSK6.DB.DATA)) -
            CAT   (DB2.DATA.CATALOG)
/*
/&
```

The following two listings show the JCL and parameters used for the 'add dbextent procedure':

ADDBEXTN

```
* $$ JOB JNM=ADDBEXTN,CLASS=7,DISP=D
// JOB ADDBEXTN ADD DBEXTENTS
// LIBDEF PROC,SEARCH=(PRD2.DB2510)
// EXEC PROC=ARIS51PL     *-- PRODUCTION LIBRARY ID PROC
// EXEC PROC=ARIS51DB     *-- DATABASE ID PROC
// EXEC PROC=ARIS250D     *-- ADD AND DELETE DBEXTENT PROC
/&
* $$ EOJ
```

ARISADD.A

```
CATALOG ARISADD.A                          REPLACE=YES
* sample input file to ADD/DELETE DBEXTENTs
* POOL statements first
* Followed by ADD/DELETE statements
* Choose an archive option
* Comments can appear anywhere in the file
POOL 5 NOLOG
ADD 2 2
ADD 3 3
ADD 4 4
ADD 5 4
ADD 6 5
UARCHIVE
/+
/*
```

Next is the add dbspace job to add additional entries with the appropriate sizes to the SYSTEM.SYSDBSPACES catalog table

ADDBSPC

```
* $$ JOB JNM=ADDBSPC,CLASS=7,DISP=D
// JOB ADDBSPC ADD DBSPACES
// LIBDEF PROC,SEARCH=(PRD2.DB2510)
// EXEC PROC=ARIS51PL     *-- PRODUCTION LIBRARY ID PROC
// EXEC PROC=ARIS51DB     *-- DATABASE ID PROC
// EXEC PGM=ARISQLDS,SIZE=AUTO,PARM='DBNAME=SJVSEDB1,SYSMODE=S,        C
               STARTUP=S'
    PUBLIC  10240 2
    PUBLIC   8192 2
    PUBLIC    256 2
    PUBLIC    256 2
    PUBLIC    512 2
    PUBLIC   5120 3
    PUBLIC   6144 3
    PUBLIC   4096 3
    PUBLIC 204800 4
    INTERNAL 30 92160 5
/*
/&
* $$ EOJ
```

The following JCL shows the acquire dbspace process. The dbspaces are acquired using different parameters, depending on the required space for data and indexes.

ACQDBSPC

```
* $$ JOB JNM=ACQDBSPC,CLASS=S,PRI=9
// JOB ACQDBSPC ACQUIRE DBSPACE FOR DOUGLAS TABLES
// LIBDEF *,SEARCH=(PRD2.DB2510)
// EXEC PGM=ARIDBS,SIZE=AUTO,PARM='DBNAME(SJVSEDB1)'
CONNECT DBADMIN IDENTIFIED BY ITSOSJ;
ACQUIRE PUBLIC DBSPACE NAMED ARTTXT
(PAGES=10240,PCTFREE=20,STORPOOL=2);
ACQUIRE PUBLIC DBSPACE NAMED SUPPLART
(PAGES=10240,PCTINDEX=50,PCTFREE=05,STORPOOL=2);
ACQUIRE PUBLIC DBSPACE NAMED ORGSTRUC
(PAGES=256,PCTFREE=20,STORPOOL=2);
ACQUIRE PUBLIC DBSPACE NAMED STRUCARTDAT
(PAGES=8192,PCTINDEX=60,PCTFREE=05,STORPOOL=3);
ACQUIRE PUBLIC DBSPACE NAMED STRUCART
(PAGES=8192,PCTINDEX=50,PCTFREE=05,STORPOOL=3);
ACQUIRE PUBLIC DBSPACE NAMED BASART
(PAGES=4096,PCTFREE=05,STORPOOL=3);
ACQUIRE PUBLIC DBSPACE NAMED DEPOT
(PAGES=512,PCTFREE=05,STORPOOL=2);
ACQUIRE PUBLIC DBSPACE NAMED PGRARTBASE03
(PAGES=256,PCTFREE=05,STORPOOL=2);
ACQUIRE PUBLIC DBSPACE NAMED SALEDAY03
(PAGES=204800,PCTFREE=15,STORPOOL=4);
/*
/&
* $$ EOJ
```

Next is the job to create all the tables needed for our production data including the primary key and index definitions:

CRETABEN

```
* $$ JOB JNM=CRETABEN,DISP=D,CLASS=S,PRI=9
* $$ LST DISP=D,CLASS=Q,DEST=(*,SJADM)
// JOB CRETABEN CREATE DOUGLAS TABLES WITH ENGLISH DEF'S
// LIBDEF *,SEARCH=(PRD2.DB2510,PRD2.CONFIG)
// EXEC PGM=ARIDBS,SIZE=AUTO,PARM='DBNAME(SJVSEDB1)'

CONNECT DBADMIN IDENTIFIED BY ITSOSJ;
SET ISOL(CS);
SET AUTOCOMMIT(ON);

CREATE TABLE ARTICLE_TXT
    (BASARTNO       DECIMAL(13,0)  NOT NULL,  -- BASIC ARTICLE NUMBER
     PRODNO         DECIMAL(3,0)   NOT NULL,  -- PRODUCT TYPE ID
     COMPNO         DECIMAL(3,0)   NOT NULL,  -- COMPANY NUMBER
     PRCRNGNO       DECIMAL(3,0)   NOT NULL,  -- PRICE RANGE ID
     STORENO        DECIMAL(3,0)   NOT NULL,  -- STORE NUMBER
     TXTTYPNO       DECIMAL(2,0)   NOT NULL,  -- TEXT TYPE ID
     ARTICLE_TEXT   CHAR(45)       NOT NULL,
  PRIMARY KEY
    (BASARTNO,
     PRODNO,
     COMPNO,
     PRCRNGNO,
     STORENO,
     TXTTYPNO)) IN ARTTXT;

CREATE TABLE BASE_ARTICLE
    (BASARTNO       DECIMAL(13,0)  NOT NULL,  -- BASIC ARTICLE NUMBER
     BASART_TXT     CHAR(45)       NOT NULL,  -- BASIC ARTICLE TEXT
```

```
    CONTENS         CHAR(7)         ,           -- CONTENS OF CONTAINER
    CREATE_DATE     DATE            NOT NULL,   -- CREATION DATE
    CHANGE_DATE     DATE            ,           -- CHANGE DATE
    BASARTDELDAT    DATE            ,           -- DELETION DATE
    BASARTSTRTDAT   DATE            NOT NULL,   -- START MERCHANDISE DATE
    MCONTENS        DECIMAL(3,0)    ,           -- NOT FILLED
    HEADARTNO       DECIMAL(13,0)   ,           -- NOT FILLED
    OWN_BRAND       DECIMAL(1,0)    ,           -- COMPANY OWN BRAND
    DISP            DECIMAL(1,0)    ,           -- DISPOSITION
    PG1             DECIMAL(5,0)    ,           -- PRODUCT GROUPS
    PG2             DECIMAL(5,0)    ,
    PG3             DECIMAL(5,0)    ,
    PG4             DECIMAL(5,0)    ,
    PG5             DECIMAL(5,0)    ,
    COLORNO         DECIMAL(3,0)    NOT NULL,   -- COLOR ID (NOT USED)
  PRIMARY KEY
    (BASARTNO)) IN BASART;

   CREATE UNIQUE INDEX BASARTNO ON BASE_ARTICLE
    (BASARTNO            ASC  ) ;

CREATE TABLE DEPOT
    (PRODNO         DECIMAL(3,0)    NOT NULL,   -- PRODUCT TYPE ID
    COMPNO          DECIMAL(3,0)    NOT NULL,   -- COMPANY NUMBER
    PRCRNGNO        DECIMAL(3,0)    NOT NULL,   -- PRICE RANGE ID
    STORENO         DECIMAL(3,0)    NOT NULL,   -- STORE NUMBER
    SUPPLNO         DECIMAL(13,0)   NOT NULL,   -- SUPPLIER NUMBER
    DEPOTNO         DECIMAL(7,0)    NOT NULL,   -- DEPOT NUMBER
    SORT_DEPOT      DECIMAL(3,0)    NOT NULL,
    SORT_LINE       DECIMAL(3,0)    NOT NULL,
    TEXT_DEPOT      CHAR(30)        NOT NULL,
    TEXT_LINE       CHAR(30)        NOT NULL,
    CREATE_DATE     DATE            NOT NULL,
    DELETE_DATE     DATE            ,
    CALC_FACTOR     DECIMAL(5,3)    ,           -- CALCULATION FACTOR
  PRIMARY KEY
    (PRODNO,
    COMPNO,
    PRCRNGNO,
    STORENO,
    SUPPLNO,
    DEPOTNO)) IN DEPOT;

CREATE TABLE SUPPLIERS_ARTICLE
    (SUPPLNO        DECIMAL(13,0)   NOT NULL,   -- SUPPLIER NUMBER
    BASARTNO        DECIMAL(13,0)   NOT NULL,   -- BASE ARTICLE NUMBER
    PRODNO          DECIMAL(3,0)    NOT NULL,   -- PRODUCT TYPE ID
    COMPNO          DECIMAL(3,0)    NOT NULL,   -- COMPANY NUMBER
    PRCRNGNO        DECIMAL(3,0)    NOT NULL,   -- PRICE RANGE ID
    STORENO         DECIMAL(3,0)    NOT NULL,   -- STORE NUMBER
    DEL_MARK        CHAR(1)         ,           -- DELETION MARKER
    DELETE_DATE     DATE            ,
    CHANGE_DATE     DATE            ,
    CREATE_DATE     DATE            NOT NULL,
    SORT_ID         DECIMAL(13,0) ,
    ORD_WEEK        DECIMAL(2,0)    ,           -- ORDERING WEEKS
    ORD_DAY         DECIMAL(3,0)    ,           -- ORDERING DAYS
    PRCLIST         CHAR(1)         ,           -- PRICE LIST ID
    CONDLIST        CHAR(1)         ,           -- CONDITION LIST ID
    BILLACCNT       DECIMAL(2,0)    ,           -- BILLING ACCOUNT
    COMM_ID         DECIMAL(2,0)    ,           -- COMMISSION ID
    DELVR_KEY       DECIMAL(2,0)    ,           -- DELIVERY KEY
    DELVR_UNIT      DECIMAL(8,3)    NOT NULL,   -- DELIVERY UNIT
```

```
     SUPPL_UNIT     DECIMAL(8,3)   NOT NULL,  -- SUPPLIED UNIT
     CONTENS        CHAR(7)        ,
     SUPPLARTTXT    CHAR(45)       ,          -- SUPPL. ARTICLE DESCR.
     SUPPLPATH      DECIMAL(3,0)   NOT NULL,  -- SUPPLY PATH ID
     ORDERNO        CHAR(13)       ,          -- ORDER NUMBER
     START_DATE     DATE           NOT NULL,
     DEPOTNO        DECIMAL(7,0)   NOT NULL,  -- DEPOT NUMBER
     DELVRTIME      DECIMAL(4,1)   ,          -- DELIVERY TIME
     SUPPLARTNO     CHAR(20)       ,          -- SUPPL. ARTICLE NUMBER
   PRIMARY KEY
     (SUPPLNO,
     BASARTNO,
     PRODNO,
     COMPNO,
     PRCRNGNO,
     STORENO)) IN SUPPLART;

CREATE INDEX SUPART_IND1 ON SUPPLIERS_ARTICLE
    (SUPPLNO             ASC,
     SUPPLARTNO          ASC,
     PRODNO              ASC,
     COMPNO              ASC,
     PRCRNGNO            ASC,
     STORENO             ASC  ) ;

CREATE INDEX SUPART_IND2 ON SUPPLIERS_ARTICLE
    (SUPPLNO             ASC,
     ORDERNO             ASC,
     PRODNO              ASC,
     COMPNO              ASC,
     PRCRNGNO            ASC,
     STORENO             ASC  ) ;

CREATE INDEX SUPART_IND3 ON SUPPLIERS_ARTICLE
    (BASARTNO            ASC,
     SUPPLNO             ASC  ) ;

CREATE TABLE ORGA_STRUC
    (PRODNO         DECIMAL(3,0)   NOT NULL,  -- PRODUCT TYPE ID
     COMPNO         DECIMAL(3,0)   NOT NULL,  -- COMPANY NUMBER
     PRCRNGNO       DECIMAL(3,0)   NOT NULL,  -- PRICE RANGE ID
     STORENO        DECIMAL(3,0)   NOT NULL,  -- STORE NUMBER
   PRIMARY KEY
     (PRODNO,
     COMPNO,
     PRCRNGNO,
     STORENO)) IN ORGSTRUC;

CREATE UNIQUE INDEX ID_ORGA_STR ON ORGA_STRUC
    (PRODNO              ASC,
     COMPNO              ASC,
     PRCRNGNO            ASC,
     STORENO             ASC ) ;

CREATE TABLE STRUC_ART_DATA
    (BASARTNO       DECIMAL(13,0)  NOT NULL,  -- BASE ARTICLE NUMBER
     PRODNO         DECIMAL(3,0)   NOT NULL,  -- PRODUCT TYPE ID
     COMPNO         DECIMAL(3,0)   NOT NULL,  -- COMPANY NUMBER
     PRCRNGNO       DECIMAL(3,0)   NOT NULL,  -- PRICE RANGE ID
     STORENO        DECIMAL(3,0)   NOT NULL,  -- STORE NUMBER
     END_DATE       DATE           NOT NULL,
     BUYERNO        DECIMAL(3,0)   ,          -- BUYER ID
     NO_LABEL       DECIMAL(5,0)   ,          -- NUMBER OF LABELS
```

```
     SELL_UNIT      DECIMAL(8,3)   NOT NULL,  -- SELLING UNIT
     CONT_TYPE      CHAR(2)        ,          -- CONTAINER TYPE
     OS_ID          DECIMAL(2,0)   ,          -- NOT USED
     TAXNO          DECIMAL(3,0)   NOT NULL,  -- TAX ID
     PGRNO          DECIMAL(5,0)   NOT NULL,  -- PRODUCT GROUP NUMBER
     START_DATE     DATE           NOT NULL,
     MOVE_PGR       DECIMAL(2,0)   ,          -- MOVING PROD. GROUP ID
     OSUNIT         DECIMAL(8,3)   ,
   PRIMARY KEY
     (BASARTNO,
     PRODNO,
     COMPNO,
     PRCRNGNO,
     STORENO,
     END_DATE))  IN STRUCARTDAT;

CREATE INDEX STRAD_IND1 ON STRUC_ART_DATA
    (PGRNO              ASC,
     BASARTNO           ASC,
     PRODNO             ASC,
     COMPNO             ASC,
     PRCRNGNO           ASC,
     STORENO            ASC,
     END_DATE           ASC  ) ;

COMMENT ON TABLE STRUC_ART_DATA IS
'STRUCTURE ARTICLE DATA' ;

CREATE TABLE STRUC_ARTICLE
    (BASARTNO       DECIMAL(13,0)  NOT NULL,  -- BASE ARTICLE NUMBER
     PRODNO         DECIMAL(3,0)   NOT NULL,  -- PRODUCT TYPE ID
     COMPNO         DECIMAL(3,0)   NOT NULL,  -- COMPANY NUMBER
     PRCRNGNO       DECIMAL(3,0)   NOT NULL,  -- PRICE RANGE ID
     STORENO        DECIMAL(3,0)   NOT NULL,  -- STORE NUMBER
     DEL_MARK       CHAR(1)        ,          -- DELETION MARKER
     CREATE_DATE    DATE           ,
     DELETE_DATE    DATE           ,
   PRIMARY KEY
     (BASARTNO,
     PRODNO,
     COMPNO,
     PRCRNGNO,
     STORENO)) IN STRUCART;

CREATE TABLE PGR_ART_BASE03
    (COMPNO         DECIMAL(3,0)   NOT NULL,  -- COMPANY NUMBER
     PGRNO          DECIMAL(5,0)   NOT NULL,  -- PRODUCT GROUP NUMBER
     PGR_DESCR      CHAR(60)       NOT NULL,  -- PROD. GRP. DESCRIPTION
     CREATE_DATE    DATE           NOT NULL,
     CHANGE_DATE    DATE           ,
     DELETE_DATE    DATE           ,
     USER_NAME      CHAR(20)       NOT NULL,
   PRIMARY KEY
     (COMPNO,
     PGRNO)) IN PGRARTBASE03;

CREATE TABLE SALE_DAY_003
    (DATE           DATE           NOT NULL,  -- DAY OF SALE
     BASARTNO       DECIMAL(13,0)  NOT NULL,  -- BASE ARTICLE NUMBER
     STORENO        DECIMAL(4,0)   NOT NULL,  -- STORE NUMBER
     COMPNO         DECIMAL(3,0)   NOT NULL,  -- COMPANY NUMBER
     DEPTNO         DECIMAL(3,0)   NOT NULL,  -- DEPARTMENT NUMBER
     NO_UNITS       DECIMAL(7,0)   NOT NULL,  -- NUMBER OF SOLD UNITS
```

```
     IN_PRC         DECIMAL(11,2)  NOT NULL,  -- BUY PRICE TIMES UNITS
     OUT_PRC        DECIMAL(11,2)  NOT NULL,  -- SELL PRICE PER UNIT
     TAX            DECIMAL(11,2)  NOT NULL,  -- TAX AMOUNT
     NO_CUST        DECIMAL(7,0)   NOT NULL,  -- NUMBER OF CUSTOMERS
     PGRNO          DECIMAL(5,0)   NOT NULL,  -- PRODUCT GROUP NUMBER
     SUPPLNO        DECIMAL(7,0)   NOT NULL,  -- SUPPLIER NUMBER
     TRANSFER_DATE  TIMESTAMP      NOT NULL,
     PROCESS_DATE   TIMESTAMP      NOT NULL,
   PRIMARY KEY (DATE,BASARTNO,STORENO,COMPNO,DEPTNO)) IN SALEDAY03;

CREATE INDEX ID_STORES03 ON SALE_DAY_003
    (STORENO            ASC,
     BASARTNO           ASC  ) ;

COMMENT ON TABLE SALE_DAY_003 IS
'SALES PER DAY' ;

/*
/&
* $$ EOJ
```

The foreign keys have to be defined as a separate jobstep. The next listing shows the JCL for this task:

ALTTABEN

```
* $$ JOB JNM=ALTTABEN,DISP=D,CLASS=0,PRI=9
* $$ LST DISP=D,CLASS=Q
// JOB ALTTABEN ALTER TABLES TO DEFINE FOREIGN KEYS
// LIBDEF *,SEARCH=(PRD2.DB2510,PRD2.CONFIG)
// EXEC PGM=ARIDBS,SIZE=AUTO,PARM='DBNAME(SJVSEDB1)'
CONNECT DBADMIN IDENTIFIED BY ITSOSJ;

ALTER TABLE ARTICLE_TXT
  FOREIGN KEY HAS
    (BASARTNO,
     PRODNO,
     COMPNO,
     PRCRNGNO,
     STORENO  )
    REFERENCES STRUC_ARTICLE ;

ALTER TABLE DEPOT
  FOREIGN KEY BELONGS
    (PRODNO,
     COMPNO,
     PRCRNGNO,
     STORENO  )
    REFERENCES ORGA_STRUC ;

ALTER TABLE SUPPLIERS_ARTICLE
  FOREIGN KEY IS_AVAIL
    (BASARTNO,
     PRODNO,
     COMPNO,
     PRCRNGNO,
     STORENO  )
    REFERENCES STRUC_ARTICLE ;

ALTER TABLE STRUC_ART_DATA
  FOREIGN KEY DESCRIBE
    (BASARTNO,
```

```
     PRODNO,
     COMPNO,
     PRCRNGNO,
     STORENO  )
    REFERENCES STRUC_ARTICLE ;

ALTER TABLE STRUC_ARTICLE
  FOREIGN KEY BELONGS
    (PRODNO,
     COMPNO,
     PRCRNGNO,
     STORENO  )
    REFERENCES ORGA_STRUC ;

ALTER TABLE STRUC_ARTICLE
  FOREIGN KEY APPLIES_
    (BASARTNO)
    REFERENCES BASE_ARTICLE ;

/*
/&
* $$ EOJ
```

Finally, we list the jobs used to reload the data. First is the dataload for the very large sales data table, and second is the JCL for all other tables. Both jobs are running in single user mode (SUM) with 'LOGMODE=N' to avoid additional overhead during the reload.

DATALDSU

```
* $$ JOB JNM=DATALOAD,DISP=D,CLASS=7
// JOB DATALOAD RELOAD SALE_DAY_003 IN SUM
// LIBDEF *,SEARCH=(PRD2.DB2510,PRD2.CONFIG)
// TLBL VKTAG,'VKTAG003',,,2001
// ASSGN SYS004,380
// MTC REW,380
// EXEC  PROC=ARIS51PL    *-- DB2 PRODUCTION LIBRARY ID PROC
// EXEC  PROC=ARIS51DB    *-- DB2 DATABASE ID PROC
// EXEC  ARISQLDS,SIZE=AUTO,PARM='SYSMODE=S,LOGMODE=N,PROGNAME=ARIDBS'
CONNECT DBADMIN IDENTIFIED BY ITSOSJ;
SET UPDATE STATISTICS OFF;
SET AUTOCOMMIT ON;
DATALOAD TABLE (SALE_DAY_003)
         BASARTNO        1-15
         STORENO        17-22
         COMPNO         24-28
         DATE           30-39
         DEPTNO         41-45
         NO_UNITS       47-55
         IN_PRC         57-69
         OUT_PRC        71-83
         TAX            85-97
         NO_CUST        99-107
         PGRNO         109-115
         SUPPLNO       117-125
         TRANSFER_DATE 127-152
         PROCESS_DATE  154-179
INFILE (VKTAG BLKSZ(32000) RECSZ(250) PDEV(TAPE) RECFM(FB))
COMMITCOUNT(10000);
/*
/&
* $$ EOJ
```

DATLDSU2

```
* $$ JOB JNM=DATALOAD,DISP=D,CLASS=7
// JOB DATALOAD RELOAD SALE_DAY_003 IN SUM
// LIBDEF *,SEARCH=(PRD2.DB2510,PRD2.CONFIG)
// TLBL WGAST,'WGAST',,,,1
// TLBL ORGSTRU,'ORGSTRU',,,,2
// TLBL DEPOT,'DEPOT',,,,3
// TLBL ARTTXT,'ARTTXT',,,,4
// TLBL BASART,'BASART',,,,5
// TLBL LIEFART,'LIEFART',,,,6
// TLBL STRARTD,'STRARTD',,,,7
// TLBL STRUKAR,'STRUKAR',,,,8
// ASSGN SYS004,380
// MTC REW,380
// EXEC  PROC=ARIS51PL    *-- DB2 PRODUCTION LIBRARY ID PROC
// EXEC  PROC=ARIS51DB    *-- DB2 DATABASE ID PROC
// EXEC  ARISQLDS,SIZE=AUTO,PARM='SYSMODE=S,LOGMODE=N,PROGNAME=ARIDBS'
CONNECT DBADMIN IDENTIFIED BY ITSOSJ;
SET UPDATE STATISTICS OFF;
SET AUTOCOMMIT ON;

DATALOAD TABLE (PGR_ART_BASE03)
         COMPNO        1-5
         PGRNO         7-13
         PGR_DESCR    15-74
         CREATE_DATE  76-85
         CHANGE_DATE  87-96  NULL IF POS (87-96) ='          '
         DELETE_DATE  98-107 NULL IF POS (98-107)='          '
         USER_NAME   109-128
INFILE (WGAST BLKSZ(30000) RECSZ(150) PDEV(TAPE) RECFM(FB))
COMMITCOUNT(10000);

DATALOAD TABLE (ORGA_STRUC)
         PRODNO        1-5
         COMPNO        7-11
         PRCRNGNO     13-17
         STORENO      19-23
INFILE (ORGSTRU BLKSZ(1000) RECSZ(30) PDEV(TAPE) RECFM(FB));

DATALOAD TABLE (DEPOT)
         PRODNO        1-5
         COMPNO        7-11
         PRCRNGNO     13-17
         STORENO      19-23
         SUPPLNO      25-39
         DEPOTNO      41-49
         SORT_DEPOT   51-55
         SORT_LINE    57-61
         TEXT_DEPOT   63-92
         TEXT_LINE    94-123
         CREATE_DATE 125-134
         DELETE_DATE 136-145  NULL IF POS (136-145)='          '
         CALC_FACTOR 147-153  NULL IF POS (147-153)='       '
INFILE (DEPOT BLKSZ(30000) RECSZ(200) PDEV(TAPE) RECFM(FB))
COMMITCOUNT(10000);

DATALOAD TABLE (ARTICLE_TXT)
         BASARTNO      1-15
         PRODNO       17-21
         COMPNO       23-27
         PRCRNGNO     29-33
         STORENO      35-39
         TXTTYPNO     41-44
```

```
        ARTICLE_TEXT 46-90
INFILE (ARTTXT BLKSZ(30000) RECSZ(100) PDEV(TAPE) RECFM(FB))
COMMITCOUNT(10000);

DATALOAD TABLE (BASE_ARTICLE)
        BASARTNO        1-15
        BASART_TXT     17-61
        CONTENS        63-69
        CREATE_DATE    71-80
        CHANGE_DATE    82-91   NULL IF POS  (82-91) ='          '
        BASARTDELDAT   93-102  NULL IF POS  (93-102)='          '
        BASARTSTRTDAT 104-113
        MCONTENS      115-119  NULL IF POS (115-119)='     '
        HEADARTNO     121-135  NULL IF POS (121-135)='               '
        OWN_BRAND     137-139  NULL IF POS (137-139)='   '
        DISP          141-143  NULL IF POS (141-143)='   '
        PG1           145-151  NULL IF POS (145-151)='       '
        PG2           153-159  NULL IF POS (153-159)='       '
        PG3           161-167  NULL IF POS (161-167)='       '
        PG4           169-175  NULL IF POS (169-175)='       '
        PG5           177-183  NULL IF POS (177-183)='       '
        COLORNO       185-189
INFILE (BASART BLKSZ(32000) RECSZ(200) PDEV(TAPE) RECFM(FB))
COMMITCOUNT(10000);

DATALOAD TABLE (SUPPLIERS_ARTICLE)
        SUPPLNO       1-15
        BASARTNO      17-31
        PRODNO        33-37
        COMPNO        39-43
        PRCRNGNO      45-49
        STORENO       51-55
        DEL_MARK      57-57
        DELETE_DATE   59-68    NULL IF POS  (59-68) ='          '
        CHANGE_DATE   70-79    NULL IF POS  (70-79) ='          '
        CREATE_DATE   81-90
        SORT_ID       92-106   NULL IF POS  (92-106)='               '
        ORD_WEEK      108-111  NULL IF POS (108-111)='    '
        ORD_DAY       113-117  NULL IF POS (113-117)='     '
        PRCLIST       119-119
        CONDLIST      121-121
        BILLACCNT     123-126  NULL IF POS (123-126)='    '
        COMM_ID       128-131  NULL IF POS (128-131)='    '
        DELVR_KEY     133-136  NULL IF POS (133-136)='    '
        DELVR_UNIT    138-147
        SUPPL_UNIT    149-158
        CONTENS       160-166
        SUPPLARTTXT   168-212
        SUPPLPATH     214-218
        ORDERNO       220-232
        START_DATE    234-243
        DEPOTNO       245-253
        DELVRTIME     255-260  NULL IF POS (255-260)='      '
        SUPPLARTNO    262-281
INFILE (LIEFART BLKSZ(30000) RECSZ(300) PDEV(TAPE) RECFM(FB))
COMMITCOUNT(10000);

DATALOAD TABLE (STRUC_ART_DATA)
        BASARTNO         1-15
        PRODNO          17-21
        COMPNO          23-27
        PRCRNGNO        29-33
        STORENO         35-39
```

```
         END_DATE         41-50
         BUYERNO          52-56  NULL IF POS  (52-56) ='     '
         NO_LABEL         58-64  NULL IF POS  (58-64) ='       '
         SELL_UNIT        66-75
         CONT_TYPE        77-78
         OS_ID            80-83  NULL IF POS  (80-83) ='    '
         TAXNO            85-89
         PGRNO            91-97
         START_DATE       99-108
         MOVE_PGR        110-113 NULL IF POS (110-113)='    '
         OSUNIT          115-124 NULL IF POS (115-124)='          '
INFILE (STRARTD BLKSZ(30000) RECSZ(150) PDEV(TAPE) RECFM(FB))
COMMITCOUNT(10000);

DATALOAD TABLE (STRUC_ARTICLE)
         BASARTNO          1-15
         PRODNO           17-21
         COMPNO           23-27
         PRCRNGNO         29-33
         STORENO          35-39
         DEL_MARK         41-41
         CREATE_DATE      43-52 NULL IF POS  (43-52) ='          '
         DELETE_DATE      54-63 NULL IF POS  (54-63) ='          '
INFILE (STRUKAR BLKSZ(32000) RECSZ(80) PDEV(TAPE) RECFM(FB))
COMMITCOUNT(10000);

/*
/&
* $$ EOJ
```

Chapter 6. The Data Warehouse Definitions

In the following chapter, we will focus on the tasks necessary to populate the data warehouse environment. We will show you how this process can be defined with the help of Visual Warehouse.

6.1 The Data Acquisition Process

In a typical data warehouse scenario, the transformation of the data—from the source structure to the final target tables, which are used for analytical processing purposes—is usually accomplished in several steps.

In the first step, the emphasis is on consolidating the data from the different sources and restructuring the data from an application-specific format to a business-related format. This step usually includes denormalization of the data. Data quality issues are also addressed during this first stage of the data acquisition process for the data warehouse.

In the following steps, the data is restructured further to satisfy the analysis requirements—that is, to facilitate the kind of queries needed to provide answers for one or more specific business questions.

The process may require the staging of the data in several intermediate structures, depending on the complexity of the transformations needed.

Examples of typical target data models that can be used for analysis purposes are the *star-schemas*, or *snowflake-schemas*, which are especially suited to support multidimensional analysis or online analytical processing (OLAP). The major advantage of these kinds of data models is that they can be understood and navigated more easily by business analysts.

In the following example, we show the transition of a number of source tables into a dimensional model for sales analysis using intermediate staging tables. We show how to derive two very commonly used dimensions.

6.1.1 The First Dimension

In the *first* dimension, we are transforming the data about products available from various data sources (see Figure 35) into a single dimension table, containing a product hierarchy. This hierarchy consists of four levels: The lowest level is the individual article, the next higher level is the product-line, followed by the brand, and finally the supplier at the highest level.

Following is an example of an instance of the product hierarchy:

PRODUCT:

```
ARTICLE:  SEA SUN SPIRIT SPRAY 50 ML
LINE:     SUN SPIRIT
BRAND:    SEA
SUPPLIER: SEA SUPPLIER
```

Figure 35 shows the relationship between the different data sources and the intermediate staging tables.

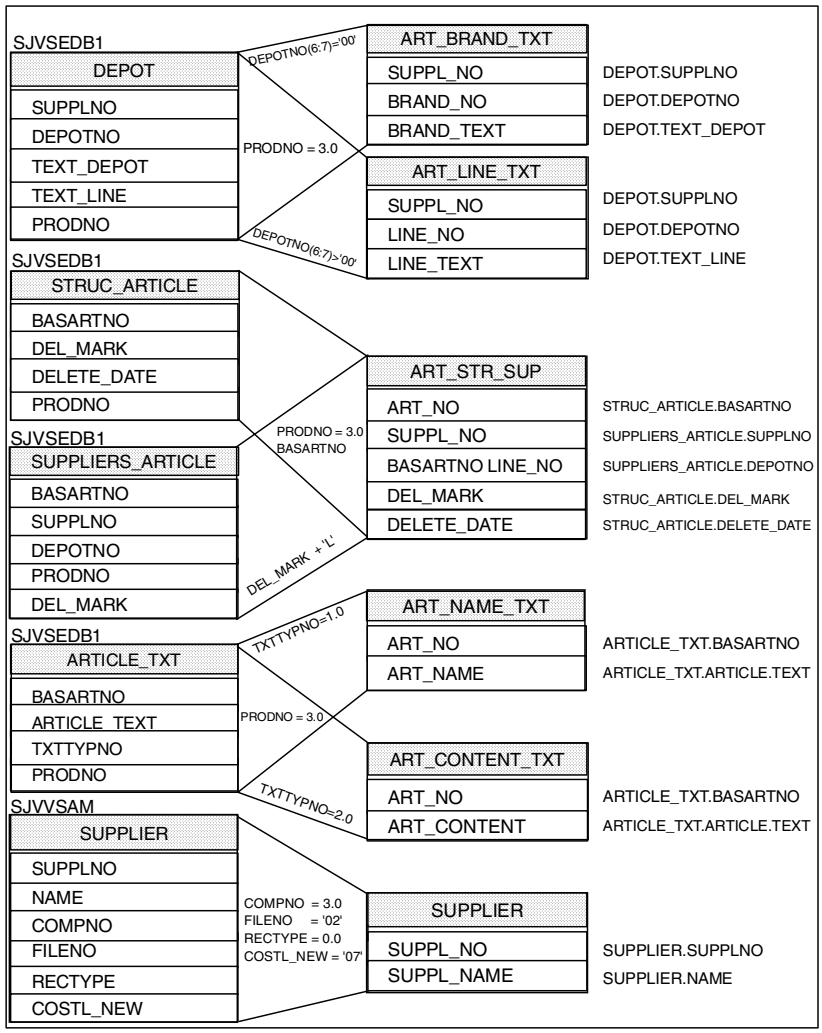


Figure 35. Sources for Dimension Table PRODUCT

The left side shows the real sources, and on the right side are the intermediate sources. As you can see, we sometimes had to derive two intermediate source tables from one original source. That is due to these tables not being normalized. So, for example, we have several entries for one article number, which had different content in the text field. These different entries were distinguished by the value in another column. A normalized DB2 table would have these different attributes in different columns, so that only one row would exist—that is, what we realized in the target business view (dimension table PRODUCT).

The graphics between the tables on the left and the right show in the intersection the *where* clause matching to all of the participating sources, and in the other part the criteria to be met by the adjacent table (this can be either source or target). So in case of the tables 'STRUC_ARTICLE' and 'SUPPLIERS_ARTICLE', 'BASARTNO' is the column used for the join, and only entries with 'PRODNO' = 3.0 are placed into the intermediate source table 'ART_STR_SUP'. In contrast, the 'DEL_MARK not equal 'L' criterion applies to the 'SUPPLIERS_ARTICLE' table only.

Figure 36 shows how the staging tables are joined to build the final dimension table.

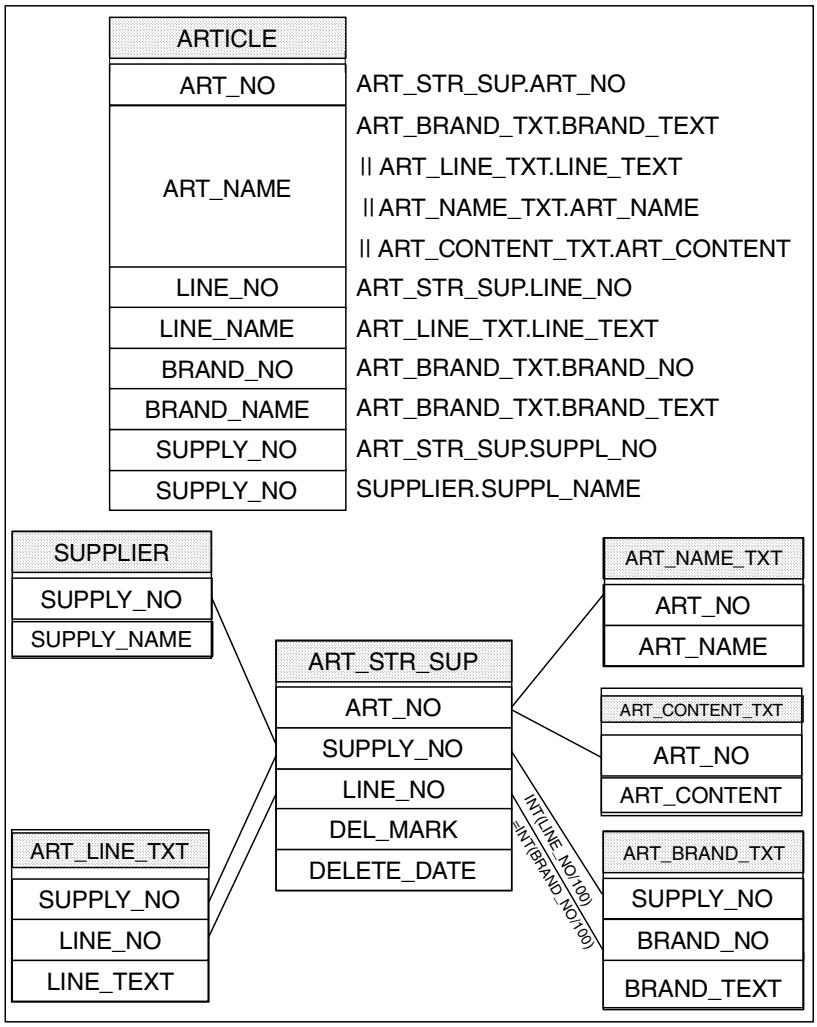


Figure 36. Dimension Table PRODUCT from Join of Intermediate Sources

6.1.2 The Second Dimension

The *second* dimension depicts the organization of the company. This dimension has a hierarchy with four levels as well. The lowest level is the store, the next one is the region, followed by company, and the highest level is the business line.

Following is an example of an instance of the organization dimension:

ORGANIZATION:

```
STORE:          SEA WEST MARKET
REGION_NO:      604
COMPANY:        SEA WEST & CO
BUSINESS_LINE: PERFUMES
```

Figure 37 shows again the relationship between the various data sources for the organization information and the consolidated staging area.

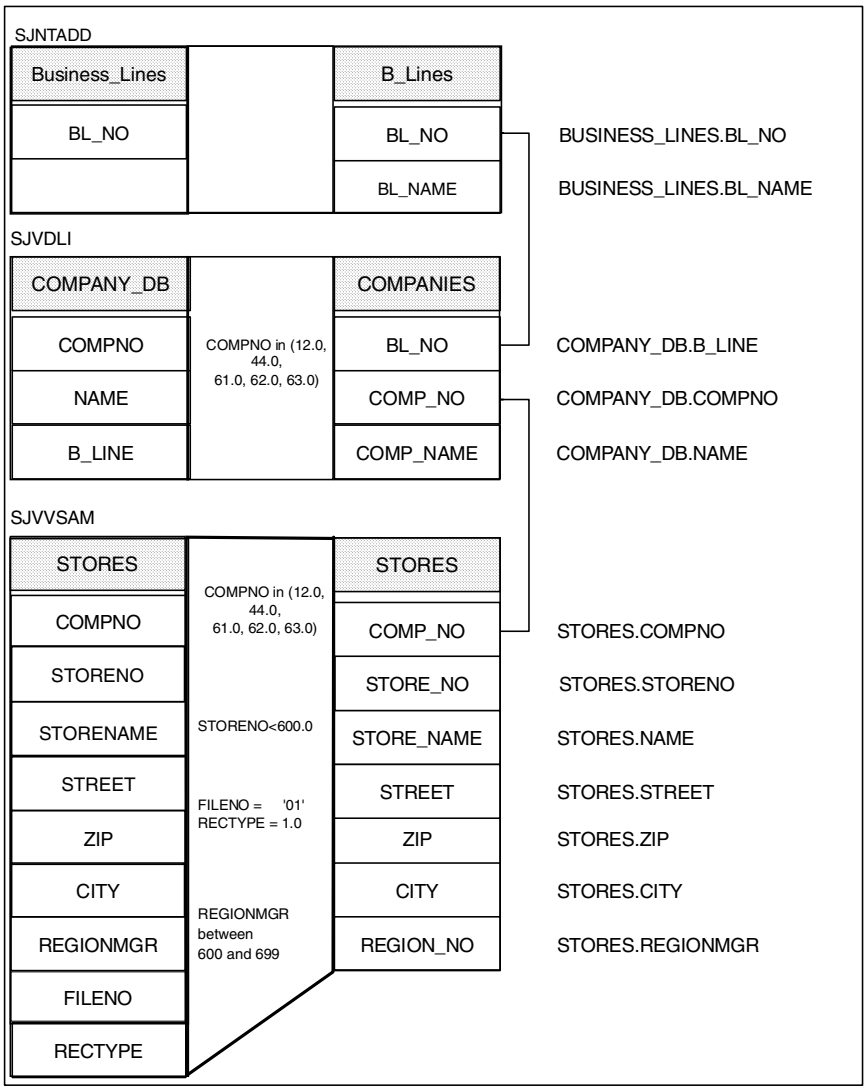


Figure 37. Sources for Dimension Table ORGANIZATION

Figure 38 shows how the intermediate staging tables are used to build the dimension table for organization.

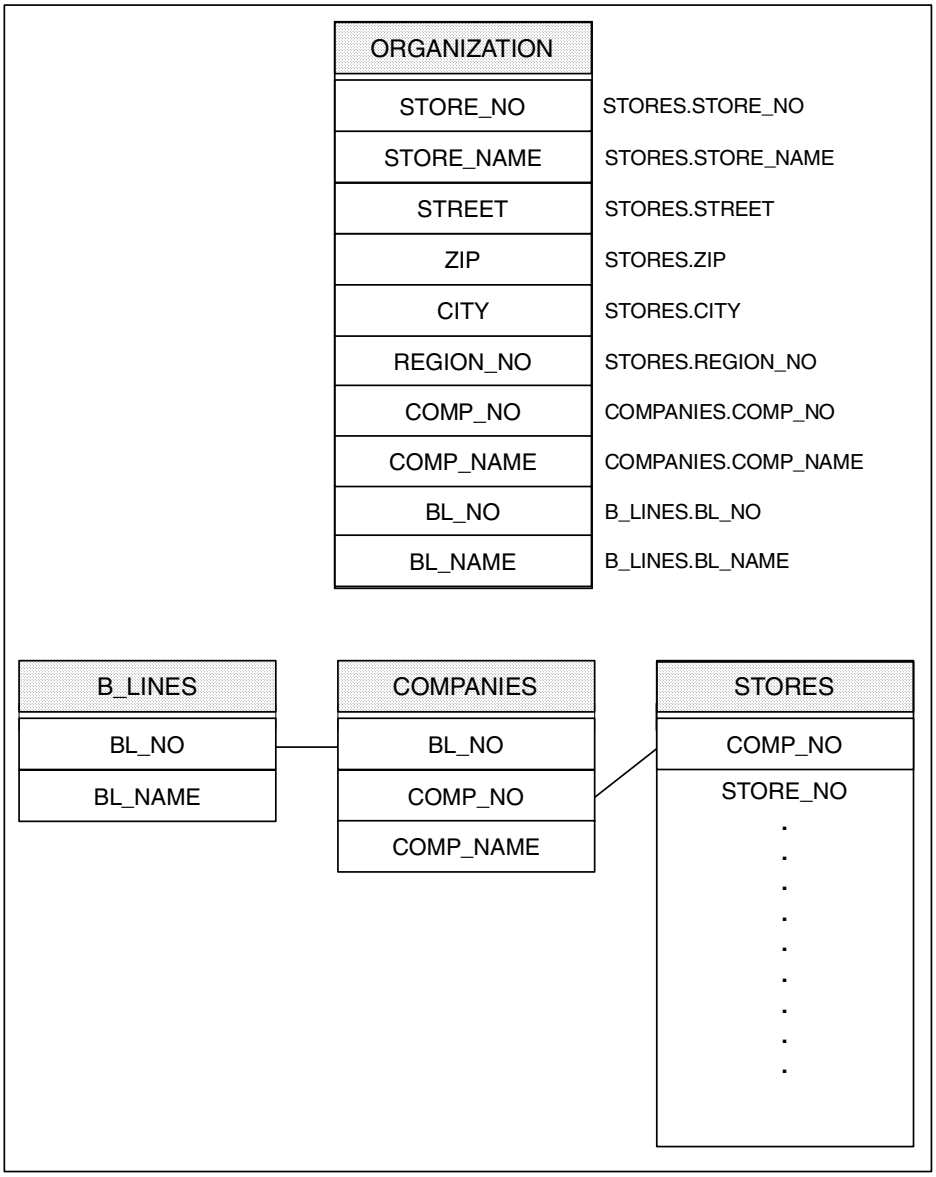


Figure 38. Dimension Table ORGANIZATION from JOIN of Intermediate Sources

6.2 Technical Implementation of the Data Acquisition Process

We used Visual Warehouse to implement the data acquisition process in this example. We implemented two different scenarios. One scenario uses the target database including the staging tables on a DB2 UDB for AIX; the other scenario was implemented using DB2 UDB on NT.

The administration of both target systems is done from the Windows NT workstation 'KHANKA', which has the Visual Warehouse server function installed. This server function is not available on AIX.

The Visual Warehouse control database 'VWCNTL01' resides on the server system 'KHANKA'. The target warehouse databases are located on the Windows NT system 'PALAU' (SJNTDWH1) and on the AIX system 'AZOV' (SJAXDWH1).

The transformation from the source data to the target model is defined and managed by Visual Warehouse using Visual Warehouse Business Views (BVs).

The following features of Visual Warehouse were used to support the data transformation:

- Transient BVs for the staging data
- Scheduling and cascading capabilities to automate the data acquisition process
- Work in Progress view of Visual Warehouse to monitor the execution of the data acquisition process
- Visual Warehouse Meta Data Catalog to document and drive the data acquisition process

The BVs for the intermediate sources can be created as transient BVs, that is, the population of the transient BV is triggered by the target BV, and the data is kept only temporarily until the data has arrived in the final dimension table safely. To do this, the **Transient Data** check box has to be selected on the **Information** folder of the **Business View** notebook.

This feature helps you to manage the space in the data warehouse more efficiently, without the administrative overhead needed to get rid of temporary result tables manually.

The actual control flow during the data acquisition process is managed with the scheduling and cascading function of Visual Warehouse.

The transient BV will be referenced by the target BV created as a dimension table for OLAP. If this target BV is populated due to an explicit request or a schedule, the transient BVs are populated first, then the target BV is filled, and the transient BV will be deleted. A transient BV cannot be scheduled!

Another way to automate the population of BVs belonging to one target BV (dimension table), is to schedule the execution of the next BV to be populated by the one which just completed. To make sure that all the sources have been populated before the target BV is run, you will have to set this up as a chain. So the first BV will be populated by request, or scheduled by another event, and the next BV will be scheduled by this one, and so on, until the target BV is scheduled as the last one. To do this, you can select the **Starts** option from the **Schedule Type** pulldown menu in the **Schedule** folder of the **Business View** notebook. You can add the appropriate BV from the selection panel, which is then displayed.

Once the BVs and the relationships between them have been defined, the entire data acquisition process can be monitored from the work in progress view within Visual Warehouse Administrator. Every planned, ongoing, and finished execution of every BV is listed in this view. At any point in time, the administrator can identify what the status of the tables in the warehouse is.

If there were errors during the execution of a BV, the details of the error situation are logged and made accessible from this work-in-progress view as well.

All the information that is generated during the data acquisition process—that is, information about the structure of the data sources and target tables, mapping information, BV descriptive and administrative information, and statistical information about the execution of the BVs—is stored in the Visual Warehouse meta data catalog. It can be enriched with business definitions and can be accessed by the business analysts in order to help them understand the content and status of the warehouse as well as to help them to navigate within the warehouse structures.

The design and implementation of a manageable data warehouse infrastructure is not a trivial task, many different functions are involved. A data staging area is needed to support the transformation of the data from an application centric model to a business centric model. The staging process can have several steps until the final target data model is reached, depending on the diversity of the data sources and the complexity of the transformations. We could solve most of the requirements using Visual Warehouse in this example.

However, in some cases, the functions provided by Visual Warehouse may not be sufficient to address all data quality and data conversion issues. You may have to incorporate user-written code to implement specific transformations or you may want to use generated code from tools such as ETI Extract and Vality Integrity to support your data acquisition and cleansing process.

Visual Warehouse supports the integration of these other components and allows for the control and management of these components from a single point.

Appendix A. The OS/390 Environment

This appendix provides detailed information and samples of the OS/390 environment.

A.1 The IMS - DBCTL Environment

The DBCTL environment is similar to the DB/DC environment; a DL/I region owns the databases to be processed. DL/I is part of the DBCTL environment, although DL/I runs in its associated address space. Database Recovery Control (DBRC) facilities, required for DBCTL, help to manage database availability, system logging, and database recovery.

The greatest dissimilarity between DBCTL and DB/DC is that DBCTL does not support user terminals, a master terminal, or message handling. Therefore, no Message Processing Program (MPP) regions exist. The Batch Message Processing (BMP) region is used only by batch applications and utilities.

The CCTL handles message traffic and schedules application programs, all outside the DBCTL environment. It passes database calls through the interface to the control region, which sends the calls to DL/I and passes the results back through the interface to the CCTL.

The information in this book that describes the IMS online system applies to both DB/DC and DBCTL. Exceptions are noted as not applicable to DBCTL.

Figure 39 on page 178 shows an example of the DBCTL environment.

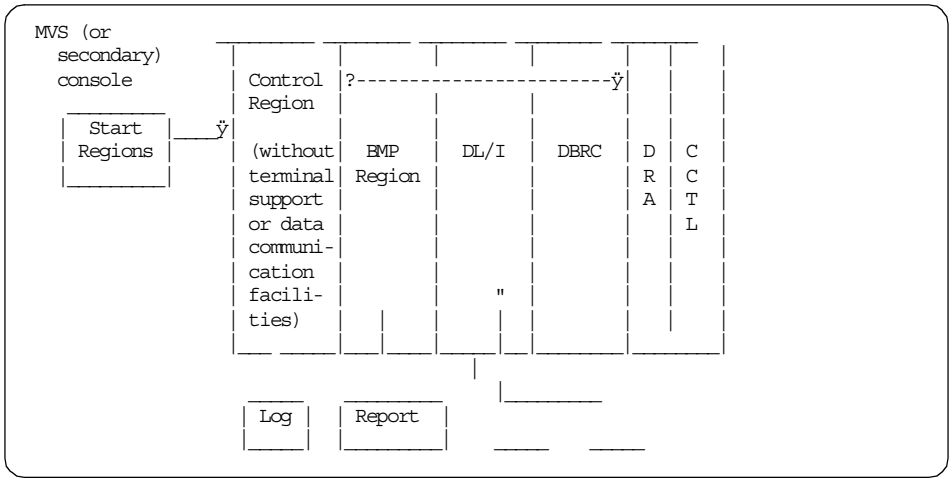


Figure 39. Example of a DBCTL Environment

A.2 The DB/DC Environment

In the DB/DC environment, data is centrally managed for applications that are being executed concurrently and made available to terminal users. Database Recovery Control (DBRC) facilities help to manage database availability and system logging.

The basic unit of work is the transaction. Transaction processing consists of:

- Receiving a request for work that has been entered at a terminal. The request is in the form of a transaction code, which identifies the kind of work to be performed and the data needed to do it.
- Invoking a program to do the work, and preparing a response for the terminal operator (for example, an acknowledgment of work performed or an answer to an inquiry).
- Transmitting the response to the terminal that requested the work.

The simplest kind of transaction involves two messages: an input message from the terminal user and an output message in return. Application programs can also send messages to terminals other than the input source, and they can generate transactions.

Figure 40 on page 179 represents a DB/DC environment.

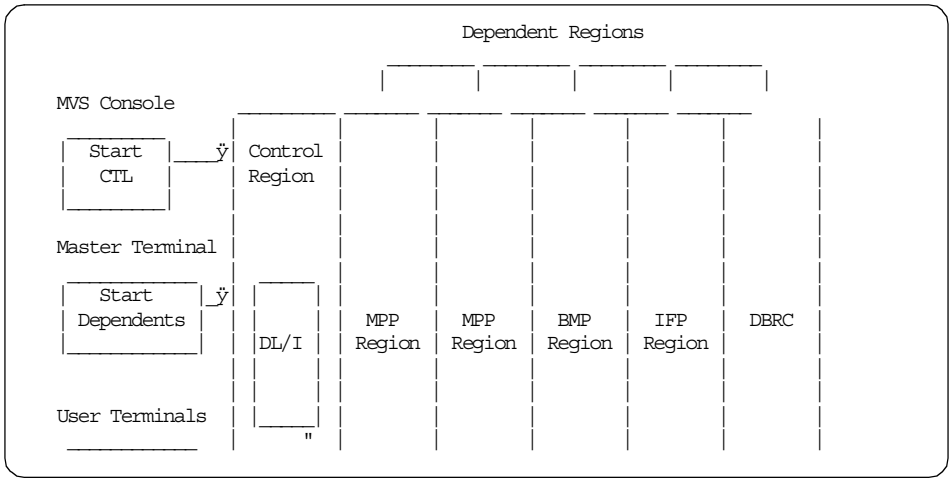


Figure 40. Example of a DB/DC Environment

A.3 Configuring the DBCTL Environment

The following sections show how the IMS/DBCTL environment at the IBM ITSO scenario was configured.

A.3.1 Create Stage 1 Input for DBCTL System

During the initialization for start-up of the IMS on-line system, a control program, which has been customized to your requirements, is loaded. The input data that drives this process is a set of macro source statements. Each statement is coded with its own parameters. The composite of all the macro statements is termed the stage 1 input.

Six sets or groupings of macro statements make up the content of the stage 1 input. The IMSGEN macro contributes to the system configuration definition. Within each set, individual macros specify data that is specific to a required function or to a part of the total physical on-line configuration.

If you use the IMS DBCTL control region, you have to include your Database Description (DBD) and Program Specification Block (PSB) information in Stage1 input as shown in Figure 41 on page 180.

```
*********************************************************************
*   DATAJOINTER CLASSIC CONNECT DATABASE & APPLICATION DEFINITION
*********************************************************************
         DATABASE DBD=FIRDB,ACCESS=UP                HIDAM/VSAM
         DATABASE INDEX,DBD=FIRDBI,ACCESS=UP         HIDAM/VSAM INDEX
         DATABASE INDEX,DBD=FIRDBS,ACCESS=UP         HIDAM/VSAM INDEX
*********************************************************************
         APPLCTN PSB=PFIRDB,PGMTYPE=BATCH            HIDAM/VSAM
```

Figure 41. Example of DBD and PSB Specifications

This example shows three DBD entries: one for the HIDAM database, and two for indexes for the HIDAM database. It also shows one PSB entry.

Following is a sample of the Stage1 input in the ITSO environment:

```
*
*********************************************************************
* INSTALL/IVP IMS 6.1
*
* SKELETON: DFSIXSC1
*
* FUNCTION: STAGE 1 SOURCE FOR A DBC SYSTEM
*********************************************************************
*
*****************************************************************@SCPYRT**
*                                                                       *
*         Licensed Materials - Property of IBM                          *
*                                                                       *
*         "Restricted Materials of IBM"                                 *
*                                                                       *
*         5655-158 (C) Copyright IBM Corp. 1989                         *
*         All Rights Reserved.                                          *
*                                                                       *
*         US Government Users Restricted Rights -                       *
*         Use, duplication or disclosure restricted by                  *
*         GSA ADP schedule contract with IBM Corp.                      *
*                                                                       *
*****************************************************************@ECPYRT**
*
* IMSCTRL MACRO --
*
```

```
         IMSCTRL  SYSTEM=(VS/2,(ALL,DBCTL),4.3),                       X
               IRLM=YES,                                               X
               IRLMNM=IR6D,                                            X
               CMDCHAR=/,                                              X
               DBRC=(YES,YES),                                         X
               DBRCNM=IVP61RC1,                                        X
               DLINM=IVP61DL1,                                         X
               IMSID=IMSD,                                             X
               NAMECHK=(YES,S1),                                       X
               MAXIO=(,015),                                           X
               MAXREGN=(005,512K,A,A),                                 X
               MCS=(2,7),                                              X
               DESC=7,                                                 X
               MAXCLAS=016
*
* IMSCTF  MACRO --
*
         IMSCTF SVCNO=(,203,202),                                      X
               LOG=SNGL,                                               X
               CPLOG=3000,                                             X
               RDS=(3380,4096),                                        X
               PRDR=IVP61RD3
*
* BUFPOOLS MACRO --
*
         BUFPOOLS PSB=24000,                                           X
               DMB=24000,                                              X
               SASPSB=(4000,20000),                                    X
               PSBW=12000
*
* SECURITY MACRO --
*
         SECURITY TYPE=(AGNEXIT),                                      X
               SECCNT=2,                                               X
               PASSWD=YES,                                             X
               TRANCMD=YES
**********************************************************************
*   DATAJOINTER CLASSIC CONNECT DATABASE & APPLICATION DEFINITION
**********************************************************************
         DATABASE DBD=FIRDB,ACCESS=UP                HIDAM/VSAM
         DATABASE INDEX,DBD=FIRDBI,ACCESS=UP         HIDAM/VSAM INDEX
         DATABASE INDEX,DBD=FIRDBS,ACCESS=UP         HIDAM/VSAM INDEX
**********************************************************************
         APPLCTN PSB=PFIRDB,PGMTYPE=BATCH            HIDAM/VSAM
         SPACE 2
**********************************************************************
*
```

```
* IMSGEN MACRO --
*
         IMSGEN ASM=(HLASM,SYSLIN),ASMPRT=OFF,                          X
               LKPRT=(XREF,LIST),LKSIZE=(880K,64K),LKRGN=900K,          X
               SUFFIX=C,                                                X
               SURVEY=YES,                                              X
               MACLIB=ALL,                                              X
               NODE=(IMS610D,                                           X
               IMS610D,                                                 X
               IMS610D),                                                X
               OBJDSET=IMS610D.OBJDSET,                                 X
               PROCLIB=YES,                                             X
               USERLIB=IMS610D.LOAD,                                    X
               UMAC0=,                                                  X
               SYSMAC=SYS1.MACLIB,                                      X
               MODGEN=SYS1.MODGEN,                                      X
               UMAC1=,                                                  X
               UMAC2=,                                                  X
               UMAC3=,                                                  X
               ONEJOB=(),                                               X
               JCL=(IMSGEN,                                             X
               (999,POK),                                               X
               'INSTALL',T,                                             X
               (CLASS=A,MSGLEVEL=(1,1),REGION=32M,NOTIFY=YOURID)),      X
               SCL=(255,,(TIME=600)),                                   X
               UJCL1='/*JOBPARM L=999,SYSAFF=SC53                       X
                        ',                                              X
               UJCL2=,                                                  X
               UJCL3=,                                                  X
               UJCL4=,                                                  X
               UJCL5=
         END ,
*
```

A.3.2 Run the IMS System Definition STAGE 1

Stage 1 is the first part of the process of defining an IMS system. Stage 1 checks input specifications and generates a series of OS/390 job steps that are the input to stage 2.

Following is a sample of the Stage1 JCL in the ITSO environment:

```
//IV2C203J JOB (999,POK),
// 'INSTALL',
// CLASS=A,MSGCLASS=T,MSGLEVEL=(1,1),
// NOTIFY=&SYSUID,
// REGION=32M
//*
/*JOBPARM L=999,SYSAFF=SC53
//*
//*********************************************************************
//* INSTALL/IVP IMS 6.1
//*
//* SKELETON: DFSIXSC3
//*
//* FUNCTION: RUN THE IMS SYSTEM DEFINITION STAGE1
//*********************************************************************
//*
//************************************************************@SCPYRT**
//*                                                                   *
//*       Licensed Materials - Property of IBM                        *
//*                                                                   *
//*       "Restricted Materials of IBM"                               *
//*                                                                   *
//*       5655-158 (C) Copyright IBM Corp. 1974,1996                  *
//*       All Rights Reserved.                                        *
//*                                                                   *
//*       US Government Users Restricted Rights -                     *
//*       Use, duplication or disclosure restricted by                *
//*       GSA ADP schedule contract with IBM Corp.                    *
//*                                                                   *
//************************************************************@ECPYRT**
//*
//STAGE1   EXEC PGM=ASMA90,PARM='NOOBJ,DECK',TIME=(600)
//SYSPRINT DD SYSOUT=*
//SYSLIB   DD DISP=SHR,DSN=IMS610D.GENLIB
//         DD DISP=SHR,DSN=IMS610D.GENLIBA
//         DD DISP=SHR,DSN=IMS610D.GENLIBB
//SYSPUNCH DD DISP=SHR,
//            DSN=SW5106R.JCLLIB(IV2C301J)
//SYSUT1   DD UNIT=3390,SPACE=(CYL,(05,05)),DCB=OPTCD=C
//SYSUT2   DD UNIT=3390,SPACE=(CYL,(05,05)),DCB=OPTCD=C
//SYSUT3   DD UNIT=3390,SPACE=(CYL,(05,05)),DCB=OPTCD=C
//SYSIN    DD DISP=SHR,
//            DSN=SW5106R.JCLLIB(IV2C201T)
```

A.3.3 Run the IMS System Definition STAGE 2

Stage 2 is the second part of the process of defining an IMS system. Stage 2 builds IMS system libraries, execution procedures, and the IMS online control program tailored to support the desired set of IMS functions. Stage 2 then stores these in an IMS library.

A.3.4 Create DFSPBxxx Member

This member contains parameters updated when the IMS control region starts. It is located in imshlq.PROCLIB, where imshlq means IMS high-level qualifier.

```
SUF=C,
IMSID=IMSD,
ISIS=0,
LGNR=10,
DBRCNM=IVP6DRC1,
DLINM=IVP6DDL1,
PRDR=IVP6DRD1,
CRC=/,
IRLM=N,
IRLMNM=,
```

Figure 42. Example of DFSPBxxx

Set "SUF" to what you specified in your Stage1 source under the parameter "SUFFIX" of IMSGEN MACRO.

Set "IMSID" to your IMS subsystem name.

Set "ISIS" to say whether resource access security checking is to be performed. You can control resource access and prevent an unauthorized CCTL from connecting to the DBCTL environment using the ISIS execution parameter. Set "ISIS" to 0 if you do not control resource access.

Set "DBRCNM" to your DBRC started procedure name.

Set "DLINM" to your DL/I started procedure name.

Set "CRC" to your command prefix name when issuing the IMS command from the OS/390 console.

Set "IRLM" to "Y" if you use IRLM for resource locking.

Set "IRLMNM" to your primary IRLM subsystem name in case of specifying "IRLM" to "Y".

For more information about the parameters of DFSPBxxx, see Section 4.23, "Parameter Descriptions", in *IMS/ESA V 6 Installation, Volume 2*, GC26-8737.

Following is a sample of the DFSPBxxx member in the ITSO environment:

```
RES=Y,
PST=5,
SRCH=0,
DMB=048,
CIOP=,
WKAP=048,
PSBW=024,
DBWP=024,
SUF=C,
FIX=DC,
PRLD=DC,
VSPEC=DC,
BSIZ=02048,
OTHR=005,
DBFX=00010,
DBBF=00050,
FMTO=D,
AUTO=N,
IMSID=IMSD,
ISIS=0,
LGNR=10,
SSM=,
WADS=D,
ARC=01,
UHASH=,
DBRCNM=IVP6DRC1,
DLINM=IVP6DDL1,
CSAPSB=12,
DLIPSB=40,
PRDR=IVP6DRD1,
EPCB=0012,
CRC=/,
DBRSE=,
FPWP=,
SPM=,
TRACK=,
RSRMBR=,
APPLID1=,
APPLID2=,
APPLID3=,
USERVAR=,
```

```
IRLM=N,
IRLMNM=,
PIMAX=20,
PIINCR=1,
AOIP=,
AOIS=,
MAXPST=,
PREMSG=
```

A.3.5 Create IMS DBCTL Started Procedure

Figure 43 shows a started procedure for the IMS DBCTL control region. You should set the "RGSUF" parameter to your suffix for the DFSPBxxx.

```
//        PROC RGN=2000K,SOUT=A,DPTY='(14,15)',
//            SYS=,SYS2=,
//            RGSUF=IV3,PARM1=,PARM2=
//IEFPROC EXEC PGM=DFSMVRC0,DPRTY=&DPTY,REGION=&RGN,
//            PARM='DBC,&RGSUF,&PARM1,&PARM2'
//*
//*
//* THE MEANING AND MAXIMUM SIZE OF EACH PARAMETER
//* IS AS FOLLOWS:
//*****************************************************
//*   RGSUF  XXX   EXEC PARM DEFAULT BLOCK SUFFIX FOR
//*                MEMBER DFSPBXXX.
//*****************************************************
:
```

Figure 43. Example of IMS Started Procedure Parameter

Following is a sample of the IMS DBCTL Started Procedure in the ITSO environment:

```
//         PROC RGN=2000K,SOUT=A,DPTY='(14,15)',
//             SYS=,SYS2=,
//             RGSUF=IV3,PARM1=,PARM2=
//IEFPROC EXEC PGM=DFSMVRC0,DPRTY=&DPTY,REGION=&RGN,
//             PARM='DBC,&RGSUF,&PARM1,&PARM2'
//*
//*
//* THE MEANING AND MAXIMUM SIZE OF EACH PARAMETER
//* IS AS FOLLOWS:
//*****************************************************
//*   RGSUF  XXX   EXEC PARM DEFAULT BLOCK SUFFIX FOR
//*                MEMBER DFSPBXXX.
//*****************************************************
//*
```

```
//*  PARM1 , PARM2 PARAMETERS BOTH ARE USED TO SPECIFY
//*  CHARACTER STRINGS THAT CONTAIN IMS KEYWORD
//*  PARAMETERS. I.E. PARM1='AUTO=Y,PST=222,RES=Y'
//*
//*  ALL OF THE VALID DBCTL KEYWORD PARAMETERS
//*  ARE DESCRIBED BELOW
//*************************************************
//*
//******** CONTROL REGION SPECIFICATIONS ********
//*   RES    X     BLOCK RESIDENT (N = NO, Y = YES)
//*   PST    XXX   NUMBER OF PST'S PERMANENTLY ALLOC
//*   MAXPST XXX   MAXIMUM NUMBER OF PST'S
//*   SRCH   X     MODULE SEARCH INDICATOR FOR DIRECTED LOAD
//*                0 = STANDARD SEARCH
//*                1 = SEARCH JPA AND LPA BEFORE PDS
//*   FMTO         T = ONLINE FORMATTED DUMP WITH
//*                    STORAGE IMAGE DELETIONS.
//*                    TERM=NO SDUMPS ALLOWED.
//*                P = FULL ONLINE FORMATTED DUMP.
//*                    TERM=NO SDUMPS ALLOWED.
//*                F = FULL ONLINE FORMATTED DUMP.
//*                    TERM=NO SDUMPS NOT ALLOWED.
//*                N = NO FORMATTED DUMP, NO OFFLINE
//*                    DUMP. TERM=NO SDUMPS ALLOWED.
//*                Z = NO FORMATTED DUMP, NO OFFLINE
//*                    DUMP. TERM=NO SDUMPS NOT
//*                    ALLOWED.
//*  (DEFAULT)     D = OFFLINE DUMP, OR ONLINE FORMAT-
//*                    TED DUMP WITH STORAGE IMAGE
//*                    DELETIONS IF OFFLINE DUMPING
//*                    FAILS. TERM=NO SDUMPS ALLOWED.
//*                X = OFFLINE DUMP, OR ONLINE FORMAT-
//*                    TED DUMP WITH STORAGE IMAGE
//*                    DELETIONS IF OFFLINE DUMPING
//*                    FAILS. TERM=NO SDUMPS NOT
//*                    ALLOWED.
//*                M = OFFLINE DUMP, ONLINE IMS DUMP
//*                    FORMATTING NOT PERMITTED
//*                    TERM=NO SDUMPS ALLOWED.
//*                R = OFFLINE DUMP, ONLINE IMS DUMP
//*                    FORMATTING NOT PERMITTED
//*                    TERM=NO SDUMPS NOT ALLOWED.
//*   AUTO   X     Y = AUTOMATIC RESTART DESIRED
//*                N = NO AUTOMATIC RESTART
//*   IMSID  XXXX  IMS SUBSYSTEM IDENTIFIER
//*   ISIS   X     0 = NO RESOURCE ACCESS SECURITY
//*                1 = RACF RESOURCE ACCESS SECURITY
```

```
//*                2 = USER RESOURCE ACCESS SECURITY
//*   ARMRST X     Y = ALLOW MVS ARM TO RESTART
//*                N = ARM NOT RESTART IMS
//*   IRLM   X     Y = YES, N = NO
//*   IRLMNM XXXX  IRLM SUBSYSTEM NAME
//*   SSM    XXXX  EXT SUBSYSTEM PROCLIB MEMBER ID
//*   WADS   X     SINGLE OR DUAL WADS,S=SINGLE,D=DUAL
//*   ARC    XX    AUTOMATIC ARCHIVE.
//*                0 = NOT AUTOMATIC
//*                1-99 = AUTOMATIC
//*   UHASH  XXXXXXXX USER HASH MODULE NAME
//*   DBRCNM XXXXXXXX DBRC PROCLIB MEMBER NAME
//*   DLINM  XXXXXXXX DL/I PROCLIB MEMBER NAME
//*   PRDR   XXXXXXXX IMSRDR PROCLIB MEMBER NAME
//*   DBRSE  XXXXXXXX 8 CHAR DBCTL RSENAME
//*   CRC    X     COMMAND RECOGNITION CHARACTER
//*   CMDMCS X     COMMAND SECURITY OPTION
//*                R=RACF COMMAND SECURITY
//*                C=DFSCCMD0 COMMAND SECURITY
//*                B=RACF AND DFSCCMD0 CMD SEC
//*   PREMSG X     PREFIX MESSAGE OPTION
//*                N=NO DFS000I PREFIX
//*                Y=DEFAULT, DFS000I PREFIX
//*   PIMAX  XXXXXX ENQ/DEQ POOL MAXIMUM BYTES
//*   PIINCR XXXXXX ENQ/DEQ POOL INCREMENT
//*   AOIS   X      ICMD SECURITY OPTION
//*   YEAR4   X     N = 2-DIGIT DATE
//*                 Y = 4-DIGIT DATE
//*
//******** FDR PARAMETER ****************************
//*
//*   FDRMBR  XX    SUFFIX FOR FDR MEMBER IN
//*                 IMS610D.PROCLIB
//*
//******** FAST PATH PARAMETERS ********
//*
//*   BSIZ   XXX   DATA BASE BUFFER SIZE
//*   OTHR   XXX   NUMBER OF OUTPUT THREADS
//*   DBFX   XXX   SYSTEM ALLOCATION OF DATA BASE BUFFERS TO BE
//*                FIXED AT START OF 1ST FAST PATH DEP REGION
//*   DBBF   XXX   NUMBER OF DATABASE BUFFERS
//*   LGNR   XX    NUMBER OF LOG ENTRIES IN DEDB BUFFERHEADER
//*
//******** RSR PARAMETERS ************************
//*
//*   RSRMBR XX    SUFFIX FOR RSR MEMBER
//*   TRACK  XXX   NO = NO RECOVERY TRACKING DONE
```

```
//*               RLT = RECOVERY TRACKING DONE
//*               DLT = DATABASE TRACKING DONE
//*
//******** STORAGE POOL VALUES IN K, M OR G ******
//*   DMB    XXXXXX DMB POOL SIZE
//*   CIOP   XXXXXX CIOP POOL UPPER LIMIT
//*   WKAP   XXXXXX WORKING STORAGE BUFFER POOL SIZE
//*   PSBW   XXXXXX PSB WORK POOL SIZE
//*   DBWP   XXXXXX DATABASE WORK POOL SIZE
//*   CSAPSB XXXXXX DLISAS: CSA PSB POOL SIZE
//*   DLIPSB XXXXXX DLISAS: DLI PSB POOL SIZE
//*   EPCB   XXXXXX EPCB POOL SIZE
//*   FPWP   XXXXXX FP WORK POOL UPPER LIMIT
//*   AOIP   XXXXXX AOI POOL UPPER LIMIT
//*
//******** MEMBER SUFFIXES **********************
//*
//*   SUF    X     LAST CHARACTER OF CTL PROGRAM LOAD
//*                MODULE MEMBER NAME
//*   FIX    XX    2 CHARACTER FIX PROCEDURE MODULE SUFFIX
//*   PRLD   XX    2 CHARACTER PROCLIB MEMBER SUFFIX FOR PRELOAD
//*   VSPEC  XX    2 CHARACTER BUFFER POOL SPEC MODULE SUFFIX
//*   SPM    XX    STORAGE POOL OPTIONS (DFSSPMXX)
//*********************************************
//*
//STEPLIB  DD DSN=IMS610D.&SYS2.RESLIB,DISP=SHR
//         DD DSN=DJX.V2R1M01.SDJXLOAD,DISP=SHR
//PROCLIB  DD DSN=IMS610D.&SYS2.PROCLIB,DISP=SHR
//*
//*************************************************
//* IN ORDER TO START A DEPENDENT REGION, MODIFIED
//* START-UP JCL IS WRITTEN FROM INTERNAL STORAGE TO
//* THE INTERNAL READER.
//*
//IMSIRD   DD SYSOUT=(A,INTRDR)
//*
//*********** DASD  LOGGING DD CARDS *************
//* THE FOLLOWING DD CARDS DESCRIBE THE DASD LOGGING
//* OLDS AND WADS. THESE CARDS ARE FOR EXAMPLE ONLY.
//* ALL OLDS AND WADS DATA SETS MAY BE DYNAMICALLY
//* ALLOCATED.  DD CARDS ARE NOT REQUIRED.
//* THE OLDS AND WADS TO BE USED DURING STARTUP MUST
//* BE SPECIFIED VIA OLDSDEF AND WADSDEF CONTROL
//* STATEMENTS IN THE DFSVSMXX MEMBER OF IMS PROCLIB.
//* THE ACTUAL SELECTION OF OLDS AND WADS MUST BE
//* TAILORED TO INSTALLATION REQUIREMENTS.  THE OLDS
//* AND WADS MUST BE PREDEFINED BY A SET UP JOB.
```

```
//* THE BLOCK SIZE OF ALL OLDS MUST BE THE SAME.
//* THE BLOCK SIZE AND DEVICE TYPE OF ALL WADS MUST
//* BE THE SAME.  AT LEAST 3 PRIMARY OLDS AND 1 WADS
//* MUST BE AVAILABLE FOR STARTUP.  THE BLOCK SIZE
//* SHOULD NOT BE SPECIFIED IN THIS JCL.  THE LOGGER
//* WILL GET THE BLOCK SIZE FROM THE VTOC.
//*
//DFSOLP00 DD DSN=IMS610D.&SYS.OLP00,DISP=SHR
//DFSOLP01 DD DSN=IMS610D.&SYS.OLP01,DISP=SHR
//DFSOLP02 DD DSN=IMS610D.&SYS.OLP02,DISP=SHR
//DFSOLP03 DD DSN=IMS610D.&SYS.OLP03,DISP=SHR
//DFSOLP04 DD DSN=IMS610D.&SYS.OLP04,DISP=SHR
//DFSOLP05 DD DSN=IMS610D.&SYS.OLP05,DISP=SHR
//*
//DFSOLS00 DD DSN=IMS610D.&SYS.OLS00,DISP=SHR
//DFSOLS01 DD DSN=IMS610D.&SYS.OLS01,DISP=SHR
//DFSOLS02 DD DSN=IMS610D.&SYS.OLS02,DISP=SHR
//DFSOLS03 DD DSN=IMS610D.&SYS.OLS03,DISP=SHR
//DFSOLS04 DD DSN=IMS610D.&SYS.OLS04,DISP=SHR
//DFSOLS05 DD DSN=IMS610D.&SYS.OLS05,DISP=SHR
//*
//DFSWADS0 DD DSN=IMS610D.&SYS.WADS0,DISP=SHR
//DFSWADS1 DD DSN=IMS610D.&SYS.WADS1,DISP=SHR
//*
//IMSACBA  DD DSN=IMS610D.&SYS2.ACBLIBA,DISP=SHR
//IMSACBB  DD DSN=IMS610D.&SYS2.ACBLIBB,DISP=SHR
//MODBLKSA DD DSN=IMS610D.&SYS2.MODBLKSA,DISP=SHR
//MODBLKSB DD DSN=IMS610D.&SYS2.MODBLKSB,DISP=SHR
//MODSTAT  DD DSN=IMS610D.&SYS.MODSTAT,DISP=SHR
//******** SYSTEM REQUIRED DD CARDS **************
//*
//SYSUDUMP DD SYSOUT=&SOUT,
//         DCB=(LRECL=125,RECFM=FBA,BLKSIZE=3129),
//         SPACE=(6050,300,,,ROUND)
//IMSRDS   DD DSN=IMS610D.&SYS.RDS,DISP=SHR
//MATRIXA  DD DSN=IMS610D.&SYS2.MATRIXA,DISP=SHR
//MATRIXB  DD DSN=IMS610D.&SYS2.MATRIXB,DISP=SHR
//PRINTDD  DD SYSOUT=&SOUT
//*
//****** EXTERNAL SUBSYSTEM DD CARDS  ***********
//*
//* USER MAY OPTIONALLY ADD THE DFSESL DD CARD
//* FOR EXTERNAL SUBSYSTEM CONNECTION.
//*
//************ DATA BASE DD CARDS ***************
//*
//* USER MAY OPTIONALLY SUPPLY THE DD STATEMENTS
```

```
//* FOR THE ON-LINE DATA BASES TO BE
//* INSERTED HERE PRIOR TO ATTEMPTING
//* AN ON-LINE SYSTEM EXECUTION USING
//* THIS PROCEDURE.
//* IF NO DD STATEMENTS ARE SUPPLIED FOR
//* A DATA BASE, IMS ASSUMES THAT THIS
//* DATA BASE HAS BEEN DESCRIBED THROUGH
//* THE DFSMDA MACRO.
//* IF THE USER WILL BE EXECUTING WITH THE DL/I
//* SAS OPTION, THESE DD STATEMENTS SHOULD BE ADDED
//* TO THE DLISAS PROCLIB MEMBER OR DESCRIBED
//* THROUGH THE DFSMDA MACRO.
```

A.3.6 Create IMS DL/I Started Procedure

This procedure initializes a DL/I (Data Language I) separate address space (DLISAS).

You have to use a DL/I separate address space (DLISAS) to contain code, control blocks, and buffers for full-function databases for the IMS DBCTL control region.

The IMS control program automatically initiates the DL/I address space. If either the control or DL/I address space terminates, the other is automatically terminated.

For using the IMS DBCTL control region, you have to add DD statements for your IMS Databases in the DL/I started procedure.

Following is a sample of the IMS DL/I Started Procedure in the ITSO environment:

```
//       PROC RGN=3072K,DPTY='(14,15)',SOUT=A,
//            IMSID=IMSD,SYS2=
//IEFPROC EXEC PGM=DFSMVRC0,REGION=&RGN,
//            DPRTY=&DPTY,PARM=(DLS,&IMSID)
//*************************************************
//*
//STEPLIB  DD DSN=IMS610D.&SYS2.RESLIB,DISP=SHR
//PROCLIB  DD DSN=IMS610D.&SYS2.PROCLIB,DISP=SHR
//****************** ACBLIB *************************
//*
//* THE SPECIFICATION OF THE ACBLIB DATASETS
//* IN THE DLI/SAS REGION PROCEDURE MUST
//* CORRESPOND EXACTLY WITH THE SPECIFICATION
//* IN THE CONTROL REGION JCL
```

```
//*
//IMSACBA  DD DSN=IMS610D.&SYS2.ACBLIBA,DISP=SHR
//IMSACBB  DD DSN=IMS610D.&SYS2.ACBLIBB,DISP=SHR
//SYSUDUMP DD SYSOUT=&SOUT
//SYSABEND DD SYSOUT=&SOUT
//************ DATA BASE DD CARDS ********************
//*
//* USER MAY OPTIONALLY SUPPLY THE DD STATEMENTS
//* FOR THE ON-LINE DATA BASES TO BE
//* INSERTED HERE PRIOR TO ATTEMPTING
//* AN ON-LINE SYSTEM EXECUTION USING
//* THIS PROCEDURE.
//* IF NO DD STATEMENTS ARE SUPPLIED FOR
//* A DATA BASE, IMS ASSUMES THAT THIS
//* DATA BASE HAS BEEN DESCRIBED THROUGH
//* THE DFSMDA MACRO.
//*
//FIRDB    DD DSN=SJVSAM.FIRMEN.STAMM,DISP=SHR
//FIRDBI   DD DSN=SJVSAM.FIRMEN.STAMM.PRIIX,DISP=SHR
//FIRDBS   DD DSN=SJVSAM.FIRMEN.STAMM.SECIX,DISP=SHR
```

A.3.7 Create IMS DBRC Started Procedure

DBRC is responsible for the following tasks:

1. This first group of tasks are those performed automatically through the interaction of DBRC and IMS (including utilities):
   - Controlling logs for IMS
   - Recording recovery information in the RECON (Recovery Control data set)
   - Verifying that database utilities have the correct input
   - Controlling the recovery of registered databases
   - Controlling the data sharing environment by maintaining authorization information for the control and serialization of access to shared databases
2. These tasks are performed when you request them by passing commands to DBRC:
   - Recording recovery information in the RECON
   - Generating JCL for various IMS utilities and generating user-defined output (Use GENJCL commands to perform these operations.)

- Listing the information in the RECONs; use LISTcommands to list this information

IMS automatically starts the DBRC procedure with an OS/390 START command during control region initialization. This procedure specifies parameters for the DBRC region.

To include the DBRC procedure during system generation, you must copy the skeletal procedure that IMS generates in IMS.PROCLIB to SYS1.PROCLIB. The member name must match the name specified on the DBRCNM parameter in the IMSCTRL macro or the applicable EXEC procedure. If DBRCNM is specified in more than one place, or if DBRCNM is not explicitly specified, the following order of precedence applies:

- DBRCNM=DBRC is the default.
- DBRCNM=name in the IMSCTRL macro overrides the default.
- DBRCNM=name defined in a DFSPBxxx member in IMS.PROCLIB overrides the IMSCTRL macro setting.
- DBRCNM=name defined in a JCL EXEC parameter overrides the IMS.PROCLIB member setting.

Following is a sample of the IMS DBRC Started Procedure in the ITSO environment:

```
//       PROC RGN=2048K,DPTY='(14,15)',SOUT=A,
//            IMSID=IMSD,SYS2=
//IEFPROC EXEC PGM=DFSMVRC0,REGION=&RGN,
//            DPRTY=&DPTY,PARM=(DRC,&IMSID)
//************************************************
//*
//STEPLIB  DD DSN=IMS610D.&SYS2.RESLIB,DISP=SHR
//PROCLIB  DD DSN=IMS610D.&SYS2.PROCLIB,DISP=SHR
//JCLOUT   DD SYSOUT=(A,INTRDR)
//JCLPDS   DD DSN=IMS610D.&SYS2.PROCLIB,DISP=SHR
//SYSUDUMP DD SYSOUT=&SOUT
//SYSABEND DD SYSOUT=&SOUT
//*
//************ DBRC RECON DD CARDS ******************
//*
//* USER MAY OPTIONALLY SUPPLY THE DD CARDS
//* REQUIRED FOR THE DBRC RECON DATA SET.
//* IF NO DD STATEMENTS ARE SUPPLIED FOR RECON
//* DATASETS, IMS ASSUMES THAT THE DATASETS
//* HAVE BEEN DESCRIBED THROUGH THE DFSMDA MACRO.
```

```
//*
```

A.3.8 Allocate RECON Data Sets

DBRC stores recovery-related information in a set of VSAM KSDSs called the RECON (Recovery Control) data sets.

Three RECONs should be defined when you install DBRC. The first two RECONs are active data sets, the third one is a spare. The second active data set is a copy of the first. For most purposes, you can think of the two active RECONs as if they were a single data set, the RECON, or simply RECON.

Allocate RECON data sets for the IMS DBCTL system.

Following is a sample of the RECON Data Sets Allocation JCL in the ITSO environment:

```
//IV2G101J JOB (999,POK),
// 'INSTALL',
// CLASS=A,MSGCLASS=T,MSGLEVEL=(1,1),
// NOTIFY=&SYSUID,
// REGION=32M
//*
/*JOBPARM L=999,SYSAFF=SC53
//*
//*********************************************************************
//* INSTALL/IVP IMS 6.1
//*
//* SKELETON: DFSIXSG0
//*
//* FUNCTION: ALLOCATE DATA SETS NEEDED FOR THE DBCTL SYSTEM IVP
//*********************************************************************
//*
//*************************************************************@SCPYRT**
//*                                                                   *
//*       Licensed Materials - Property of IBM                        *
//*                                                                   *
//*       "Restricted Materials of IBM"                               *
//*                                                                   *
//*       5655-158 (C) Copyright IBM Corp. 1974,1996                  *
//*       All Rights Reserved.                                        *
//*                                                                   *
//*       US Government Users Restricted Rights -                     *
//*       Use, duplication or disclosure restricted by                *
//*       GSA ADP schedule contract with IBM Corp.                    *
```

```
//*                                                                   *
//*****************************************************************@ECPYRT**
//*
//* SCRATCH DATA SETS
//*
//SCRATCH  EXEC PGM=IDCAMS,DYNAMNBR=200
//SYSPRINT DD SYSOUT=*
//SYSIN    DD *
  DELETE IMS610D.RECON1 CLUSTER
  DELETE IMS610D.RECON2 CLUSTER
  DELETE IMS610D.RECON3 CLUSTER
//*
//* ALLOCATE DATA SETS
//*
//ALLOCATE EXEC PGM=IDCAMS,DYNAMNBR=200
//SYSPRINT DD SYSOUT=*
//SYSIN    DD *
  DEFINE CLUSTER(                                -
                 NAME(IMS610D.RECON1)         -
                 FREESPACE(20 20)                -
                 INDEXED                         -
                 KEYS(32 0)                      -
                 RECORDSIZE(4086 32600)          -
                 SHAREOPTIONS(3 3)               -
                 RECOVERY                        -
                 NOERASE                         -
                 SPANNED                         -
                 NOREUSE                         -
                 UNORDERED                       -
                 UNIQUE                          -
                 VOLUMES(TOTIM3)              -
                 CYL(3 1)  -
                )                                -
            DATA(                                -
                 NAME(IMS610D.RECON1.DATA)    -
                )                                -
           INDEX(                                -
                 NAME(IMS610D.RECON1.INDX)    -
                )
  DEFINE CLUSTER(                                -
                 NAME(IMS610D.RECON2)         -
                 FREESPACE(20 20)                -
                 INDEXED                         -
                 KEYS(32 0)                      -
                 RECORDSIZE(4086 32600)          -
                 SHAREOPTIONS(3 3)               -
                 RECOVERY                        -
```

```
                    NOERASE                          -
                    SPANNED                          -
                    NOREUSE                          -
                    UNORDERED                        -
                    UNIQUE                           -
                    VOLUMES(TOTIM3)             -
                    CYL(3 1)  -
                   )                                 -
                DATA(                                -
                    NAME(IMS610D.RECON2.DATA)    -
                   )                                 -
               INDEX(                                -
                    NAME(IMS610D.RECON2.INDX)    -
                   )
  DEFINE CLUSTER(                                    -
                    NAME(IMS610D.RECON3)         -
                    FREESPACE(20 20)                 -
                    INDEXED                          -
                    KEYS(32 0)                       -
                    RECORDSIZE(4086 32600)           -
                    SHAREOPTIONS(3 3)                -
                    RECOVERY                         -
                    NOERASE                          -
                    SPANNED                          -
                    NOREUSE                          -
                    UNORDERED                        -
                    UNIQUE                           -
                    VOLUMES(TOTIM3)             -
                    CYL(3 1)  -
                   )                                 -
                DATA(                                -
                    NAME(IMS610D.RECON3.DATA)    -
                   )                                 -
               INDEX(                                -
                    NAME(IMS610D.RECON3.INDX)    -
                   )
//*
```

A.3.9 Register DBRC Information

Figure 44 shows you an example of RECON records registration.

```
INIT.RECON SSID(IMSD)                    -                              00041006
           FORCER CHECK17 SHARECTL NONEW  -                               00042006
           DASDUNIT(3390) TAPEUNIT(3490)                                  00043006
  INIT.DB    DBD(FIRDB)  SHARELVL(2)                                     00050004
  INIT.DBDS  DBD(FIRDB)  DDN(FIRDB)  GENMAX(2)  -                        00060004
     REUSE  DSN(SJVSAM.FIRMEN.STAMM)  -                                  00070004
     ICJCL(ICJCL)  OICJCL(OICJCL) -                                      00080004
     RECOVJCL(RECOVJCL)                                                  00090004
  INIT.IC    DBD(FIRDB)  DDN(FIRDB) -                                    00100004
      ICDSN(SJVSAM.FIRDB.IC)                                             00110005
  INIT.DB    DBD(FIRDBI)  SHARELVL(2)                                    00130004
  INIT.DBDS  DBD(FIRDBI)  DDN(FIRDBI)  GENMAX(2)  -                      00140004
     REUSE  DSN(SJVSAM.FIRMEN.STAMM.PRIIX)  -                            00150004
     ICJCL(ICJCL)  OICJCL(OICJCL) -                                      00160004
     RECOVJCL(RECOVJCL)                                                  00170004
  INIT.IC    DBD(FIRDBI)  DDN(FIRDBI) -                                  00180004
      ICDSN(SJVSAM.FIRDB.PRIIX.IC)                                       00190005
:
:
```

Figure 44. Example of RECON Records Registration

In this example, you would need to add at least the following three types of statements:

INIT.RECON

After allocating the RECONs, use the INIT.RECON command to initialize the RECON header and control records. This command is only valid for an empty, uninitialized RECON. If the initialization job fails before it has completed successfully, delete and redefine the data sets before rerunning it.

Set SSID to IMS subsystem ID.

INIT.DB

Use an INIT.DB command to create a database record in RECON and register the database with DBRC. The database must be registered in RECON before you can initialize a new DBDS area with the INIT.DBDS command. You can also use the INIT.DB command to specify the level of database sharing.

Set DBD to the name of your DBD. You need INIT.DB statements for each DBD.

INIT.DBDS

Use an INIT.DBDS command to initiate DBRC's control of the recovery of a DBDS area. The INIT.DBDS command causes a DBDS record to be written in RECON. The DBDS record must exist for any of the other commands to work for a given DBDS area. Before creating the DBDS record, DBRC examines the IMS DBDLIB data set to:

- Verify that the DBDS area exists.
- Obtain the DBDS's data set identifier (DSID), its data set organization, and its database organization.

Set DBD to the name of your DBD for the DBDS.

Set DDN to the ddname of your DBDS.

See the manual, *IMS/ESA V6 DBRC Guide and Reference*, SC26-8733-01 for more information about each of the command parameters.

Following is a JCL sample of the Register DBRC Information in the ITSO environment:

```
//INIT04   EXEC PGM=DSPURX00
//STEPLIB  DD   DSN=IMS610D.RESLIB,DISP=SHR
//SYSPRINT DD   SYSOUT=*
//IMS      DD   DSN=IMS610D.DBDLIB,DISP=SHR
//         DD   DSN=IMS610D.PSBLIB,DISP=SHR
//SYSIN    DD   *
  INIT.RECON SSID(IMSD)                      -
             FORCER CHECK17 SHARECTL NONEW   -
             DASDUNIT(3390) TAPEUNIT(3490)
   INIT.DB    DBD(FIRDB)   SHARELVL(2)
   INIT.DBDS  DBD(FIRDB)   DDN(FIRDB)   GENMAX(2)   -
      REUSE   DSN(SJVSAM.FIRMEN.STAMM)   -
      ICJCL(ICJCL)   OICJCL(OICJCL) -
      RECOVJCL(RECOVJCL)
   INIT.IC    DBD(FIRDB)   DDN(FIRDB) -
       ICDSN(SJVSAM.FIRDB.IC)
   INIT.DB    DBD(FIRDBI)   SHARELVL(2)
   INIT.DBDS  DBD(FIRDBI)   DDN(FIRDBI)   GENMAX(2)   -
      REUSE   DSN(SJVSAM.FIRMEN.STAMM.PRIIX)   -
      ICJCL(ICJCL)   OICJCL(OICJCL) -
      RECOVJCL(RECOVJCL)
   INIT.IC    DBD(FIRDBI)   DDN(FIRDBI) -
       ICDSN(SJVSAM.FIRDB.PRIIX.IC)
   INIT.DB    DBD(FIRDBS)   SHARELVL(2)
   INIT.DBDS  DBD(FIRDBS)   DDN(FIRDBS)   GENMAX(2)   -
      REUSE   DSN(SJVSAM.FIRMEN.STAMM.SECIX)   -
```

```
      ICJCL(ICJCL)  OICJCL(OICJCL) -
      RECOVJCL(RECOVJCL)
   INIT.IC    DBD(FIRDBS)  DDN(FIRDBS) -
       ICDSN(SJVSAM.FIRDB.SECIX.IC)
/*
   INIT.CAGRP  GRPNAME(CAGRPSJ)  GRPMAX(2) REUSE -
     GRPMEM((FIRDB,FIRDB))
   INIT.CA  GRPNAME(CAGRPSJ) CADSN(SW5106R.*.CADSN1) -
       VOLLIST(TOTDB7)  FILESEQ(4)
   INIT.CA  GRPNAME(CAGRPSJ) CADSN(SW5106R.*.CADSN2) -
       VOLLIST(TOTDB8)
```

A.4 Data Creation

A.4.1 IMS Definitions

This section describes how you would define the IMS database. The sample definitions are for the HIDAM database.

A.4.1.1 Generate DBD

The sample JCL to generate DBDs is as follows:

```
//DBDGEN PROC MBR=TEMPNAME,SOUT=A,RGN=0M,SYS2=
//C      EXEC PGM=ASMA90,REGION=&RGN,
//            PARM='OBJECT,NODECK,NODBCS'
//SYSLIB   DD DSN=IMS610D.&SYS2.MACLIB,DISP=SHR
//SYSLIN   DD UNIT=SYSDA,DISP=(,PASS),
//         SPACE=(80,(100,100),RLSE),
//         DCB=(BLKSIZE=80,RECFM=F,LRECL=80)
//SYSPRINT DD SYSOUT=&SOUT,DCB=BLKSIZE=1089,
//         SPACE=(121,(300,300),RLSE,,ROUND)
//SYSUT1   DD UNIT=SYSDA,DISP=(,DELETE),
//         SPACE=(CYL,(10,5))
//L      EXEC PGM=IEWL,PARM='XREF,LIST',
//            COND=(0,LT,C),REGION=2M
//SYSLIN   DD DSN=*.C.SYSLIN,DISP=(OLD,DELETE)
//SYSPRINT DD SYSOUT=&SOUT,DCB=BLKSIZE=1089,
//         SPACE=(121,(90,90),RLSE)
//SYSLMOD  DD DISP=SHR,
//         DSN=IMS610D.&SYS2.DBDLIB(&MBR)
//SYSUT1   DD UNIT=(SYSDA,SEP=(SYSLMOD,SYSLIN)),
//         SPACE=(1024,(100,10),RLSE),DISP=(,DELETE)
//       PEND
//*
//DBDGEN   EXEC DBDGEN,MBR=FIRDB
//C.SYSIN  DD  *
```

```
DBD   NAME=FIRDB,                                              *
      ACCESS=HIDAM
DATASET DD1=FIRDB,                                             *
      DEVICE=3380,                                             *
      BLOCK=(4096),                                            *
      FRSPC=(0,0)
SEGM  NAME=FAST,                                               *
      BYTES=130,PARENT=0,                                      *
      RULES=(,LAST),POINTER=(TB)
FIELD NAME=(FIRMA,SEQ,U),TYPE=P,                               *
      START=1,BYTES=2
FIELD NAME=FILLER,TYPE=C,                                      *
      START=3,BYTES=128
LCHILD NAME=(FIRDBI$,FIRDBI),                                  *
      POINTER=INDX
SEGM  NAME=FABU,                                               *
      BYTES=1500,PARENT=((FAST,SNGL)),                         *
      RULES=(,LAST),POINTER=(TB)
FIELD NAME=(KZ,SEQ,U),TYPE=C,                                  *
      START=1,BYTES=1
FIELD NAME=FILLER1,TYPE=C,                                     *
      START=2,BYTES=255
FIELD NAME=FILLER2,TYPE=C,                                     *
      START=257,BYTES=256
FIELD NAME=FILLER3,TYPE=C,                                     *
      START=513,BYTES=256
FIELD NAME=FILLER4,TYPE=C,                                     *
      START=769,BYTES=256
FIELD NAME=FILLER5,TYPE=C,                                     *
      START=1025,BYTES=256
FIELD NAME=FILLER6,TYPE=C,                                     *
      START=1281,BYTES=220
SEGM  NAME=FALI,                                               *
      BYTES=500,PARENT=((FAST,SNGL)),                          *
      RULES=(,LAST),POINTER=(TB)
FIELD NAME=(PROGNR,SEQ,U),TYPE=C,                              *
      START=1,BYTES=8
FIELD NAME=PROGFA,TYPE=P,                                      *
      START=0009,BYTES=002
FIELD NAME=FILLER1,TYPE=C,                                     *
      START=11,BYTES=246
FIELD NAME=FILLER2,TYPE=C,                                     *
      START=257,BYTES=244
LCHILD NAME=(FIRDBS$,FIRDBS),                                  *
      POINTER=INDX
XDFLD NAME=LISTNR,                                             *
      SEGMENT=FALI,                                            *
```

```
            SRCH=(PROGNR,PROGFA)
         DBDGEN
         FINISH
         END
/*
//*
//DBDGEN   EXEC DBDGEN,MBR=FIRDBI
//C.SYSIN  DD  *
         PRINT NOGEN
         DBD   NAME=FIRDBI,                                    *
               ACCESS=INDEX
         DATASET DD1=FIRDBI,                                   *
               DEVICE=3380,                                    *
               BLOCK=291,RECORD=14
         SEGM  NAME=FIRDBI$,                                   *
               BYTES=2,PARENT=0,                               *
               RULES=(,LAST)
         FIELD NAME=(FIRMA,SEQ,U),TYPE=C,                      *
               START=1,BYTES=2
         LCHILD NAME=(FAST,FIRDB),                             *
               INDEX=FIRMA,                                    *
               POINTER=SNGL
         DBDGEN
         FINISH
         END
/*
//*
//DBDGEN   EXEC DBDGEN,MBR=FIRDBS
//C.SYSIN  DD  *
         PRINT NOGEN
         DBD   NAME=FIRDBS,                                    *
               ACCESS=INDEX
         DATASET DD1=FIRDBS,                                   *
               DEVICE=3380,                                    *
               BLOCK=185,RECORD=22
         SEGM  NAME=FIRDBS$,                                   *
               BYTES=10,PARENT=0,                              *
               RULES=(,LAST)
         FIELD NAME=(LISTNR,SEQ,U),TYPE=C,                     *
               START=1,BYTES=10
         LCHILD NAME=(FALI,FIRDB),                             *
               INDEX=LISTNR,                                   *
               POINTER=SNGL
         DBDGEN
         FINISH
         END
/*
```

A.4.1.2 Allocate the VSAM file for IMS

The sample JCL to allocate VSAM files is as follows:

```
//DEFINE  EXEC PGM=IDCAMS
//*STEPCAT   DD DSNAME=IMSCAT1,DISP=SHR
//SYSPRINT  DD SYSOUT=A
//SYSABEND  DD SYSOUT=A
//*VSA       DD UNIT=SYSDA,DISP=OLD,VOL=SER=VSIMS
//SYSIN     DD *
 DELETE SJVSAM.FIRMEN.STAMM
 DELETE SJVSAM.FIRMEN.STAMM.PRIIX
 DELETE SJVSAM.FIRMEN.STAMM.SECIX
 DEFINE  CLUSTER                      -
        (NAME(SJVSAM.FIRMEN.STAMM)    -
         NONINDEXED                   -
         SHR(3 3)                     -
         CISZ(4096)                   -
         RECSZ(4089 4089)             -
         CYL(2 1)                    -
         VOL(TOTDB9))                 -
        CAT(SJVSAM)

 DEFINE  CLUSTER                      -
        (NAME(SJVSAM.FIRMEN.STAMM.PRIIX)       -
         INDEXED                    -
         SHR(3 3)                     -
         RECSZ(14 14)              -
         CYL(2 1)                     -
         KEYS(2 5)                    -
         FSPC(0 0)                     -
         VOL(TOTDB9))                -
         DATA(                        -
         CISZ(4096))                  -
        CAT(SJVSAM)

 DEFINE  CLUSTER                      -
        (NAME(SJVSAM.FIRMEN.STAMM.SECIX)       -
         INDEXED                    -
         SHR(3 3)                     -
         RECSZ(22 22)              -
         CYL(2 1)                     -
         KEYS(10 5)                   -
         FSPC(0 0)                     -
         VOL(TOTDB9))                  -
         DATA(                        -
         CISZ(4096))                  -
        CAT(SJVSAM)
```

```
//*
```

A.4.1.3 Generate PSB

The sample JCL to generate PSB is as follows:

```
//PSBGEN PROC MBR=TEMPNAME,SOUT=*,RGN=0M,SYS2=
//C      EXEC PGM=ASMA90,REGION=&RGN,
//            PARM='OBJECT,NODECK,NODBCS'
//SYSLIB   DD DSN=IMS610D.&SYS2.MACLIB,DISP=SHR
//SYSLIN   DD UNIT=SYSDA,DISP=(,PASS),
//         SPACE=(80,(100,100),RLSE),
//         DCB=(BLKSIZE=80,RECFM=F,LRECL=80)
//SYSPRINT DD SYSOUT=&SOUT,DCB=BLKSIZE=1089,
//         SPACE=(121,(300,300),RLSE,,ROUND)
//SYSUT1   DD UNIT=SYSDA,DISP=(,DELETE),
//         SPACE=(CYL,(10,5))
//L      EXEC PGM=IEWL,PARM='XREF,LIST',
//            COND=(0,LT,C),REGION=20M
//SYSLIN   DD DSN=*.C.SYSLIN,DISP=(OLD,DELETE)
//SYSPRINT DD SYSOUT=&SOUT,DCB=BLKSIZE=1089,
//         SPACE=(121,(90,90),RLSE)
//SYSLMOD  DD DISP=SHR,
//         DSN=IMS610D.&SYS2.PSBLIB(&MBR)
//SYSUT1   DD UNIT=(SYSDA,SEP=(SYSLMOD,SYSLIN)),
//         SPACE=(1024,(100,10),RLSE),DISP=(,DELETE)
//         PEND
/*
//PSBGEN   EXEC PSBGEN,MBR=PFIRDB
//C.SYSIN  DD  *
 PCB            TYPE=DB,DBDNAME=FIRDB,                              *
                PROCOPT=GOTP,KEYLEN=10
 SENSEG         NAME=FAST,PARENT=0
 SENSEG         NAME=FABU,PARENT=FAST
 SENSEG         NAME=FALI,PARENT=FAST
 PCB            TYPE=DB,DBDNAME=FIRDBI,                             *
                PROCOPT=G,KEYLEN=2
 SENSEG         NAME=FIRDBI$,PARENT=0
 PCB            TYPE=DB,DBDNAME=FIRDBS,                             *
                PROCOPT=GE,KEYLEN=10
 SENSEG         NAME=FIRDBS$,PARENT=0
 PSBGEN         LANG=COBOL,PSBNAME=PFIRDB
 END
/*
```

A.4.1.4 Generate ACB

If you use the IMS DBCTL control region, you have to generate ACB. The sample JCL to generate ACB is as follows:

```
//ACBGEN PROC  SOUT=*,COMP=,RGN=256K
//G      EXEC  PGM=DFSRRC00,PARM='UPB,&COMP',REGION=&RGN
//SYSPRINT DD  SYSOUT=&SOUT
//STEPLIB  DD  DSN=IMS610D.RESLIB,DISP=SHR
//DFSRESLB DD  DSN=IMS610D.RESLIB,DISP=SHR
//IMS      DD  DSN=IMS610D.PSBLIB,DISP=SHR
//         DD  DSN=IMS610D.DBDLIB,DISP=SHR
//IMSACB   DD  DSN=IMS610D.ACBLIB,DISP=OLD
//SYSUT3   DD  UNIT=SYSDA,SPACE=(80,(100,100))
//SYSUT4   DD  UNIT=SYSDA,SPACE=(256,(100,100)),DCB=KEYLEN=8
//COMPCTL  DD  DSN=IMS610D.PROCLIB(DFSACBCP),DISP=SHR
//       PEND
//*
//ACBGEN   EXEC ACBGEN
//SYSIN    DD   *
 BUILD PSB=(PFIRDB)
```

A.4.2 DB2 Definitions

A.4.2.1 Create Storage Group

Create a storage group from SPUFI, or by any other method, as shown in the following example:

```
CREATE STOGROUP SJDB1SG1
       VOLUMES (TOTDB9)
       VCAT DB2V510I ;
```

A.4.2.2 Create Database

Create a database from SPUFI, or by any other method, as shown in the following example:

```
CREATE DATABASE SJ390DB1
       STOGROUP SJDB1SG1
       BUFFERPOOL BP1 ;
```

A.4.2.3 Create Tablespaces

Create tablespaces from SPUFI or any other methods. The following are the sample DMLs for each table.

WGRARTST003

```
CREATE TABLESPACE SJDB1TS1
  IN SJ390DB1
  USING STOGROUP SJDB1SG1
    PRIQTY 1024
    SECQTY 1024
    ERASE NO
  PCTFREE 05
  LOCKSIZE PAGE
  BUFFERPOOL BP1
  CLOSE NO  ;
```

ORGSTRUC

```
CREATE TABLESPACE SJDB1TS2
  IN SJ390DB1
  USING STOGROUP SJDB1SG1
    PRIQTY 10240
    SECQTY 4096
    ERASE NO
  PCTFREE 20
  LOCKSIZE PAGE
  BUFFERPOOL BP1
  CLOSE NO  ;
```

DEPOT

```
CREATE TABLESPACE SJDB1TS3
  IN SJ390DB1
  USING STOGROUP SJDB1SG1
    PRIQTY 2048
    SECQTY 512
    ERASE NO
  PCTFREE 05
  LOCKSIZE PAGE
  BUFFERPOOL BP1
  CLOSE NO ;
```

ARTTXT

```
CREATE TABLESPACE SJDB1TS4
    IN SJ390DB1
    USING STOGROUP SJDB1SG1
      PRIQTY 40980
      SECQTY 10240
      ERASE NO
    PCTFREE 20
    LOCKSIZE PAGE
    BUFFERPOOL BP1
    CLOSE NO  ; .
```

BASART

```
CREATE TABLESPACE SJDB1TS5
  IN SJ390DB1
  USING STOGROUP SJDB1SG1
    PRIQTY 16384
    SECQTY 4096
    ERASE NO
  PCTFREE 05
  LOCKSIZE PAGE
  BUFFERPOOL BP1
  CLOSE NO  ;
```

SUPPLART

```
CREATE TABLESPACE SJDB1TS6
  IN SJ390DB1
  USING STOGROUP SJDB1SG1
    PRIQTY 32768
    SECQTY 8192
    ERASE NO
  PCTFREE 05
  LOCKSIZE PAGE
  BUFFERPOOL BP1
  CLOSE NO  ;
```

STRARTDAT

```
CREATE TABLESPACE SJDB1TS7
  IN SJ390DB1
  USING STOGROUP SJDB1SG1
    PRIQTY 20800
    SECQTY 5120
    ERASE NO
  PCTFREE 05
  LOCKSIZE PAGE
  BUFFERPOOL BP1
  CLOSE NO  ;
```

STRUCART

```
CREATE TABLESPACE SJDB1TS8
  IN SJ390DB1
  USING STOGROUP SJDB1SG1
    PRIQTY 40960
    SECQTY 10240
    ERASE NO
  PCTFREE 20
  LOCKSIZE PAGE
  BUFFERPOOL BP1
  CLOSE NO  ;
```

SELLDAY003

```
CREATE TABLESPACE SJDB1TS9
  IN SJ390DB1
  USING STOGROUP SJDB1SG1
    PRIQTY 819200
    SECQTY 204800
    ERASE NO
  PCTFREE 15
  LOCKSIZE PAGE
  BUFFERPOOL BP1
  CLOSE NO  ;
```

A.4.2.4 Create Tables

You must consider referential integrity when creating tables. According to the relationship desired, create the tables in order. In our case, we had to create the tables in the following sequence.

WGRARTST003

```
CREATE TABLE WGRARTST003
    (COMPANY             DECIMAL(3,0)            NOT NULL,
     WAREGROUP           DECIMAL(5,0)            NOT NULL,
     WGR_DESCR           CHAR(60)                NOT NULL,
     CREATE_DATE         DATE                    NOT NULL,
     CHANGE_DATE         DATE                    ,
     DELETE_DATE         DATE                    ,
     USER_NAME           CHAR(20)                NOT NULL,
  PRIMARY KEY
    (COMPANY,
     WAREGROUP)) IN SJ390DB1.SJDB1TS1 ;
CREATE UNIQUE INDEX WGRASTST003IX ON WGRARTST003
    (COMPANY             ASC,
     WAREGROUP           ASC) ;
```

ORGSTRUC

```
CREATE TABLE ORGSTRUC
    (GRPNO               DECIMAL(3,0)            NOT NULL,
     COMPNO              DECIMAL(3,0)            NOT NULL,
     PRCRNGNO            DECIMAL(3,0)            NOT NULL,
     LOCNO               DECIMAL(3,0)            NOT NULL,
  PRIMARY KEY
    (GRPNO,
     COMPNO,
     PRCRNGNO,
     LOCNO)) IN SJ390DB1.SJDB1TS2;
```

```
CREATE UNIQUE INDEX ID_ORGANISATIONSTR ON ORGSTRUC
    (GRPNO              ASC,
     COMPNO             ASC,
     PRCRNGNO           ASC,
     LOCNO              ASC ) ;
```

DEPOT

```
CREATE TABLE DEPOT
    (GRPNO              DECIMAL(3,0)          NOT NULL,
     COMPNO             DECIMAL(3,0)          NOT NULL,
     PRCRNGNO           DECIMAL(3,0)          NOT NULL,
     LOCNO              DECIMAL(3,0)          NOT NULL,
     SUPPLNO            DECIMAL(13,0)         NOT NULL,
     DEPOTNO            DECIMAL(7,0)          NOT NULL,
     SORT_DEPOT         DECIMAL(3,0)          NOT NULL,
     SORT_LINE          DECIMAL(3,0)          NOT NULL,
     TEXT_DEPOT         CHAR(30)              NOT NULL,
     TEXT_LINE          CHAR(30)              NOT NULL,
     CREATE_DATE        DATE                  NOT NULL,
     DELETE_DATE        DATE                  ,
     CALC_FACTOR        DECIMAL(5,3)          ,
  PRIMARY KEY
    (GRPNO,
     COMPNO,
     PRCRNGNO,
     LOCNO,
     SUPPLNO,
     DEPOTNO)) IN SJ390DB1.SJDB1TS3;
ALTER TABLE DEPOT
  FOREIGN KEY BELONGS_
    (GRPNO,
     COMPNO,
     PRCRNGNO,
     LOCNO    )
    REFERENCES ORGSTRUC ;
CREATE UNIQUE INDEX DEPOTIX ON DEPOT
  (GRPNO        ASC,
   COMPNO       ASC,
   PRCRNGNO     ASC,
   LOCNO        ASC,
   SUPPLNO      ASC,
   DEPOTNO      ASC) ;
```

ARTTXT

```
CREATE TABLE ARTTXT
    (BASARTNO           DECIMAL(13,0)          NOT NULL,
     GRPNO              DECIMAL(3,0)           NOT NULL,
     COMPNO             DECIMAL(3,0)           NOT NULL,
     PRCRNGNO           DECIMAL(3,0)           NOT NULL,
     LOCNO              DECIMAL(3,0)           NOT NULL,
     TEXTTYPNO          DECIMAL(2,0)           NOT NULL,
     ARTICLETEXT        CHAR(45)               NOT NULL,
  PRIMARY KEY
    (BASARTNO,
     GRPNO,
     COMPNO,
     PRCRNGNO,
     LOCNO,
     TEXTTYPNO)) IN SJ390DB1.SJDB1TS4;
CREATE UNIQUE INDEX ARTTXTIX ON ARTTXT
    (BASARTNO        ASC,
     GRPNO           ASC,
     COMPNO          ASC,
     PRCRNGNO        ASC,
     LOCNO           ASC,
     TEXTTYPNO       ASC)
    CLUSTER
    USING STOGROUP SJDB1SG1
      PRIQTY 10240
      SECQTY 5120 ;
ALTER TABLE ARTTXT
  FOREIGN KEY HAS
    (BASARTNO,
     GRPNO,
     COMPNO,
     PRCRNGNO,
     LOCNO    )
    REFERENCES STRUCART ;
```

BASART

```
CREATE TABLE BASART
    (BASARTNO           DECIMAL(13,0)          NOT NULL,
     BASARTDESC         CHAR(45)               NOT NULL,
     CONTENS            CHAR(7)                ,
     CREATE_DATE        DATE                   NOT NULL,
     CHANGE_DATE        DATE                   ,
     BASARTDELDAT       DATE                   ,
     BASARTSTRTDAT      DATE                   NOT NULL,
```

```
    MCONTENS            DECIMAL(3,0)          ,
    HEADARTNO           DECIMAL(13,0)         ,
    OWN_BRAND           DECIMAL(1,0)          ,
    DISP                DECIMAL(1,0)          ,
    WG1                 DECIMAL(5,0)          ,
    WG2                 DECIMAL(5,0)          ,
    WG3                 DECIMAL(5,0)          ,
    WG4                 DECIMAL(5,0)          ,
    WG5                 DECIMAL(5,0)          ,
    COLORNO             DECIMAL(3,0)          NOT NULL,
  PRIMARY KEY
    (BASARTNO)) IN SJ390DB1.SJDB1TS5 ;
CREATE UNIQUE INDEX BASARTNO ON BASART
    (BASARTNO           ASC  ) ;
```

SUPPLART

```
CREATE TABLE SUPPLART
    (SUPPLNO            DECIMAL(13,0)         NOT NULL,
    BASARTNO            DECIMAL(13,0)         NOT NULL,
    GRPNO               DECIMAL(3,0)          NOT NULL,
    COMPNO              DECIMAL(3,0)          NOT NULL,
    PRCRNGNO            DECIMAL(3,0)          NOT NULL,
    LOCNO               DECIMAL(3,0)          NOT NULL,
    DEL_MARK            CHAR(1)               ,
    DELETE_DATE         DATE                  ,
    CHANGE_DATE         DATE                  ,
    SUPPLARTCREDAT      DATE                  NOT NULL,
    SORT_ID             DECIMAL(13,0)         ,
    ORD_WEEK            DECIMAL(2,0)          ,
    ORD_DAY             DECIMAL(3,0)          ,
    PRLIST              CHAR(1)               ,
    CONDLIST            CHAR(1)               ,
    BILLACCNT           DECIMAL(2,0)          ,
    COMM_MARK           DECIMAL(2,0)          ,
    DELVR_KEY           DECIMAL(2,0)          ,
    DELVR_UNIT          DECIMAL(8,3)          NOT NULL,
    SUPPL_UNIT          DECIMAL(8,3)          NOT NULL,
    CONTENS             CHAR(7)               ,
    SUPPLARTTXT         CHAR(45)              ,
    SUPPLPATH           DECIMAL(3,0)          NOT NULL,
    ORDERNO              CHAR(13)              ,
    SUPPLARTOUTDAT      DATE                  NOT NULL,
    DEPOTNO             DECIMAL(7,0)          NOT NULL,
    DELVRTIME           DECIMAL(4,1)          ,
    SUPPLARTNO          CHAR(20)              ,
```

```
  PRIMARY KEY
    (SUPPLNO,
     BASARTNO,
     GRPNO,
     COMPNO,
     PRCRNGNO,
     LOCNO)) IN SJ390DB1.SJDB1TS6 ;
CREATE UNIQUE INDEX SUPPLARTIX ON SUPPLART
    (SUPPLNO             ASC,
     BASARTNO            ASC,
     GRPNO               ASC,
     COMPNO              ASC,
     PRCRNGNO            ASC,
     LOCNO               ASC)
    CLUSTER
    USING STOGROUP SJDB1SG1
      PRIQTY 10240
      SECQTY 5120 ;
CREATE INDEX SUP_IND1 ON SUPPLART
    (SUPPLNO             ASC,
     SUPPLARTNO          ASC,
     GRPNO               ASC,
     COMPNO              ASC,
     PRCRNGNO            ASC,
     LOCNO               ASC  ) ;
CREATE INDEX SUP_IND2 ON SUPPLART
    (SUPPLNO             ASC,
     ORDERNO             ASC,
     GRPNO               ASC,
     COMPNO              ASC,
     PRCRNGNO            ASC,
     LOCNO               ASC  ) ;
CREATE INDEX SUPE_IND3 ON SUPPLART
    (BASARTNO            ASC,
     SUPPLNO             ASC  ) ;
ALTER TABLE SUPPLART
  FOREIGN KEY IS_AVAIL
    (BASARTNO,
     GRPNO,
     COMPNO,
     PRCRNGNO,
     LOCNO    )
    REFERENCES STRUCART ;
```

STRARTDAT

```
CREATE TABLE STRARTDAT
    (BASARTNO            DECIMAL(13,0)          NOT NULL,
     GRPNO               DECIMAL(3,0)           NOT NULL,
     COMPNO              DECIMAL(3,0)           NOT NULL,
     PRCRNGNO            DECIMAL(3,0)           NOT NULL,
     LOCNO               DECIMAL(3,0)           NOT NULL,
     STRADATTODATE       DATE                   NOT NULL,
     BUYERNO             DECIMAL(3,0)           ,
     NO_LABEL            DECIMAL(5,0)           ,
     SELL_UNIT           DECIMAL(8,3)           NOT NULL,
     CONT_TYPE           CHAR(2)                ,
     OS_ID               DECIMAL(2,0)           ,
     TAXNO               DECIMAL(3,0)           NOT NULL,
     WGRNO               DECIMAL(5,0)           NOT NULL,
     STRADATFROMDAT      DATE                   NOT NULL,
     TOV_WGR             DECIMAL(2,0)           ,
     OSUNIT              DECIMAL(8,3)           ,
  PRIMARY KEY
    (BASARTNO,
     GRPNO,
     COMPNO,
     PRCRNGNO,
     LOCNO,
     STRADATTODATE)) IN SJ390DB1.SJDB1TS7;
CREATE UNIQUE INDEX STRARTDATIX ON STRARTDAT
    (BASARTNO            ASC,
     GRPNO               ASC,
     COMPNO              ASC,
     PRCRNGNO            ASC,
     LOCNO               ASC,
     STRADATTODATE       ASC)
    CLUSTER
    USING STOGROUP SJDB1SG1
      PRIQTY 10240
      SECQTY 5120 ;
CREATE INDEX STD_IND1 ON STRARTDAT
    (WGRNO               ASC,
     BASARTNO            ASC,
     GRPNO               ASC,
     COMPNO              ASC,
     PRCRNGNO            ASC,
     LOCNO               ASC,
     STRADATTODATE       ASC  )
    USING STOGROUP SJDB1SG1
      PRIQTY 10240
      SECQTY 5120 ;
```

```
COMMENT ON TABLE STRARTDAT IS
'ARTICLE STRUCTURE DATA' ;
ALTER TABLE STRARTDAT
  FOREIGN KEY DESCRIB_
    (BASARTNO,
     GRPNO,
     COMPNO,
     PRCRNGNO,
     LOCNO    )
    REFERENCES STRUCART ;
```

STRUCART

```
CREATE TABLE STRUCART
    (BASARTNO            DECIMAL(13,0)          NOT NULL,
     GRPNO               DECIMAL(3,0)           NOT NULL,
     COMPNO              DECIMAL(3,0)           NOT NULL,
     PRCRNGNO            DECIMAL(3,0)           NOT NULL,
     LOCNO               DECIMAL(3,0)           NOT NULL,
     DEL_MARK            CHAR(1)                ,
     CREATE_DATE         DATE                   ,
     DELETE_DATE         DATE                   ,
  PRIMARY KEY
    (BASARTNO,
     GRPNO,
     COMPNO,
     PRCRNGNO,
     LOCNO)) IN SJ390DB1.SJDB1TS8;
CREATE UNIQUE INDEX STRUCARTIX ON STRUCART
    (BASARTNO       ASC,
     GRPNO          ASC,
     COMPNO         ASC,
     PRCRNGNO       ASC,
     LOCNO          ASC)
    CLUSTER
    USING STOGROUP SJDB1SG1
      PRIQTY 10240
      SECQTY 5120 ;
ALTER TABLE STRUCART
  FOREIGN KEY REFERS__
    (BASARTNO)
    REFERENCES BASART ;
ALTER TABLE STRUCART
  FOREIGN KEY BELONGS_
    (GRPNO,
     COMPNO,
     PRCRNGNO,
     LOCNO    )
```

```
    REFERENCES ORGSTRUC ;
```

SELLDAY003

```
CREATE TABLE SELLDAY003
    (DATE               DATE                  NOT NULL,
     BASARTNO           DECIMAL(13,0)         NOT NULL,
     LOCATION           DECIMAL(4,0)          NOT NULL,
     COMPANY            DECIMAL(3,0)          NOT NULL,
     DEPTNO             DECIMAL(3,0)          NOT NULL,
     PIECES             DECIMAL(7,0)          NOT NULL,
     IN_PRC             DECIMAL(11,2)         NOT NULL,
     OUT_PRC            DECIMAL(11,2)         NOT NULL,
     TAX                DECIMAL(11,2)         NOT NULL,
     NO_CUST            DECIMAL(7,0)          NOT NULL,
     WGRNO              DECIMAL(5,0)          NOT NULL,
     SUPPLNO            DECIMAL(7,0)          NOT NULL,
     TRANSFER_DATE      TIMESTAMP             NOT NULL,
     PROCESS_DATE       TIMESTAMP             NOT NULL)
  IN SJ390DB1.SJDB1TS9;
CREATE INDEX ID_LOCATION03 ON SELLDAY003
    (LOCATION           ASC,
     BASARTNO           ASC  )
    USING STOGROUP SJDB1SG1
      PRIQTY 20480
      SECQTY 5120 ;
COMMENT ON TABLE SELLDAY003 IS
'DAILY SELLINGS COMPANY 003' ;
```

A.4.3 VSAM Definitions

A.4.3.1 Create User Catalog for VSAM Files

```
//DSNTCAT EXEC PGM=IDCAMS
//SYSPRINT DD  SYSOUT=*
//SYSUDUMP DD  SYSOUT=*
//CAT      DD  UNIT=3390,DISP=OLD,VOL=SER=TOTCAT
//SYSIN    DD  *
   DEFINE UCAT                                -
         ( NAME(CATALOG.SW5106R.VTOTCAT)      -
           FILE(CAT)                          -
           CYLINDERS(2 1)                     -
           VOL(TOTCAT)                        -
           ICFCATALOG   )                     -
      DATA                                    -
         ( CYLINDERS (1 1)    )               -
      INDEX                                   -
         ( CYLINDERS (1 1)    )
```

```
   DEFINE ALIAS                              -
         ( NAME(SJVSAM)                      -
           RELATE(CATALOG.SW5106R.VTOTCAT))
```

A.4.3.2 Allocate VSAM File

```
//STP98   EXEC PGM=IDCAMS
//SYSPRINT  DD SYSOUT=*
//SYSABEND  DD SYSOUT=*
//SYSIN     DD *
   DEFINE      CLUSTER (NAME(SJVSAM.SDAT03)                    -
                        IMBED                                   -
                        FSPC(37 4)                              -
                        INDEXED                                 -
                        KEYS (13 1)                             -
                        SHR (2 3) )                             -
               DATA (CISZ(2048)                                 -
                     RECSZ (636 636)                            -
                     NAME (SJVSAM.SDAT03.DATA)                  -
                     CYL(1070 100)                              -
                     VOLUMES (TOTDB9) )                         -
               INDEX (CISZ(3584)                                -
                      NAME (SJVSAM.SDAT03.INDEX)                -
                      TRK(25 20)                                -
                      VOLUMES (TOTDB9) )                        -
               CATALOG (SJVSAM)
//*
```

A.4.3.3 Reload VSAM File

```
//ROADVSM EXEC PGM=IDCAMS
//SYSPRINT  DD SYSOUT=*
//SYSABEND  DD SYSOUT=*
//SOURCE    DD DSN=DSF$EXP,LABEL=(,SL),
//          UNIT=(B3F,,DEFER),DISP=OLD,VOL=SER=BB1112
//SYSIN     DD *
     IMPORT -
          INFILE(SOURCE)                    -
          OUTDATASET(SJVSAM.SDAT03)         -
          INTOEMPTY                         -
          OBJECTS( -
                (STAMM.DATEI03 -
                   NEWNAME(SJVSAM.SDAT03) -
                   VOLUMES(TOTDB9) ) -
                 ) -
          CATALOG(SJVSAM)
//*
```

A.4.4 Classic Connect Definitions

A.4.4.1 Data Server Configuration File

The sample configuration file is provided from djxhlq.SDJXCONF(DJXDSCF). 'djxhlq' is a high level qualifier for DataJoiner Classic Connect.

```
************************************************************************
***                                                                  ***
***            CLASSIC CONNECT DATA SERVER CONFIGURATION             ***
***            (DJXDSCF)                                             ***
***                                                                  ***
***            THIS FILE CONTAINS CONFIGURATION DATA REQUIRED        ***
***            FOR THE OPERATION OF THE CLASSIC CONNECT DATA         ***
***            SERVER ON MVS.                                        ***
***                                                                  ***
***            THE FILE IS ORGANIZED AS A SERIES OF ENTRIES EACH     ***
***            OF WHICH CONSISTS OF A KEYWORD AND VALUE PAIR         ***
***            SEPARATED BY A REQUIRED "=" SIGN.  ORDER OF THE       ***
***            ENTRIES IS NOT IMPORTANT, EXCEPT WHERE NOTED.         ***
***            MAXIMUM LENGTH OF AN ENTRY IS 80 CHARACTERS PER       ***
***            LINE, WITH A MAXIMUM PARAMETER LENGTH OF 255          ***
***            CHARACTERS, SPANNED BY THE BACKSLASH CONTINUATION     ***
***            CHARACTER -                                           ***
***                                                                  ***
***            NOTE: WHEN EDITING CONFIGURATION MEMBERS ENSURE THAT ***
***            "NUM OFF" IS SPECIFIED. IF THE CONFIGURATION          ***
***            CONTAINS SEQUENCE NUMBER, UNKNOWN CONFIGURATION       ***
***            PARAMETERS, OR INVALID SUB-PARAMETER VALUES THE       ***
***            DATA SERVER WILL NOT RUN.                             ***
***                                                                  ***
***            PLEASE REFER TO CLASSIC CONNECT DOCUMENTATION FOR     ***
***            ADDITIONAL INFORMATION ON SPECIFIC PARAMETERS.        ***
***                                                                  ***
************************************************************************
*
* THE FOLLOWING 2 SERVICE INFO ENTRIES ARE REQUIRED SERVICES
SERVICE INFO ENTRY = DJXCNTL CNTL 0 1 1 100 4 5M 5M NO_DATA
SERVICE INFO ENTRY = DJXLOG LOGGER 1 1 1 100 4 5M 5M NO_DATA
*
************************************************************
*
* QUERY PROCESSOR SERVICE INFO ENTRY
*   THE LAST SUBPARAMETER POINTS TO A QP SERVICE CONFIGURATION FILE
 SERVICE INFO ENTRY = DJXQP DJXSAMP 2 1 2 50 4 5M 5M DJXQPCF
 SERVICE INFO ENTRY = DJXQP MVSCC   2 1 2 100 4 5M 5M DJXQPCF
*
************************************************************
```

```
*
* ALL IMS INTERFACE SIE'S MUST BE PLACED IN THE CONFIGURATION FILE
*   ABOVE XM CONNECTION HANDLER SIE.  IMS INITIALIZATION FAILURE
*   MAY OCCUR IF NOT.
*
* IMS DBB/BMP INTERFACE SERVICE INFO ENTRY
*SERVICE INFO ENTRY = DJXIMSIF IMS  2 0 1 1 4 5M 5M NO_DATA
*
* IMS DRA INTERFACE SERVICE INFO ENTRY
*   REFER TO CLASSIC CONNECT DOCUMENTATION FOR DETAILED
*   INFORMATION ON LAST SUBPARAMETER
*SERVICE INFO ENTRY = DJXDRA IMS  2 0 1 10 4 5M 5M SF,DRAUSER,DEFPSB
 SERVICE INFO ENTRY = DJXDRA IMS  2 1 1 10 4 5M 5M SJ,YOURID,PFIRDB
*
************************************************************
*
* XM CONNECTION HANDLER SERVICE INFO ENTRY
*   REFER TO CLASSIC CONNECT DOCUMENTATION FOR DETAILED
*   INFORMATION ON LAST SUBPARAMETER
*SERVICE INFO ENTRY = DJXINIT XMNT 2 0 1 100 4 5M 5M XM1/DJX/DJX
*
* TCP/IP CONNECTION HANDLER SERVICE INFO ENTRY
*   REFER TO CLASSIC CONNECT DOCUMENTATION FOR DETAILED
*   INFORMATION ON LAST SUBPARAMETER
*SERVICE INFO ENTRY = DJXINIT TCPIP 2 0 1 100 4 5M 5M
*TCP/111.111.111.111/SOCKET#
SERVICE INFO ENTRY = DJXINIT TCPIP 2 1 1 100 4 5M 5M
 TCP/9.12.14.223/3500
*
*  TCP/IP SYSTEM FILE HIGH LEVEL QUALIFIER AND SUBSYSTEM NAME
*TASK PARAMETERS = =TCPIP_PREFIX=HLQUAL =TCPIP_MACH=TCPIP
 TASK PARAMETERS = =TCPIP_PREFIX=TCPIPMVS.SC53 =TCPIP_MACH=TCPIPMVS
*
* SNA CONNECTION HANDLER SERVICE INFO ENTRY
*   REFER TO CLASSIC CONNECT DOCUMENTATION FOR DETAILED
*   INFORMATION ON LAST SUBPARAMETER
*SERVICE INFO ENTRY = DJXINIT LU62 2 0 1 100 4 5M 5M
*       VIM//SERVERLU//DJXTP
************************************************************
*
* WLM USER EXIT INTERFACE INITIALIZATION SERVICE INFO ENTRY
*SERVICE INFO ENTRY = DJXWLM WLM01 2 1 1 1 4 5M 5M
*       DJXSX06 SUBSYS=JES SUBSYSNM=DJX01
*
* THE FOLLOWING PARAMETER ACTIVATES THE SAF (SECURITY) SYSTEM EXIT
*SAF EXIT = DJXSX04 IMS CLASS=PIMS
*
```

```
* THE FOLLOWING PARAMETER ACTIVATES THE SMF (REPORTING) SYSTEM EXIT
*SMF EXIT = DJXSX02 RECTYPE=255,SYSID=JES2
*
************************************************************
*
*  MISC REQUIRED PARAMETERS
*
MESSAGE POOL SIZE = 16777216
*
NL = US ENGLISH
NL CAT = DD:ENGCAT
*
* IF YOU ARE NOT ALLOWING UPDATES TO THE CATALOG FILES WHILE
* ANY DATA SERVERS ARE ACCESSING THE CATALOG FILES, CHANGE THE
* VALUE TO A ONE.  THE CATALOG FILES WILL ONLY BE OPENED DURING
* QP INITIALIZATION RATHER THAN DURING EACH QUERY OPEN CURSOR
*
STATIC CATALOGS = 0
```

A.4.4.2 Data Server Started JCL for DRA

The sample configuration file is provided from djxhlq.SDJXSAMP(DJXDRA).

```
//DJXDRA   JOB (999,POK),'INSTALL',NOTIFY=&SYSUID,
//    CLASS=A,MSGCLASS=T,TIME=1439,
//    REGION=2M,MSGLEVEL=(1,1)
//*   DJXDRA   PROVIDE VALID JOB CARD
//*********************************************************************
//*                                                                   *
//*    LICENSED MATERIALS                                             *
//*    5655-A41                                                       *
//*      (C) COPYRIGHT CROSS ACCESS CORPORATION                       *
//*          1993,1998 ALL RIGHTS RESERVED.                           *
//*    US GOVERNMENT USERS RESTRICTED RIGHTS -                        *
//*    USE, DUPLICATION OR DISCLOSURE RESTRICTED.                     *
//*                                                                   *
//*********************************************************************
//*                                                                   *
//*   DJXDRA                                                          *
//*   SAMPLE DATA SERVER JCL                                          *
//*       IMS DATA ACCESS USING THE DRA INTERFACE                     *
//*                                                                   *
//*     1) IF THIS DATA SERVER IS TO BE RUN AS A BATCH JOB:           *
//*          PROVIDE A JOB CARD THAT IS VALID FOR YOUR SITE.          *
//*                                                                   *
//*        IF THIS DATA SERVER IS TO BE RUN AS A BATCH JOB THAT WILL  *
//*          BE AUTOMATICALLY DISPATCHED BY AN ENTERPRISE SERVER:     *
//*          ENSURE THAT THE JOBNAME IS 6 OR LESS CHARACTERS LONG,    *
```

```
//*          AND IS SUFFIXED BY &DJXJSFX AS IN THE FOLLOWING EXAMPLE:*
//*  //JOBNAM&DJXJSFX JOB (ACCT),ABCDEF,CLASS=A.........              *
//*           (THE ENTERPRISE SERVER REPLACES &DJXJSFX WITH A        *
//*            TWO DIGIT NUMBER TO ENSURE A UNIQUE JOBNAME.)         *
//*                                                                  *
//*        IF THIS DATA SERVER IS TO BE RUN AS A STARTED TASK,       *
//*          REMOVE THE PEND AND EXEC STATEMENTS FROM THE END OF     *
//*          THIS MEMBER.                                            *
//*                                                                  *
//*     2) IF THIS DATA SERVER IS GOING TO BE STARTED MANUALLY AND   *
//*          NOT AUTOMATICALLY DISPATCHED BY AN ENTERPRISE SERVER,   *
//*          CHANGE PARM1 PARM TO NULL AS IN THE FOLLOWING EXAMPLE:  *
//*  //DJXDBB  PROC PARM1='',     .....                               *
//*                                                                  *
//*     3) CHANGE DJX PARM TO CLASSIC CONNECT HIGH LEVEL QUALIFIER   *
//*     4) CHANGE CRUN PARM TO THE NETVIEW C RUNTIME LIBRARY HLQ     *
//*     5) CHANGE CONFIG PARM TO THE APPROPRIATE CONFIG MEMBER       *
//*     6) SEE NOTE REGARDING RGN PARAMETER                          *
//*     7) PROVIDE APPROPRIATE DATASET NAMES IN THE DJXCAT AND       *
//*        DJXINDX DD STATEMENTS.  THIS DATA SERVER CAN ONLY PROCESS *
//*        QUERIES AGAINST TABLES DEFINED IN THE META DATA CATALOG   *
//*        FILES REFERENCED BY THESE TWO DD STATEMENTS.              *
//*     8) IF ACCESSING TABLE(S) THAT WERE DEFINED USING DD NAME     *
//*        REFERENCE(S) AS OPPOSED TO DATASET NAME REFERENCE(S), THE *
//*        APPROPRIATE DD STATEMENT(S) MUST ALSO BE INCLUDED.  IF    *
//*        ALL TABLES SERVICED BY THIS DATA SERVER WERE DEFINED WITH *
//*        DATASET NAME REFERENCES, NO DD STATEMENTS NEED TO BE      *
//*        INCLUDED (DYNAMIC FILE ALLOCATION IS USED).               *
//*                                                                  *
//********************************************************************
//DJXDRA  PROC PARM1='&DJXPRM1',       COMM PARM FROM ENTERPRISE SERVER
//             DJX='DJX',              CLASSIC CONNECT HLQ
//             CRUN='RUNTIMEC.V1R2M0', NETVIEW C RUNTIME LIB HLQ
//             SOUT='*',               SYSOUT CLASS
//             CONFIG=DJXDSCF,         DATA SERVER CONFIG FILE
//             IMS=IMS610D,            IMS SYSTEM DATASET HLQ
//             RGN=0M                  REGION SIZE
//********************************************************************
//*   IF YOUR SITE LIMITS THE AMOUNT OF MEMORY ALLOCATED TO A REGION *
//*   WHEN ZERO MEG IS SPECIFIED, YOU NEED TO ENSURE THAT            *
//*   A LARGE ENOUGH REGION IS ACTUALLY ALLOCATED.                   *
//*   THE REGION SIZE MUST BE COORDINATED WITH THE MESSAGE POOL SIZE *
//*   PARAMETER.  THE RECOMMENDATION IS TO SET THE REGION SIZE       *
//*   TWO MEG GREATER THAN THE MESSAGE POOL SIZE.  REFER TO          *
//*   THE OPTIMIZATION CHAPTER OF THE CLASSIC CONNECT MVS GUIDE.     *
//********************************************************************
//DJXPROC EXEC PGM=DJXCNTL,TIME=240,REGION=&RGN,
```

```
//  PARM='&PARM1 '
//STEPLIB  DD DISP=SHR,DSN=&DJX..V2R1M01.SDJXLOAD
//         DD DISP=SHR,DSN=&IMS..RESLIB
//VHSCONF  DD DISP=SHR,DSN=&DJX..V2R1M01.SDJXCONF(&CONFIG)
//DJXCAT   DD DISP=SHR,DSN=&DJX..V2R1M01.SYSIBM.CATALOG
//DJXINDX  DD DISP=SHR,DSN=&DJX..V2R1M01.SYSIBM.CATINDX
//*
//CTRANS   DD DISP=SHR,DSN=&CRUN..SCNMCRUN
//*
//FILSTAM  DD DISP=SHR,DSN=SJVSAM.SDAT03
//LIFSTAM  DD DISP=SHR,DSN=SJVSAM.SDAT03
//*
//SYSTERM  DD SYSOUT=&SOUT
//SYSPRINT DD SYSOUT=&SOUT
//*
//DJXLOG   DD DISP=(NEW,PASS,KEEP),DSN=&&LOG,
//   UNIT=SYSDA,SPACE=(TRK,(30,10))
//*****************************************************************
//*  PRINT LOG SUMMARY REPORT                                     *
//*                                                               *
//*  CHANGE SYSIN DD TO POINT AT FILTERING MEMBER IF DESIRED      *
//*    EXAMPLE IN SDJXSAMP MEMBER DJXLGFLT                        *
//*                                                               *
//*****************************************************************
//LOGSUM   EXEC PGM=DJXPRTLG,PARM='SUMMARY=Y',COND=EVEN
//STEPLIB  DD  DISP=SHR,DSN=&DJX..V2R1M01.SDJXLOAD
//VHSCONF  DD  DISP=SHR,DSN=&DJX..V2R1M01.SDJXCONF(&CONFIG)
//ENGCAT   DD  DISP=SHR,DSN=&DJX..V2R1M01.SDJXMENU
//CTRANS   DD  DISP=SHR,DSN=&CRUN..SCNMCRUN
//DJXLOG   DD  DISP=(OLD,PASS),DSN=&&LOG
//SYSTERM  DD  SYSOUT=&SOUT
//SYSPRINT DD  SYSOUT=&SOUT
//SYSIN    DD  DUMMY
//*****************************************************************
//*  PRINT LOG DETAIL REPORT                                      *
//*                                                               *
//*  CHANGE SYSIN DD TO POINT AT FILTERING MEMBER IF DESIRED      *
//*    EXAMPLE IN SDJXSAMP MEMBER DJXLGFLT                        *
//*                                                               *
//*****************************************************************
//LOGPRINT EXEC PGM=DJXPRTLG,PARM='SUMMARY=N',COND=EVEN
//STEPLIB  DD  DISP=SHR,DSN=&DJX..V2R1M01.SDJXLOAD
//VHSCONF  DD  DISP=SHR,DSN=&DJX..V2R1M01.SDJXCONF(&CONFIG)
//ENGCAT   DD  DISP=SHR,DSN=&DJX..V2R1M01.SDJXMENU
//CTRANS   DD  DISP=SHR,DSN=&CRUN..SCNMCRUN
//DJXLOG   DD  DISP=(OLD,DELETE),DSN=&&LOG
//SYSTERM  DD  SYSOUT=&SOUT
```

```
//SYSPRINT DD  SYSOUT=&SOUT
//SYSIN    DD  DUMMY
//    PEND
//RUNDJX   EXEC DJXDRA
```

A.4.4.3 Meta Data Utility

This sample JCL is provided in a djxhlq.SDJXSAMP(DJXMETAU).

```
//DJXMETAU JOB (999,POK),'INSTALL',NOTIFY=&SYSUID,
//    CLASS=A,MSGCLASS=T,TIME=1439,
//    REGION=5000K,MSGLEVEL=(1,1)
//*********************************************************************
//*                                                                   *
//*    LICENSED MATERIALS                                             *
//*    5655-B73                                                       *
//*      (C) COPYRIGHT CROSS ACCESS CORPORATION                       *
//*          1993,1998 ALL RIGHTS RESERVED.                           *
//*    US GOVERNMENT USERS RESTRICTED RIGHTS -                        *
//*    USE, DUPLICATION OR DISCLOSURE RESTRICTED.                     *
//*                                                                   *
//*********************************************************************
//*                                                                   *
//*   DJXMETAU                                                        *
//*   SAMPLE META DATA UTILITY JCL                                    *
//*                                                                   *
//*   THIS UTILITY GENERATES THE META DATA CATLALOG FILES, DJXCAT     *
//*   AND DJXINDX, USING META DATA GRAMMAR AS INPUT.                  *
//*                                                                   *
//*   THIS JOB CONTAINS TWO IN-STREAM PROCEDURES, ALLOC AND METAUTL.  *
//*   THE FIRST ALLOCATES A SET OF CATALOG FILES AND IS COMMENTED     *
//*   OUT.  UNCOMMENT THIS STEP AND CHANGE THE FOLLOWING PARMS        *
//*   IF YOU NEED TO ALLOCATE A NEW SET OF CATALOG FILES.             *
//*                                                                   *
//*     1) CHANGE DJX PARM TO CLASSIC CONNECT HIGH LEVEL QUALIFIER.   *
//*     2) CHANGE DISKU PARM TO A DASD UNIT NAME THAT IS VALID AT     *
//*        YOUR SITE.                                                 *
//*     3) CHANGE DISKVOL PARM TO A DASD VOLSER THAT IS VALID AT      *
//*        YOUR SITE.                                                 *
//*                                                                   *
//*********************************************************************
//*
//*ALLOC   PROC DJX='DJX211',            CLASSIC CONNECT HLQ
//*             DISKU=SYSDA,             DASD UNIT
//*             DISKVOL=PERM01           DASD VOLSER
//*ALLOC    EXEC PGM=IEFBR14
//*DJXCAT   DD  UNIT=&DISKU,VOL=SER=&DISKVOL,
//*             DSN=&DJX..SYSIBM.CATALOG,
```

```
//*             SPACE=(CYL,(1,1)),
//*             DCB=(RECFM=FBS,LRECL=80,BLKSIZE=6080),
//*             DISP=(NEW,CATLG,DELETE)
//*DJXINDX  DD  UNIT=&DISKU,VOL=SER=&DISKVOL,
//*             DSN=&DJX..SYSIBM.CATINDX,
//*             SPACE=(CYL,(1,1)),
//*             DCB=(RECFM=FBS,LRECL=80,BLKSIZE=6080),
//*             DISP=(NEW,CATLG,DELETE)
//*         PEND
//*ALLOCATE EXEC ALLOC
//*
//*********************************************************************
//*                                                                   *
//*     THE SECOND INSTREAM PROC INVOKES THE META DATA UTILITY.       *
//*     IT READS IN META DATA GRAMMAR FROM SYSIN AND POPULATES THE    *
//*     CATALOG FILES POINTED AT BY THE DJXCAT AND DJXINDX DD         *
//*     STATEMENTS.                                                   *
//*                                                                   *
//*     1) CHANGE DJX PARM TO CLASSIC CONNECT HIGH LEVEL QUALIFIER    *
//*     2) CHANGE THE IMS PARM TO THE IMS SYSTEM HLQ,                 *
//*        COMMENT IMS PARM OUT IF NOT DEFINING IMS TABLES.           *
//*     3) CHANGE CRUN PARM TO THE NETVIEW C RUNTIME LIBRARY HLQ      *
//*     4) CHANGE THE GRAMMAR PARM TO THE MEMBER THAT CONTAINS THE    *
//*        META DATA TO BE PROCESSED                                  *
//*     5) COMMENT OUT THE DBDLIB DD IF NOT DEFINING IMS TABLES.      *
//*     6) COMMENT OUT THE DJXIVP DD IF NOT DEFINING VSAM IVP TABLE   *
//*     7) ADD DD STATEMENTS FOR ANY VSAM TABLES THAT YOU ARE         *
//*        DEFINING WITH THE DD CLAUSE                                *
//*     8) CHANGE DATASET NAMES IN DJXCAT AND DJXINDX DD STATEMENTS   *
//*        IF NECESSARY                                               *
//*                                                                   *
//*********************************************************************
//METAUTL PROC DJX='DJX.V2R1M01',       CLASSIC CONNECT HLQ
//            IMS='IMS610D',            IMS HIGH-LEVEL QUALIFER
//            CRUN='RUNTIMEC.V1R2M0', C RUNTIME LIB HLQ
//            GRAMMAR=DI21PART          META DATA GRAMMAR MEMBER NAME
//*           GRAMMAR=DJXIVGIM          META DATA GRAMMAR MEMBER NAME
//*           GRAMMAR=DJXIVGVS          META DATA GRAMMAR MEMBER NAME
//*
//*   SUPPLIED IVP META DATA GRAMMAR MEMBER NAMES
//*           GRAMMAR='DJXIVGVS'         VSAM IVP GRAMMAR
//*           GRAMMAR='DJXIVGIM'         IMS IVP GRAMMAR
//*
//*******************************************************************
//METAU   EXEC PGM=DJXMETA
//STEPLIB  DD  DISP=SHR,DSN=&DJX..SDJXLOAD
//CTRANS   DD  DISP=SHR,DSN=&CRUN..SCNMCRUN
```

```
//DBDLIB   DD  DISP=SHR,DSN=&DJX..IVP.DBDLIB
//         DD  DISP=SHR,DSN=IMS.SJIMSC.DBDLIB
//         DD  DISP=SHR,DSN=&IMS..DBDLIB
//DJXIVP   DD  DISP=SHR,DSN=&DJX..IVP.EMPDATA
//DJXCAT   DD  DISP=SHR,DSN=&DJX..SYSIBM.CATALOG,
//             DCB=RECFM=FBS
//DJXINDX  DD  DISP=SHR,DSN=&DJX..SYSIBM.CATINDX,
//             DCB=RECFM=FBS
//SYSTERM  DD  SYSOUT=*
//SYSPRINT DD  SYSOUT=*
//SYSIN    DD  DISP=SHR,DSN=&DJX..SDJXSAMP(&GRAMMAR)
//        PEND
//METAUTL EXEC METAUTL
```

A.5 Hints and Tips

A.5.1 TCP/IP for MVS Environment Setup

Make sure to pick up the free port number to use for Classic Connect. It must not be the same number of port already defined in hlq.PROFILE.TCPIP.

A.5.2 IMS Environment Setup

The DBCTL region is required if you want to be enable the DRA for use by Classic Connect to access IMS resources.

All PSB and DBD must be specified in Stage 1 and Stage 2.

Copy all of the MODBLKS modules to the current active library after Stage 1 and Stage 2 generation.

Copy the all of ACBLIB modules to the current active library after the ACBGEN.

A.5.3 Classic Connect Setup (for Data Server)

All PSB and DBD modules must be in the APF library if you want to use the BMP/DBB interface.

Set TASK PARAMETERS correctly. TCPIP_PREFIX is the TCP/IP high-level qualifier (hlq). TCP_MACH is specified in the hlq.TCPIP.DATA file under the parameter TCPIPJOBNAME.

The CCTLDD dd statement must not be placed in the Data Server JCL. You will get the error "DRA: Initialization PAPLRETC=12(x0c)", which is a dynamic allocation error of DRA RESLIB.

A.5.4 Classic Connect Setup (for Client)

Make sure to install the necessary components in the AIX client. (At this moment, the Classic Connect data access module is available only in the AIX platform.) For TCP/IP protocol, "djx_02_01_01.cs.DRDA" is necessary to install.

Set PROTOCOL to "djxclassic2" when creating a server mapping. This information is provided in the manual *DB2 DataJoiner Classic Connect Installation, Configuration, and Reference Version 2 Release 1 Modification 1, SC26-9319*.

Important: Do *not* refer to the manual *DB2 DataJoiner Application Programming and SQL Reference Supplement Version 2 Release 1 Modification 1*, SC26-9148. This manual describes the *old* version of Classic Connect.

Appendix B. Special Notices

This publication is intended to provide guidance for various types of users, especially system programmers and database administrators, in understanding the Data Warehouse and Business Intelligence environments.

See the PUBLICATIONS section of the IBM Programming Announcement for the DB2 family of products, including DataJoiner, DataJoiner Classic Connect, Visual Warehouse, and DB2 OLAP, for more information about what publications are considered to be product documentation.

References in this publication to IBM products, programs or services do not imply that IBM intends to make these available in all countries in which IBM operates. Any reference to an IBM product, program, or service is not intended to state or imply that only IBM's product, program, or service may be used. Any functionally equivalent program that does not infringe any of IBM's intellectual property rights may be used instead of the IBM product, program or service.

Information in this book was developed in conjunction with use of the equipment specified, and is limited in application to those specific hardware and software products and levels.

IBM may have patents or pending patent applications covering subject matter in this document. The furnishing of this document does not give you any license to these patents. You can send license inquiries, in writing, to the IBM Director of Licensing, IBM Corporation, North Castle Drive, Armonk, NY 10504-1785.

Licensees of this program who wish to have information about it for the purpose of enabling: (i) the exchange of information between independently created programs and other programs (including this one) and (ii) the mutual use of the information which has been exchanged, should contact IBM Corporation, Dept. 600A, Mail Drop 1329, Somers, NY 10589 USA.

Such information may be available, subject to appropriate terms and conditions, including in some cases, payment of a fee.

The information contained in this document has not been submitted to any formal IBM test and is distributed AS IS. The information about non-IBM ("vendor") products in this manual has been supplied by the vendor and IBM assumes no responsibility for its accuracy or completeness. The use of this information or the implementation of any of these techniques is a customer responsibility and depends on the customer's ability to evaluate and integrate

them into the customer's operational environment. While each item may have been reviewed by IBM for accuracy in a specific situation, there is no guarantee that the same or similar results will be obtained elsewhere. Customers attempting to adapt these techniques to their own environments do so at their own risk.

Any pointers in this publication to external Web sites are provided for convenience only and do not in any manner serve as an endorsement of these Web sites.

Any performance data contained in this document was determined in a controlled environment, and therefore, the results that may be obtained in other operating environments may vary significantly. Users of this document should verify the applicable data for their specific environment.

Reference to PTF numbers that have not been released through the normal distribution process does not imply general availability. The purpose of including these reference numbers is to alert IBM customers to specific information relative to the implementation of the PTF when it becomes available to each customer according to the normal IBM PTF distribution process.

The following terms are trademarks of the International Business Machines Corporation in the United States and/or other countries: :

AS/400	CICS
DATABASE 2	DataGuide
DataPropagator	DB2
DFSMS	DFSMS/MVS
DFSORT	DRDA
ESCON	Hiperspace
IBM	IBMLink
IMS	Information Warehouse
Intelligent Miner	MVS
MVS/ESA	Net.Data
OS/2	OS/390
Parallel Sysplex	QMF
RACF	RAMAC
RS/6000	S/390
S/390 Parallel Enterprise Server	System/390
Visual Warehouse	VisualAge
VM/ESA	VSE/ESA
VTAM	DB2 OLAP Server
SQL/DS	ACF/VTAM
AIX	DataJoiner

The following terms are trademarks of other companies:

C-bus is a trademark of Corollary, Inc.

Java and HotJava are trademarks of Sun Microsystems, Incorporated.

Microsoft, Windows, Windows NT, and the Windows 95 logo are trademarks or registered trademarks of Microsoft Corporation.

PC Direct is a trademark of Ziff Communications Company and is used by IBM Corporation under license.

Pentium, MMX, ProShare, LANDesk, and ActionMedia are trademarks or registered trademarks of Intel Corporation in the U.S. and other countries.

UNIX is a registered trademark in the United States and other countries licensed exclusively through X/Open Company Limited.

SET and the SET logo are trademarks owned by SET Secure Electronic Transaction LLC.

Other company, product, and service names may be trademarks or service marks of others.

Appendix C. Related Publications

The publications listed in this section are considered particularly suitable for a more detailed discussion of the topics covered in this redbook.

C.1 International Technical Support Organization Publications

For information on ordering these ITSO publications see “We accept American Express, Diners, Eurocard, Master Card, and Visa. Payment by credit card not available in all countries. Signature mandatory for credit card payment.” on page 234.

- *Intelligent Miner for Data: Enhance Your Business Intelligence*, SG24-5422
- *My Mother Thinks I'm a DBA! Cross-Platform, Multi-Vendor, Distributed Relational Data Replication with IBM DB2 DataPropagator and IBM DataJoiner Made Easy!,* SG24-5463
- *Connecting IMS to the World Wide Web A Practical Guide to IMS Connectivity*, SG24-2220
- *From Multiplatform Operational Data to Data Warehousing and Business Intelligence*, SG24-5174
- *WOW! DRDA Supports TCP/IP: DB2 Server for OS/390 and DB2 Universal Database*, SG24-2212
- *Managing Multidimensional Data Marts with Visual Warehouse and DB2 OLAP Server*, SG24-5270
- *Intelligent Miner for Data Applications Guide*, SG24-5252
- *Mining Relational and Nonrelational Data with IBM Intelligent Miner for Data Using Oracle, SPSS, and SAS as Sample Data Sources*, SG24-5278
- *Distributed Relational Database, Cross-Platform Connectivity and Applications*, SG24-4311
- *Data Modeling Techniques for Data Warehousing*, SG24-2238

C.2 Redbooks on CD-ROMs

Redbooks are also available on the following CD-ROMs. Click the CD-ROMs button at `http://www.redbooks.ibm.com/` for information about all the CD-ROMs offered, updates and formats.

CD-ROM Title	Collection Kit Number
System/390 Redbooks Collection	SK2T-2177
Networking and Systems Management Redbooks Collection	SK2T-6022
Transaction Processing and Data Management Redbooks Collection	SK2T-8038
Lotus Redbooks Collection	SK2T-8039
Tivoli Redbooks Collection	SK2T-8044
AS/400 Redbooks Collection	SK2T-2849
Netfinity Hardware and Software Redbooks Collection	SK2T-8046
RS/6000 Redbooks Collection (BkMgr)	SK2T-8040
RS/6000 Redbooks Collection (PDF Format)	SK2T-8043
Application Development Redbooks Collection	SK2T-8037
IBM Enterprise Storage and Systems Management Solutions	SK3T-3694

C.3 Other Publications

These publications are also relevant as further information sources:

- *DB2 DataJoiner Classic Connect Installation, Configuration, and Reference Guide*, SC26-9319
- *DB2 DataJoiner Classsic Connect Data Mapper Installation and User's Guide*, SC26-9318
- *DB2 DataJoiner Classic Connect Planning, Installation, and Configuration Guide,* GC26-8869
- *DB2 DataJoiner for AIX Systems Planning, Installation and Configuration Guide*, SC26-9145
- *DB2 DataJoiner Administration Supplement*, SC26-9146
- *DB2 DataJoiner Generic Access API*, SC26-9147
- *DB2 DataJoiner Application Programming and SQL Reference Supplement*, SC26-9148
- *DB2 DataJoiner Messages and Problem Determination Guide,* SC26-9149
- *IMS/ESA V6 Admin Guide: System*, SC26-8730
- *IMS/ESA V 6 Installation, Volume 2*, GC26-8737

- *IMS/ESA V6 DBRC Guide and Reference*, SC26-8733
- *DB2 Connect Enterprise Edition Quick Beginnings*, S10J-7888
- *IBM DB2 Universal Database Administration Guide*, S10J-8157
- *DB2 UDB System Monitor Guide and Reference*, S10J-8164
- *IBM DB2 Universal Database SQL Reference*, S10J-8165
- *IBM DB2 Universal Database Command Reference*, S10J-8166
- *IBM DB2 Universal Database API Reference*, S10J-8167

How to Get ITSO Redbooks

This section explains how both customers and IBM employees can find out about ITSO redbooks, redpieces, and CD-ROMs. A form for ordering books and CD-ROMs by fax or e-mail is also provided.

- **Redbooks Web Site** http://www.redbooks.ibm.com/

  Search for, view, download, or order hardcopy/CD-ROM redbooks from the redbooks Web site. Also read redpieces and download additional materials (code samples or diskette/CD-ROM images) from this redbooks site.

  Redpieces are redbooks in progress; not all redbooks become redpieces and sometimes just a few chapters will be published this way. The intent is to get the information out much quicker than the formal publishing process allows.

- **E-mail Orders**

  Send orders by e-mail including information from the redbooks fax order form to:

	e-mail address
In United States	usib6fpl@ibmmail.com
Outside North America	Contact information is in the “How to Order” section at this site: http://www.elink.ibmlink.ibm.com/pbl/pbl/

- **Telephone Orders**

United States (toll free)	1-800-879-2755
Canada (toll free)	1-800-IBM-4YOU
Outside North America	Country coordinator phone number is in the “How to Order” section at this site: http://www.elink.ibmlink.ibm.com/pbl/pbl/

- **Fax Orders**

United States (toll free)	1-800-445-9269
Canada	1-403-267-4455
Outside North America	Fax phone number is in the “How to Order” section at this site: http://www.elink.ibmlink.ibm.com/pbl/pbl/

This information was current at the time of publication, but is continually subject to change. The latest information may be found at the redbooks Web site.

IBM Intranet for Employees

IBM employees may register for information on workshops, residencies, and redbooks by accessing the IBM Intranet Web site at http://w3.itso.ibm.com/ and clicking the ITSO Mailing List button. Look in the Materials repository for workshops, presentations, papers, and Web pages developed and written by the ITSO technical professionals; click the Additional Materials button. Employees may access MyNews at http://w3.ibm.com/ for redbook, residency, and workshop announcements.

IBM Redbook Fax Order Form

Please send me the following:

Title	Order Number	Quantity

First name	Last name	
Company		
Address		
City	Postal code	Country
Telephone number	Telefax number	VAT number

☐ Invoice to customer number _____

☐ Credit card number _____

Credit card expiration date	Card issued to	Signature

We accept American Express, Diners, Eurocard, Master Card, and Visa. Payment by credit card not available in all countries. Signature mandatory for credit card payment.

List of Abbreviations

ACEE	access control environment element
ADK	application development toolkit
ANN	artificial neural network
ANSI	American National Standards Institute
APAR	authorized program analysis report
APPC	advanced program to program communication
API	application programming interface
AR	application requester
ARM	automatic restart manager
ASCII	American National Standard Code for Information Interchange
BV	Business View
CAE	client application enabler
CAF	call attachment facility
CBIPO	custom-build installation process offering
CBPDO	custom-build product delivery offering
CCSID	coded character set identifier
CFRM	coupling facility resource management
CLIST	command list
DAM	data access module
DARM	data archive retrieval manager
DASD	direct access storage device
DBMS	database management system
DBRM	database request module
DB2PM	DB2 performance monitor
DCE	Distributed Computing Environment
DCL	data control language
DDF	distributed data facility
DDL	data definition language
DES	Data Encryption Standard
DLL	dynamic link library
DML	data manipulation language
DMS	database managed storagespace
DPropR	dataPropagator Relational
DRDA	distributed relational database architecture
DUW	distributed unit of work
DW	data warehouse
DSS	decision support system
EIS	executive information system
ESO	expanded service option
ERP	enterprise resource planning

FTP	File Transfer Protocol
GBP	group buffer pool
GID	group ID
GUI	graphical user interface
GWAPI	Domino Go Web server application programming interface
HLQ	high level qualifier
H-OLAP	hybrid OLAP
HTML	hypertext markup language
IBM	International Business Machines Corporation
ICAPI	internet connection application programming interface
ICF	integrated coupling facility
IDS	intelligent decision support
IFI	instrumentation facility interface
IRLM	internal resource lock manager
ISO	International Organization for Standardization
I/O	input/output
IM	Intelligent Miner
IMS	Information Management System
IT	information technology
ITSO	International Technical Support Organization
JCL	job control language
JDBC	Java Database Connectivity
JDK	Java Developers Ki
JIT	just in time compiler
JRE	java runtime environment
JVM	Java Virtual Machine
LE	Language Environment
LIS	large item set
LOB	large object
LPP	licensed program product
LRO	linked reporting object
LRU	last recently used
MDIS	Metadata Interchange Specification
MLP	multilayer perceptron
M-OLAP	multidimensional OLAP
MPP	massive parallel processing
NCF	IBM Network Computing Framework
ODBC	open database connectivity
OEM	original equipment manufacturer
OLAP	online analytical processing
OLE	object linking and embedding
OLTP	online transaction processing
OMG	Object Management Group
OSA	open systems adapter
PSP	preventive service planning
RACF	OS/VS2 MVS Resource Access Control Facility
RAM	random access memory

RBA relative byte address

RBF radial basis function

RBFN radial basis function network

RDBMS relational database management system

ROI return on investment

R-OLAP relatiobal OLAP

RDS relational data system

RRS recoverable resource manager services

RRSAF recoverable resource manager services attachment facility

RUW remote unit of work

SCA shared communication area

SDSF system display and search facility

SMP symmetrical multiprocessor

SMP/E system modification program/enhanced

SMS storage management system

SNA systems network archtecture

SQL Structured query language

SQLDA SQL descriptor area

SWA scheduler work area

TCP/IP Transmission Control Protocol/Internet Protocol

UDA user defined attribute

UDB Univarsal Database

UDF user defined function

UDT user-defined type

URL Universal Resource Locator

VSAM Virtual Storage Access Method

VWP Visual Warehouse Program

XES MVS Cross-system extended services

XMI XML Metadata Interchange

XML extended markup language

Index

S

T

U

V

ITSO Redbook Evaluation

Getting Started with Data Warehouse and Business Intelligence
SG24-5415-00

Your feedback is very important to help us maintain the quality of ITSO redbooks. **Please complete this questionnaire and return it using one of the following methods:**

- Use the online evaluation form found at `http://www.redbooks.ibm.com/`
- Fax this form to: USA International Access Code + 1 914 432 8264
- Send your comments in an Internet note to `redbook@us.ibm.com`

Which of the following best describes you?
_ Customer _ Business Partner _ Solution Developer _ IBM employee
_ None of the above

Please rate your overall satisfaction with this book using the scale:
(1 = very good, 2 = good, 3 = average, 4 = poor, 5 = very poor)

Overall Satisfaction _____

Please answer the following questions:

Was this redbook published in time for your needs? Yes___ No___

If no, please explain:

What other redbooks would you like to see published?

Comments/Suggestions: (THANK YOU FOR YOUR FEEDBACK!)

SG24-5415-00
Printed in the U.S.A.

Getting Started with Data Warehouse and Business Intelligence

SG24-5415-00