

R/3[®] System

SAP R/3[®] on DB2 Universal Database



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Written by Technology Marketing, SAP AG

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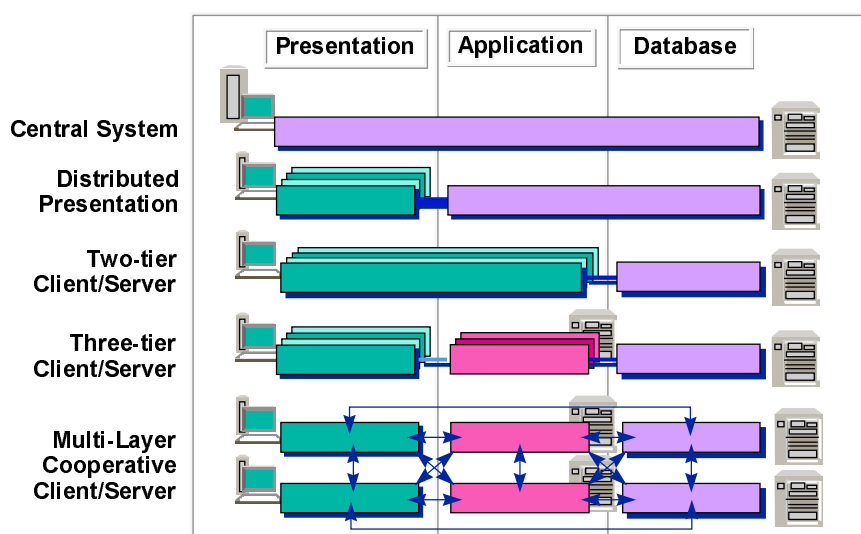
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SAP R/3 on DB2 Universal Database

If the enterprise application is the nervous system of a company, the database is the backbone. In the SAP R/3 system, the database server is the core of the SAP R/3 multi-tier design. As R/3 has evolved from a three-tier architecture to a multi-tier architecture, the database continues to play a prominent role.



The database plays an important role in all platform configurations.

The software on the database server controls the data management, retrieves the data from the database, and contains all the programs downloaded to the appropriate application server. The application data is processed on the application server, as the work processes of the application server connect to the database as the central data repository.

This paper explores a particular database management system for the R/3 environment, the IBM DB2 Universal Database, and details its main advantages for enterprise computing: database administration, tools support, and operational performance.

Database is the backbone

What is DB2 Universal Database?

The DB2 Universal Database is an object-relational database management system (RDBMS) that spans multiple platforms, from Intel-based class machines to RISC-based UNIX servers to IBM 390 systems. DB2 UDB has a rich heritage coming from IBM's DB2 Common Server and DB2 Parallel Edition, and offers tight integration support to DB2 for OS/390, OS/400, and VSE & VM (SQL/DS). Current UDB supported platforms for R/3 include UNIX systems and Intel-based systems including NT. DB2 UDB features

IBM UDB Features



data management, connectivity, replication functions and support for object-relational data structures.

Why is DB2 Universal Database Important for SAP Customers?

Performance Enhancements

On the database level, R/3 employs relational database systems from multiple manufacturers. R/3 makes use of supplier-specific implementation, but without jeopardizing its own portability. While SAP R/3 may treat database systems as “ordinary citizens,” choosing the right database management system is critical to R/3 customers. The database issues of interest to them center upon operational performance and the effectiveness and maintainability of the database management system as a whole.

R/3 on DB2 UDB was released by SAP because of its well known stability and robustness, necessary in enterprise computing. It delivers very high OLTP performance notably in large multi-user environments and provides industry-leading advanced optimization technology backed by IBM’s solid research-background. These capabilities will be discussed in greater detail later in the paper.

Administration and Tools

The differences between DB2 and other database systems are the effectiveness of its administration and the quality of its supporting tools. Built for a distributed computing environment, DB2 UDB Enterprise Edition includes backup and recovery utilities, control center, and tools—which have been extended by SAP for DB2 customers. DB2 administration, tools, and operational performance help create the necessary environment for supporting such SAP mission critical tasks as data warehousing, data-mining, decision support, and transaction processing.

Administration

Reducing the cost of data management is a major concern for today’s enterprise systems departments. The reduction, however, cannot come at the expense of usability and performance. One of the primary tasks of an RDBMS in the SAP R/3 environment is to support R/3 applications with easy-to-use management tools. DB2 UDB administration tools which have been further extended by SAP are designed to maximize R/3 system availability and minimize database administration effort. DB2 UDB features proven backup and recovery, and availability and space management tools that seek to reduce operator intervention. For the DBA, less intervention translates into less effort, greater usability, and fewer errors.

Backup and Recovery

The R/3 system includes utilities for backup and recovery, and has an interface that controls vendor tools from SAP’s Computing Center Management System. In addition to this basic offering, DB2 UDB provides the following database mechanisms:



- Online or offline backup and restore
- Online and offline tablespace-level backup and restore
- Point-in-time rollforward recovery
- Fast restart recovery

During the installation of the R/3 system, the DB2 UDB database server is configured to allow automatic recovery without any operator intervention. If an abnormal shutdown— a power loss, for example—is detected during the first connection to the database, DB2 calls the restart database utility. The database restart brings the database to the latest consistent state based on the disk image and the online log files. Within this process, the DB2 UDB database server rebuilds the state of the Buffer Pool (memory cache) to offer immediate optimum performance for the R/3 system. No database restore is necessary.

Crash Recovery

Forward recovery uses a backup image (online or offline) and the subsequent log files to recover the database to a consistent state. More current online backups enable faster rollforward recovery, as there are fewer log files to redo. The database can be rolled forward to a certain point in time or to the end of the logs. Using roll forward will extend the recovery of the database, after the time of the backup, to the last committed transaction. True online backup enables R/3 customers to schedule this important „operation“ at their own discretion.

Forward Recovery

R/3 mandates that its databases can be re-created any time based on the contents of the log files which have been created in the course of operation. However, as the number of log files grows, it is useful to archive those files.

Archiving

In the R/3 DB2 environment, log files are archived using the SAP provided logging user-exit program. As a log file data set becomes full, its content is automatically copied, or offloaded, to the R/3 log-archive directory. From there, it can be archived to tape with SAP's standard tool or to third party systems. For example, the IBM ADSTAR Distributed Storage Manager (ADSM), is a client/server product that allows client system files to be archived on and retrieved from host storage media. The archived log file may be retrieved from the Control Center or CCMS for a specified backup (see tools below).

Availability and Space Management

Ordinary use of the R/3 system results in the inevitable fragmentation of the underlying database. Reorganization is used for defragmentation (automatic or manual) of tables and indexes. The internal DB2 architecture typically results in less frequent reorganizations than other database management systems, but when a specific table becomes overly fragmented, DB2's powerful reorg utility improves database performance by making efficient use of disk space, reducing time required for OTLP transactions, and providing better response-times to users. Minimal interruption of online operation is assured.

Reorg Utility



Online Reorg Most R/3 customers demand 24 x 7 availability. For them, in-flight, online reorganization is a necessity. DB2's online reorg tool does not require shutdown of R/3, unlike the export/import utilities of other database systems.

Online Database Extension A data or index container may be added to a tablespace without an R/3 or database shutdown. With DB2 the data of one tablespace is efficiently spread over several disks to allow disk striping. By adding a new container, the data is automatically rebalanced without operator intervention; further improving the desired distributed I/O behavior.

Tools Support

Much of the added value of a database management system lies in its tool support. Effective tools maximize existing database potential, while allowing a minimal disruption of the production environment.

DB2 UDB provides a powerful and robust set of tools, which have been tightly integrated into the R/3 environment by SAP.

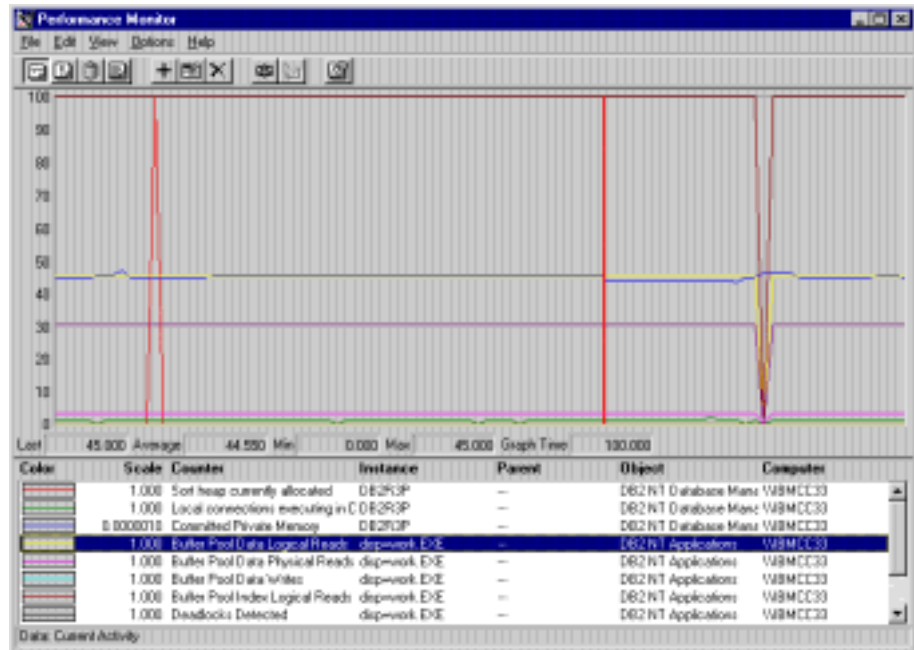
DB2 Control Center

All R/3 systems running DB2 UDB within a network can be administered with one single point of control – the DB2 Control Center. The Control Center contains tools for performing common database administration tasks. It provides:

- Seamless integration of the DB2 administration tools
- Clear views of all managed DB2 UDB database servers within the network
- Remote database management
- Step-by-step assistance for certain tasks through DB2 SmartGuides

R/3 extensions for the DB2 CC are shipped starting with R/3 4.0A and are also available in R/3 Ready-to-Run on DB2 UDB. The R/3 extensions enable additional functionality, such as log file management (see above) or system-wide password management for R/3 databases.

Database Backup Other features such as SAP R/3 Database Backup with DB2 CC allow for point-and-click back up. The graphical user interface of DB2 CC eliminates the need to learn complex DB2 commands. To back up a database, as an example, the DBA simply has to right-click on the database name and select BACKUP.



EXPLAIN Interface

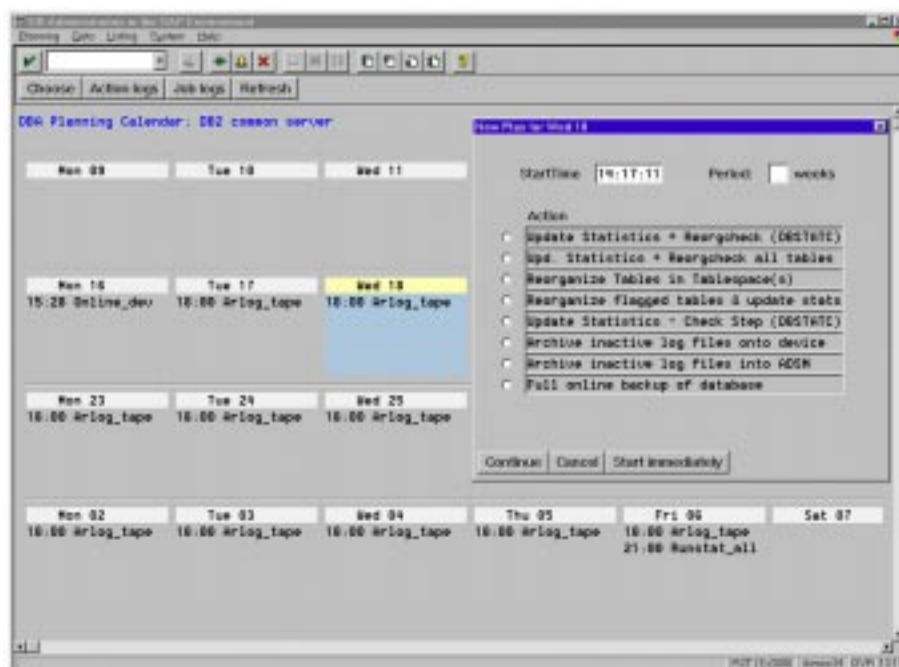
Trace Explain

SAP's SQL trace facility contains an interface to DB2 EXPLAIN, which offers detailed information about the way R/3 SQL statements are processed by the DB2 UDB cost-based optimizer through the SAP graphical user interface. For R/3, all SQL statements sent to the database engine can be traced and the access path to data explored. The inherent cost model of IBM's advanced cost-based optimizer is fully transparent to the user.

Computer Center Management System

CCMS

The R/3 Computer Center Management System (CCMS) has been extended to include the DB2 DBA Planning Calendar which is used to schedule database administration jobs such as online backups, updating database statistics, archiving log files and reorganizing tables.



Integration and Add-ons

R/3 on DB2 UDB has been tested with other offerings including ADSM for backup and recovery, Tivoli TME10 for Network Management, the MQ Series for messaging and connectivity, and many other products available in the SAP R/3 environment.

Microsoft Cluster Server - MSCS

MSCS, formerly known as "Wolfpack" Clustering, is intended to enhance data and application availability on Windows NT Servers by allowing two servers to work together as a single logical system. MSCS is supported with DB2 UDB starting with R/3 Release 4.5A. These capabilities further provide SAP customers with high availability platforms that are necessary for mission-critical systems.

HACMP

Another high-availability software for R/3 DB2 UDB systems is HACMP (for AIX). This proven and well-known solution is in use by many R/3 customers with DB2 UDB database servers and offers 7x24 hour operation through fail-over switching of database servers. The fast restart capability of DB2 UDB is a beneficial factor for these implementations.

Operational Performance

The benchmark for SAP applications on database management systems is measured by scalability and performance in an online transaction processing (OLTP) environment. The DBMS for R/3 must deliver high throughput and provide increasing support for large databases. Close cooperation between

System Enhancements



IBM's DB2 benchmark group and R/3 development leads to rapid integration of new enhancements into the R/3 on DB2 UDB product offering.

DB2 UDB improves the operating environment for R/3 through the following system enhancements:

- ❑ Very large memory support, including 32-bit systems and 64-bit memory exploitation (through DB2 buffer pools)
- ❑ Reduced network consumption
- ❑ Parallel query (intra-query parallelism)
- ❑ System-wide common SQL statement caching.

Symmetric Multi-Processing Systems

Parallel Processing

IBM is a leader in parallel processing research with many innovations flowing into product development, like DB2 UDB. R/3 on DB2 UDB exploits parallelism for use on SMP systems to full extent. The ability to unfold queries as appropriate is immediately exploited on all hardware platforms. The importance for R/3 customers lies in the ability to break the SQL statements down to "threads." Dividing SQL statements into threads enables parallel processing without application intervention. The threading level, however, can be controlled through configuration parameters. DB2 UDB also supports other forms of parallelism (e.g. I/O parallelism through various types of "prefetching", index-rebuild parallelism or backup/restore parallelism).

Locking

Enterprise applications require the highest standards in data integrity. IBM's extensive experience establishes DB2 as the leader in standards and development. DB2 implements locking—the method used to ensure the integrity of data—based on ANSI standards. For other database systems, "read" integrity can be compromised, especially during multi-versioning, which can cause queries to end abruptly in high-transaction rate OLTP environments.

Row-level locking

In a multi-user environment, data is protected by row-level locking, ensuring that an application maintains control over the database row until the transaction completes. DB2 provides four isolation levels which allow for a high degree of concurrency. More than 90% of all R/3 SQL queries are prepared with Uncommitted Read (UR), and the more restrictive isolation levels CS and RS are only used when specifically required by R/3 modules. This process improves performance while preventing simultaneous data changes that may result in data loss.

Cost-based Optimizer

Within R/3, systems RDBMS are used with cost-based optimizers (CBO) that generate “optimal” access plans for a given SQL statement. IBM has a proven cost-based optimizer that has been in place for many years with R/3 customers. The DB2 UDB CBO determines the access path based on the input data like

- Available table/index statistics
- CPU speed, number of processors
- I/O speed
- Database, tablespace, table structure
- Optimization level selected by the application
- Data Distribution

While some databases require the database administrator to hand-code optimizer “hints” to achieve performance, DB2 UDB does not require hints. Tight cooperation between SAP and DB2 UDB development ensures that DB2’s CBO is providing the best data access path without any manual intervention, even for complex SQL statements. This leads to lower cost of development.

Conclusion

Enterprise applications thrive on high performance, scalable and reliable database backbones. IBM, a leader in enterprise technology, provides a version of DB2 UDB for R/3 that harnesses the power of SAP’s R/3 multi-tier client server solution. Due to its technical superiority and battery of tools and utilities for managing the database system, DB2 UDB helps customers reduce the total cost of ownership.

IBM and SAP satisfy customer demands with coordinated worldwide, 7x24 hour support. The partnership between SAP and IBM in the utilization of IBM software components like DB2 UDB is longstanding and has proven to be highly beneficial for the ever-growing SAP customer base. The synergy of the two industry-leading companies results in a better return-on-investment for their enterprise software customers.