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1.1 Major Characteristics of AS/400

The AS/400 is IBM's new generation of full-range, multi-user, and general-purpose computer system. Although it is generally considered a mid-range system, the AS/400 is a mid-range in price and size only. The power and functionality of the AS/400 are far more advanced than its mid-range counterparts, such as System/36 and System/38. The higher-end models of the AS/400 offer size and power comparable to the mainframes, although not with respect to cost.

AS/400 is reputed for its ease of use and high level of system integration that includes the state-of-the-art system architecture, object oriented technology, and integrated database. More recently, the AS/400 has made significant inroads into networking, client/server computing, internet, intranet, and Web with the release of new system models, new version of operating system, and software designed for the net generation. All in all, the AS/400 has become the server of choice as the in the enterprise-wide internet, intranet, and client/server environment.

The system architecture of the AS/400 provides many distinctive features that form this revolutionary system. These features include:

- High level of integration
- Object orientation
- Relational and integrated database
- Data and program independence
- Single-level storage
- SAA conformance
- Client/Server technology
- Domino groupware enabling
- Internet, Intranet, and Web enabling
- SAP enabling
- e-business solutions and the net generation
- Year 2000 Ready Solutions

1.1.1 High Level of Integration

One of the most distinctive features of the AS/400 system architecture is its high level of system integration. Unlike traditional systems that generally separate their database and application development tools from their operating system, the AS/400 offers a full-fledged operating system that integrates most aspects of the machine and user interface. On the AS/400, the work management, storage management, database, control language, query management, security management, and

application development tools such as Data File Utility, Source Entry Utility, Programming Development Manager, and Screen Design Aid are all preloaded and integrated into the AS/400 operating system. This high level of integration offers the following advantages:

It provides a single, consistent interface to all the system functions.

It greatly reduces the cost of the system. For a traditional system, users frequently must purchase the operating system, storage management, database, and application development tools separately with significant add-on prices. For the AS/400, users need only pay for the hardware and the operating system. The database and most other utilities are preloaded and integrated into the operating system. All are shipped with the operating system.

It greatly reduces the need for technical support, which has been traditionally provided by systems programmers, database administrators, and technical support specialists. The high level of integration means that the operating system now supports the system and management functions of the database and utilities, which are now part of the operating system's structure.

1.1.2 Object Orientation

An object-oriented approach is fundamental to the system architecture of the AS/400. On traditional systems only compiled programs are called objects. This is not true on the AS/400. In addition to compiled programs, many other items are also objects on the AS/400. In fact, nearly everything on the AS/400 is an object, and objects are differentiated from one another by their names and types. Each type of object has unique characteristics and purposes within the system. Among the major types of objects are programs, files, libraries, commands, user profiles, job descriptions, folders, subsystems, job queues, message queues, and output queues.

AS/400 object management provides functions necessary to group objects, to differentiate object types, and to locate and retrieve objects needed for processing. Object management keeps track of files, programs, libraries, queues, and all other types of objects on the system. Object-oriented architecture offers users flexibility in performing system and programming functions on the system.

1.1.3 Relational and Integrated Database

The AS/400 database, named DB2/400, is a relational database. It is one of the few systems that provides an integrated database that is part of the operating system. There is no need to purchase, install, and maintain a separate database. Some advantages of an integrated database are standardization of data definitions and structures, lower initial and maintenance costs, automatic data management and processing, and improved productivity.

The database model of DB2/400 is relational. However, unlike other relational database management systems, which owe their structure to a collection of tables and views, DB2/400 masks the terms commonly used in other relational databases (i.e., tables and views) and, instead, uses the terms of physical files and logical files to accommodate the programming requirements of the system. Despite the difference in the terminology, DB2/400 is fully relational. It embodies the structure and functions of a relational database management system.

1.1.4 Data and Program Independence

On most traditional systems, programs are tied very closely to the way the data are defined and stored on the system. Record layouts of the files (i.e., record and field specifications) are defined in the programs that process the files. When file layouts are changed, such as by adding new fields to the file, all the programs that use the file must be changed and recompiled.

The AS/400 database management system, on the other hand, separates data definitions from programs by offering externally described files in addition to the traditional program described files. An externally described file is defined by a data definition that exists outside the

programs. Data Description Specifications (DDS) are used for describing files externally. There are several advantages to making data independent from programs:

It reduces the need for file and program maintenance.

It improves data integrity.

It increases programmer productivity.

1.1.5 Single-level Storage

AS/400 storage management implements a virtual storage scheme through an advanced structure called single-level storage. The term virtual storage refers to a technique for managing a limited amount of main memory and a much larger amount of lower-speed disk storage in such a way that the distinction is largely transparent to users.

On the AS/400, all disk storage is regarded by the operating system as virtual memory. No distinction is made between disk storage and main memory. All storage appears to be one homogeneous sea of main memory. Unlike most traditional systems that utilize virtual storage, the AS/400 creates and maintains only one address space for its objects. Other virtual storage implementations must create and maintain separate address spaces and often treat programs different than they treat data. The simplicity of single-level storage results in a consistent and more complete virtual storage system than most other systems.

1.1.6 Systems Application Architecture (SAA) Conformance

Systems Application Architecture (SAA) is a blueprint published by IBM to provide open communications architecture for developing consistent applications across IBM's major computer systems. SAA utilizes an extensive set of software interfaces, conventions, and protocols that provides a framework to guide users building open integrated information systems. The three key elements of SAA are:

Common Communications Support (CCS): a set of standards for connecting and communicating computer systems.

Common Programming Interface (CPI): describes the languages to be used by developers to build SAA compliance applications.

Common User Access (CUA): a set of screen standards used for interacting between applications and users.

The following table shows the three major systems covered by SAA:

System Operating System	
Mainframe	MVS/ESA and VM/ESA
AS/400	OS/400
PC	OS/2

The AS/400 fully supports SAA. It ensures horizontal and vertical growth and enhances the customer's investment in application software.

1.1.7 Client/Server Technology

Client/server technology is the single most irresistible movement in the computer industry in recent years. It represents a new concept and technology that links computers from different platforms. In a client/server environment, one or more computer systems function as servers that provide services to their client systems. The services offered by server systems include administration of data retrieval and update, data processing and computing, and distributed data management.

Client/server computing links the intuitive graphical user interface of client computers with the processing power and sophisticated database of a server computer. It allows end users from client systems such as PCs to access data and request services from a server such as the AS/400. With its many advanced client/server hardware and software features, the AS/400 is very well positioned in the client/server market segment. See Part 4 for more details about client/server technology on AS/400.

1.1.8 Domino Groupware Enabling

Groupware is a software that allows an user to work together with a group of other people. The groupware enables you to:

- Create database to be used by a group of people working on a common project.
- Send e-mail to individuals and groups in an organization.
- Collect data from individuals in a group or in an organization.
- Combine data, spreadsheets, graphics, text, and tables from different systems and sources.

Lotus Notes/Lotus Domino, or simply called Notes and Domino, arguably, is the most widely used groupware in the industry. Lotus and Domino go hand in hand, and use computers all connected together in a Client/Server and network environment. The clients are individual computers (i.e., PCs or workstations) that are connected together by a server acting as a central nerve center for the Notes network. The Notes' server is named Lotus Domino or simply called Domino. In other words, Lotus Notes is the client product that runs on a variety of workstations, and Lotus Domino is the server product that runs on a variety of server platform. Server Domino integrates multiple Notes' clients.

AS/400 is enabled to be the server in the Notes network. It is a full-fledged Lotus Domino server that allows multiple clients to be connected and administer by a single AS/400 server. The AS/400 Domino server is named Domino for AS/400. It combines the strength of AS/400 and Lotus Notes to allow the integration of Domino database and DB2/400 database, flexible network communications, mature system administration, and proven security.

1.1.9 Internet, Intranet, and Web Enabling

Internet is the world-wide "network of networks" that are connected to each other sharing information. Intranet is an organization's internet network that uses internet tools within the organization. World Wide Web, or simply called WWW or Web, is a mesh of interconnected

servers and clients that use the same standard format for creating documents (HTML) and accessing documents (HTTP).

Internet technology is fundamentally changing the way organizations do business. AS/400 provides internet, intranet, and Web support such as:

TCP/IP (Transmission Control Protocol/Internet Protocol) and LAN (Local Area Network) networking capabilities.

Internet Connect for AS/400 enables you to put together internet and intranet solutions in an organization. AS/400 is enabled to be used as a Web server. DB/2 WWW can deliver data to users over the internet or intranet. The AnyMail server provides an integrated e-mail service between an AS/400 internet server and Lotus Notes on various client workstations. The IBM Internet Connect Secure Server (ICSS) for AS/400 supports the Secure Sockets layer (SSL) protocol for securing World Wide Web communications between an AS/400 server and Web browsers.

In the system area, AS/400e series and advanced series with Internet Connect for AS/400 delivers the simplicity and ease of use in an internet and/or intranet environment.

Firewall for AS/400 provides security and data integrity in the internet environment where AS/400 is the internet server. It controls the access and flow of information between a secure network and an unsecured network.

1.1.10 SAP Enabling

SAP AG, is the third largest software company worldwide. It is the world's leading provider of client/server business applications. Its suite of client/server data processing products, called SAP R/3, is based on the concept of combining all the business activities and technical processes that are used within an organization into a single, integrated software. SAP R/3 has been installed in most of the Fortune 500 companies, and has become a software standard in many industries.

SAP AG and IBM AS/400 Division have been working together to provide "business re-engineering" and the "ultimate business management solution" for organizations. Both companies are worldwide leaders in their respective fields. AS/400 is the leading commercial business system with over 275,000 systems installed in over 140 countries. SAP AG is the leading provider of integrated business applications in more than 4300 companies and is represented in 41 countries.

The strengths of both AS/400 and SAP R/3 system complement each other to provide a complete business solution. The SAP R/3 System on AS/400 provides user interface (presentation clients), application logic (application server), and data management (database server). It allows SAP R/3 to port on AS/400, incorporating AS/400 existing function into R/3.

1.1.11 e-businesss Solutions and Net Generation

The term, "e-business solutions", is used by IBM to emphasize the information system technologies that integrate internet, intranet, web, electronic network, client/server, and traditional

data processing capabilities for companies to conduct their business in a the net generation. Please note that the first letter of e-business "e" is not supposed to be capitalized.

AS/400e series is an integrated system designed to reduce complexity and provide faster development of e-business applications. It offers a series of new system models, including AS/400e server, such as Models 150, 170, S10, S20, S30, and S40, and AS/400e system, such as Models 600, 620, 640, and 650. These models have expanded their integrated environment to embrace today's newest Web technologies.

AS/400e series with the latest release of the AS/400 new system models, the new release of AS/400 operating system, and a variety of new Web enabled software offering including Domino for AS/400, DominoGo (formerly Internet Connection Server), Java, Net.Commerce, and Net.Data, makes it easier for an organization to conduct its business in the net generation.

1.1.12 Year 2000 Ready Solutions

All AS/400 system models running on AS/400 operating system, OS/400, are Year 2000 ready. From its cutting-edgy applications to its advanced technology, AS/400 provides year 2000 interfaces that are fully integrated and tested.

For any organization that uses application software, such as Accounts Payable, Inventory Control, and Cost Accounting, chances are that these software rely on accurate date calculation. The organization must ensure that its hardware, operating system, and applications are Year 2000 ready. If that organization currently runs on AS/400, it is ready for Year 2000 on all counts.

AS/400 operating system incorporates flexible ways to handle dates and use dates in calculation. In addition, AS/400 and IBM business partners provides a number of tools and application software designed to assist organizations with their Year 2000 transformations. These products provide AS/400 users and developers with a standard set of system calls for date retrieval, date arithmetic, date format conversions and other routines. An impact analysis tool and a conversion tool, SEARCH2000 and BYPASS2000, developed by an IBM business partner, assist in finding dates, identifying their formats, and converting old date formats to new formats.

1.2 Operating System/400

1.2.1 The Integrated Operating System: OS/400

An operating system is a set of software routines that directs the operation of the computer. It manages the hardware resources and executes tasks under the control of software or interactive commands. All AS/400 models are supported by a single, integrated operating system called Operating System/400 (OS/400).

OS/400 is a preloaded, integrated operating system for all models of the AS/400. The single, integrated system approach makes it easy for AS/400 users to upgrade their models within the system unit and to standardize their software development. For users who have a System/36 or System/38, OS/400 provides migration capabilities to the AS/400.

In addition, OS/400 uses the blueprints and principles of Systems Application Architecture (SAA). It allows support for many application programs that have already been developed on other operating systems such as MVS/ESA. It also provides features for connecting the AS/400 with other IBM systems and for sharing data and documents.

OS/400 controls the operating system functions, manages system resources, controls security, handles messages, supports database management, provides work management, and controls job processing. The key components and functions of OS/400 include

Work Management controls job processing. This allows multiple interactive and batch jobs to run simultaneously in different subsystems and job queues. It also schedules jobs and governs input and output spool functions.

Database Management facilitates the retrieval, addition, and updating of data on the AS/400 database. It adopts the relational model for a database management system. This allows users to use physical files as well as logical files. It also permits data definitions to be independent from application programs and, thus, ensures greater data integrity.

Communications Support offers a wide range of communications and networking capabilities. It allows the AS/400 to communicate and transfer data among AS/400 machines, mainframe systems, and PCs.

Control Language (CL) provides CL commands and CL programs that allow users to perform various system, operational, and programming functions.

Application Development Support provides utilities such as Source Entry Utility (SEU), Data File Utility (DFU), Programming Development Manager (PDM), and Screen Design Aid (SDA). They are collectively called the Application Development Tools. These utilities increase the productivity of application programmers in developing and maintaining application software.

System Operation Support allows operators to perform work from the system workstations using menus and CL commands.

Message Handler controls communications between the users, between users and the operating system, and between users and programs.

System Security polices system access, manages object authorizations, and protects data and other system resources from unauthorized access.

Online Help and Index Search allows users to obtain instant information through the use of Help Key, command prompting, and Index Search.

Object Management provides the functions necessary to create objects, to maintain objects, and to locate and retrieve objects for processing in accordance with the names, types, and attributes specified by users.

Storage Management performs functions necessary for placing objects into storage, for retrieving them from storage, and for updating objects in storage. It also allows users to compress storage and reclaim storage space.

Query Management provides a query utility that enables users to retrieve data from the database and to create and format reports quickly and efficiently.

1.2.2 Java's Integration into the AS/400 System

OS/400 enables integrated network computing, object-oriented portability, and Web technology to open gateway for Java functionality. The latest release of AS/400 operating system provides an integrated Java compliant implementation that includes Virtual Machine (JVM). JVM is implemented under the machine interface (MI), the AS/400 Developer Kit for Java, and the AS/400 Toolbox for Java.

Java has become predominant programming language for Web development and network computing. It can be used for stand-alone applications or client/server applications running over the internet. Remote Method Innovation (RMI) is built into the AS/400 Java software and can be used to communicate with AS/400 Toolbox for Java. Only the client part of the client/server applications need to be written. Since the client application programs are written in Java, they can run virtually on any client platform (i.e., PC or UNIX) that communicates with the AS/400 server. Client application programs can be developed using IBM Visual Age for Java. The Visual Age for Java software is delivered with OS/400 license.

1.3 AS/400 Advanced Series

1.3.1 A Full Range of Product Lines

The AS/400 system units consist of a family of models that forms a full range of product lines. Since its introduction in 1988, these modes have been revamped many times. They have evolved from the original B models to C, D, E, and F models, with each new generation of models becoming more powerful and versatile than its predecessor.

As part of the client/server product strategy, the AS/400 product lines were overhauled. This new family of products, called the AS/400 Advanced Series, include three major lines: Advanced Portable Model, Advanced System Models, and Advanced Client/Server Models.

Advanced Portable Models

AS/400 Advanced Portable models P02 and its subsequent P series. As the name implies, it is a small, portable, and highly mobile computer. The portable system is targeted toward AS/400 users who operate in a single-user environment and who need greater flexibility and mobility.

Advanced System Models

The AS/400 Advanced System Models are the first to offer IBM Powerful 64-bit RISC PowerPC AS microprocessors. The Advanced System models are optimized for business transactions in a batch mode as well as for an interactive server environment. All Advanced System models offer various processor capacities, which are identified by different feature codes. This allows customers to choose the different features from the same model based on their speed and performance requirements.

Advanced Server Models

The AS/400 Advanced Server Models are the core of IBM's new client/server hardware solution. These models are specifically designed and built for client/server computing. They use different processors and microcode designed to meet the special requirements of the client/server environment.

1.3.2 Major Traits of the AS/400 System Units

The AS/400 system units have many unique traits. Some of the more important traits include

All AS/400 models use the same operating system, OS/400.

All AS/400 models use the same database, DB2/400.

All AS/400 models use the same basic utilities, including PDM, SEU, DFU, and SDA.

1.4 AS/400e Series and e-business Solutions

1.4.1 e-Commerce and e-Business Solutions

The latest industry buzz is the development of Web applications, such as e-commerce, internet, and intranet that integrate an organization's in-house systems and database with Web Browser interfaces. The introduction of new AS/400e series is intended to position AS/400 as the server platform for e-commerce and to provide integrated solutions for the net generation. The term, "e-business solutions", is used by IBM to depict the solutions that integrate operating system, database, network, software, and applications in a single system platform such as AS/400. Please note that the first letter of e-business "e" is not supposed to be capitalized.

AS/400e series are the collection of new models that embrace latest internet and web technologies in order to provide e-business solutions to organizations to conduct their business in the client/server environment. The solutions combine the latest internet, intranet, web, and client/server features with the traditional information system technologies that allow organizations to conduct their business competitively and effectively.