

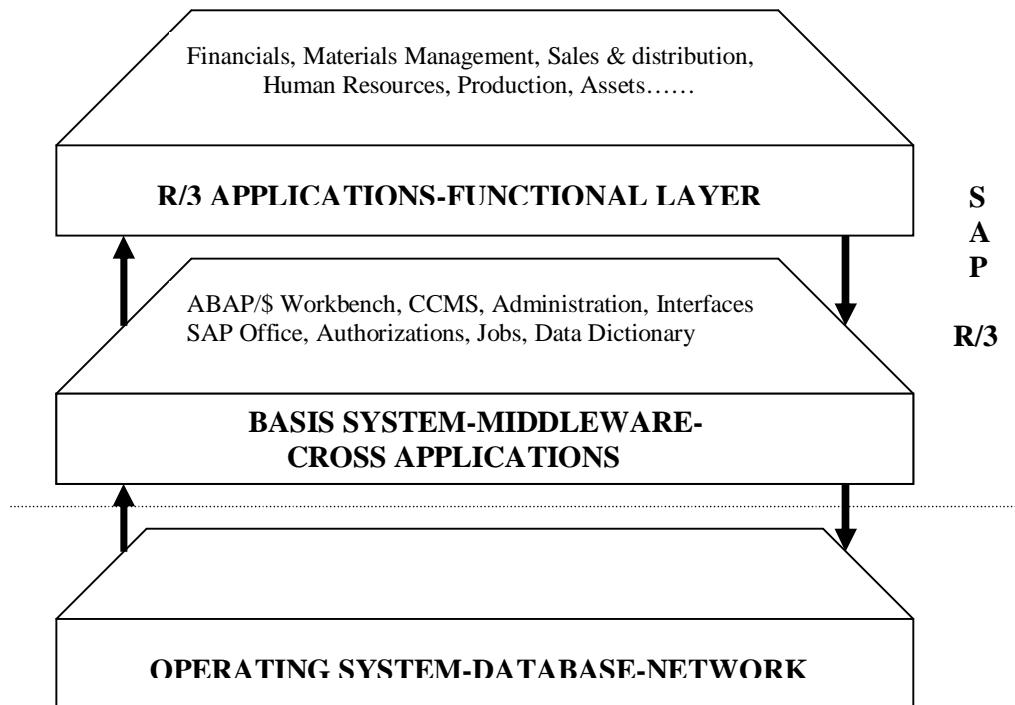
INTRODUCTION

After the Internet, sap r/3 is one of the hottest topics in the computer industry, and the company that developed it, SAP AG, has become one of the successful in the software market. The SAP R/3 system is targeted to most industries: manufacturing, retail, oil and gas, electricity, health care, pharmaceutical, banking, insurance, telecommunications, transport, automotive, chemical, and so on. All hard ware vendors, without exception, are fully engaged to partner with SAP: currently, AT&T, Bull, Compaq, Data General, Digital, Hewlett-Packard, IBM, Pyramid, Sequent, Siemens-Nixdorf, and SUN has supported and certified SAP R/3 platforms.

SAP AG was found in 1972 by four former IBM employees. Since its foundation, SAP has made significant development and marketing efforts on standard application software, being a global market player with its R/2 system for mainframe applications and its R/3 system for open client/server technologies.

The company name SAP stands for *Systems, Applications and Products in Data Processing*. It is a *standard software package* that can be configured in multiple areas and adapted to specific needs of the company. To support those needs, SAP includes large number of business functions, leaving room for further enhancements or adaptability to business practice changes.

FUNCTIONAL DIAGRAM



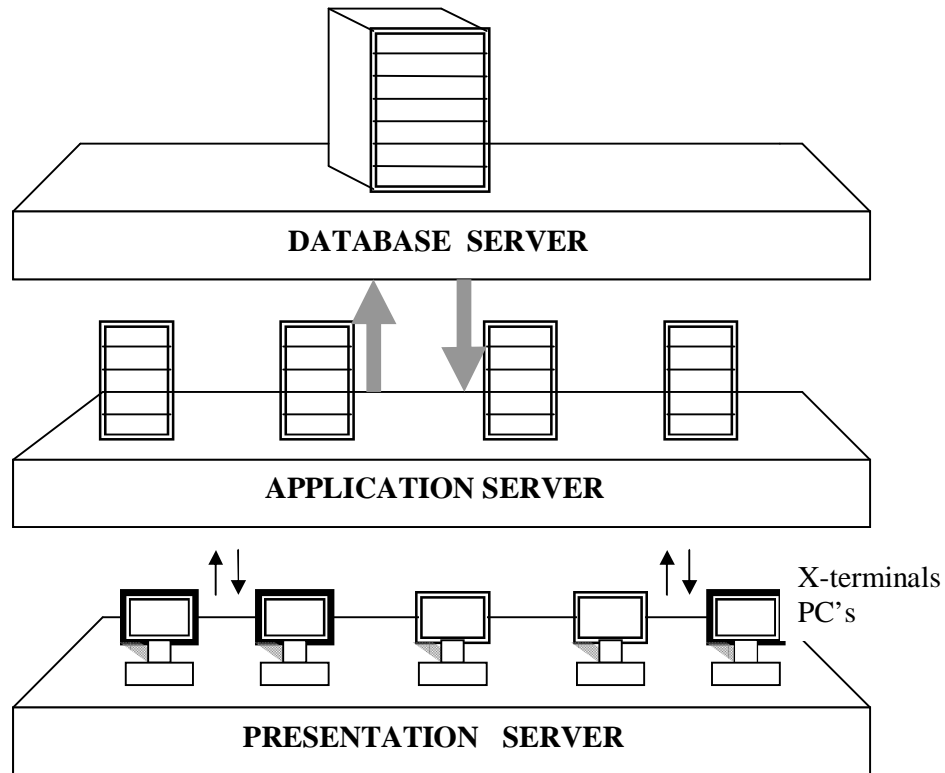
The lower layer is made of operating system, physical database (whose software is included in the SAP kit), and the network. The middleware layer, which is above it, interfaces with the lower one and integrates SAP applications on top of it. This middle layer is known as the *basis system*, or *R/3 kernel*, and includes components such as the ABAP/4 development work bench, the system administration tools, batch job handling, authorization and security management, and all *cross application* modules.

ABAP/4 is the 4GL (fourth-generation programming language) in which all R/3 applications (the upper layer) are developed. *Middleware* are the layered software components that facilitate the development of client/server applications that can be deployed in heterogeneous vendor platforms. The basis system, also known as kernel, is the SAP R/3 middleware.

The upper layer, the functional layer, contains the different business applications: financial, human resources, sales and distribution, materials management, and so on. The integration of all applications relies on the basis system.

The R/3 kernel makes use of standard communications and application program interfaces to access the operating system, the database, and the network. This architecture allows users to change system configuration and install new systems without interrupting or altering the applications themselves.

CLIENT/SERVER SOLUTION



In general *client/server* is a style of computing that distributes the workload of a computer application across several cooperating computer programs. This type of computing separates user-oriented, application, and data management tasks. Client/server is mainly a software concept that includes a set of service providers and service requesters. In client/server computing, individual software components act as service providers, service requesters, or both. These software services communicate with each other via predefined interfaces.

Major advantages of the client/server approach are as follows:

- **Flexible configuration.** With the deployment of standard communication interfaces, there are many possibilities for planning a client/sever installation: from a centralized configuration to a highly distributed system.
- **Workload distribution.** Since application servers work in parallel, and communicate with the data base, users can be evenly distributed based on their job tasks. Also there is the possibility of deploying dedicated application servers to specific business areas.
- **High scalability.** Client/server permits users to adapt their capacity of their hardware according to the performance needs of their businesses, such as adding application servers when there is an increase in the number of users, when additional modules start production, and when data base becomes larger. This enables companies to protect their hardware and software investments.

One of the widely used client/server configurations with the R/3 system is the three-tiered architecture, which separates system's computers in to three functional groups: presentation, application, and database. The central server contains the database, widely known as *database server*. *Application servers* include the processing logic of the system, including services such as spooling, dispatching user requests, and formatting

SAP R/3
data.

www.bestneo.com

The tasks related to presentation of data are handled by the *presentation servers*, which typically are personal computers or, workstations, enabling easy access to the system.

Communication among the three tiers is accomplished with the use of standard protocol services, such as the one provided by TCP/IP or CPIC.

The key to SAP/R3 success was the strategy of making *open solutions*, in which applications can run on multiple operating systems, databases, and communication technologies. This enables customers to remain independent of a single vendor if they wish.

ABAP/4 DEVELOPMENT WORKBENCH

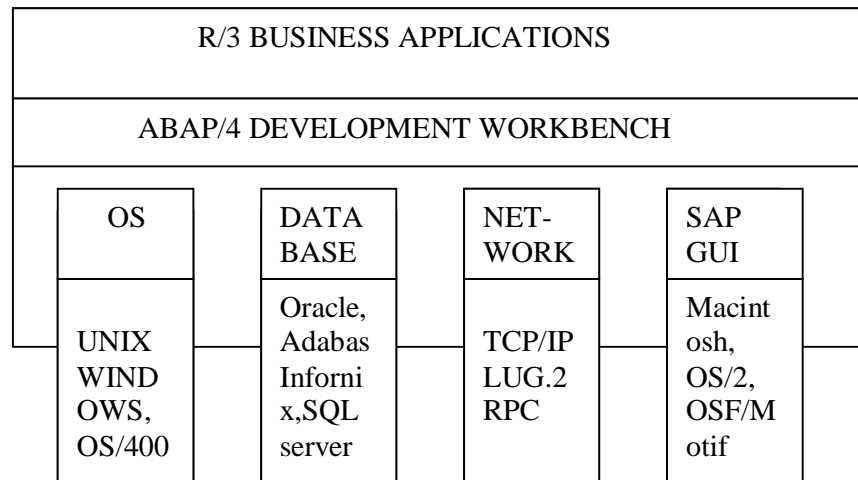
ABAP/4 is a 4GL (fourth-generation programming language); the acronym stands for *Advanced Business Application Programming Language*. It is the SAP programming language used in the development of all standard applications included with R/3.

On top of ABAP/4, SAP has designed a full-purpose development environment, known as the ABAP/4 development workbench, which is integrated with R/3 system and is available for customers to develop their own solutions and enhance or extend the capabilities of the existing applications.

It includes all tools necessary to develop and design programs, screens, menus, and so forth. It also contains performance and debugging facilities. Central to the workbench is the ABAP/4 object repository and the data dictionary.

Object repository stores all the development objects of workbench: programs, dictionary data, *dynpros* (dynamic programs), and documentation. The repository is the key to managing and testing ongoing development. *Data dictionary* contains the descriptions of the data structures used with in programs. This is metadata repository that includes table definitions, allowed values and relationship between tables.

ARCHITECTURE OF SAP/R3



SAP R/3 MIDDLEWARE

R/3 BASIS SOFTWARE

The basis software is the set of programs and tools which interfaces with the computer operating system, the underlying database, the communication protocols, and the presentation interfaces. This software enables R/3 applications to have the same functionality and work exactly the same way no matter what operating system or database the system is installed on. It is an independent layer which integrates all application modules. It is the kernel of SAP R/3 software.

In addition to that R/3 basis also provides:

- The environment for R/3 applications.
- System administration and monitoring tools.
- Architectural software client/server design.
- Authorization and profile management tools.
- Database monitoring and administration utilities.

The features of the R/3 basis system which enables these types of interfaces are as follows:

- The client/server architecture and configuration
- The use of relational database management systems
- Graphical user interface design for presentation

The R/3 basis system is based on standards: ANSI-C for the programming of the run time environment, Open SQL for embedded SQL calls inside, ABAP/4 for interfacing with the database, communication standards such as TCP/IP, and graphical interfaces such as Microsoft Windows, Motif, or Macintosh.

ARCHITECTURAL CONCEPTS

The R/3 system uses some widely known terms to which SAP gives some specific meanings.

TRANSACTION

Generally, a *transaction* is an operation that lets user make changes to a database. The overall R/3 system must be seen as a business transaction processing system.

In the SAP system, a transaction is a sequence of related steps. These logically related steps, known as *dialog steps*, are screens in which the data is introduced causing the generation of other events. There is a special transaction monitor, the *SAP dispatcher*, which takes care of handling the sequence of those steps.

The final task of transaction is to modify the information which ultimately goes in to the database. The transactions usually contain two phases: an interactive phase and an update phase. The interactive phase may be at least one step, but can have many. This phase is responsible for preparing the database records that can update the database. The update may be one step or many. This phase processes the previously prepared records and updates the database.

DILOG STEP

A dialog step is a SAP R/3 screen, which is represented by a dynpro. A dynpro, or *dynamic program*, consists of a screen and associated processing logic. A dialog step is controlled exactly by a dydpro.

LOGICAL UNITS OF WORK (LUWs)

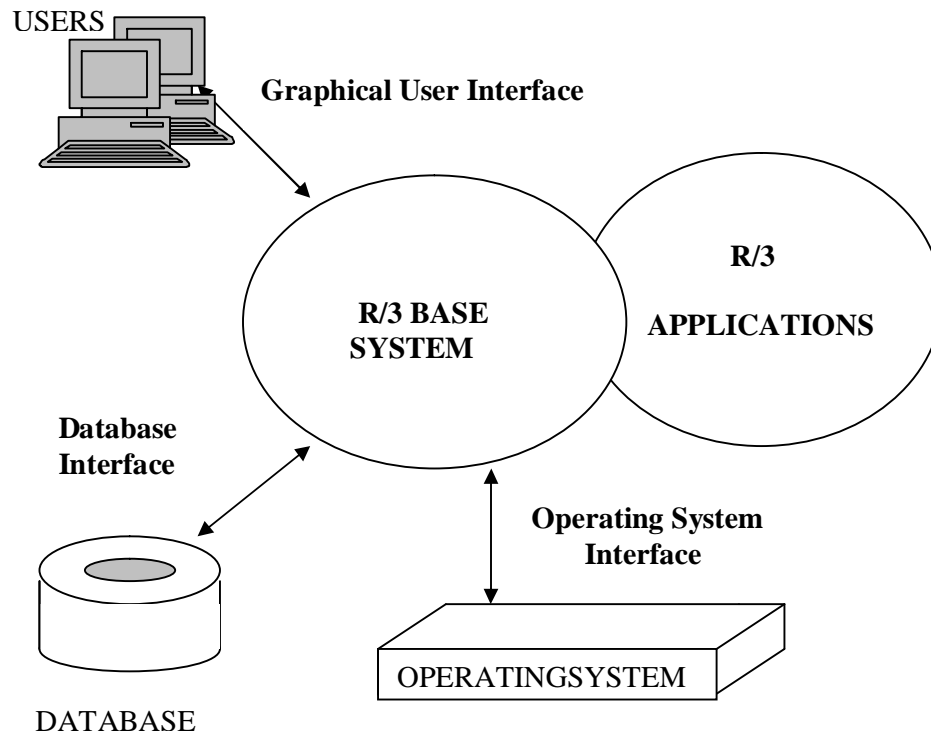
Conceptually, a logical unit of work (LUW) is an elementary processing step which works as a locking mechanism to protect the transactions integrity. A LUW is a set of steps with in a transaction, and all those steps must be correctly completed to go ahead with transaction logic. If there are errors before the end of transactions, the current LUW is canceled, but not the previous ones.

Three kinds of work processes can be distinguished.

- A database transaction, known as LUW or database LUW, is the period of time in which the operation requested must be performed as a unit. This is an all nothing operation, i.e. at the end of LUW either changes are committed or they are rolled back.

- An update transaction or SAP LUW is the equivalent to the database concept for the SAP systems. Generally it consists of numerous database LUWs.
- ASAP transaction or ABAP transaction is made up of set of related tasks combined under one transaction code.

SYSTEM CENTRAL INTERFACES



The R/3 middle ware is made of central interfaces as shown in the figure

- The interface with the operating system.
- The interface with the database.
- The interface for presentation.
- Communication can be seen as a special type of interface which directly or indirectly is present in the other three types.

For compatibility and portability reasons, all these interfaces are grouped together in the central interface functions of the SAP system kernel.

OPERATING SYSTEM INTERFACE

One of the main task of the operating system inter face is to guarantee the portability of the whole system. This done using an internal portability layer.This layer offers to the applications nearest services to the system, such as message handling and memory management, independently of the platform and optimized for performance. The inherent openness of R/3 makes it run over different operating systems, which has to be POSIX standard-compliant.

The mission of system interfaces is to provide services such as scheduling, memory management, and similar tasks, which could be partially done by the operating system software, but SAP executes them internally for portability reasons. The R/3 run time environment is written in ANSI-C, but all application programs inside R/3 are written in the interpreted programming language ABAP/4 developed by SAP.

The components in charge of controlling the user dialogs are the dynpros. The technology base for R/3 application is made of the interrelation of the dynpro interpreters and the ABAP/4 language.

From the view point of the operating system, the runtime system of R/3 can be seen as a group of parallel processes (*work process*). Among these processes there is a special one, *the dispatcher*, which controls and assigns tasks to the other processes.

DISPATCHER PROCESS

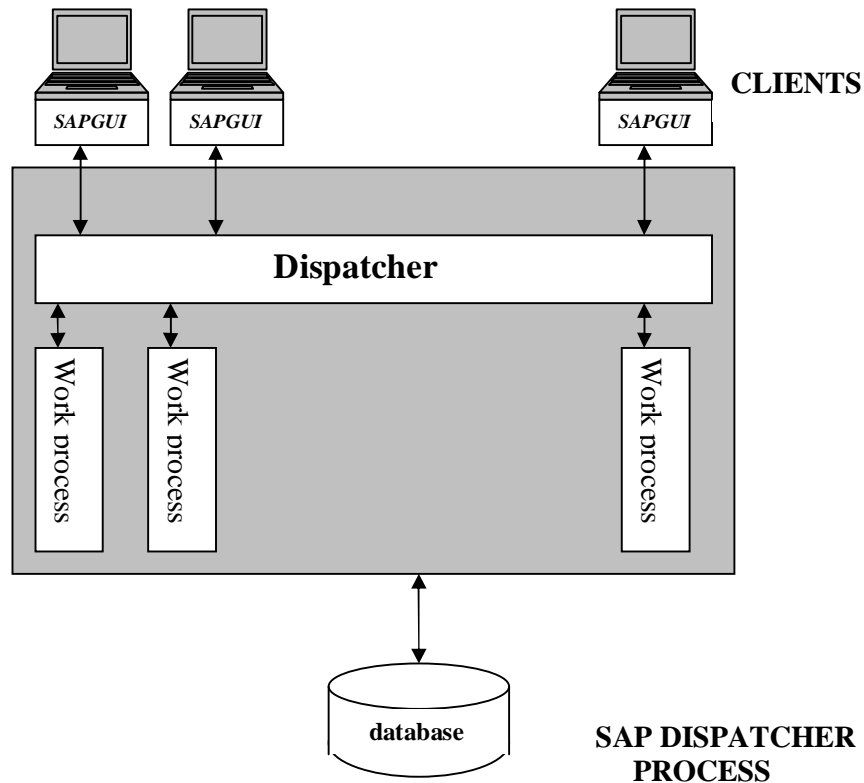
The SAP dispatcher is the control program which manages the resources of the R/3 applications. It works as a typical transaction monitor which receives screens and data from the presentation services and passes them to the corresponding work processes.

Using client/server terminology, a work process is a service offered by the server and requested by the client. Dispatcher manages the information exchange between the SAPGUIs and the work processes, enabling users to share the different work processes available.

Main tasks of dispatcher are as follows:

- Balanced assignment of the transaction load to the work processes.
- Buffer management in main memory.
- Connection with presentation level.

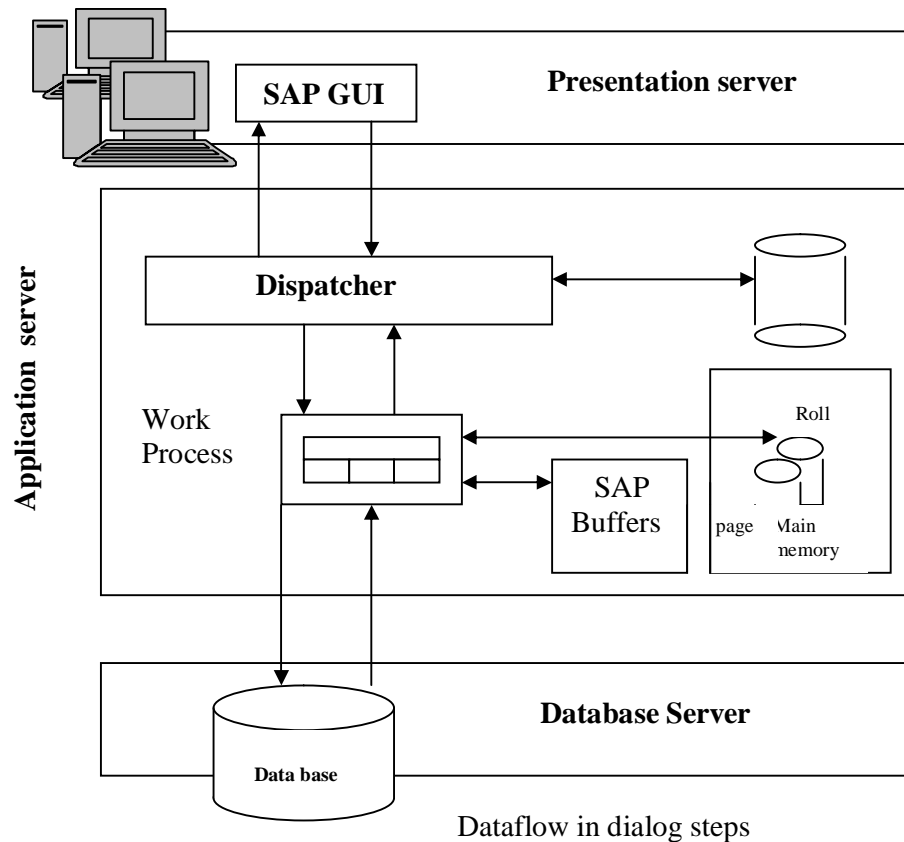
- Organization of communication processes.



The logical flow of execution of a user request follows:

1. Users enter data in the presentation server; the data is received by SAPGUI, converted to a SAP format, and send to the dispatcher.
2. Initially, the dispatcher keeps the requests in queues, where the dispatcher later processes them one by one.
3. The dispatcher allocates the user requests using the free work processes. The real execution takes place inside the work processes themselves.

4. At the end of execution, the result of the work process task goes back to the SAPGUI through the dispatcher. SAPGUI interprets the received data and fills up the user screen.

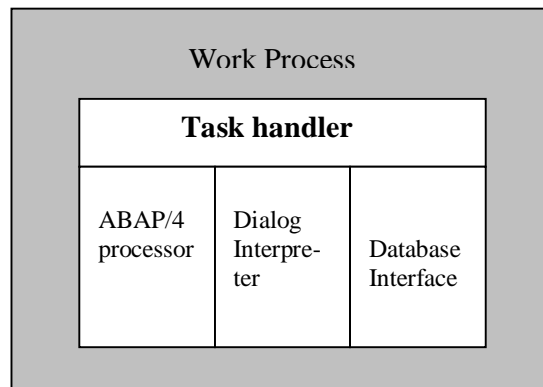


SAP has optimized the data flow between the presentation and application servers. Typically the quantity of data that goes in the network from dispatcher to the SAPGUI does not exceed 2K. The communication is established via standard TCP/IP sockets.

The dispatcher has a special advanced program-to-program communication (APPC) server built in to it which communicates and responds to requests submitted by the work

processes. On each application server there is one dispatcher but multiple work processes.

WORK PROCESS ARCHITECTURE



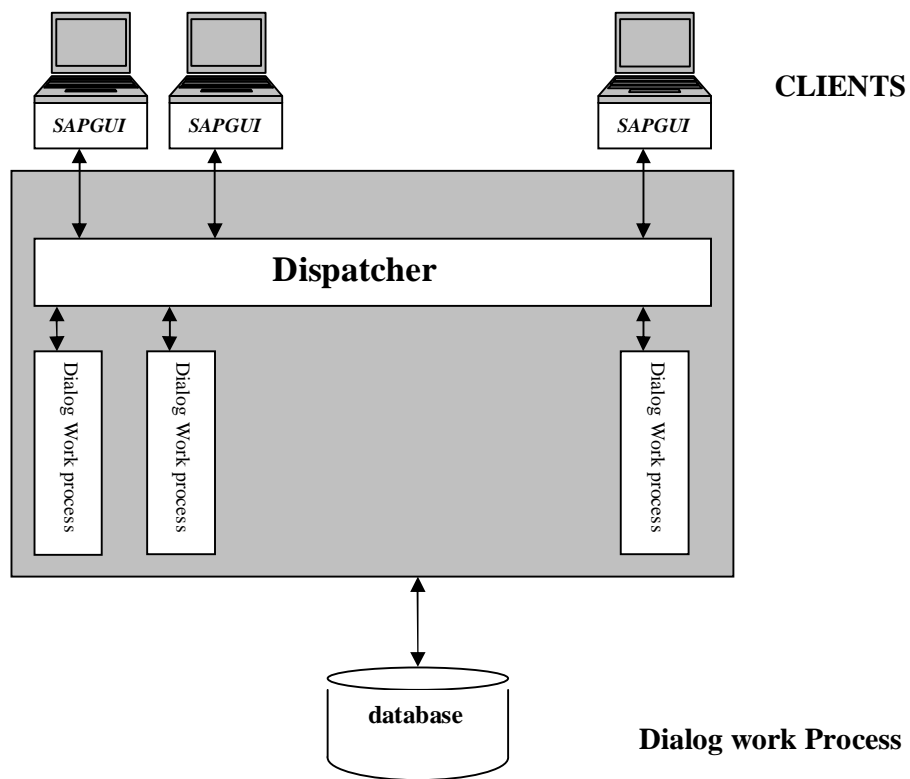
A work process is a program in charge of execution the R/3 application tasks. It consists of a task handler, ABAP/4 processor, dialog interpreter, and database interface. Activities inside the work process are coordinated by task handler. It is the control program inside the work process. The processing of the codes of the application program is done by ABAP/4 processor. Dialog interpreter manages the user dialogs. The database interface allows the work processes to establish direct links with the database.

SERVICES: WORK PROCESS TYPES

Depending on the type of services provided work processes are: dialog, batch, update, enqueue, spool, message, and gateway.

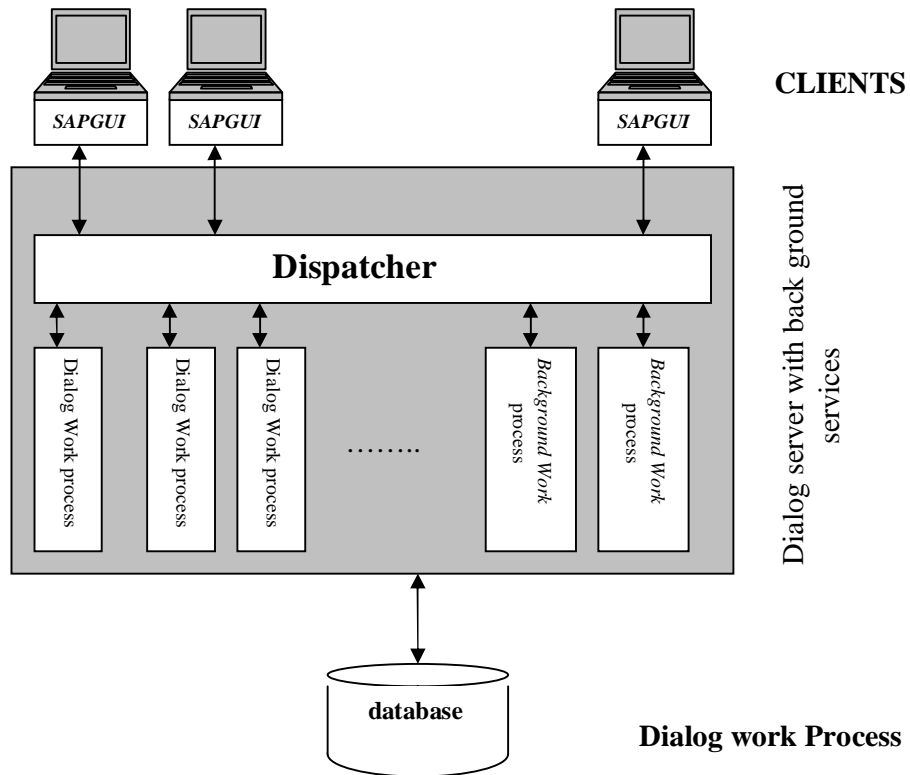
DIALOG WORK PROCESS

A dialog work process is in charge of the interactive tasks of the R/3 system. Dialog work processes execute just one single dialog step at a time and becomes immediately available for the next user request, which is assigned by the dispatcher.

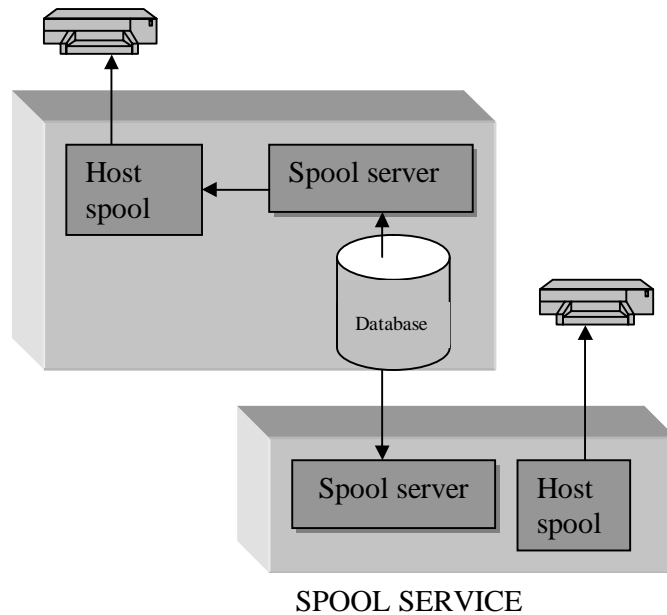


BACKGROUND WORK PROCESS

The back ground work processes are in charge of executing ABAP/4 programs submitted by for background execution. The ABAP/4 programs submitted for background processing are executed in the planned time by the background work processes.

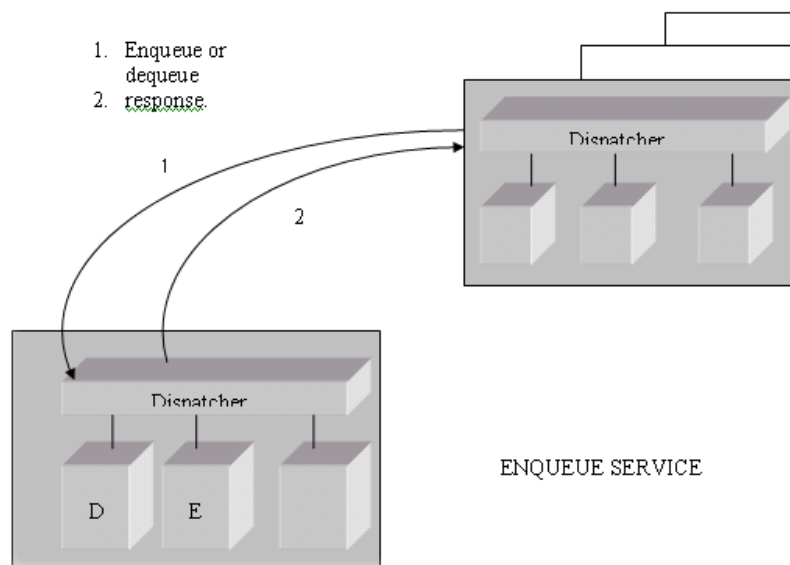


SPOOL WORK PROCESS



Spool work process is in charge of formatting the data for printing and passing it to the host spool system. The spool requests, indicating the printer and the printing format of the spool request, are generated during dialog or background processing and are held in spool database.

ENQUEUE WORK PROCESS

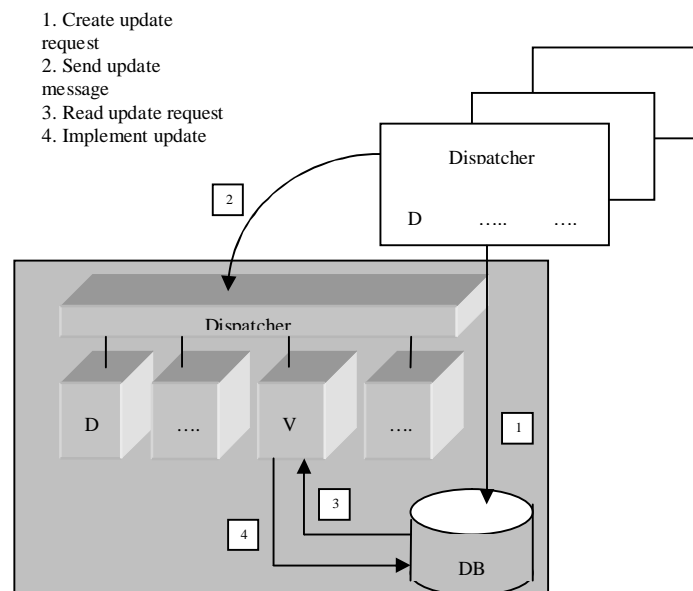


Enqueue work process is in charge of lock management system. In order for the system to run in a consistent manner, it must ensure that when a transaction's dialog steps are handled by different work processes, they retain the assigned locks until the end of the transaction or intentional release of lock, even when switching work processes.

Locks are managed by the enqueue work process using lock table which resides in the main memory. Locking objects are of two types: type S, object that can be shared, type E, objects that cannot be shared.

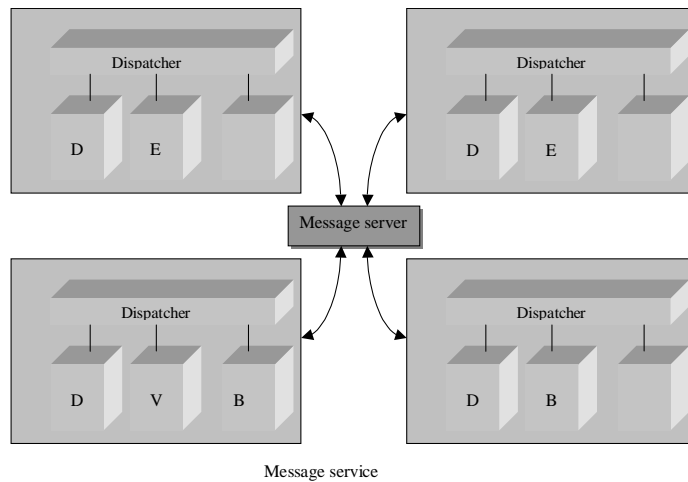
UPDATE WORK PROCESS

The update work process is in charge of executing database changes when requested by the dialog or background work processes. A dialog program first generates log records in the VBLOG table, which are then passed by the update program once dialog is finished. The update log record can have two components, primary update component (V1) and secondary update component (V2). Time critical processes are held inside the V1, less critical ones inside V2.



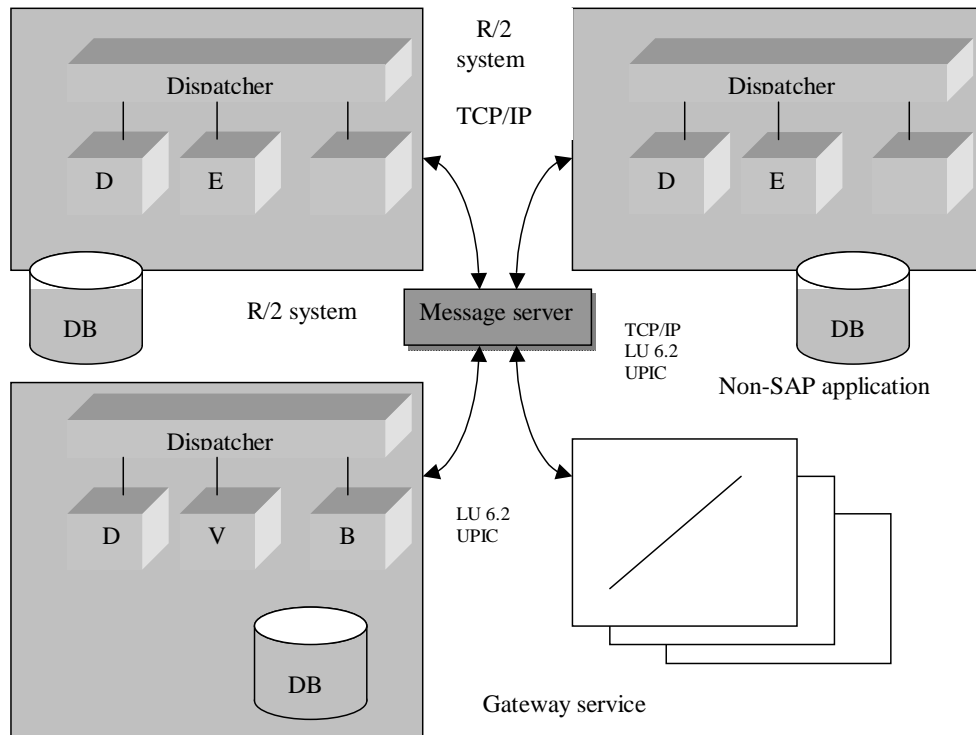
MESSAGE SERVER

The message server is a service used by the different application servers to exchange data and internal messages. There is only one message server per R/3 system. Every application server has a unique name for the message server.



GATEWAY SERVER

The gateway services allow the communication between R/3, R/2, and external applications.



PRESENTATION INTERFACE

The presentation interface is the component is in charge of making functionally equivalent the presentation and handling of R/3, no matter the type of front end used.

The connection between the SAPGUIs and the SAP dispatcher is made with an optimized protocol, in which small data packets are send through the network. The presentation interface allows for upload and download functions from the application server.

DATABASE INTERFACE

The underlying database of he SAP/3 system acts as the main container for all the information managed by the system. The database interface supports different relational databases from different vendors. The main task of the database interface is to convert SQL requests from the SAP development environment to the database's own SQL requests.

SAP R/3 COMMUNICATION PROTOCOLS AND INTERFACES

Inside R/3, communication is an overall process which involves most of the components of the systems both internally and to the exterior world. At the operating system level, the protocol used is TCP/IP. Communication with the database is accomplished using remote SQL calls. Between applications there are many programming interfaces which use an underlying communication layer, such as CPIC, RFC, ALE, and EDI.

The communication interfaces are employed to integrate all the layers of the client/server architecture, from database server to application server to presentation servers. Additionally they define channels for exchange of information.

APPLICATIONS

The R/3 applications are usually categorized in three core functional areas: financial, logistics, human resources. Additionally SAP actively develops special software packages on top of R/3, targeted to specialized vertical industries.

SAP financial modules give customers the whole picture of accounting functions, with excessive report facilities to allow for fast decision-making support. They are also suited for international corporations with multiple subsidiaries, including support for foreign currencies and multilingual capabilities.

HR modules include all necessary business processes to efficiently manage all the needs of a company's human resource area- application screening to payroll accounting or personnel development.

Logistics applications manage all processes involved in the supply chain of goods: from raw material procurement to final customer delivery and billing.

CONCLUSION

Looking from whole point of view SAP R/3 is one of the suitable software for managing large number of business processes. SAP AG provides online service systems for administration and guidance. It provides consulting, information and maintenance services for the customers of SAP/3 software. Thus SAP R/3 would be the most suitable software package to almost every industrial application for medium as well as large scale industries.