In this chapter, you will be introduced to the DB2 Universal Database (DB2 UDB) family of products for UNIX and Intel platforms. DB2 has the ability to store all kinds of electronic information. This includes traditional relational data as well as structured and unstructured binary information, documents and text in many languages, graphics, images, multimedia (audio and video), information specific to operations like engineering drawings, maps, insurance claims forms, numerical control streams, or any type of electronic information. This chapter will illustrate some of the ways to access data in a DB2 database using some of the interfaces provided with the products. A description of each of the DB2 products will be provided to illustrate some of the features and functions.

The DB2 database is an important part of IBM’s e-business software portfolio. The e-business Application Framework provides an open blueprint on how to build e-business applications. Popular IBM e-business tools include Visual Age for Java for developing Java programs or components and Tivioli software for distributed systems management. As for application server software, IBM offers several types of servers depending on the business requirement, from Message Queuing (MQ) software to Java-based transaction processing with Websphere Application Server.
The most popular IBM software servers are its database servers, specifically the DB2 Family.

Fig. 1–1 *The e-business Application Framework*

The DB2 Family executes on pervasive devices, Intel, UNIX, AS/400, and mainframe platforms. Supported operating environments include: OS/2, Windows 95/98/2000/NT, Linux, AIX, HP-UX, Sun Solaris, NUMA-Q, OS/400, VSE/VM, and OS/390. The DB2 code base is optimized for each platform to ensure maximum performance. The SQL API is common to all platforms, which allows applications written on one platform to access data on any platform. Internally, the OS/400, VM/VSE, and OS/390 differ from DB2 on the UNIX and Intel platforms, but it is the common SQL API that enables applications to work together. The DB2 code base on Intel and UNIX platforms are identical.

DB2 V7.1 for UNIX, Linux, Windows, and OS/2, provides seamless database connectivity using the most popular network communications protocols, including NetBIOS, TCP/IP, IPX/SPX, Named Pipes, and APPC.
DB2 and e-business

As a core component of IBM’s e-business cycle, DB2 is a catalyst for delivering applications that transform a company’s operations. Transform is the process that takes a business to an e-business, common applications in this area include: electronic commerce, Enterprise Resource Planning (ERP), Customer Relationship Management (CRM), and Supply Chain Management (SCM). Build is the process of exploiting the integrated Java and multimedia features of DB2. Run is the part of the e-business cycle that ensures performance and scalability; this is especially important with the new Internet-based companies. Finally, with respect to leveraging the data assets, DB2 offers a variety of business intelligence tools to enable end-users makers to make more effective business decisions.

Fig. 1–2 The e-business cycle
In leveraging information in an e-business environment, IBM’s Enterprise Information Portal (EIP) provides a secure foundation for a single point of access to diverse information, business processes, and expertise. Today’s high demand for complete and correlated information requires portal access not only to structured transactional and warehouse data, but also to a broader range of content, including XML, HTML, host computer-generated output, images, and audio/video. The IBM Enterprise Information Portal offers access to business data from sources such as spreadsheets, document libraries, company literature, databases, data warehouses, and unstructured information from Web pages. The information can also be searched using parametric or contextual search technologies, with results aggregated across multiple sources and relevant information presented in a context tailored to the user’s needs.

Fig. 1–3 IBM’s Enterprise Information Portal
DB2 Universal Database

In the distributed environment, DB2 offers several packaging options:

- **Enterprise Edition** - This offering is often used to build e-business applications and to support large departmental applications. It offers the most connectivity options and can share data with third-party databases and DB2 on heterogeneous platforms.

- **Workgroup Edition** - This offering is often used for smaller departmental applications or for applications that do not need access to remote databases on the OS/400, VM/VSE, or OS/390 platform.

- **Enterprise Extended Edition** - This offering is used most often to support very large databases. Popular applications include supporting large data warehouses. By providing intra- and interquery parallelism, databases can scale to multiple terabytes. DB2 UDB EEE can exploit clusters or massively parallel hardware architectures.

- **Personal Edition** - This full-function database offering is for single-users and will not accept remote database requests. This offering is available on Windows, OS/2, and Linux.

- **Satellite Edition** - This offering is for single-users and has a smaller footprint than Personal Edition. It will not accept remote database requests. This offering is available on the Windows platform.

- **Everyplace** - This is a mobile computing offering that gives mobile workers access to DB2 data sources in the enterprise through handheld devices such as personal digital assistants (PDAs) and handheld personal computers (HPCs).

The new DB2 Everyplace executes on a number of pervasive operating environments, including: Palm OS, Windows CE, and EPOC.

**DB2 Enterprise Edition**

DB2 Enterprise Edition is a relational database management system that is the foundation of many mission-critical systems and the primary focus of this certification guide. It is fully Web enabled, scalable from single processors to symmetric multiprocessors and to massively parallel clusters; and supports unstructured data such as image, audio, video, text, spatial, and XML with its object relational capabilities.
Applications for DB2 Enterprise Edition can scale upward and execute on massively parallel clusters or can scale downward with applications executing on single-user database systems.

DB2 Enterprise Edition is available on the Windows, OS/2, Linux, and UNIX platforms.

Fig. 1–4  *DB2 Universal Database*

**DB2 Workgroup Edition**

DB2 Workgroup Edition is designed for use in a LAN environment. It provides support for both remote and local clients. A server with DB2 Workgroup Edition installed can be connected to a network and participate in a distributed environment as show in Figure 1–5.
In Fig. 1–5, App1 and App2 are local database applications. Remote clients can also execute App1 and App2 if the necessary setup has been performed. A DB2 application does not contain any specific information regarding the physical location of the database. DB2 client applications communicate with DB2 Workgroup Edition using a supported distributed protocol. Depending on the client and server operating systems involved, DB2 Workgroup Edition supports the TCP/IP, NetBIOS, IPX/SPX, Named Pipes, and APPC protocols.

DB2 Workgroup Edition includes DB2 Extenders and Net.Data, a product that allows you to build Internet-ready applications that store data in DB2 databases.

DB2 Workgroup is available on the Windows, OS/2, AIX, Solaris, HP-UX, and Linux platforms.

**DB2 Enterprise - Extended Edition**

DB2 Enterprise-Extended Edition (or DB2 EEE) is the scalability option that enables DB2 to partition data across clusters or massively parallel computers. To the end-user or application developer, the database appears to be on a single computer. All SQL statements are processed in parallel, thus increasing the execution speed for any given query.
DB2 Enterprise-Extended Edition is available on the Windows, AIX, Solaris, HP-UX, and NUMA-Q platforms. This product is covered in detail in the *DB2 Cluster Certification Guide*.

**DB2 Personal Edition**

DB2 Personal Edition is a full-function database that enables a single-user to create databases on the workstation on which it was installed. It can be used as a remote client to a DB2 server, since it also contains the DB2 client components. Applications written to execute on the Personal Edition offering can also be used to access a DB2 Server, with no programming changes.

The DB2 Personal Edition product is often used by end-users requiring access to local and remote DB2 databases or developers prototyping applications that will be accessing other DB2 databases.

Fig. 1–7 shows an example of a DB2 Personal Edition installation. In this example, the user can access a local database on his or her desktop machine and access remote databases located on the database server. From the desktop, the user can make changes to the database throughout the day and replicate those changes as a client to the remote database on the DB2 server.

*Fig. 1–6*  *DB2 processing a query in parallel*
DB2 Personal Edition includes graphical tools (via the DB2 Administration Client component) that enable a user to administer, tune for performance, access remote DB2 servers, process SQL queries, and manage other servers from a single workstation.

This product is available on Windows, OS/2, and Linux.

**DB2 Satellite Edition**

DB2 Satellite Edition forms part of a DB2 solution to support systems that operate disconnected from the corporate system the majority of the time and connect occasionally to the corporation’s central database to exchange data.

DB2 Satellite Edition is a full-function, high-performance DB2 database specially designed for occasionally connected workers using systems running Windows operating systems. The satellite system itself does not require the user to manage the database. This means the end-user is free to focus on business results - the user does not even need to know a database is installed.

The application areas that can benefit from this solution include contract management, insurance application automation, securities marketing, and automobile insurance claims processing. In addition, large-scale branch office deployments are being used to provide automation to franchise stores, insurance agents, and regional offices of large corporations. In these kinds of environments, the applications are custom built, purchased, or a combination.
The satellite environment administration model minimizes the cost of administering a large number of systems by administering collections of systems running the same application and database in groups. Scripts stored at a central administration control point are used to accomplish administrative tasks on the systems in a group. This model also allows for centralized problem determination.

Replication administration uses the same model. Replication subscription definitions are stored in a central control server as scripts. When executed at the satellite system, the scripts set up each satellite for replication with a corporate data store.

DB2 V7.1 can centrally manage DB2 Workgroup and Enterprise Edition database servers using script-based administration.

DB2 Satellite Edition's small footprint and application compatibility with the rest of the DB2 family make it an ideal candidate for the delivery of distributed applications on systems that will occasionally connect with corporate data stores to exchange data.

This product is only available on the Windows platform.
DB2 Everyplace

DB2 Everyplace is a tiny “fingerprint” database of about 100K. It is designed for low-cost, low-power, small form-factor devices such as personal digital assistants (PDAs), handheld personal computers (HPCs), or embedded devices. DB2 Everyplace runs on devices that use the Palm Computing® Platform, Windows CE, the EPOC operating system, and the QNX Neutrino. DB2 Everyplace provides a local data store on the mobile or embedded device for storing relational data from elsewhere in the enterprise. Relational data can be synchronized to the handheld device from other DB2 data sources such as DB2 Universal Database for UNIX, OS/2 and Windows NT, DB2 for OS/390, and DB2 for AS/400. DB2 Everyplace with IBM Mobile Connect will also synchronize data from other ODBC-compliant data sources such as Oracle and Microsoft.

The DB2 Everyplace Sync Server mobilizes professionals with e-business information anywhere, anytime. It extends the power of DB2 to a wide range of handheld devices, such as those running the Palm Pilot.

![DB2 Everyplace Synchronization Server](image)

**Fig. 1–9** *DB2 Everyplace*
The DB2 Everyplace Personal Application Builder supports building applications for small handheld devices that access DB2 Everyplace databases. Some of its capabilities include:

- Supports visual construction of forms for different devices
- Supports the lightweight DB2 Everywhere database on the device
- Provides scripting capabilities for user-defined logic
- Integrates with other tools for application testing and debugging
DB2 Connectivity

DB2 is a very open database and provides a variety of options for connecting to DB2 and non-DB2 databases.

- **DB2 Clients** - Client code is required on workstations for remote users to access a DB2 database.

- **DB2 Connect** - This product provides support for applications executing on UNIX and Intel platforms to transparently access DB2 databases on the OS/400, VM/VSE, and OS/390 environments. Note that DB2 Connect is not required to access DB2 for any of the UNIX or Intel platforms.

- **DB2 DataPropagator** - This product provides replication capabilities for DB2 databases and is integrated in DB2 on the UNIX and Intel platforms.

- **DB2 Net.Data** - Provides the ability for a Web browser to access relational or non-relational data. This middleware provides an easy way to embed database calls into a macro language.

- **DB2 DataJoiner** - This product allows DB2 clients to access, join, and update tables from heterogeneous databases, such as Sybase, Informix, and Microsoft SQL Server.

- **DB2 Relational Connect** - This product allows DB2 clients to access and join tables from Oracle databases, such as Sybase, Informix, and Microsoft SQL Server.

- **DB2 Relational Connect** - This product allows DB2 clients to access and join tables from Oracle databases.

- **WebSphere Application Server** - This Application Server is shipped with DB2 Enterprise Edition and allows developers to use Java as platform in a transaction processing environment.

The DB2 UDB Quick Beginnings manual for each platform provides operating system requirements for implementing DB2 distributed configurations.

DB2 Universal Database Clients

A DB2 client can be configured to establish communications with a DB2 server using various communication protocols. The supported protocols vary according to operating system:
- TCP/IP - used in all environments
- NetBIOS - used in OS/2 and Windows environments
- APPC - used in IBM operating environments
- IPX/SPX - used in Novell NetWare LANs
- Named Pipe - used in Windows NT environments

A DB2 client has a number of options for what client code needs to be installed, which will depend on the requirements of the client. The options include:

- DB2 Runtime Client
- DB2 Administration Client
- DB2 Application Development Client
- DB2 Thin Client

Once a DB2 application has been developed, the DB2 Runtime Client component must be installed on each workstation executing the application. Fig.1–10 shows the relationship between the application, DB2 Runtime Client, and the DB2 database server. If the application and database are installed on the same system, the application is known as a local client. If the application is installed on a system other than the DB2 server, the application is known as a remote client.

![Fig. 1–10 DB2 Universal Database - Runtime Client](Image)

The Runtime Client provides functions other than the ability to communicate with a DB2 server or DB2 Connect server machine. For example, you can do any of the following:

- Issue an interactive SQL statement on a remote client to access data on a DB2 server or DB2 Connect server.
- Run applications that were developed to comply with the Open Database Connectivity (ODBC) standard or OLE DB.
- Run Java applications that access and manipulate data in DB2 databases using Java Database Connectivity (JDBC) or SQLJ.
If you need to graphically administer and monitor a DB2 database server, then you should install the DB2 Administration Client. It includes all the graphical DB2 administration tools in addition to all of the functionality of the DB2 Runtime Client.

If you need to develop applications, then you should install the DB2 Application Development Client (previously known as the DB2 Software Development Kit). This is a collection of developer’s tools that are designed to meet the needs of database application developers. The DB2 Application Development Client includes all of the graphical DB2 administration tools and the DB2 Runtime Client functionality.

The DB2 client product that you should install depends on your requirements and the operating system on the client machine. For example, if you have a database application developed for AIX, and you do not require the DB2 administration or application development tools, you should install the DB2 Runtime Client for AIX.

Some installations prefer having the DB2 Runtime Client reside remotely on another server. Remote workstations then need to access the DB2 Runtime Client code remotely, before getting access to DB2.

DB2 V7.1 supports a federated database environment, where applications see a single database, but they may be located on multiple different DB2 servers.

DB2 V7.1 client support includes: Windows, OS/2, Linux, UNIX, and SGI-IRIX.

**DB2 Connect**

The DB2 Connect product allows clients to access data stored on database servers that implement the Distributed Relational Database Architecture (DRDA). The target database server for a DB2 Connect installation is known as a **DRDA Application Server**.

**Note:** The most commonly accessed DRDA application server is DB2 for OS/390.

DB2 Connect supports both the TCP/IP and APPC DRDA communication protocols. The protocol supported depends on the DRDA application server being connected to and the version of the host software being run. For instance, a DB2 Connect server acting as a DRDA Application Requester to a host DRDA
Application Server can connect to DB2 for OS/390 at version 5.1 and higher. Any of the supported network protocols can be used for a DB2 client to establish a connection to the DB2 Connect server.

Some of the major capabilities provided by DB2 Connect include:

- Support for ODBC, OLE DB, CLI, JDBC, and SQLJ applications
- Distributed Join across all DB2 databases
- Distributed Join with Oracle (via Relational Connect)
- Connection Pooling
- S/390 Sysplex Exploitation for failover and load balancing

Some of the common uses of DB2 Connect are:

- Web-enabling DB2 OS/390 by providing browsers direct access
- Leveraging Microsoft applications written using ADO, ODBC, or OLE DB can transparently access DB2 on mainframe platforms
- Offloading mainframe development cycles

The database application must request the data from a DRDA Application Server through a DRDA Application Requester.

**Note:** The DB2 Connect product provides the DRDA Application Requester functionality.

The DRDA Application Server accessed using DB2 Connect could be any DB2 Server on OS/390, VM, VSE, or OS/400. If TCP/IP is the protocol of choice, then the following are prerequisites:

- DB2 for OS/390. Only version DB2 5.1 or higher supports TCP/IP in a DRDA environment.
- DB2 for OS/400. Only OS/400 version 4.3 or higher supports TCP/IP.
- DB2 Server for VSE/VM. Only version DB2 6.1 or higher for VM supports TCP/IP.
DB2 Connect is available as a server (Enterprise Edition) and a single-user package (Personal Edition). The DB2 Connect Enterprise Edition product provides the ability for multiple clients to access host data. A DB2 Connect server routes each database request from the DB2 clients to the appropriate DRDA Application Server (Figure 1–11). The remote client communicates with the DB2 Connect server using any of the supported communication protocols. DB2 Connect Personal Edition is available on the following platforms: Windows, OS/2, and Linux. It provides access to host databases from the system where it is installed.

**DB2 Replication**

DB2 replication (DB2 DataPropagator) allows for data to be propagated from one location to another. It supports a wide variety of databases including DB2, Oracle, Microsoft, Sybase, Informix, IMS, Lotus Notes, and flat files. Replication is also a core technology that enables mobile users to keep their data synchronized with corporate data residing on a DB2 server.
DB2 Net.Data

Net.Data provides high-performance Web applications with robust application development function. Net.Data exploits Web server interfaces (APIs), providing higher performance than common gateway interface (CGI) applications. Net.Data supports client-side processing as well as server-side processing with languages such as Java, REXX, Perl, and C++. Net.Data provides conditional logic and a rich macro language, support for Java, JavaScripts, and XML.

In a Net.Data environment, users connected to the Internet or an Intranet can access database applications. Users can either select automated queries or define new ones that retrieve specified information directly from a variety of data sources. The results are returned to the Web browser in HTML format. The Net.Data diagram illustrates how Net.Data allows not only access to DB2 data but also offers native access to Oracle and Sybase, flat files, and other data sources that support ODBC.
DB2 Relational Connect

DB2 Relational Connect provides applications access to both DB2 and Oracle. This is particularly useful if there is a heterogeneous database environment where DB2 and Oracle coexist.

DB2 Relational Connect is targeted for environments where DB2 and Oracle need to share data.
**DB2 DataJoiner**

DB2 DataJoiner provides applications to both DB2 and multi-vendor relational databases such as Microsoft, Sybase, and Informix. With a single SQL statement an application can transparently access, join, and update data located across multiple data sources.
IBM WebSphere Application Server

IBM WebSphere Application Server is built on an open Java-based platform that enables applications to leverage existing application resources and access various databases, including DB2. Some of the capabilities of WebSphere Application Server include the use of Java servlets, Java Server Pages, and XML to quickly transform static Web sites into vital sources of dynamic Web content. Enterprise Java Beans (EJB) can also be used for implementing EJB components that incorporate business logic. WebSphere Application Server is packaged with DB2.
DB2 Application Development

DB2 offers a rich application development environment that allows the developer to build databases supporting requirements from e-business and business intelligence applications. Many of these tools are integrated with the database; the major tools will be reviewed.

- **DB2 Universal Developer’s Edition** - provides the tools for developers to build database applications

- **Stored Procedure Builder** - enables the creation, testing, and debugging of stored procedures on local and remote DB2 servers

- **DB2 Relational Extenders** - enables the SQL API to access unstructured data types including: text, image, audio, video, XML, and spatial data

- **DB2 OLAP Server Starter Kit** - provides the ability to build OLAP cubes using DB2 as the relational data store; a higher-end version, DB2 OLAP Server, is available when there are more users

- **DB2 Data Warehouse Center** - provides the ability to build data marts/warehouses by automating the processes involved in managing, refreshing, moving, and transforming data, including the ability to define star schema model

- **DB2 Data Warehouse Manager** - provides all the capabilities of the Data Warehouse Center, but includes support more data sources and includes the Information Catalog, Query Patroller, and QMF for Windows

- **DB2 Data Links Manager** - DB2 offers supports all popular programming languages and supports the latest Java-based application programming APIs, including: JDBC, SQLJ, ODBC, OLE DB, and CLI.

DB2 Universal Developer’s Edition

The DB2 development environment can be installed either on a DB2 server or on a DB2 client. The installation provides all of the necessary data access tools for developing database applications. There are two offerings:

- **DB2 Personal Developer’s Edition (PDE)** - for Windows, OS/2, and Linux platforms.
- **DB2 Universal Developer’s Edition (UDE)** - for all server platforms

The application development environment provided with both product packages allows application developers to write programs using the following methods:
• Embedded SQL
• Call Level Interface or CLI (compatible with the Microsoft ODBC standard)
• DB2 Application Programming Interfaces (APIs)
• DB2 data access through the World Wide Web
• Java applets or applications using JDBC or SQLJ.

The programming environment also includes the necessary programming libraries, header files, code samples, and precompilers for the supported programming languages. Several programming languages, including COBOL, FORTRAN, C, C++, and Java are supported by DB2.

An application developed using the Developer Edition can be executed on any system with the same operating system that has the DB2 Runtime Client installed. To run the application on another operating system requires the application be rebuilt on the target operating system.

DB2 Personal Developer’s Edition (PDE) includes:
• DB2 Personal Edition
• DB2 Connect Personal Edition
• DB2 Extenders

PDE allows a single application developer to develop and test a database application. It is available for Windows, OS/2, and Linux.

DB2 Universal Developer’s Edition (UDE) includes all the components in the PDE and:
• DB2 Enterprise Edition
• DB2 Connect Enterprise Edition
• DB2 Workgroup Edition
• Net.Data
• DB2 Application Development Client Pack
• DB2 Administration Client Pack
• DB2 Runtime Client Pack

The Client Packs include the Application Development Client and Administration and Runtime clients for all supported platforms. You can use these to build and run applications on all platforms that DB2 supports.

DB2 Universal Developer’s Edition is supported on all platforms that support DB2 Enterprise Edition. It is intended for application development and testing only. The database server can be on a platform that is different from the platform on which the application is developed.
DB2 Stored Procedure Builder

The DB2 Stored Procedure Builder is a graphical application that supports the rapid development of DB2 stored procedures written in Java or SQL. The builder can be launched as a separate application from the DB2 program group or from the integrated development environments such as VisualAge for Java or Microsoft VisualStudio. The Stored Procedure Builder can be used to create stored procedures on local and remote DB2 servers and test, execute, and debug stored procedures.

Fig. 1–16 DB2 Stored Procedure Builder

The DB2 Stored Procedure has been enhanced to build stored procedures written in SQL.
DB2 Relational Extenders

DB2 Relational Extenders offer the ability to manipulate data outside of conventional rows and columns to include the manipulation these types of data: text, image, audio, video, and XML. The DB2 Relational Extenders encapsulates the attributes, structure, and behavior of these unstructured data types and stores this information in DB2. From the developer’s perspective, the DB2 Relational Extenders appear as seamless extensions to the database and enable the development of multimedia-based applications. The following DB2 Relational Extenders are provided by IBM:

- Text Extender
- Image Extender
- Audio Extender
- Video Extender
- Spatial Extender
- XML Extender
- Net.Search Extender
The purpose of the DB2 Relational Extenders is to provide for the management of unstructured data through the SQL API. By preserving the current investment in relational applications, new nontraditional applications can be introduced by leveraging existing skills. This open environment enables developers and independent software vendors to develop and introduce their own extenders as extensions to DB2.

With DB2 V7.1, the XML Extender is provided with DB2 and allows you to store eXtensible Markup Language (XML) documents as a new column datatype. You also have the ability to decompose and store XML in its component parts as columns in multiple tables. In either case, indexes can be defined over the element or attribute of an XML document for fast retrieval. Furthermore, text search and section search can be enabled on the XML column or its decomposed part via DB2 Text Extender. You can also formulate an XML document from existing DB2 tables for data interchange in business-to-business environments.
The DB2 Net Search Extender combines in-memory database technology with text search semantics for high-speed text search in DB2 databases. Searching with it can be particularly advantageous in Internet applications where performance is an important factor. Net Search Extender can add the power of fast full-text retrieval to Net.Data, Java, and CLI applications. Its features let you store unstructured text documents of up to 2 gigabytes in databases. It offers application developers a fast, versatile, and intelligent method of searching through such documents.

The new Net Search Extender was designed to manage heavy text search demands from Internet users querying the Website.

The new XML Extender allows the storage and retrieval of XML documents using the SQL API.
DB2 OLAP Server Starter Kit

The DB2 OLAP Server Starter Kit is a scalable, industrial-strength Online Analytical Processing (OLAP) software that enables you to build sophisticated decision support, planning, and analysis applications for your enterprise. DB2 OLAP Server Starter Kit provides a fast path to turn your warehouse data into business insight. It delivers “speed of thought” query performance to a large set of online users. It is built for e-business with tools to help you quickly deploy Web-based analytical applications.

DB2 OLAP Starter Kit provides DB2 integrated OLAP capabilities. Also, included to build OLAP solutions are: Integration Server to pull data from DB2, an OLAP spreadsheet plug-in for Excel and Lotus 1-2-3, and an Administration Manager.

Fig. 1–19  Multidimensional cube

DB2 OLAP Server Starter Kit Version 7.1, based on Hyperion Essbase 6.0, provides significant improvements, in the areas of functionality, scalability, performance, and usability, over the previous release, DB2 OLAP Server Version 1.1.

- Attributes, such as colors and sizes can now be defined and analyzed easily. It lets you do detail analysis without increasing the size of your cube.
Overall performance of system is improved. A reduction of 20% of combined Load and Calculation time has been observed in internal benchmarks based on a mixture of customer applications.

Flexibility in storage is extended to the application level. Depending on individual application needs, the cube can be stored in either DB2 for added flexibility of SQL access or multidimensional storage for optimal performance.

Improved scalability enables analysis at much finer levels of detail with:

- Support of large outlines
- Enhanced concurrent operations
- Optimized I/O operations
- Large data export capability
- Richer calculation functions, including statistical, allocation and forecasting, and member set functions, are added to extend application capabilities
- New features in Spreadsheet Add-in include the new Essbase Query Designer and support of attributes to enhance your usability and productivity

As the number of users grows, the DB2 OLAP Server is available to service greater work demands.

**DB2 Data Warehouse Center**

This new offering brings together the tools to build, manage, govern, and access DB2 data warehouses. The DB2 Warehouse Center simplifies and speeds warehouse prototyping, development, and deployment. It gives the data center the control for governing queries, analyzing costs, managing resources, and tracking usage. It helps satisfy user requirements for finding, accessing, and understanding information. It provides flexible tools and techniques for building, managing, and accessing the warehouse. And it meets the most common reporting needs for enterprises of any size.

The Data Warehouse Center is integrated with DB2 UDB V7.1 and provides the basic extraction, transformation, and load capabilities to build data warehouses. This tool also provides a star schema builder and a process modeler for automating the steps of transforming data for end-users.
DB2 Warehouse Manager

The DB2 Warehouse Manager adds to basic warehouse and analytical functions available in DB2 Universal Database by providing:

- Additional warehouse scalability through warehouse agents co-located with the database. Warehouse agents manage the flow of data between warehouse sources and warehouse targets.
- Advanced transformations using Java stored procedures and user-defined functions including cleaning data, pivoting tables, and generating keys.
- An integrated business information catalog to guide users to relevant information that they can use for decision making.
- Sophisticated query governing and workload distribution (DB2 Query Patroller).
- Query report that satisfies the common reporting needs of most enterprises.
- An integrated business information catalog to guide users to relevant information that they can use for decision making.
The Data Warehouse Manager extends the functions of the Data Warehouse Center by providing support for additional data sources, additional warehouse and statistical transformations, an Integrated Information Catalog, QMF for Windows, and Query Patroller.

**Information Catalog**

The Information Catalog is a tool for end-users to help easily find, understand, and access available information in the corporation. This graphical tool uses a Business View Model, built by the Data Warehouse Administrator, that can be used by the business user to navigate through the data in an enterprise. It allows users to:

- Populate the catalog through metadata interchange with the Data Warehouse Center and other analytical and reporting tools

![Fig. 1–21 Information Catalog](image-url)
• Directly register shared information objects
• Navigate or search across the objects to find relevant information
• Display the metadata about the object
• Launch the tools used to render the information for the end-user

The Information Catalog keeps metadata on data that end-users need to access. This tool automates the exchange of metadata with the Data Warehouse Center.

Query Management Facility
Query Management Facility (QMF) for Windows is an easy-to-use query and reporting tool for publishing reports either locally or onto the Internet. It also easily integrates with other Windows desktop tools. End-users can easily do the following:
• Build queries and reports easily using its graphical interface
• Integrate query results with desktop tools such as spreadsheets and personal databases
• Rapidly build data access and update applications
• Exploit DB2 performance and all of its SQL capabilities
DB2 Query Patroller

DB2 Query Patroller controls and monitors query execution while exploiting the capabilities of uniprocessors, SMP systems, and MPP systems. DB2 Query Patroller works with queries to prioritize and schedule user queries based on user profiles and cost analysis performed on each query. Large queries are put on hold and scheduled for a later time during off-peak hours. Queries with high priority (based on user profiles) are promoted to the top of the schedule. In addition, DB2 Query Patroller monitors resource utilization statistics to determine which CPUs are the least used. Then it provides load distribution functionality that increases the num-

QMF for Windows can also be used to access DB2 on OS/390 directly if DB2 Connect is installed.
ber of users allowed to submit queries at any given time as well as decreases the response time for a query.

DB2 Query Patroller greatly improves the scalability of a data warehouse by allowing hundreds of users to safely submit queries on multi-terabyte class systems. Its components span the distributed environment to better manage and control all aspects of query submission.

DB2 Query Patroller acts as an agent on behalf of the end-user. It prioritizes and schedules queries so that query completion is more predictable and computer resources are efficiently utilized. After an end-user submits a query, DB2 Query Patroller frees up the user’s desktop so that he or she can perform other work, or even submit other queries, while waiting for the original query results. DB2 Query Patroller obtains the query cost from the DB2 Optimizer and then schedules and dispatches those queries so that the load is balanced across the installation-specified nodes.

DB2 Query Patroller sets individual user and user class priorities as well as user query limits. This enables the data warehouse to deliver the needed results to its most important users as quickly as possible. If desired, an end-user can choose to receive notice of scheduled query completion through electronic mail.

DB2 Query Patroller consists of components running on the database server and end-users’ desktops. DB2 Query Patroller is made up of several components, each having a specific task in providing query and resource management.

DB2 Query Patroller traps all dynamic queries running against DB2 and is now an integrated component of DB2 UDB V7.1 Warehouse Manager.
The Server is the core component of DB2 Query Patroller. It provides an environment for storing user profiles, setting up system parameters, maintaining job lists, and storing node information. The DB2 Query Patroller system administrator has an interface to the Server to perform these tasks. The Server component executes on a node within the Database Management System (DBMS) called the Management Node.

The Administrator component gives a DBA or system administrator the tools needed to manage the DB2 Query Patroller environment. This tool allows for the management and viewing of queries. The administrator provides menus to display job lists and history, user profiles, node information, and system parameters. It also provides for the display of utilization graphs.

**DB2 Data Links Manager**

DB2 Data Links Manager can be used to build applications that need to combine the search capabilities of SQL with the advantages of working directly with files to manipulate raw data. A reference is stored for each external file, along with metadata that describes the contents of each file.
DB2 Data Links Manager uses the DATALINK data type, which points to an external file, and the DB2 Data Links Manager components.

You use the DATALINK data type, just like any other data type, to define columns in tables. The DATALINK values encode the name of the Data Links Server containing the file and the file name in terms of a Uniform Resource Locator (URL).

Using DB2 Data Links Manager means that external files can be backed up with the database and SQL Data Control Language statements (GRANT and REVOKE) can be used to control permissions to those files.

Examples of applications that can use the DATALINK data type are:

- Medical applications, in which X-rays are stored on the file server and the attributes are stored in the database.
- Entertainment industry applications that perform asset management of video clips. The video clips are stored on a file server, but attributes about the clips are stored in a database. Access control is required for accessing the video clips based on database privileges of accessing the metainformation.
- World Wide Web applications to manage millions of files and allow access control based on database privileges.
- Financial applications, which require distributed capture of check images, and a central location for those images.
• CAD and CAM applications, where the engineering drawings are kept as files, and the attributes are stored in the database. Queries are run against the file attributes.

Even though the DATALINK column represents an object that is stored outside the database system, you can use SQL queries to search metadata to obtain the file name that corresponds to the query result. You can create indexes on videos, images, text (and so on), and store those attributes in tables along with the DATALINK column. With a central repository of files on the file server and DATALINK data types in a database, you can obtain answers to questions like “what do I have?” and “find what I am looking for.”

The DB2 Data Links Manager supports DCE Distributed File System (DFS), supports archiving of linked files to third-party backup solutions, and supports replication using DB2 DataPropagator.

DATALINK Compared to Relational Extenders and LOBs

The DB2 Relational Extenders provide a similar functionality. They keep the metadata that describes the raw data for objects so that you can search on the important aspects of those objects. The extenders allow you to specify whether the object itself is to be maintained either in or outside the database. The extenders, however, do not provide referential integrity between the files on a file server and their references in the database. Thus, it is possible to independently delete either the reference or the file. Moreover, the extenders provide neither access control to the related files nor coordinated backup and recovery of the database and the files.

In contrast to the LOB data type, applications cannot use SQL to access the data in the referenced files. The application gets the file names and uses the file APIs (read/write) to get or manipulate the content.
DB2 Administration

Database administrators have a number of graphical-based tools they can use to manage and administer DB2 databases. Alternatively, a DBA can also use script-based tools to administer the database environment. The main tools available with DB2 will now be examined.

Control Center

The Control Center is the central point of administration for DB2. The Control Center provides the user with the tools necessary to perform typical database administration tasks. It allows easy access to other server administration tools, gives a clear overview of the entire system, enables remote database management, and provides step-by-step assistance for complex tasks.

![Control Center Diagram]

**Fig. 1–25 DB2 Control Center**

The Systems object represents both local and remote machines. To display all the DB2 systems that your system has cataloged, expand the object tree by clicking on the plus sign (+) next to Systems. The left portion of the screen lists available DB2 systems (local and remote). From this example, the system LOCAL contains a DB2 instance, DB2, in which the database SAMPLE is located. When Tables is highlighted,
details about each system is shown in the Contents Pane. A number of the existing tables in the SAMPLE database are displayed.

The main components of the Control Center are:

- **Menu Bar** - Used to access Control Center functions and online help.
- **Tool Bar** - Used to access the other administration tools.
- **Objects Pane** - This is shown on the left-hand side of the Control Center window. It contains all the objects that can be managed from the Control Center as well as their relationship to each other.
- **Contents Pane** - This is found on the right side of the Control Center window and contains the objects that belong or correspond to the object selected on the Objects Pane.
- **Contents Pane Toolbar** - These icons are used to tailor the view of the objects and information in the Contents pane. These functions can also be selected in the View menu.

Hover Help is also available in the Control Center, providing a short description for each icon on the tool bar as you move the mouse pointer over the icon.

**Other Tools Available from the Control Center**

By using the Control Center Tool Bar, you can access other administration tools to help you manage and administer databases in your environment:

- **Satellite Center** - Used to manage the satellite environment.
- **Data Warehouse Center** - Used to build the data mart/warehouse.
- **Command Center** - This provides an interactive window that allows input of SQL statements or DB2 commands, the viewing of execution results, and explain information. The graphical command utility is the preferred method for text commands as it provides enormous flexibility and function; interacts with the Script Center.
- **Script Center** - Used to create, schedule, and manage scripts that can contain SQL statements, DB2 commands, or operating systems commands.
- **Alert Center** - used to view performance variables that have reached a threshold. For example, use the Alert Center to work with alerts generated by DB2.
- **Journal** - This keeps a record of all script invocations, all DB2 messages, and the DB2 recovery history file for a database. It is used to show the results of a job and, contents of a script and also to enable or disable a job.
- **License Center** - Used to manage licenses and check how many connections are used.
- Stored Procedure Builder - This tool enables the creation and testing of DB2 stored procedures.
- Tools Settings - Allows you to configure the DB2 graphical tools and some of their options.
- Information Center - Provides the user with quick access to the DB2 product documentation. Information is available about common tasks, problem determination, DB2 online manuals and the sample programs provided with DB2.

The graphical tool set provided with DB2 is full functioned and very powerful, allowing you to administer and access your DB2 system from graphical interfaces.

**Wizards**

Wizards (formerly known as SmartGuides) are tutors that help you create objects and perform other database operations. Each Wizard has detailed information available to help the user. The DB2 Wizards are integrated into the administration tools and assist in completing administration tasks. For example, the Add Database Wizard is used to set up communications on a DB2 client with a database on a DB2 server and is invoked from the Client Configuration Assistant (CCA).

![Add Database Wizard](image)

**Fig. 1–26 Client Configuration Assistant - Add Database Wizard**

Fig. 1–26 shows that there are a number of ways to add a remote database. You do not have to know the syntax of commands or even the location of the remote database server. One option searches the network, looking for valid DB2 servers.
The Configure Performance Wizard (Fig. 1–27) can be used to get a database system up and running quickly.

Invoked from the DB2 Control Center, the wizard extracts information from the system and asks questions about the database workload. It then runs a series of calculations designed to determine an appropriate set of values for the database and database manager configuration variables. You can choose whether to apply the changes immediately or to save them in a file that can be executed at a later time.

DB2 Wizards include:
- Create, Add, Backup, Restore Database
- Configure multisite update
- Create Table
- Create Table Space
- Create Index
- Configure Performance
Chapter 1  Product Overview

The Command Line Processor (CLP)

The Command Line Processor (CLP) is a component common to all DB2 products. It is a text-based application that is used to execute SQL statements and DB2 commands. For example, you can create a database, catalog a database, and issue dynamic SQL statements from the CLP.

Note: The commands and statements issued through the DB2 CLP can also be issued through the DB2 Command Center, which is a preferred graphical interface.

C:\>db2 list db directory

System Database Directory
Number of entries in the directory = 1

Database 1 entry:

<table>
<thead>
<tr>
<th>Database alias</th>
<th>DB2CERT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Database name</td>
<td>DB2CERT</td>
</tr>
<tr>
<td>Local database directory</td>
<td>G:\DB2</td>
</tr>
<tr>
<td>Database release level</td>
<td>9.00</td>
</tr>
<tr>
<td>Comment</td>
<td></td>
</tr>
<tr>
<td>Directory entry type</td>
<td>Indirect</td>
</tr>
<tr>
<td>Catalog node number</td>
<td>0</td>
</tr>
</tbody>
</table>

Fig. 1–28  Command Line Processor

Fig. 1–28 shows a command and its output as executed from the Command Line Processor. The Command Line Processor can be used to issue interactive SQL statements or DB2 commands. The statements and commands can be placed in a file and executed in a batch environment or they can be entered in interactive mode.

The DB2 Command Line Processor (CLP) is provided with all DB2 Universal Database, DB2 Connect, and DB2 Developer’s products and Clients.

All SQL statements issued from the Command Line Processor are dynamically prepared and executed on the database server. The output, or result, of the SQL query is displayed on the screen by default.

All of the DB2 commands are documented in the DB2 UDB V7.1 Command Reference.
Visual Explain

Other graphical tools can be used for tuning or monitoring performance. Visual Explain is a graphical utility that provides a visual representation of the access plan that DB2 uses to execute an SQL statement.

![Access Plan Graph in Visual Explain](image)

**Fig. 1–29 Access Plan Graph in Visual Explain**

Visual Explain can be invoked from the Control Center or from the Command Center. Fig. 1–29 shows the type of information that is displayed. This example shows that two tables are being accessed and an approximation of the cost of the query is also provided in the Visual Explain output. The estimated query costs represent the complexity and resource usage expected for a given SQL query. More details on the usage of Visual Explain are provided in “Monitoring and Tuning” on page 583.

Performance Monitor

The Performance Monitor is a graphical tool that displays information from the two basic monitoring facilities: Snapshot Monitor and Event Monitor.
The **Snapshot Monitor** captures database information at specific intervals. The interval time and data represented in the performance graph can be configured. Fig. 1–30 is an example of Snapshot Monitor output that displays various pieces of information and threshold actions. The Snapshot Monitor can help analyze performance problems, tune SQL statements, and identify exception conditions based on limits or thresholds.

The **Event Monitor** captures database activity events as defined by the event monitor definition. Event Monitor records are usually stored on disk and then analyzed after the data has been captured. The **Event Analyzer** graphical tool provided with DB2 can be used to analyze the captured data. More details on the usage of the DB2 monitors are provided in “Monitoring and Tuning” on page 583.

Fig. 1–31 shows the DB2 Command Window available from the Windows NT desktop folder. The DB2 Command Window can also be invoked from the Windows NT command prompt using the `db2cmd` command.
The DB2 folder is created on the desktop for environments such as Windows or OS/2. This DB2 folder is typically used to invoke the graphical tools provided with DB2. Fig. 1–31 shows some of the components of the DB2 product as they appear in the DB2 folder. A component usually relates to an executable application or utility.

**Fig. 1–31 DB2 desktop folder (Windows)**

The graphical tools integrated with DB2 support these functions:

- Create, alter, and drop databases, table spaces, tables, views, indexes, triggers, schemas, users, user groups, and aliases
- Load, import, export, and reorganize data and gather statistics
- Schedule jobs to run unattended
- Back up and restore databases
- Monitor and tune performance
- Tune queries using access path analysis
- Manage data replication

The following are also available in the DB2 desktop folder:

- Query Patroller - These are the client interfaces to Query Patroller: QueryAdmin, QueryMonitor, and Tracker.
- Information - This folder contains the DB2 online books in HTML format and the release notes that are provided with the product.
• Client Configuration Assistant (CCA) - This is a graphical tool that is used to configure access to remote databases. It can be invoked from the DB2 Desktop folder or from the command line with the `db2cca` command.

• Command Line Processor (CLP) - The CLP is a text-based program that allows you to enter DB2 commands or SQL statements.

• Command Window (Windows platform).

• Command Center - a graphical tool that allows you to enter one or more DB2 commands and statements, store the commands as scripts, view the explain information for a statement, and schedule scripts via the Script Center.

• Control Center - The central point of administration for DB2 Universal Database. This tool allows you to access other tools such as the Command Center and the Journal.

• Event Analyzer - This allows you to access information on database activities collected by event monitors.

• Event Monitor - This allows you to work with DB2 event monitors including creating, starting, stopping, and removing event monitors.

• First Steps - This allows you create the `SAMPLE` database, view sample contents, and access the on-line DB2 library.

• Start/Stop HTML Search Server - This enables (or disables) the searching of a topic in the online books.

• Stored Procedure Builder - assists with the creation of stored procedures that run on DB2 servers

• SQL Assist - a graphical online tool that can be used to build Select, Insert, Update, and Delete statements
Summary

This chapter discussed the DB2 Version 7.1 products for UNIX, Linux, Windows, and OS/2. There are a number of offerings available:

- DB2 Universal Database
- DB2 Connect
- DB2 Universal Developer’s Edition
- DB2 OLAP Server Starter Kit
- DB2 Data Warehouse Center

These products provide specific function that allow you to build a complete database environment. In this chapter, the various DB2 packaging options were reviewed and the applications they might support:

- DB2 UDB Everyplace Edition
- DB2 UDB Satellite Edition
- DB2 UDB Personal Edition
- DB2 UDB Workgroup Edition
- DB2 UDB Enterprise Edition
- DB2 UDB Enterprise-Extended Edition

DB2 Connect provides access to DRDA host databases. It is available as DB2 Connect Personal Edition and DB2 Connect Enterprise Edition. The ability to connect to a host database is also included in the DB2 Enterprise and Enterprise-Extended Edition products.

DB2 Satellite Edition and DB2 Everyplace supports occasionally connected systems. DB2 Data Links Manager extends the functions of an RDBMS to files stored outside the database. DB2 Query Patroller provides query and resource management for decision support systems.

This chapter also introduced some of the graphical and command line tools available in DB2. The Command Line Processor (CLP) is a text-based application that allows you to enter DB2 commands and SQL statements and is found in all DB2 products. From the desktop, an administrator can configure remote and local systems, administer instances and databases, and create database objects. In the remaining chapters, additional DB2 functions and tools will be examined in how they assist the end-user, application developer, and administrator.