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IBM U.S. PRODUCT LIFE CYCLE  
IBM U.S. Product Life Cycle Dates

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ABSTRACT

The following description of OS/400 includes functions announced specifically for V4R4 along with functions announced previously.

HIGHLIGHTS

- o Single Integrated Operating System for All Models

- o Investment Protection
- o Network Computing
- o Logical Partitioning
- o Client/Server Support
- o Integrated DB2 Universal Database for AS/400
- o Transaction Processing
- o Batch Processing
- o Ease of Installation, Use, and Maintenance
- o Extensive Run-time Application Function
- o Productive Application Development Environment
- o Integrated Language Environment (ILE)
- o Enabling Technologies
- o Openness
- o Optical Support
- o High System Availability
- o Systems Management
- o Electronic Customer Support
- o Comprehensive Security for System Resources
- o Interfaces to System Functions
- o Printed Output Support
- o Multiple Operating Environments
- o Connectivity to Remote Devices, Systems and Networks
- o Office Host Services
- o National Language Versions and Multilingual Support

The IBM Operating System/400 licensed program provides system support for all models of the IBM AS/400 System. The single Operating System spanning all models of hardware represents a significant protection of customer investment in skills and applications. OS/400 benefits are:

- o Supports the highest number of commercial host and client/server business applications (including 64-bit) available in the industry.
- o Provides ease of implementation, management and operation in one totally integrated operating system.
- o Optimizes commercial and client/server environments with excellent performance across the system models.
- o Enables low total cost of ownership through its many integrated functions and ease-of-use.
- o Customers can consolidate their systems. Consolidation provides the potential to reduce the costs associated with installing, operating, and maintaining numerous different computer systems while preserving the customer's investment in applications, operations, and end-user knowledge.

## DESCRIPTION

SINGLE INTEGRATED OPERATING SYSTEM FOR ALL MODELS:

All functions of the OS/400 follow a consistent design philosophy; this consistency is one of the cornerstones of AS/400 ease-of-use. The ease-of-use translates into higher productivity for its users and easier systems management. The Operating System/400 licensed program includes everything described in this document. Some important characteristics are:

- o Object-Oriented Architecture

All system and user resources are stored on the system as "objects," having a consistent architecture. Every object includes a description containing such information as the name of the creator and current owner, date created, object size (in bytes), date of last save, date of last reference, volume identifier of the media on which the save occurred, and text describing the object.

- o Library Support

A library is a directory to objects (for example, programs and files), allowing a convenient grouping of the objects for either application or control purposes. Options exist to display, delete, or change objects in a library or to move or copy an object from one library to another. This function makes systems management of authorization to objects easier. The normal method of processing is to use a list of libraries to control how the system accesses objects. A library can also be secured to prevent unauthorized users from accessing any objects.

- o Single-Level Storage

Object placement on different disk units is controlled by the system. The auxiliary storage disk units contribute to an overall pool of storage called single-level storage. It is not necessary to be concerned with the size of individual objects or where they are placed; the libraries are used to locate any object. The architecture provides additional disk allocations automatically as an object (for example, a physical or logical file) grows in size. You need to monitor only the overall use of auxiliary storage. This contributes significantly to the ease of operating the AS/400 system. Auxiliary storage capacity can be added as needed without changing current application programs.

- o Message Handling

Messages are displayed for various system and user operations. Message handling functions allow feedback for successful operations or to identify error conditions. Messages can be defined and sent between users, between users and applications, or between applications. Message replies can be sent; a "break" option allows immediate interruption of the end user's activities.

- o Job Accounting

The system supports multiple levels of job accounting and captures job-related information through the assignment of account codes to users. The accounting information on defined units of work is recorded in a journal receiver and may be accessed and processed by user-written programs.

o Device Support

The operating system supports use of:

- Tape and diskette devices for data interchange and save/restore functions. A high level language (HLL) program or the copy command can read or write directly to a specific device.
- A CD-ROM device (read only) for software and PTF distribution
- A range of work station printers for data processing or text quality output. Graphics (bar codes and images) may be printed with these devices.
- A range of work station displays, attached locally or remotely. Some devices support graphical data display.

o Display Data Management

Interactive applications are supported by a screen definition language that provides greater flexibility in designing the "look and feel" of interactive interfaces. In addition, many attributes of the screen can be controlled outside application programs to simplify the development effort and improve programmer productivity (for tasks like validation of keyed input and punctuation of numeric output). Cursor-sensitive help information may be designed into user applications, including use of hypertext and index search function that allows easy access to descriptions of system functions.

o Data Areas

The operating system supports local and global data area objects that allow storage of up to 2,000 bytes of information. Global data areas can be accessed and updated by various programs within a single job or across jobs. A local data area can also be used to pass information between programs operating within a job or to programs the job has submitted to batch. Data areas are also directly supported by some HLLs.

o Data Queues

The operating system supports a call interface to send and receive information from a data queue object. This is designed to handle job-to-job communication with a high volume of requests.

o Work Management

The work management function eases the job of systems management by giving the operator control of the activities of a job and of its performance characteristics. Work management supports concurrent execution of batch jobs, interactive jobs, and non-conversational transactions on the system. Each job is protected from other jobs on the system; however, job-to-job communication is allowed.

Different levels of interfaces to work management allow users to operate with the system defaults or tailor specific functions. Automatic tailoring of the execution environment to the CPU model, size of main storage, and configured devices can be done using an option. This automatically-established execution environment should provide good performance for many installations, although better performance may be achieved in some installations by explicitly changing some of the execution environment attributes.

In addition, there is an option to allow the system to dynamically adjust the execution priority of jobs that are forced to wait for an opportunity to use the CPU. This is designed to prevent high priority jobs from monopolizing the CPU at the expense of all other jobs in the system.

- o Save/Restore

Save is the capability of making a backup copy of objects or members on tape, diskette, or online save file. Restore is the capability to copy saved objects back to the original or a different system. Objects saved on V4R4 systems can be restored on V3R2, V4R2, and V4R3 systems. The OS/400 save/restore functions are designed to ease the job of systems management.

Saves can be done by library, object, changed object, or for all auxiliary storage, without regard to library or object contents. The system is available when saving documents and folders during normal operations; however, documents being updated during the save process are not saved.

"Save while active" enables objects to be saved while they are being used by applications. The system ensures the entire object saved to the save media is consistent with the status of the object when the save operation was initiated. However, it is the user's responsibility to establish an application synchronization point either by temporarily quiescing the application for the time required to initiate the save operation or using journal/commit for all processes which impact any objects related to the save operation.

Copying to a save file allows an unattended, off-shift save with a subsequent copy to media when the system operator is available.

- o Remote or Timed IPL

Key to convenient system management is the capability to power on the system manually or automatically, at a specific time of day, and from a remote location. Power down of the system can be done by a command executed interactively or under program control.

- o Multiple Concurrent Tasks at the Same Work Station

Up to 16 different functions can be active as a result of a single sign-on to a work station. To switch from one function to another requires pressing an "interrupt" key and then selecting a new function from a menu. This can significantly increase the productivity of users who perform a variety of tasks of short duration (for example, interrupting an order entry application to switch to an unrelated inquiry

application to answer a telephone request). It is also possible to sign on to the same workstation a second time and have two different sessions active, with up to 16 active functions in the second session.

- o Performance Information

A user can manually collect system performance data for a single time period or automatically collect data on a weekly schedule using a set of commands/menus. This systems management function provides data to assist the user in workload scheduling, system tuning, performance reporting, performance-problem analysis, and capacity planning. The user can also work with this data using the Performance Tools/400 licensed program.

In addition, Performance Management/400 (PM/400), a no-charge licensed program automatically shipped with OS/400, can be used to help plan for and manage the growth and performance of the system. It gathers performance measurement information and produces trend reports to help the customer decide when a hardware upgrade is warranted. Additional analysis of PM/400 data is provided by IBM for a fee.

For example, the data provided by PM/400 can provide the information necessary to tune the system, schedule jobs, manage the overnight workload, and by using the trending data the customer can determine when a resource constraint will occur. The customer can then manage the system so as to provide consistent service levels to their end users.

- o Copy Facility

The copy facility copies data from one file to another. The files may be input from the database, tape, or diskette and be output to the database, tape, diskette or printer. Various options control format and record selection.

- o OS/400 Query Support

Applications may use OS/400 functions to display a list of queries for selection to execute or delete and to display a list of files available to query.

Some query capability is provided directly by OS/400. It includes processing database files, default output formatting, and windowing left and right for results that exceed the width of the screen. Extensive query capability is available with Query for AS/400 (5769-QU1) licensed program and DB2 Query Manager and SQL Development Kit for AS/400 (5769-ST1) licensed program.

- o OS/400 Data File Utility (DFU) Support

Applications may use OS/400 functions to display a list of DFU programs to select for execution, and to display a list of files available to DFU. Some data entry capability is provided directly in OS/400. Functions include processing non-join database files, default selection of fields and record formats, and default audit log listing.

INVESTMENT PROTECTION:

Moving to the new AS/400 PowerPC Technology is a straightforward evolutionary step that builds on V3R1 and provides an easy migration from the IBM System/38 and System/36. OS/400 continues to utilize emerging technologies such as open distributed computing, object-oriented programming, client/server support, multimedia support, and sophisticated application development tools. AS/400 Advanced Application Architecture provides the support necessary for observable programs developed on prior versions to be automatically translated the first time they are used on the current version/release. This helps to protect the customer's investment, and their applications can continue to evolve on the AS/400 Advanced Series. Selected objects created on the current release can be used on prior releases.

The state-of-the-art code optimization provided by ILE C is important in taking advantage of the performance offered by the 64-bit PowerPC processor. ILE offers many advantages over previous program models, such as binding, modularity, common run-time services, and state-of-the-art code optimization.

This product is Year 2000 Ready. When used in accordance with its associated documentation, it is capable of correctly processing, providing, and/or receiving date data within and between the 20th and 21st centuries provided all other products (for example, software, hardware, and firmware) used with the product properly exchange accurate date data with it.

#### NETWORK COMPUTING:

The network computing capabilities of the AS/400 system allow electronic business to be carried out over the Internet and intranets. The following functions of the OS/400 operating system, in concert with the security and reliability of the AS/400 system help make it a market leader in network computing.

- o Support for Lotus Domino for AS/400 (V4R2)
- o Support for Lotus Enterprise Integrator for AS/400
- o Java for AS/400
- o Support for Lotus Notes on IPCS (V4R1)
- o Internet Connection Server for AS/400 (V4R1 and V4R2 only)
- o HTTP Server for AS/400 (V4R3)
- o WebSphere for AS/400 (V4R4)
- o Network Security
- o Net.Data
- o NetQuestion (V4R3)
- o Lightweight Directory Access Protocol (LDAP) on the AS/400 (V4R3)
- o Virtual Private Networks (V4R4)

#### SUPPORT FOR LOTUS DOMINO FOR AS/400 (V4R2):

Domino for AS/400 is Domino 5.0 release combining the AS/400 system's strengths of integration, ease-of-use, and scalability with the world's leading groupware offering. Domino for AS/400 is a full-function Domino server following the Domino architecture. The AS/400 system implementation provides significant function and integration with the OS/400 operating system. The Domino software runs as an application on the AS/400 system using PowerPC technology and:

- o Provides the Notes client and Notes applications with direct access to DB2 UDB for AS/400 database files
- o Supports two-way, real-time directory synchronization
- o Co-exists with other AS/400 mail services
- o Leverages the high availability and reliability of the AS/400 system.
- o Can co-exist with the Integrated PC Server running Domino

Direct access to the DB2 UDB for AS/400 database is provided without the need for ODBC drivers. The Notes C and C++ interfaces are provided, enabling AS/400 versions of stand-alone applications, server add-ins, database hook drivers, extension manager hook libraries, and external database drivers. A database driver to access DB2 UDB for AS/400 data is shipped with the Domino server. Notes clients with proper authorization can import DB2 UDB for AS/400 data directly into Notes documents. Domino for AS/400 provides Notes clients with direct access to DB2 UDB for AS/400 using an inherent ODBC driver.

Two-way, real-time directory synchronization between the AS/400 System Distribution Directory and the Domino Name and Address Book is also provided. Any change to user information in either location is automatically reflected in the other location, minimizing administration costs.

Lotus' Simple Mail Transport Protocol Mail Transport Agent (SMTP MTA) runs on the AS/400 system and is integrated with the AnyMail framework enabling Domino for AS/400 to interact with other mail systems on the AS/400 system, including OfficeVision for AS/400.

The scalability of Domino for AS/400 provides an excellent opportunity to consolidate Notes/Domino servers onto a single AS/400 system. Domino for AS/400 supports the advanced services facilities of Domino; up to 30 partitioned servers can be supported on a single system. These partition servers allow multiple instances of the Domino server to be running on a single system, which enables the workload to be split up for various applications. Server reliability improves because of the overall high reliability of the AS/400 system, its mirroring capabilities, and RAID-5 implementation.

Domino for AS/400 is packaged, priced and supported by Lotus and must be purchased through an Authorized Lotus Reseller.

Further information can be found on the Internet at the following Web site:

[HTTP://WWW.AS400.IBM.COM/NOTES](http://www.as400.ibm.com/notes)

#### SUPPORT FOR LOTUS ENTERPRISE INTEGRATOR FOR AS/400:

Enterprise Integrator for AS/400 is an optional Lotus program that allows data transfer automation between heterogeneous data sources including: Notes, DB2, Oracle, Sybase, and many 32-bit, ODBC-compliant databases. Enterprise Integrator for AS/400 includes all applicable functions supported in the current NotesPump 2.5 release which is also available on numerous other platforms.

Enterprise Integrator provides pre-established activities that allow a



variety of data transfer requests. For example:

- o Query of data on one system and transfer of results to a different target system
- o Replication of data between two dissimilar (or similar) data sources
- o Propagation of data from a DB2 UDB for AS/400 source to an Enterprise Integrator target using the IBM DataPropagator program activity
- o Polling for a condition and a scheduled transfer when the condition is met
- o Archiving data based on condition or timestamp
- o Accessing data in real time using a Domino application and an Enterprise Integrator program supported back-end (relational) database

These transfer activities can be scheduled, event-driven, or executed ad hoc and are administered using the Enterprise Integrator Administration Notes database. An additional activity provided by Enterprise Integrator for AS/400 allows synchronization of data security mapping between DB2 UDB for AS/400 and Notes databases.

In addition to using Enterprise Integrator's predetermined activities, customized data transfer requests can be written to provide additional data transfer control or manipulation. This is done using the Enterprise Integrator program extensions to LotusScript and the new Enterprise Integrator C APIs. Data source views and fields can be selected using the Enterprise Integrator Administrator database. Web clients can be enabled to submit Enterprise Integrator program activities from any browser.

Enterprise Integrator for AS/400 is packaged, priced and supported by Lotus and must be purchased through an Authorized Lotus Reseller.

Further information can be found on the Internet at the following Web sites:

[HTTP://WWW2.LOTUS.COM/SERVICES/NOTESUA.NSF](http://WWW2.LOTUS.COM/SERVICES/NOTESUA.NSF)

[HTTP://WWW.EDGE.LOTUS.COM](http://WWW.EDGE.LOTUS.COM)

[HTTP://WWW.AS400.IBM.COM/NOTES](http://WWW.AS400.IBM.COM/NOTES)

#### JAVA FOR AS/400:

Java is the preferred language for network computing and can be used for stand-alone applications or client/server applications running over the Internet. Remote Method Invocation (RMI) is built into the AS/400 Java software and can be used to communicate with the the AS/400 Toolbox for Java support running on any platform.

IBM has integrated a Java-compatible Java Virtual Machine (JVM) under the AS/400 Machine Interface (MI) to optimize Java software performance on an AS/400 system. In addition, the AS/400 Developer Kit for Java and AS/400 Toolbox for Java are included with every OS/400 V4R2, or later release, shipped. They are also preloaded on new AS/400e systems but must be separately installed when upgrading to the current OS/400 operating system on existing RISC systems.

Java is a complete computing environment, setting new standards for program portability and programmer productivity. It includes three primary functions

and capabilities:

1. An Object-Oriented Programming Language, developed at Sun Microsystems
2. A Java Virtual Machine (run-time environment) that can be integrated in Web browsers (such as Netscape Navigator and Microsoft Internet Explorer), and operating systems (such as OS/400)
3. A standardized set of Class Libraries (packages), that support:
  - o Creating GUIs
  - o Controlling multimedia data
  - o Communicating over networks
  - o Accessing data in stream files and relational databases

Java provides an object-oriented programming environment that is dramatically simpler than C++. Other aspects of the AS/400 Java implementation provide improved scalability compared to other Java platforms owing to JVM enhancements and synergy with AS/400's object-based architecture.

Java programs are compiled into platform-independent object code interpreted by the run-time support (JVM) on each platform. There is also a Java "static compilation" option, designed for improved performance, that compiles Java into AS/400-dependent object code. Java's primary benefit is its ability to develop portable client/server applications using the Internet and intranets, whose "objects" can run on many different platforms in the same network.

A Java SSL package on AS/400 leverages the integrated SSL function built into the AS/400. You can easily build more secure client/server applications using Java. All data exchanged between the client and the server can be encrypted using the SSL protocol.

The AS/400 Developer Kit for Java facilitates the creation of Java applets and full-scale applications. It includes a collection of development tools, help files, and documentation for Java programmers. As Sun Microsystems, Inc. rolls out new Java technologies and provides updates, the Developer Kit will also be updated. AS/400 system support of Java will be made available over several releases, and applications written using the Developer Kit are portable.

With V4R4, multiple JDK levels are supported on a single AS/400 system.

The AS/400 Developer Kit for Java is compliant with Sun's Java 1.1.6 specifications and includes:

- o Java programming language and compiler
- o Java interpreter and virtual machine
- o Java run-time (class files and packages)
- o Java Developer Kit commands and utilities
- o AS/400 system CL commands for creating and managing Java programs
- o Java debugging facility

For additional JDK support information, including service requirements, refer

to the online publication "AS/400 Developer Kit for Java" available from the AS/400 Book Server at URL:

[HTTP://PUBLIB.BOULDER.IBM.COM/PUBS/HTML/AS400/INFOCENTER.HTM](http://PUBLIB.BOULDER.IBM.COM/PUBS/HTML/AS400/INFOCENTER.HTM)

The AS/400 Toolbox for Java enables a Java applet or application to easily access AS/400 data. It is a collection of classes that represent AS/400 data, providing familiar AS/400 client/server program interfaces for Java programs. The Toolbox also provides a set of GUI classes. These classes use the access classes to retrieve data, then present the data to the user. The classes use Java's Swing 1.0.03 framework.

The toolbox supports the Secure Sockets Layer (SSL) specification. Data flowing between the workstation and an AS/400 running OS/400 V4R4 can run across an SSL connection providing data encryption and server authentication.

AS/400 Toolbox for Java provides access to the following AS/400 system resources:

	GUI Class?	
Connections to the AS/400	No	
Security	No	
Digital certificates stored on the AS/400	No	
AS/400 user and group information	Yes	
Database access via JDBC	Yes	
Database access via Record-Level File Input/Output	Yes	Yes
AS/400 program call	Yes	
AS/400 command call	Yes	
AS/400 Integrated File System	Yes	
AS/400 print resources, including spooled files	Yes	Yes
AS/400 message queues	Yes	
AS/400 data queues	Yes	
AS/400 user spaces	No	
Data description and conversion	No	
AS/400 active job information	Yes	
AS/400 message files	No	
AS/400 data areas	No	
AS/400 system values	Yes	
Authority on an AS/400 object	Yes	
Information about jobs running on the AS/400	No	No
Information on users on the AS/400	No	No
AS/400 system status	No	

The AS/400 Toolbox for Java includes:

- o A user interface framework to provide a productive development environment for building graphical panels. The framework automatically handles the exchange of data. The developer only needs to create one or more data beans and bind them to the panel components using tags defined by the Panel Definition Markup Language (PDML).

- o A user interface framework to create a platform and technology-independent representation of graphical panels based on the Extensible Markup Language (XML). Also included is a pure Java framework for interpreting the XML and constructing user interface panels based on the Java Foundation Classes (JFC).
- o A resource script converter to convert Windows dialogs to equivalent Java panels defined in XML.
- o A GUI builder tool (a WYSIWYG GUI editor) to develop Java GUIs.
- o A program-called framework, provided via a program call markup language (PCML) -- a tag language used for supporting the program call function of the toolbox. The language fully describes all parameters, structures, and field relationships necessary to call an AS/400 program.

AS/400 Toolbox for Java is Java-compatible so it can run on any platform that fully supports the JVM 1.1.6 specification, supports Java applets and applications, and provides Java beans for most public interfaces. It uses OS/400 servers as the access points to the AS/400 system and is fully NLS enabled.

#### NOTES:

- o When a Java program using the toolbox is running on a workstation, the toolbox can connect to V4R2, V4R3, and V4R4 versions of OS/400.
- o OS/400 V4R4 is required when a Java program using the toolbox is running on the AS/400.
- o The toolbox requires JVM 1.1.6, or later, and Swing 1.0.3, or later.

#### SUPPORT FOR LOTUS NOTES ON IPCS (V4R1):

Lotus Notes is the leading client/server platform for developing and deploying groupware applications that help organizations to communicate, collaborate, and coordinate strategic business processes within and beyond their organizational boundaries to achieve improved business results.

Lotus Notes Release 4 includes e-mail and messaging based on a scalable and manageable infrastructure. The Notes Mail user interface is based on the cc: Mail user interface and takes advantage of the Notes Release 4 server enhancements including usability, mobility, and replication capabilities.

Lotus Notes Release 4 provides a rich, application development environment including facilities to support and enable workflow applications, electronic mail, document data storage and replication, and an integrated address book. Also included is administrative support to allow users to share, track, store, access, and view data of any type in Notes databases.

Lotus Notes is packaged, priced and supported by Lotus and must be purchased through an Authorized Lotus Reseller.

#### INTERNET CONNECTION SERVER FOR AS/400 (V4R1 AND V4R2 ONLY):

Internet Connection Server for AS/400 provides World Wide Web (WWW) server capability integrated with OS/400 security, enabling exploitation of the Internet for marketing and merchandising. Multiple Internet Connection Servers are supported to balance content and workload. A Web browser can be used to administer and configure these servers.

The Internet Connection Server for AS/400 provides:

- o Tracking of WWW activity through the server to identify the audiences accessing the customer server
- o Direct WWW access to existing DB2 UDB for AS/400 data via Internet browser with no programming language required
- o Exploitation of existing AS/400 applications to any Internet browser via the Workstation Gateway

On a system with multiple network addresses, you can configure it to serve different files based on the IP address accompanying the request. You can also configure multiple server instances, allowing a single server to supply customers with multiple Web sites with differing welcome pages, mapping rules, and access control.

#### HTTP SERVER FOR AS/400 (V4R3):

HTTP Server for AS/400 provides World Wide Web (WWW) server capability integrated with OS/400 security, enabling exploitation of the Internet for marketing and merchandising. Multiple HTTP Servers are supported to balance content and workload. A Web browser can be used to administer and configure these servers.

The HTTP Server for AS/400 provides:

- o Tracking of WWW activity through the server to identify the audiences accessing the customer server
- o Direct WWW access to existing DB2 UDB for AS/400 data via Internet browser with no programming language required
- o Exploitation of existing AS/400 applications to any Internet browser via the Workstation Gateway

The following functions are enhanced over Internet Connection Server support:

- o Client Authentication -- supports SSL V3, including client and server authentication. You can associate client certificates with AS/400 user profiles or validation lists, allowing users seamless access to your Web servers resources without having to sign on.

- o Socks support and SSL tunneling -- If your environment has a Socks-based firewall for access to the Internet, you can use the HTTP Server for AS/400 proxy server to access destinations outside the firewall. Client connections that use SSL are tunneled through the proxy server, eliminating the need to decrypt and reencrypt the data at the proxy.
- o Expanded CGI support -- includes Java, REXX, and C++. You can bypass the server on output using no-parsed header CGIs. You can also fully configure any codepage conversions the server performs on your Web application's input or output.
- o Server API Support -- a follow-on to ICAPI, it enables users to write applications that extend or customize how the Web server handles client requests.
- o Automatic Browser Detection -- Use this feature to provide different documents for different clients, allowing your Web site to seamlessly exploit the unique capabilities of whatever browser your customers are using.
- o Digital ID -- authentication requires SSL client authentication for HTTP Server client certificates. This offers resource protection with:
  - Valid client certificates
  - Client certificates with certain distinguished names values
  - Client certificates associated with AS/400 user profiles
  - Client certificates associated with AS/400 validation lists

V4R4 enhancements include:

- o Improved management
  - You can remotely access your HTTP server logs, statistics and status to see how your HTTP server is functioning. You can also generate and view reports on how your HTTP server is being used.
  - SNMP Subagent allows use of any SNMP-capable network management system, such as TME 10 NetView, TME 10 Distributed Monitoring, or HP OpenView to monitor your server's health, throughput, and activity.
  - Extended Log Format allows a broader use of industry-wide Log Analysis tools and log file customization
  - Log archiving allows you to manage and maintain your log files
  - Error logs are NLS-enabled

- o Additional security

The administration of certificates is now centralized in the DCM product. The HTTP Server is now a certificate "customer".

- o Performance improvements

Dynamic caching of web pages gives you better static page serving performance without manual configuration.

- o Tools enablement

- APIs are provided to allow third-party tools to access configuration information: one to map a URL (request) through the Map/Pass/Exec/Fail rules of the server's configuration and output the physical resource on the server; another that will return the value(s) of a given configuration directive.
  - PUT, DELETE, and User-Defined HTTP methods are now supported, enabling tools such as Netscape Composer.
- o LDAP support
    - The HTTP server now supports the use of LDAP to store configuration information.
    - LDAP integration allows you to use directory services for server configuration and authentication.
  - o Lotus Domino support
 

Domino now runs "on top of" IBM HTTP Server.
  - o Built-in search capability for SBCS and DBCS data

On a system with multiple network addresses, you can configure it to serve different files based on the IP address accompanying the request. You can also configure multiple server instances, allowing a single server to supply customers with multiple Web sites with differing welcome pages, mapping rules, and access control. The Automatic Browser Detection feature allows your Web site to seamlessly exploit the unique capabilities of whatever browsers your customers are using.

#### IBM WEBSPHERE APPLICATION SERVER FOR AS/400 (V4R4):

Version 1.1 of the Java-based environment for development and deployment of dynamic, e-business Web sites is available as a feature of OS/400. WebSphere Application Server for AS/400 is IBM's premier Web application server. WebSphere Application Server builds dynamic Web applications when using WebSphere Studio Pack, a set of the most popular state-of-the-art development tools.

It also includes these functions:

- o Middleware for Web enablement
- o Java servlet run-time environment
- o Connectors for common back-end databases
- o Industry-standard object-request brokers
- o Compatibility with HTTP Server for AS/400

#### NETWORK SECURITY:

Support for X.509 certificates can be used by the Web Server, Secure Sockets Layer, IPSec, AS/400 Client Access, and other applications. The user interface is easier to use.

Global Server Certificate support is added to the certificate services

available on the AS/400. the Web Server and other applications use certificates for network and Web-based security. Global Server Certificate support is also available to V4R3 users via a PTF.

The following services support SSL:

- o HTTP Server
- o LDAP Server
- o Telnet Server
- o Management Central
- o DDM and DRDA
- o Client Access servers
- o Operations Navigator

With SSL support, these services can establish secure communications sessions with their corresponding clients. Data exchanged between the clients and servers are encrypted and therefore not subject to eavesdropping.

NET.DATA:

Net.Data makes it much easier to create great-looking Web pages with built-in Web Registry and Flat File support.

Web Registry support allows storage and retrieval of macro variables, giving them persistence across macro boundaries. A macro variable and its value can be saved into a Web Registry by one macro, and later retrieved for use in another.

Flat File support allows storage and retrieval of user data into files that contain single-field records. Multiple pieces of data can be contained in this single record, separated by user-defined delimiters. A Net.Data table built in one macro can be retrieved in a second for use in a report, for example.

NETQUESTION (V4R3):

NetQuestion is a powerful, full-text search engine that builds a global Internet or centralized intranet search service. It can handle the large amounts of information that are typically stored on Web sites. Documents to be indexed by NetQuestion need to be provided in either plain text or text with HTML markup. CGI scripts and HTML forms are provided for search and administration. Administration can also be done, via command line functions.

For all single-byte character languages, NetQuestion features:

- o Boolean queries for phrase and proximity searches as well as for front-, middle-, and end-masking using wildcards
- o Precise term searches optimized for Web applications in both Internet and intranet environments
- o High speed in indexing and retrieval where one precise index is built
- o An optimized and reduced index to about 35% to 40% of the document size
- o Sophisticated lexical affinities-based ranking for free-text and hybrid queries
- o Advanced relevance ranking
- o Detection of misspellings in documents and expanding the search request



accordingly

#### LIGHTWEIGHT DIRECTORY ACCESS PROTOCOL (LDAP) ON THE AS/400 (V4R3):

OS/400 provides an LDAP-accessible directory server and corresponding APIs that communicate with other LDAP directory servers. APIs are provided for both OS/400 and Windows applications written in Java, C, and C++. LDAP-enabled applications, such as Internet mail clients, can access, update, and manage the AS/400 directory.

You can develop OS/400 applications to use LDAP for managing distributed information across the Internet and intranets using LDAP directories for both IBM and non-IBM platforms. AS/400 user information, such as e-mail addresses, is accessible to mail clients and other LDAP applications. The AS/400 directory server supports LDAP version 2, which is limited to the IA5 character set (which is comprised of the Latin alphabet and a few additional characters).

#### VIRTUAL PRIVATE NETWORKS (V4R4):

AS/400 virtual private networking support is based on industry standards that include:

- o IP Security Protocol (IPSec)
- o Internet Key Exchange (IKE)
- o Layer 2 Tunneling Protocol (L2TP)

The AS/400 virtual private network (VPN) solution applies to these environments:

- o Intranets - secure connections within an intranet
- o Extranets or ValueNets - secure connections between intranets of different companies
- o Remote office or branch office - secure connections between intranets of the same company
- o Mobile workers - secure connection from a mobile worker, using different Internet service providers (ISPs) to an intranet

#### LOGICAL PARTITIONING (V4R4):

Logical partitioning lets you run multiple independent OS/400 instances or partitions (each with its own processors, memory, and disks) in an n-way symmetric multiprocessing AS/400e 6xx, Sxx, or 7xx model. You can now address multiple system requirements in a single machine to achieve server consolidation, business unit consolidation, mixed production/test environments, and integrated clusters.

Each partition's system values can be set independently. Partitions have different system names and may have a different primary/secondary national

language, or be operated using different time zones. This flexibility is ideal for banks and other multinational companies that want to centralize operations in a single location yet retain the national characteristics of each system. Logical partitioning is also ideal for companies that want to run mixed interactive and server workloads in a single AS/400. Logical partitioning allows the interactive performance of an AS/400 to be flexibly allocated between partitions.

All V4R4 systems have a primary partition with all resources initially allocated to it. Creating and managing secondary partitions is performed from the primary partition. Processors, memory, and interactive performance between partitions can be moved with only an IPL of the affected partitions. IOP resources can be moved without IPL.

Logical partitions operate independently. Communication between partitions is achieved with standard LAN/WAN facilities. You can install OptiConnect software for high-performance communications between partitions with out the need for additional OptiConnect hardware.

OS/400 is licensed once for the entire system by its normal processor group, regardless of the number of partitions. License management across partitions is not supported. OS/400 V4R4 must be installed on each partition. Previous releases are not supported on a logical partition.

Early adopters of logical partitioning on AS/400 can visit the following Web site for information regarding installing and managing LPAR on AS/400:

[HTTP://WWW.AS400.IBM.COM/LPAR](http://www.as400.ibm.com/lpar)

#### CLIENT/SERVER SUPPORT:

AS/400 system resources are provided for client/server solutions via:

- o AS/400 Support for Windows Network Neighborhood (AS/400 NetServer)
- o AS/400 Client Access Express for Windows
- o Novell NetWare support
- o Enhanced Novell Netware support
- o AS/400 Integration with Windows NT Server (Version 4.0)
- o AS/400 Client Access connectivity via X.25 PAD

#### AS/400 SUPPORT FOR WINDOWS NETWORK NEIGHBORHOOD (AS/400 NETSERVER):

The AS/400 Support for Windows Network Neighborhood allows personal computers running Windows 95, Windows 98, Windows NT, and Windows for Workgroups software to seamlessly access data and printers managed by the AS/400 system.

This support does not require any additional software to be loaded on the personal computer. It takes advantage of the native file sharing protocol delivered with Windows 95, Windows 98, Windows NT or Windows for Workgroups. It does not require any software on the AS/400 system other than the OS/400 operating system. The only prerequisites for this support are that the AS/400 system and the personal computer be configured with TCP/IP, and that the file sharing protocol on the personal computer be configured to use TCP/IP.

Any data available through the AS/400 Integrated File System (including database, stream files, and CD-ROM) and any Output Queues on the AS/400 system can be shared with the network by the AS/400 system administrator. All administration of this function is through the AS/400 Operations Navigator program.

This support may be an alternative to the AS/400 Client Access for clients that only require simple file and print services from the AS/400 system. For clients that require the richer functions provided by AS/400 Client Access, this support will allow the AS/400 Client Access program to be installed across the network from the AS/400 system. The AS/400 Client Access and AS/400 NetServer programs have separate identities and can coexist on the same AS/400 systems and workstations.

The AS/400 Support for Windows Network Neighborhood program complies with the "Common Internet File System" (CIFS) standard currently proposed by Microsoft.

#### AS/400 CLIENT ACCESS EXPRESS FOR WINDOWS:

AS/400 Client Access Express for Windows is shipped with OS/400 V4R4 as Operations Navigator. This client can be installed on PCs and work with AS/400 resources. The Express client:

- o Runs on PCs installed with Microsoft Windows 95, Windows 98, or Windows NT 4.0 workstation or server operating systems
- o Provides TCP/IP connectivity
- o Uses secured sockets layer (SSL) for client functions to improve TCP/IP network security
- o Uses AS/400 NetServer for PC file serving and network print support
- o Includes Operations Console for both local and remote system console access
- o Contains 32-bit client/server application enablers for AS/400, such as OLE DB data provider, ODBC driver, Remote Command, and data queues
- o Includes all functions of Operations Navigator for working with AS/400 resources and administering and operating AS/400 systems, plus new graphical interfaces for working with these AS/400 functions:
  - SQL performance monitor, SQL scripts, SQL indexes, stored procedures, user-defined functions, and user-defined types (database enhancements)
  - Virtual private networks (VPN) and application and network security (TCP/IP enhancements)
  - New Management Central system group functions for object packaging and distribution, remote operations, PTF, inventory, and job scheduler
  - File system enhancements
  - Server jobs

- Application administration of third-party plug-ins
- Java and Visual Basic third-party plug-in enablement

When you acquire an AS/400 Client Access Family for Windows license, these functions and PC5250 display and printer emulation, and data transfer are also available.

#### NOVELL NETWARE SUPPORT:

AS/400 solutions for LANs are enhanced with the integration of the AS/400 system and NetWare PC file, print, and application serving solutions for LANs. NetWare support is provided with these OS/400 features:

##### o INTEGRATION SERVICES FOR FSIOP (FEATURE OF OS/400, ORDER SEPARATELY)

With Integration Services for FSIOP, the Integrated PC Server (formerly called the FSIOP) can be used as an Ethernet or Token-Ring LAN adapter and provides a platform for selected workgroup applications or network operating systems such as NetWare.

After installation, you will be able to configure and vary on an Integrated PC Server (IPCS) that can be used as a LAN adapter to run APPC, TCP/IP, or IPX protocols. For example, customers with AS/400 Client Access could connect to the AS/400 system through the IPCS in the same way that they connect using a Token-Ring or Ethernet adapter.

To obtain the full function of the Integrated PC Server as a file server or groupware application server, you must install the appropriate server or groupware application.

An Integration Services for FSIOP feature is required for each IPCS on an AS/400 system. For example, if you have two IPCSs on one AS/400 system, you need two Integration Services for FSIOP features.

##### o OS/400 INTEGRATION FOR NOVELL NETWARE (FEATURE OF OS/400, ORDER SEPARATELY)

OS/400 Integration for Novell NetWare provides support for installing customer-supplied NetWare 4.10 or NetWare 4.11 (NetWare 4.1x) on the Integrated PC Server (IPCS, formerly called the FSIOP).

OS/400 Integration for Novell NetWare allows the AS/400 disk to be used for NetWare file serving, extending the AS/400 system's disk reliability, RAID-5, and mirroring capabilities to NetWare users. You can consolidate your AS/400 and NetWare servers into a single hardware platform. Also, NetWare volumes created on the AS/400 disk can be saved/restored to AS/400 removable media devices.

Unlike LAN Server for AS/400, OS/400 Integration for Novell NetWare does not include the server software or license. You retain the existing relationships with your NetWare distributor for purchase or upgrade to NetWare 4.1x.

NetWare 4.1x (purchased from a NetWare distributor) is installed directly

from the AS/400's integrated CD-ROM drive.

An OS/400 Integration for Novell NetWare feature is required for each IPCS on an AS/400 system where NetWare 4.1x will be installed. For example, if two IPCSs are running NetWare 4.1x on one AS/400 system, two OS/400 Integration for Novell NetWare features are needed.

#### o NOVELL NETWARE TAPE SUPPORT

Novell NetWare tape support within OS/400 Integration for Novell NetWare provides the capability to save and restore NetWare data to an AS/400 tape drive. When saved with Novell's SBACKUP or Cheyenne Software, Inc.'s ARCserve ([www.cheyenne.com](http://www.cheyenne.com)), you can save and restore NetWare data to an AS/400 tape device. This provides the NetWare user with enhanced save/restore function on the AS/400 system. Previously the NetWare administrator could save and restore individual NetWare files to a tape device on the LAN, but not on the AS/400 system.

Running the Novell NetWare tape support with either ARCserve or SBACKUP in a local IPCS provides save/restore that is intended to be used with a range of common AS/400 tape drives, including 1/4 inch cartridge, 8mm cartridge and 1/2 inch cartridge (3570, 3590) drives. The following drives cannot be used with Novell NetWare Tape Support: 3480, 3490, 3490e, all 1/2 inch reel drives (including 9348) and all tape libraries (including 3494).

Enhanced Integration for Novell NetWare adds support for save/restore of individual NetWare files in the QNetWare file system using AS/400 save and restore commands. This provides you with the ability to save/restore individual files in place of saving a complete storage space. Novell NetWare data from servers (including external PC-based servers) throughout the network can be saved through the integrated file system using this save/restore support.

#### ENHANCED NOVELL NETWARE SUPPORT:

OS/400 Enhanced Integration for Novell NetWare provides integration services for AS/400 users and operators via OS/400 and a NetWare Loadable Module (NLM) that runs on NetWare 3.12, 4.1x, or 5.0 servers. This product supersedes the functions previously provided by LANRES/400.

It supports NetWare 3.12, 4.1x and 5.0 servers, whether or not you have an IPCS installed on your AS/400. A license is required for each NetWare server. IPX or TCP/IP support in OS/400 is used to connect the AS/400 using a token-ring adapter, an Ethernet adapter, IPCS, X.25, or frame relay adapters.

OS/400 Enhanced Integration for Novell NetWare provides user profile and password integration from the AS/400 to NetWare. AS/400 user or group profiles can be propagated to multiple NetWare Directory Services (NDS) trees and/or NetWare 3.12 servers. When AS/400 users change their passwords, the change is propagated to NetWare.

OS/400 Enhanced Integration for Novell NetWare provides integrated file system support, allowing AS/400 users and applications to access files and

directories in multiple NDS trees or NetWare 3.12 servers throughout the network. For example, an AS/400 Client Access user can access files on a NetWare server throughout the AS/400 network. Another use of the file system would be to access files on NetWare servers to be served by OS/400 Internet connection support:

- o Internet Connection Server for AS/400 (V4R1 and V4R2 only)
- o HTTP Server for AS/400 (V4R3, or later release)

OS/400 Enhanced Integration for Novell NetWare provides AS/400 to NetWare printing support. AS/400 users' printed output is sent from an AS/400 output queue to a printer queue managed by the NetWare server. OS/400 host print transform services are used to translate the output to print on common PC printers.

Full integration with NetWare security ensures that each AS/400 user of these services is fully authenticated in NetWare Directory Services or the NetWare 3.12 binder.

OS/400 Enhanced Integration for Novell NetWare provides a set of server configuration and management tasks from AS/400 interfaces. Although this product is not intended to enable full management and operations of a NetWare server, AS/400 operators can manage user connections and disk resources. Facilities are provided for creating, extending, and mounting/dismounting volumes on NetWare servers.

#### AS/400 INTEGRATION WITH WINDOWS NT SERVER (VERSION 4.0):

AS/400 Integration with Windows NT Server enables Microsoft Windows NT Server Version 4.0 to be installed on the AS/400 Integrated PC Server (IPCS). In a single combination server, customers can now run their mission critical business applications on the AS/400, while also running Windows NT Server for file, print, personal productivity and other applications.

The three main advantages of running Windows NT Server on the AS/400 IPCS are:

1. Flexibility for AS/400 applications and NT services in a combination server
2. Improved hardware control and availability with reduced maintenance costs
3. Simplified user administration and server operations

An AS/400 Integrated PC Server with a Pentium Pro processor and a minimum of 64 MB of memory is required to install Windows NT Server. A PC screen, keyboard and mouse must be attached to the AS/400 IPCS to provide a console for the Windows NT Server.

The AS/400 operator can start and stop the Windows NT Server, improving server management in remote branch office and dealership installations. The AS/400 operator can also manage NT disk resources, allocating disk space from the AS/400's disk pool. The AS/400 operator can also better manage server

operations by filtering and sending messages from Windows NT Server to the AS/400 operator's message queue. Maintenance costs are reduced compared to a PC-based server, since Integrated PC Server maintenance charges are included in the AS/400 system maintenance offering.

AS/400 Integration with Windows NT Server allows customers to share hardware resources between the AS/400 and Windows NT Server. The AS/400 CD-ROM drive and tape drives can be allocated to Windows NT for installing an application or for data backup, from both Windows NT Backup and Seagate Backup Exec.

AS/400 Integration with Windows NT Server provides simplified user administration of a combined network environment. Network operators can create both AS/400 and NT user profiles in a single step; users can change their password on the AS/400 and have it automatically updated on the Windows NT Server.

AS/400 Integration with Windows NT Server provides an internal connection between the AS/400 and Windows NT Server. This internal TCP/IP link provides a reliable and secure connection for applications and database integration utilities between the two systems, protecting the application from local area network hub failures.

OS/400 includes a file system, QNTC, that connects the AS/400 to a Windows NT domain as a client.

- o Standard POSIX APIs provide access to the QNTC.
- o Industry standard protocols, NetBIOS over TCP/IP, are used as a transport mechanism.
- o Industry standard messaging protocols, Common Internet File System (CIFS), also known as Server Message Block (SMB), are used.
- o By allowing access to data stored within a Windows NT domain, the AS/400 can become a mechanism for distribution of applications and data within the domain.
- o The file system can also be used by any AS/400 application that can use data as formatted on the Windows NT server, such as Java applications.
- o It allows access to data on both stand-alone Windows NT servers and the AS/400 Windows NT application processor on the Integrated PC Server.
- o Windows NT 4.0 and later are supported.

NOTE: The QNTC file system lets you share data with servers that can communicate using the Windows NT LM 0.12 dialect. The SMB server (AS/400 support for Windows Network Neighborhood) does not use the Windows NT LM 0.12 dialect.

Windows NT Server (Version 4.0) is packaged, priced and supported by Microsoft and must be purchased through a Microsoft dealer.

Further information can be found on the Internet at the following Web site:

[HTTP://WWW.AS400.IBM.COM/NT](http://www.as400.ibm.com/nt)

For information on Microsoft Windows NT Server, Terminal Server Edition, and Citrix MetaFrame, see the same Web site.

## AS/400 CLIENT ACCESS CONNECTIVITY VIA X.25 PAD:

This is an attractive solution for customers using X.25 Packet Assembler / Disassembler (PAD) switching with large numbers of individual remote geographically dispersed PCs, who need to connect to the AS/400 system for terminal emulation or file transfer/mail type of functions. Many customers choose X.25 as their WAN connectivity solution of choice due to tariffing costs and the stability of the X.25 network technology and standards. With X.25 the system administrator can manage concurrent remote PCs via a single X.25 line versus many ASCII controllers/lines/modems. This reduces customer cabling complexity and external modem management while providing the additional error recovery built into an X.25 network.

X.25 PAD, together with AS/400 Client Access, offers the data reliability of SNA, the connectivity, flexibility, and availability of X.25 networking, along with all of the functional capabilities of AS/400 Client Access Family.

## NETWORK COEXISTENCE WITH AS/400 CLIENT ACCESS

The NetWare client requesters provided by the Novell Corporation and AS/400 Client Access clients can be used concurrently.

## CLIENT/SERVER PRODUCT POSITIONING:

OS/400 ENHANCED INTEGRATION FOR NOVELL NETWARE: supersedes LANRES/400 for integration services between the AS/400 and NetWare servers. LANRES/400 provided five main functions: Host-LAN printing, LAN-Host printing, disk serving, server administration, and data distribution. The following chart shows how these functions are replaced by Enhanced Integration support.

Function	LANRES/400   OS/400 Enhanced Integration   for Novell NetWare	
Host-to-LAN Print	Yes	Yes
Data Distribution	Yes	Yes (Note 3)
Integrated File System	No	Yes
Volume Management	No	Yes
User Synchronization	No	Yes
LAN-to-Host Print	Yes	Note 1
Disk Serving	Yes	Note 2
NetWare Administration	3.12	4.1x and 3.12
Runs on Novell NetWare	3.12	4.1x and 3.12
Protocols	SNA, TCP/IP	IPX

## Notes:

1. Provided with AS/400 Client Access Virtual Printing
2. Provided with Integrated PC Server
3. Now includes ASCII to EBCDIC data conversion

## INTEGRATED DB2 UNIVERSAL DATABASE FOR AS/400:



DB2 Universal Database (UDB) for AS/400 is fully integrated into the OS/400 operating system software. It is not a separate product. DB2 UDB for AS/400 offers state of the art database functions and open-systems, standards based technology, while providing the maturity, stability, and ease of use that has become the trademark of the AS/400 system.

The AS/400 system can be used for both traditional, transaction processing and decision support and data warehousing applications. Advanced parallel processing and advanced query optimization techniques support queries of large decision support databases.

An integrated AS/400 database offers many advantages. As an integrated part of OS/400, DB2 UDB for AS/400 is installed with the system providing automatic bring up and recovery functions when the system is IPLed. Integration also allows the database commands and display interfaces to have a look and feel that is consistent with the rest of the system. For example, database objects are automatically included as part of the system-wide cross reference facilities and the basic system administration commands for save, restore, security, and object management can be used to administer the database. This allows the database to exploit new system functions and hardware for improved availability, recovery, security, concurrency, and performance as they are introduced.

Conformance to industry database standards, advanced functions, and distributed data capabilities with supporting performance allows DB2 UDB for AS/400 to operate equally well with centralized database applications, or as the database server in complex heterogeneous client/server networks. DB2 UDB for AS/400's unique combination of function and reliability make the AS/400 the ideal database server for many customers' needs.

#### BASIC DESCRIPTION OF DB2 UNIVERSAL DATABASE FOR AS/400:

- o Relational Model

DB2 UDB for AS/400 is a relational database by design but may be viewed by users in terms of either a relational model or a file model, depending on choice of interface. Those choosing the relational model see tables and views while those using the file model see physical and logical files. The data resides in tables or physical files but may be seen in different sequences, with omissions or additions in logical views. Productivity of doing program maintenance is increased because programs that use a logical view of the data need not change when the physical data is updated.

- o Defining Files

Files can be defined using data description specifications (DDS), interactive data definition utility (IDDU), or DB2 Query Manager and SQL Development Kit for AS/400 (a separate licensed program, 5769-ST1). The file definitions can be used by a variety of functions on the system, including utilities and HLL programs. Database also allows a record-level definition of a file, enabling HLL programs to provide the field definitions when the file is processed. Files, including multiple record types defined only to the record level on the system, can be defined at a field level using IDDU. Utilities such as Data File Utility

(DFU) and Query can process the file, minimizing the System/36 migration effort. These utilities are available as separate licensed programs: DFU in Application Development ToolSet for AS/400 (5769-PW1); Query in Query for AS/400 (5769-QU1). System/38 versions of these utilities are available in System/38 Utilities for AS/400 (5769-DB1).

- o Access Paths

Access paths may be defined for files to allow access in either keyed or arrival sequence order. Access paths are maintained when a change to the data occurs, allowing multiple users to be immediately aware of changes in the database and to access the current information in their required sequence.

DDS can define a field reference file, a form of data dictionary, that describes the attributes of all data fields for use by multiple applications. It contains all attributes and descriptive information about the data. The field reference file ensures consistency in field names and defined attributes, resulting in significant benefits to application design, maintenance, standardization, and programmer productivity.

The database supports record additions, updates, deletions, initialization, and reorganization. A full range of processing options is available for HLL programs such as sequential or random access (by key or relative record number), and retrieval of next and previous record. Many database functions can be described dynamically and performed externally to the HLL program, thus maximizing programmer productivity.

- o Distributed Database Support

OS/400 supports distributed relational database, SQL, and a wide range of data types, including date and time. This support allows read and write access from an AS/400 system to another AS/400 system or to any other DB2 family member.

The CPI for database is Structured Query Language (SQL). Customer investment in data is protected by this distributed support, which allows data connectivity across platforms. Interactive access to distributed database is possible using the prompted facilities of interactive SQL (ISQL). Both are available in separate licensed program DB2 Query Manager and SQL Development Kit for AS/400 (5769-ST1).

Distributed file access between an AS/400 system, CICS, PCs, System/36, and System/38 is also available using Distributed Data Management, included in OS/400. This support allows access to remote files by applications using file and database interfaces.

The SQL Client Integration API allows providers of gateways and client/server solutions to integrate their products with DB2 UDB for AS/400. Many AS/400 customers have the need for applications that not only access DB2 UDB for AS/400 data, but also access data on other databases platforms such as Oracle or Sybase.

Existing DB2 UDB for AS/400 SQL applications, including applications using AS/400 Client Access SQL interfaces, can be easily modified with

this API to perform database requests on other databases. The data is returned to the application for processing as if it had come from DB2 UDB for AS/400. With this support, the programmer's interface is the same whether Distributed Relational Database Architecture (DRDA) or the SQL Client Integration API is used.

- o National Language Capability

Data in multiple national languages may reside in the same table and be accessed across the distributed database platforms.

#### ADDITIONAL FEATURES OF DB2 UNIVERSAL DATABASE FOR AS/400:

- o FILE- AND DATABASE-ORIENTED INTERFACES

The same copy of data may be shared by applications using file and database interfaces. This data sharing, along with the data mapping features of views and logical files, reduces the need for redundant copies of data.

- o STRUCTURED QUERY LANGUAGE (SQL) STANDARDS CONFORMANCE

Supplies the industry standard database access language for consistent data access across heterogeneous platforms, conforming to the IBM SQL Version 1, ANSI X3.135.1992, ISO 9075-1992 and FIPS 127-2 standards. Support is provided for embedded static, dynamic, and extended dynamic SQL. ANSI- and ISO-defined SQL procedures are also supported.

- o LARGE OBJECT SUPPORT

With the addition of large objects (LOBs), DB2 UDB for AS/400 can store and manipulate data fields much larger than the current limits. An AS/400 record with LOB fields can hold up to 15 MB of data. With the new LOB support, you can look to DB2 UDB for AS/400 as a platform for building applications that hold new data such as very large text, image, and audio.

- o DATALINK DATA TYPE

The DATALINK data type extends the types of data that can be stored in database files. The actual data stored in the column is only a pointer to the object such as an image file, a voice recording, or a text file. The method used for resolving to the object is to store a uniform resource locator (URL). This means that a row in a table can be used to contain information about the object in traditional data types, and the object itself can be referenced using the DATALINK data type.

Datalinks also allow the referenced object to be "linked" to the database to prevent modification or deletion of the object while it is linked to the database file. This relationship is maintained by having the database interact with the file system that contains the object.

- o USER-DEFINED TYPES

User-defined types are derived from existing predefined types such as integer and character. You can create your own types for strong typing and creating functions for different types. You can call a function for each row of a result set and return a value based on the user-defined type.

- o USER-DEFINED FUNCTIONS

SQL now lets you define your own functions to use within SQL itself. This saves you time in reusing common building blocks that you develop yourself. User-defined functions are necessary building blocks to support the database extenders (extensions to support rich text and multimedia search and manipulation) currently supported on DB2 UDB for AS/400.

- o DECLARATIVE REFERENTIAL INTEGRITY

Provides SQL database integrity support intrinsic to the database, eliminating the need to code integrity constraints into each application program. This support ensures database consistency by preventing conflicting data from being entered into the database.

- o USER-ACCESSIBLE LOGS

Journal entries (i.e., records of database changes) can be searched and viewed interactively, and may be retrieved by a user program for further processing or analysis. This can lead to improved security and/or database integrity and is also an important component or open access to the database.

- o COLUMN-LEVEL SECURITY

Access to individual table columns can be controlled for each user.

- o ROW-LEVEL LOCKING

Individual records (i.e., records) are locked from simultaneous, conflicting access as appropriate to the type of processing being done. Using commitment control, the user can define a group of records all of whose locks are held until the user application declares a multiple-change transaction complete.

- o DATA STRIPING

Data is automatically distributed over all available disk units within a set defined by the user. This can improve the performance of applications that make heavy use of a single database file or table.

- o STORED PROCEDURES

Provides the ability to distribute the application workloads between clients and servers. The ability to split an application program by executing the processing logic on the server and the presentation logic on the client can provide increased performance over traditional requester access. These improvements can be dramatic for applications requiring intermediate processing of data, which can be performed at the server locally, instead of remotely at the client.

## o TRIGGERS

Provides for automatic program/procedure execution, based on user-specified rules, before and/or after database modifications.

## o OUTER JOIN

The Outer Join function is another SQL standard compliant function that can improve both query performance and function. Performance is enhanced with a syntax that allows SQL users to specify outer joins or exception joins, thus reducing the number of queries required. A NULL field is now returned when a file query does not find records that meet the join criteria. This allows users to develop and use more efficient reports.

## o ALTER TABLE

The Alter Table function enhances database administration while improving SQL standards conformance. This function allows the user to add a column, drop a column, or change a column's attributes for an existing database table.

End-user productivity can be greatly enhanced with this standard conforming function for database changes and administration. Both SQL and native interfaces are provided.

## o X/OPEN CALL LEVEL INTERFACE TO SQL

Support of the X/Open standard for an SQL Call Level Interface (CLI) allows users to easily access DB2 UDB for AS/400 SQL functions directly from high-level languages (HLL) without performing an SQL precompile. This standard CLI support also allows SQL access from languages such as C++ that currently do not have another SQL interface or precompiler. There is an option to enable writing applications that do database serving for multiple users (server mode).

- Each connection runs under a different user profile. When not using server mode, all connections run under the profile of the requesting job.
- Multiple connections to the same relational database (data source). When not using server mode, a particular job can only have one connection to a particular database at any one time.
- Each connection contains its own transaction, which can be committed or rolled back independently. When not using server mode, all connections are part of a single transaction.
- Greater total number of allocated handles. In regular mode, the limit is 500 total handles per job. In server mode, the limits are 500 statement handles per connection and 40,000 total handles per job.
- Multiple connections operate simultaneously if the application is using threads and not sharing connections handles across threads. When not using server mode, all SQL statements in a job are single-threaded, even if the requests come from different threads.

The X/Open standard CLI is supported on several other database platforms, which makes SQL application portability to and from the DB2 UDB for

AS/400 platform even easier.

- o SQL REPEATABLE READ

Support of the standard compliant isolation level, Repeatable Read, enables users to ensure that, if a specific query is issued in a unit of work multiple times, the same result will be returned each time by preventing concurrent jobs from changing the queried data. This isolation level also offers increased interoperability in distributed DB2 and DRDA environments. Users can also now specify the isolation level (commitment control level) on a per statement basis for the SELECT, UPDATE, INSERT, and DELETE statements. This provides greater flexibility when executing under commitment control.

- o ACCESS TO DATA AREAS AND DATA QUEUES

DB2 UDB for AS/400 includes support for transparent remote access to data areas and data queues. Applications that use data areas or data queues for interprocess communications can be distributed across multiple AS/400 systems, providing new options as users move into distributed AS/400 networks and multi-tiered application models. Additional data queue support is included in MQSeries for AS/400, a separately-licensed program, 5769-MQ1.

- o TWO-PHASE COMMIT TRANSACTION MANAGEMENT

Allows applications to access multiple heterogeneous databases simultaneously in complex client/server and peer to peer environments using APPC sync point protocols.

- o DATA REPLICATION

Provides automatic data replication facilities in distributed DATABASE 2 family environments. Local SHADOW copies of a master database are automatically updated at specified intervals.

- o SYSTEM-WIDE DATABASE CATALOG

Allows applications to query information concerning ALL objects on a system using a single system catalog, instead of requiring separate catalog accesses for each SQL collection.

- o MULTIPLE-LEVEL CONCURRENCY CONTROL

Provides read stability, cursor stability, uncommitted read, repeatable read, and no commit isolation levels with row-level locking to support large numbers of users in complex application scenarios.

- o NATIONAL LANGUAGE SUPPORT (NLS)

Allows customers to interact with DB2 UDB for AS/400 and store data in their preferred language, character set, and sort sequence. The ability to store double-byte graphic characters and compare data in different character sets is also provided.

## HIGH PERFORMANCE DATABASE SERVER:

The high performance AS/400 Advanced Server and improvements in communication performance combine to strengthen the position of the AS/400 system as a high performance database server. In addition, DB2 UDB for AS/400 offers enhanced performance for both centralized and distributed client/server database access, making the AS/400 the database server of choice for many computing needs. The following DB2 UDB for AS/400 functions are available to enhance application performance:

### o ADVANCED SQL OPTIMIZER

Converts SQL requests into optimally efficient database access methods using proven mathematical rules as well as query specific cost estimates. Optimal performance is maintained over time by the automatic rebind feature, which redetermines access methods based upon changes to the database objects and statistics.

### o SQL ENCODED VECTOR INDEXES (EVI) (V4R3)

This new type of index can be created through SQL and may improve query performance -- especially for long-running queries against large files using many selection criteria. An EVI has several advantages over a traditional index with the same keys:

- Precise statistics about the distribution of key values are automatically maintained and can be accessed much more quickly by the query optimizer than traditional indexes.
- EVIs can be built much faster and take significantly less storage than traditional indexes. Less storage means less main storage is necessary to run the query.
- The query optimizer can scan EVIs and dynamically build bit maps much more quickly than from traditional indexes.

### o EXPLAIN FUNCTION

Examines and reports the access method used by individual SQL queries. The output can be examined to determine whether the access method generated for the query could be improved by query and/or database changes.

### o MULTIPLE ISOLATION LEVELS

Four record locking options are available to fine tune application performance:

- READ STABILITY (\*ALL) locks all rows read during transaction and maintains locks until the transaction ends.
- REPEATABLE READ (\*RR) locks all rows read during remote unit of work and maintains locks until the unit of work ends.
- CURSOR STABILITY (\*CS) maintains locks on the current and previously changed rows only, which can offer increased performance for multiple

applications contending for the same rows.

- UNCOMMITTED READ (\*CHG) offers higher performance by not acquiring or examining database locks for read-only operations.
- NO COMMIT (\*NONE) provides the highest performance of the four isolation levels, by not examining locks and disabling transaction management: the ability to either COMMIT or ROLLBACK a transaction.

- o BLOCK INSERT AND FETCH

Provides applications with the ability to store and retrieve arrays of data directly, instead of one row at a time.

- o AUTOMATIC RECORD BLOCKING

Improves client/server performance by returning rows to the client in blocks rather than individually. Subsequent record access of the current block can then be performed locally at the client without accessing the server. This ability is now provided for all isolation levels.

- o PARALLEL DATA ACCESS

Queries returning or requiring DB2 UDB for AS/400 to process large amounts of data require significant I/O activity. Due to the AS/400's single-level store architecture, this data is often spread across many physical devices. The parallel data access feature now allows multiple internal DB2 UDB for AS/400 tasks to be activated for each physical device, allowing DB2 UDB for AS/400 to transfer data from disk to memory faster than with the previous single task I/O architecture.

- o QUERY GOVERNOR

Long-running queries can have negative performance effects for other users of a database. The governor facility allows a TIME LIMIT to be set for a query, so as to avoid a single query from consuming unusually large amounts of resources, negatively affecting the performance of other users. Before the query is started, its run time is estimated, and if the estimate exceeds the specified time limit, the query is not started.

#### EASE OF USE AND MANAGEMENT:

The AS/400's reputation for usability and maintainability is unsurpassed in the industry. This is due in part to the tight integration of OS/400 and DB2 UDB for AS/400. Users do not have to learn separate operating system and database functions, nor are they burdened with maintaining the complex interfaces between multiple layers of software. In addition to seamless integration, a rich set of utilities continue to be provided for easy management of DB2 UDB for AS/400 databases. Some of these utilities include:

- o ONLINE BACKUP AND RESTORE

Allows database maintenance to be performed while users are accessing and



changing the database, providing around-the-clock operation.

- o OBJECT LEVEL RECOVERY

Allows restoration of a single file when necessary; it is not necessary to restore the entire database to "fix" a single file.

- o ROLL FORWARD AND BACKWARD RECOVERY

Allows database changes made after the last backup to be reapplied after a restore, or recent changes to be backed out if the database needs to be returned to a specific state. This can be done for a specific user, time, or job.

- o AUDIT TRAIL

Maintains a record of database changes such as the user, program, and job making the change.

- o PERFORMANCE TUNING AND TRACE

Analyzes processor and disk workloads for improved performance. The integrated nature of the database allows the entire system to be tuned - not only the database.

#### OPEN STANDARDS-BASED INTEROPERABILITY:

Support for client/server environments has been greatly enhanced by incorporating popular database standards and transmission protocols. DB2 UDB for AS/400 provides support for:

- o ANSI X3.135.1992, ISO 9075-1992, and FIPS 127-2 Structured Query Language (SQL)
- o IBM's Distributed Relational Database Architecture (DRDA) Distributed Unit of Work - Application Directed
- o Microsoft's Open Database Connection (ODBC)
- o Apple's Data Access Language (DAL)
- o X/Open's Call Level Interface (CLI)

Supported transmission protocols for the AS/400 include:

- o Transmission Control Protocol/Internet Protocol (TCP/IP)
- o Advanced Program-to-Program Communication (APPC)
- o Advanced Peer-to-Peer Networking (APPN)

This support allows customers to exploit the maturity and stability of the AS/400 database server with a wide range of client applications running on OS/2, DOS, Windows 3.1 and Windows 95, AIX, and Apple workstations.

#### INDUSTRY-LEADING APPLICATION SUPPORT:

Over 20,000 commercially available AS/400 application solutions take advantage of the power, flexibility, and ease of use of the DB2 UDB for AS/400 database manager. These applications are written for a wide range of industries and users: from the small business with base accounting needs to the large corporation with complex computing environments. Over 3,000 client/server applications are available, including SAP R/3.

In addition, DB2 UDB for AS/400's support of popular database standards combined with the AS/400 system support of popular transmission protocols makes the wide range of client applications running on UNIX, OS/2, DOS, and Windows 3.1 and Windows 95 workstations immediately available. Support of popular transmission protocols allows customers to exploit the client/server environment while protecting their investments in hardware and software from multiple vendors.

#### RELATED PRODUCTS:

DB2 UDB for AS/400's is integrated directly into the OS/400 operating system. It includes all the support necessary for new and existing database applications to run on the AS/400 system.

Application development facilities are provided in the optional DB2 QUERY MANAGER AND SQL DEVELOPMENT KIT FOR AS/400, the next evolution of the SQL/400 product. This product includes QUERY MANAGER, an interactive panels and query builder for user-developed report generation, and INTERACTIVE SQL, a prompted interface for running and testing SQL queries. For the application developer, the SQL DEVELOPMENT KIT provides SQL precompilers and tools to assist in developing custom SQL applications in languages such as C, RPG, COBOL, REXX, and PL/1. Once created, the applications and queries can be run on any AS/400 system.

#### SUPPORT FOR THE PERSONAL COMPUTER (PC):

OS/400 provides the platform for a distributed client serving environment. DB2 UDB for AS/400 database access is supported from the following popular client database interfaces:

- o Open Database Connect (ODBC) - the database interface used by Microsoft
- o Data Access Language (DAL) - the database interface used by Apple
- o Distributed Relational Data Access (DRDA) - the interface architecture defined by IBM for databases spread across multiple nodes that ensures users will have access to data regardless of its location.

#### INTEGRATED FILE SYSTEM (IFS):

The Integrated File System (IFS) allows libraries/objects, folders/documents, or LAN Server/400 file system data to be accessed in a consistent manner. A separate subsystem can be allocated specifically for file serving, and a set of commands are provided to make it easy to move one's PC data from the

folders directory (i.e., shared folders) to the "root" file system directory. The major benefits for using the new file system directory are increased performance over shared folders and providing system users easier access to PC information.

IFS integrates the existing AS/400 library/objects, folders/documents, and shared folders into a single hierarchical name space and file system with simple command interfaces for file management and improved levels of performance. New OS/400 file systems include:

- o "Root" file system: OS/2, DOS, and NT compatible
- o QOpenSys file system: POSIX, XPG, UNIX compatible
- o QLANSrv file system: OS/2 Lan Manager compatible
- o QFileSrv.400 file system
- o Qopt file system

User applications can store and manipulate stream file sizes up to 256 GB in the root ('/'), QOpenSys, and user-defined file systems.

The Integrated File System supports a set of industry standard APIs to the byte stream file system and the hierarchical directory. The APIs provide a common directory for existing objects and extended attributes supporting PC file systems. Examples of byte stream file system objects on the system are: documents and byte stream files. Examples of hierarchical directory objects on the system are: libraries/contexts, folders and directories. IFS is compatible with and can co-exist with previous releases.

#### QFILESRV.400 CLIENT FILE SYSTEM SUPPORT:

Using IFS commands and APIs, users can perform such tasks as determining what is in a directory that resides on a target system, or use the APIs to copy files from one system to another.

In addition, PC users using AS/400 Client Access Optimized for OS/2 or AS/400 Client Access Family can access the QFileSrv.400 file system allowing access to data on multiple AS/400 systems with just one communications connection.

The QFileSrv.400 file system operates between AS/400 systems that are connected by standard communications facilities using the APPC or TCP/IP protocols.

#### QOPT CLIENT FILE SYSTEM SUPPORT:

Using IFS commands and APIs, users can access a CD drive: either a direct-attached 3995 or the system drive.

#### INTEGRATED FILE SYSTEM (IFS) AND SELECTED INDUSTRY STANDARDS:

IFS and selected standards provide portability and interoperability functions that support the integration of the entire customer enterprise in a heterogeneous networked environment. The challenge of implementation is accomplished through the traditional AS/400 strengths such as ease of use, security and system integrity. The customer's investments in existing systems, networks, applications, data and people are preserved.

The AS/400 system provides support for source code portability of many OS/2, DOS, NT and UNIX based applications over a wide variety of systems by providing a set of standard interfaces between applications and operating system functions. With V3R1, the AS/400 system supports over 70% of the POSIX 1003.1 APIs. Together with BSD Sockets, TCP/IP and UNIX Spec 1170 support, we have nearly doubled UNIX C portability to the AS/400. With V3R1, the AS/400 system complies with selected elements of:

- o POSIX IEEE 1003.1 (ISO/IEC 9945-1)
- o POSIX IEEE 1003.1a
- o POSIX IEEE 1003.1b (formerly 1003.4)
- o POSIX IEEE 1003.1c (formerly 1003.4a)
- o FIPs 151-1
- o X/Open CAE Specification, System Interfaces Definitions, System Interfaces and Headers Issue 4 (XPG4)
- o Berkely Software Distribution (BSD) Sockets Version 4.3
- o USL 1170 Specification (X/Open UNIX Extensions)
- o USL System V Interface Definition Third Edition
- o ISO/IEC 10646-1

To enhance application program distribution and data interchange on the AS/400 system, unlabeled 1/4" and 8mm tape media have been added. The tape media is compatible with POSIX, XPG, and UNIX support.

**DB2 SYMMETRIC MULTIPROCESSING FOR OS/400:** expands on the parallel capabilities of DB2 UDB for AS/400. This separately priced feature of OS/400 improves the performance of the database for the AS/400 system. This improved performance is critical, especially in a data warehouse or decision support environment. The performance gains provided by this feature help to allow for better and more effective business decisions to be made in a timely manner.

DB2 Symmetric Multiprocessing for OS/400 further enables DB2 UDB for AS/400 with symmetric multiprocessing (SMP) on any of the AS/400 N-way systems. SMP capabilities have existed since the introduction of the AS/400 N-way architecture. This form of SMP allowed multiple database operations to take place simultaneously on multiple processors. Each database operation would run on a single processor, thus optimizing DB2 UDB for AS/400 for online transaction processing. With the availability of DB2 Symmetric Multiprocessing for OS/400, DB2 UDB for AS/400 also becomes optimized for decision support processing. DB2 UDB for AS/400 is one of the few databases that can take full advantage of an SMP architecture for online transaction processing environments and decision support environments.

With the introduction of DB2 Symmetric Multiprocessing for OS/400, a single database operation can run on multiple processors at the same time or, in other words, in parallel. These database operations are typically queries, which are run through Query for AS/400, the DB2 Query Manager, a PC-based query tool, or a report writing tool. However, parallel processing is also supported for import and export between DB2 UDB for AS/400 and other databases.

Parallel index build capability is included in DB2 Symmetric Multiprocessing (SMP) for AS/400. An index build can utilize multiple processors at the same time, or in other words, work on multiple parts of the index in parallel.

This allows significant performance increases in cases where an index is created or rebuilt.

For queries, both SQL and native database interfaces are supported.

To achieve this parallelism involving multiple processors, an individual query is split into many smaller subtasks. Each subtask can run independently on a separate processor. Once the subtasks are complete, the results of each subtask are then combined to form the complete query result. Because of the advanced, single-level store architecture of OS/400, these subtasks can efficiently process information on the behalf of a user query request.

Those queries, which include table scans, index scans, joins, or group-by operations, will realize the greatest performance benefit from SMP database parallelism.

This process of splitting queries to run in parallel allows for significant performance increases. These performance increases become more pronounced with the addition of more processors. For example, if a query is running in 20 seconds on an AS/400 with a single dedicated processor, adding a second dedicated processor along with the DB2 Symmetric Multiprocessing for OS/400 feature may allow this query to run in approximately 10 seconds. Adding two additional processors may allow this query to run in approximately five seconds.

The previous example illustrates something that is very important with database parallelism -- how scalable is the technology. Scalability will govern how much benefit is gained from adding additional processors. Perfect scalability allows for four processors to run a query in one-fourth the amount of time that a single processor could, as shown in the previous example. The advanced architecture of the AS/400 system and of OS/400 have enabled DB2 Symmetric Multiprocessing for OS/400 to show industry-leading scalability across all AS/400 N-way systems.

DB2 Symmetric Multiprocessing for OS/400 can be configured differently for each user of the system. This allows a system administrator to have the greatest control over how parallelism is used on a system and thus greater control over how system resources are used. Part of this enablement process allows the selection of just how much parallelism is used, or in other words, how many subtasks are used for each query. Using fewer subtasks than processors available will allow a greater amount of the total system resources to be used by other users. Using more subtasks than processors available, allows an individual user to use more of the total system resources. This flexibility is needed to allow administrators to balance the needs of all system users with the available resources.

New parallel query technologies are made available through the DB2 Symmetric Multiprocessing for OS/400 feature. These query optimization techniques are designed to take advantage of the parallel technologies being added to DB2 UDB for AS/400. These allow faster resolution of queries involving a join or group-by operation without the need to create and maintain indexes over the tables involved in the query.

DATA WAREHOUSING:

DB2 Multisystem for AS/400 can be ordered as a separately priced feature of OS/400.

The AS/400 system and DB2 Multisystem for AS/400 provide a scalable solution for data warehousing that spans from the smallest datamart to the largest enterprise data warehouse. DB2 Multisystem for AS/400 will allow multiple AS/400 systems to be connected to allow the processing power and storage capacity of all of the systems to be used. From a database perspective, these interconnected AS/400 systems will appear as a single, large system. For more details on Data Warehousing, refer to Software Announcement 295-420, dated October 10, 1995.

DB2 Multisystem for AS/400 is intended for large data warehouse installations. Key to the successful implementation of a multisystem data warehouse is a good understanding of data partitioning, the performance characteristics of the query or data mining application, and the configuration of the systems and network.

Data Mining is a key technology in allowing a business to take full advantage of the information that is hidden in their data. Data Mining is the automated discovery of useful information held within large amounts of transaction data. For example, you will no longer have to go searching for that one piece of information that allows an exact target market to be identified.

Data Mining is different from decision support in one fundamental way. When using a decision support product, the user formulates a query in hopes that the query will return useful information. If the query doesn't specifically ask for a piece of information, it is not returned to the user. Data Mining solves this problem by finding the important information with little user involvement.

IBM recently announced the IBM Intelligent Miner. This product combines all of IBM's data mining technology into a single product that runs using AS/400 Advanced Series systems to mine the hidden information from data. AS/400 support for this product is only available on RISC systems. Refer to Software Announcement 296-117, dated April 16, 1996, for details on the IBM Intelligent Miner.

#### TRANSACTION PROCESSING:

Most systems today support a variety of transaction processing requirements ranging from interactive to batch. But not all systems provide this support in the same manner.

Support for all transaction processing environments such as native OS/400 interactive, System/38, System/36, Batch and Client/Server are all integrated into OS/400. There is no separate software to purchase and the interface to these transaction processing environments is the same interface used for all other parts of the operating system, so consistency is maintained.

The transaction processing functions of OS/400 provide for flexible implementation of your workloads. Through the use of priorities a certain group can be ensured first processing in the system, or by simply adjusting resource allocation a given batch job can be allowed to run to completion

without interruption from an interactive job.

OS/400 offers comprehensive transaction processing capabilities coupled with the ability to run applications migrated from other systems and it provides this with no additional software or integration required.

Using CICS for AS/400, a separately-licensed program (5769-DFH), customers can port System/390 CICS applications to AS/400 without excessive cost of code conversion.

#### BATCH PROCESSING:

Jobs that do not require user interaction can be processed as batch jobs. A batch job is typically a low priority job which may require a special system environment in which to run in order to reduce contention for system resources.

Most batch jobs are submitted to the system through job queues. The job queue may or may not be active at the time of submission. If inactive, the jobs await its activation. Jobs can be placed on job queues from:

- o an interactive job
- o a diskette or database file
- o a job schedule entry

Submitted jobs can be specified to run:

- o immediately (as soon as all previous jobs in the job queue have completed)
- o one time only, on a specified date/time
- o daily (or on certain days of the week), at a given time
- o weekly, on a given day of the week, at a given time
- o monthly, on a given day of the month, at a given time

Batch job processing can be controlled from any work station, and each job queue can be controlled separately, including:

- o Activating/de-activating
- o Holding/releasing

For example, during heavy interactive use, batch jobs can be submitted to an inactive job queue to be run later when adequate system resources are available.

Multiple batch jobs can be run simultaneously on a single system, with the number depending upon the availability of the resources each requires and the impact on other jobs running on the system at the same time, for example, interactive jobs. In general, as more CPU, memory, and DASD resources are available, more batch jobs can be run simultaneously.

#### EASE OF INSTALLATION, USE, AND MAINTENANCE:

- o EZ-Setup

EZ-Setup code is delivered on a CD-ROM shipped with the AS/400 system hardware. The code runs on a PC under Windows 95, Windows 98, and Windows NT 4.0 and requires the Operations Console cable be connected to the host AS/400.

EZ-Setup has three components:

- EZ-Setup Wizard
- Guided Setup
- The Next Step

EZ-SETUP WIZARD reduces both the number of decisions you need to make during setup and the amount of installation information you need to enter. The interface is all graphical.

GUIDED SETUP is a collection of HTML pages for the same tasks as those in the EZ-Setup Wizard. You read the information using a browser and enter AS/400 commands to perform tasks.

THE NEXT STEP is a set of HTML pages that you read and then perform the task. Topics include Exploring Operations Navigator, Setup Printing, Create User Profiles, Install Additional Software, Define System Cleanup Options, Create a System Backup and more. Use Next Step after the EZ-Setup Wizard or Guided Setup is complete.

- o Table-driven Design

Operating system installation and modification are table-driven to allow easy and quick tailoring of basic system operations. This results in less effort required for initial installation and system maintenance which provides better system uptime. The installation of OS/400 software involves copying the system objects from the distribution media onto the system auxiliary storage and then changing variables in external tables (System Values) to tailor operations in the following areas:

- Security and auditing
- Storage allocation and use
- System operation
- Messages and logging
- System date and time
- Numeric editing
- Default job library list

- o Automatic Configuration for Local Devices

The user can request that locally-attached devices be automatically configured. Local displays and printers can be added, changed or removed without affecting users signed on to displays connected to other controller ports.

- o Automatic Configuration for Remote Control Units and Devices

Remote controllers require two descriptions: an APPC Controller Description and a Remote Workstation Controller Description. The user



can request that both descriptions be automatically created for all 5394 Type 2.1 (with RPQ 8Q0775) and 5494 Remote Control Units attached to the AS/400 system via token-ring. If the 5394 or 5494 remote controller is not token-ring attached, the user must create the APPC Controller Description but can request that the Remote Workstation Controller Description be created automatically.

Programmable workstations attached to a remote controller are automatically configured when the controller description is created. The user can request automatic configuration for nonprogrammable workstations attached to a remote controller (it's the default).

Devices can be added, changed or removed without affecting users signed on to displays connected to other 5394 or 5494 controller ports.

#### o AS/400 Operations Navigator

AS/400 Operations Navigator is an integrated graphical interface developed to assist users performing AS/400 tasks and working with AS/400 system resources. Operations Navigator provides Windows 95/NT desktop integration and interfaces for doing the following AS/400 administrative tasks:

MANAGEMENT CENTRAL -- enables administrators or system operators to manage AS/400 systems in their network from a central AS/400 server. This includes the following functions:

- Manage endpoint systems
- Create and manage AS/400 system groups
- Monitor performance -- view real-time performance information about systems being managed. Allows administrators and operators to easily gather, analyze, and react to performance information. Monitor information about your AS/400, such as the CPU utilization, interactive response time, and disk space utilization. Other functions include:
  - Monitor multiple systems or system groups
  - Establish thresholds for each monitor
  - Execute programs automatically when threshold events occur
- Collection Services -- provides more control in data collection; the user defines when (scheduled or immediate), how (individually or together), what (e.g., IOP or CPU information may be collected at different intervals without collecting DASD information), and how the data is managed. This increased control results in reduced overhead.
- Messages -- send, view, and manipulate messages on AS/400 systems; properties of a message can be displayed and replied to.
- Printers -- view and manipulate printers on the AS/400 system
- Printer Output -- work with printer output that is waiting to be printed (i.e., open, hold, release, move, delete, etc.). Users can also change the properties of the output (i.e., printer, number of copies, priority, form type, etc.). Output can be moved to other queues using drag-and-drop operations. Output can also be copied to your PC using drag-and-drop.

A subset of the Advanced Function Presentation Workbench product called the AFP Viewer is included with the printer output capability. The AFP viewer provides powerful viewing capabilities. The viewer

allows users to view the contents of AS/400 printer output from the Printer Output list.

- Jobs -- perform actions against or change the properties of jobs on AS/400 systems
- Hardware and Software Inventory -- Multiple Systems --

With a graphical interface, you can schedule regular inventory collections of hardware, software, and PTF information for a group or network of AS/400s.

- Network Configuration:
  - Configure TCP/IP using a wizard to simplify the steps
  - Set up TCP/IP security
  - Configure point-to-point connection profiles and modems
  - Configure and monitor Client Access and TCP/IP servers, including:
    - o DNS -- set up the domains and hosts
    - o DHCP -- set up the subnets, classes, and clients
    - o NFS (AS/400 Network File System server) -- manage the exports and netgroups
    - o AS/400 NetServer (AS/400 Support for Windows Network Neighborhood) -- view the server statistics, the shared objects for a session, and sessions using a shared object
    - o DCE
    - o Directory server (Lightweight Directory Access Server, LDAP)
      - Configure the server and publish user information to an LDAP directory
  - Internet Administration -- manage the following internet configuration functions:
    - o IBM Firewall for AS/400
    - o Net.Commerce
    - o Digital Certificate Manager
    - o Internet Connection Server for AS/400 (V4R1 and V4R2 only)
    - o IBM HTTP Server for AS/400 (V4R3, or later release)
    - o IBM Payment Server for AS/400
    - o IBM Network Station Manager
- Security Configuration, Resource Security and Security/Audit Policies
  - Configure the AS/400 security using a wizard which asks questions about your AS/400 system and then recommends how to configure base system security. Reports for both the administrator and end users are fully NLS-enabled and are saved as text files that can be processed by an editor or word processor. Some or all of the recommendations can be automatically applied, and there is an option to reset the security configuration to what it was before the changes were made. Resource Security enables control of user and object information such as user's authority, public authority, owner, primary group, authorization list, default public authority for newly created objects (libraries only), and sensitivity level (QDLS objects only). Security/Object Policies can be changed easily.
- User and Group Administration -- create, change, or delete AS/400 users with the click of a mouse and easy-to-use dialog boxes. Users can be added to a group through drag-and-drop operations. Users can also be copied to other AS/400s using drag-and drop.
- Database Administration:
  - Set up ODBC configurations for other PCs in the network
  - Create and change database object definitions
  - Control access to database objects

- Backup database objects
- Organize file data to enhance performance
- Copy object definitions and data
- Display data in tables and views
- Manage journal objects
- Update table contents
- Manage remote journals
- Manage aliases
- Copy and move tables between systems
- File System Administration -- work with file system properties; filter the objects shown in the file system; open AS/400 objects using PC programs
- Managing multimedia data on the AS/400 using the Ultimedia System Facilities feature
- Backup Support -- schedule daily, weekly, and monthly backups of remote AS/400 systems. Through easy-to-use panels, select what should be backed up, when to schedule it, and where to save it.
- Application Administration -- control a user's access to functions in Operations Navigator for each AS/400
- Object Packaging -- The object packaging and distribution graphical interface makes it easy to send objects from any file system to one or more AS/400s in a network. You can also restore, take snapshots of, and version packages of objects, and post execution of commands. You can perform these functions on a group or network of AS/400s and schedule them to occur at a time most convenient for your staff.
- PTF Management for a Distributed Environment -- The easy-to-use wizards simplify PTF management in a distributed environment. They walk you through the process of comparing the PTF levels of multiple AS/400s to a model system that has a proven set of PTFs already installed. You then distribute and install any missing PTFs on the remote AS/400s by simply identifying the system or group of systems to be updated. You can run AS/400 commands as part of completing PTF installations or as part of normal day-to-day operations.

Third Party Plug-In Support -- allows other applications to "plug-in" by adding new folders and objects to the Operations Navigator window or by extending existing objects with new menu items or properties.

Operations Navigator also provides function to make managing your AS/400 easier and more productive. These functions include:

- Create shortcuts -- to AS/400 functions on your desktop (e.g., create a shortcut which brings up the list of messages for the system operator)
- Auto-refresh -- set up a folder to automatically refresh the contents after a period of time.
- Find -- an AS/400 object
- Print Details -- Print the right pane of Operations Navigator on your PC printer
- Cancel Request -- Cancel a request for data from the AS/400

## PRODUCT POSITIONING FOR MANAGEMENT CENTRAL AND PERFORMANCE MANAGEMENT/400

Management Central Monitors are now provided with the base operating system, and can be used to drive real time automation tasks. Customers

can now monitor and display short term trends in specific performance metrics and have the ability to set triggers, so that when a floor or a ceiling threshold is reached, a user defined action can be invoked: alarms to alert the operator of this occurrence, or an automated response can be executed. Management Central Monitors are not designed for medium or longer term performance analysis.

Performance Management/400 (PM/400) software assists customers by helping them plan for and manage system resources through ongoing analysis of key performance indicators on a regularly scheduled basis. PM/400 uses software and procedures to automate performance utilization and capacity usage reports. PM/400 helps the user maximize application and hardware performance (using performance trend reports), and better understand (using capacity usage reports) how the business trends relate to the timing of required hardware upgrades such as CPU, memory, or disk. PM/400 is designed for for medium/long term performance analysis and trending, not real-time monitoring and automation.

The new Management Central monitors and Performance Management/400 functions are designed to complement each other, with one providing real time monitoring functions, and the other focused on trending/analysis to insure performance.

o Operations Console

The AS/400 supports a new directly-attached, full-function 5250 PC console that includes a graphical control panel application. The user interface of the control panel application resembles its hardware counterpart. The console emulator application (PC5250) serves as the console "device" of the AS/400, therefore it permits the entry of restricted-state commands as SAVSYS and RCLSTG. The graphical control panel application permits remote entry of most of the functions supported by the hardware control panel mounted on the front of AS/400 system units. Control panel functions such as power up/down, re-IPL, mode changes, etc. are supported.

The console and control panel applications can be used together or separately, but each requires its own direct cable attachment to an AS/400 system. Each cable must be purchased separately from IBM for the AS/400 model being used. Both cables are only available in a single length of 6 meters. The tables below list the cables available for each supported AS/400 model.

Cables for the console application

AS/400 Models	I/O Features	Part Number	CIN	Description
600/620/S10/S20/150/170/720	2721/2745	97H7557	0367	36 pin PCI
640/650/S30/S40/SB1/730/740	9699	97H7556	0328	36 pin square
4xx/5xx (Note 1)	2609/2612			

### Cables for the control panel application

AS/400 Models	Part Number	CIN	Description
600/620/S10/S20/150/170/720	97H7591	0381	Connects to 9-pin D-shell labeled MI/J19
640/650/S30/S40/SB1/730/740	97H7584	0380	Connects to 9-pin D-shell on lower left side of HW panel
4xx/5xx (Note 1)			

Note 1: For 4xx/5xx systems upgraded to V4R3, or later release, the cables required for the console and control panel applications are available in RPQ 843964.

### Remote capabilities

The direct-attach Operations Console can also serve as a gateway for a remote, dial-in Operations Console. The remote Operations Console can also be configured to run the 5250 emulator application and/or the graphical control panel application. Both applications in general make it possible to perform the majority of system operations tasks, for example back-up and recovery, with the AS/400 systems and the managing staff in physically separate locations. The connection between the remote and direct-attach Operations Consoles uses Windows dial-up networking (PPP) with the direct-attach Operations Console utilizing Windows NT Remote Access Service (RAS) for access.

### Software Requisites:

The applications are included on the AS/400 Client Access for Windows 95/NT CD-ROM shipped with OS/400 V4R3, or later release. The Operations Console applications are installed and used on PC's using the Windows NT Workstation 4.0 with Service Pack 3 (required for the direct-attach Operations Console when it serves as a remote console gateway) or Windows 95/98 operating systems. OS/400 V4R3 or later release, is always required for direct/remote 5250 console attachment, however the control panel application will function as a stand-alone application with any IMPI or RISC "black-box" system. The table below illustrates the supported OS/400 levels and the possible AS/400 models supported for each application.

### Supported OS/400 versions and AS/400 models

Operations Console application	OS/400 version	AS/400 Models
5250 console device emulator	V4R3, or later	6xx/Sxx/150/170/4xx/5xx/7xx
Graphical control panel	V3R0.5, or later	6xx/Sxx/150/170/4xx/5xx/7xx 2xx/3xx (Note 1)

Note 1: Valid OS/400 level/hardware model combinations are not listed

for brevity, but any supported combination will work.

- o Operational Assistant

Operational Assistant (OA) presents a group of tasks, commonly done by an application end user or system operator, in easily understood non-technical terms. Users unfamiliar with the AS/400 system, its terminology, and sequence of steps to do a task are relieved of these complexities.

User productivity is improved by operational assistant making it easy to do tasks such as managing printer output, managing batch jobs, sending and answering messages. Systems management is facilitated by using OA to enroll and delete users on the system, to back up libraries, and automatically clean up job logs, history log files, and system journals. The system administrator is also assisted in setting up and scheduling simple backups, managing users signed on to the system, understanding the status of the system and managing the system's disk space.

The operational assistant function can be accessed in four ways:

- Information Assistant

Information Assistant options provide one-stop shopping for a user's AS/400 information needs. A menu provides selectable options to inform the user about where to look for information, how to submit comments on information, and highlights about what is new in the current release of the AS/400 system. In addition, access to searching the help index, starting online education and starting the question and answer function is provided. Information Assistant options are accessed from the AS/400 Main Menu, the Operational Assistant Information and Problem Handling menu, or by typing GO INFO on the command entry line.

- Existing system commands, which have the parameter, ASSISTANCE LEVEL (basic, intermediate, or advanced)
- An attention program that brings up the OA main menu
- Application programs that use the OA programming interfaces

- o Menu Interface

System-supplied menus to most system functions provide a task-oriented approach so that a user unfamiliar with control language can set up and use Operating System/400. The menus use an object-oriented approach by providing list of objects for the user to work with. A fast path gives quick access to system functions for the more experienced users.

- o Online Help

The AS/400 help facility provides comprehensive explanations of display

functions to help users be more productive. The index search facility can be used to request help for a task that involves multiple displays. Index search includes many synonyms so that users may ask for information in their own words or in the terms used by the system.

The help information provided is determined by the current location of the cursor on the display. It may be specific to a field or line on the screen, or to extended help on the use of the display as a whole.

- o System Operation

System operational functions can be performed on an attended, partially attended, or a predominantly unattended basis. System operator functions can be interactively entered or executed under program control. Printer paper and media handling are manual functions. Various displays are provided to allow for control of jobs, spooling operations and communication lines.

- o Problem Determination

Several system functions provide assistance in problem determination including dedicated and system service functions, messages, help information, and problem analysis commands.

A useful function in problem determination is copying a screen image from one work station for display on another work station. This is especially useful when used in conjunction with remote service support.

- o Improved Software Problem Isolation and Data Collection

User-friendly, easy-to-use OS/400 tools provide customers with the ability to collect problem data at a central site. This OS/400 support for software problem isolation and data collection enables customers to recreate software problems, save the results, and then view the data from a central site. Initiation of the tools can be done locally or remotely.

- o System Detected Software Problems

Symptom strings are now automatically created by the OS/400 licensed program at the time an error occurs, thus making management of problems in the system easier and recovery quicker. The automatic generation of symptom string data improves in the rate at which customers can find appropriate PTFs for problems. Problem resolution time is decreased when failure data is collected at the time of occurrence thus reducing the need for failure recreation.

- o Programming Temporary Fixes (PTFs)

PTFs (including licensed internal code changes) may be loaded and applied using a command. Deferred PTFs can be applied only at IPL time, but an option allows this to be done unattended. PTFs can be shipped to a central site, either on media or electronically, and may then be packaged and distributed to remote or DSLO license sites, either on media or electronically. With the exception of the loading of media, the handling of PTFs can be automated for remote sites.

With V4R3 AS/400 customers can download PTFs over the Internet. The client hardware needed is a PC with WIN95/NT, a TCP connection to the AS/400 over a LAN, and access to the Internet. The various configurations and set up information are documented on the Internet at the following Web site:

[HTTP://AS400SERVICE.ROCHESTER.IBM.COM](http://AS400SERVICE.ROCHESTER.IBM.COM)

Except for the medium of transport (Internet), the functionality and entitlement rules are the same as for the ECS method of transport.

#### o Software Management Services

Software Management Services, a framework for software packaging, provides a consistent process for managing software on an AS/400 system. This consistent process covers IBM and non-IBM AS/400 software and PC-based software using AS/400 folders/documents support. When a vendor or customer uses the SystemView System Manager/400 licensed program to package an application, that application can now be installed and maintained using the same procedures that are used for installing and maintaining IBM AS/400 licensed programs. These procedures include software media packaging and distribution, application installation, application registration within the AS/400 system, and application servicing. Convergence to a common process for packaging enables the OS/400 facilities to provide consistent management of these packaged applications. This reduces redundancy and inconsistencies for applications and current procedures.

#### o Reading AS/400 Books Online

Softcopy publications are shipped on machine-readable CD-ROM medium as a no-charge feature of OS/400. The books may be downloaded from the medium and are then available for search and/or display from either programmable or nonprogrammable workstations.

Downloading can be done from either the system CD drive or a programmable workstation with a CD drive attached. It is not necessary to download the books since all workstations can access the system CD drive to read them directly.

On a programmable workstation, either the Library Reader licensed program (included on the medium with the books) or the BookManager READ licensed program is used to search/read the books.

On a nonprogrammable workstation, the InfoSeeker function of OS/400 is used to search/read the books.

The design of the softcopy library allows you to:

- Install only those books that you need for your installation
- Create customized bookshelves that contain only those books that you use most frequently
- Search quickly for a word or phrase across a book, bookshelf, or the entire library



- Select and jump directly to a topic
- Look only at information that has been changed in the current release
- Copy or print topics from a book
- Copy coding examples to AS/400 files

With the BookManager BUILD products (available for OS/2, VM, and MVS platforms), users can create their own softcopy books.

#### o Software Delivery on CD

All licensed programs ordered with a System Program Order (SPO) are shipped on a single CD, tailored for each order. The licensed programs are loaded by the install process directly from the CD.

While IBM software distribution is on CD only, customers may create their own media or continue to use tape for redistribution of products. Tape will still be used for backup and save/restore activities.

IBM will provide PTFs on CDs also.

#### EXTENSIVE RUN-TIME APPLICATION FUNCTION:

Operating System/400 is a functionally-rich platform for applications. Because it is enabled to run a wide range of applications, customers can easily grow their application base as their business needs grow. The extensive run-time function integrated into the OS/400 licensed program enables application programs created with the following languages, utilities, and support to run without the corresponding licensed programs:

- o ILE RPG for AS/400
- o RPG/400
- o IBM System/36-Compatible RPG II
- o IBM System/38-Compatible RPG III
- o ILE COBOL for AS/400
- o COBOL/400
- o IBM System/36-Compatible COBOL
- o IBM System/38-Compatible COBOL
- o ILE C for AS/400
- o SAA AD/Cycle C/400
- o System C/400
- o VisualAge C++ for AS/400
- o AS/400 BASIC
- o AS/400 Pascal
- o AS/400 PL/1
- o RM/COBOL-85 for the AS/400
- o Structured Query Language (SQL) (part of DB2 Query Manager and SQL Development Kit for AS/400)
- o Query for AS/400
- o Data File Utility (DFU) (part of Application Development ToolSet for AS/400)
- o DFU and Query (part of System/38 Utilities for AS/400)

For other separately-licensed programs, please refer to the Programming Requirements section for the specific program.

## PRODUCTIVE APPLICATION DEVELOPMENT ENVIRONMENT:

Operating System/400 includes many functions to assist in programming the system. These functions, along with the Application Development ToolSet for AS/400 (5769-PW1) licensed program, provide a productive application development environment. This environment supports a hierarchical approach to application development which can increase programmer productivity. The programming functions included in OS/400 are:

### o Interactive Debug

These facilities increase programmer productivity by providing assistance in creation and maintenance of programs written in RPG/400, COBOL/400, BASIC, PL/I, CL, and Pascal. Debugging of batch or interactive jobs can be done at any time; no special compilation is needed. Included are:

- Breakpoints
- Conditional breakpoints
- Display/change program variables at breakpoint
- Statement trace

### o Command Prompting

Productivity of users executing commands is increased by command prompting. Each system and user command can be prompted for help with parameters. Parameters can be filtered based on values previously entered or predetermined parameters. Online help explains parameters and values.

### o Cross-Reference Facility

Programmer productivity is increased by relieving the burden of cross-referencing. The system has the capability to cross-reference files to related programs and fields to related files.

### o Programmer Menu

Using this menu, creation and maintenance of objects require minimal use of system commands.

### o Interactive Data Definition Utility (IDDU)

IDDU assists in the creation of database files by creating IDDU data dictionaries, defining files, record formats, and fields. Programmer productivity is thus enhanced by using IDDU. It is an alternative to using Data Description Specifications (DDS). Easy-to-use functions within IDDU assist in the creation of files with existing field definitions.

## INTEGRATED LANGUAGE ENVIRONMENT (ILE):

The Integrated Language Environment (ILE) is an architectural enhancement to the AS/400 system to meet the challenge of providing new function and greater

application design flexibility. ILE exploits modern high-level language (HLL) technology while maintaining compatibility with existing applications.

The AS/400 system's ability to integrate multiple applications from multiple independent sources is improved. Each application is allowed to define its own boundaries. Multiple applications within the same job each have their own commitment control in effect for data base management. This is accomplished through improved isolation in data and commit scoping.

ILE provides a common framework for ILE-conforming languages in the areas of program activation, storage management, condition management, and program debugging. ILE also defines calling conventions for access to ILE bindable APIs and provides consistency and improved performance for interlanguage communication.

ILE-conforming languages are:

- o ILE C for AS/400
- o ILE COBOL for AS/400
- o ILE RPG for AS/400
- o ILE Control Language (CL)

New elements introduced by ILE:

- o ILE PROGRAM BINDER

The Integrated Language Environment introduces a new step in the application development process: binding. The purpose of binding and the Program Binder is to create program objects in such a way that efficient external calls may be performed.

ILE compilers create modules (object type \*MODULE), and the Binder is used to bind several modules together to form a program object. Note that these ILE program objects are logically as well as physically different from unbound program objects.

Modules from any of the ILE compilers (C, CL, COBOL, and RPG) can be bound together permitting applications to be created entirely in ILE which provides a greater level of environment consistency and isolation from other applications.

- o ILE MESSAGE HANDLING

With ILE, the concepts of a message and an exception are unified; both are sent at the same time. Although this exception model is applicable to both ILE and non-ILE programs, the concepts of monitoring for and handling an exception are significantly different between the two.

- o ILE SOURCE DEBUGGER

The ILE Source Debugger is used to debug all bound programs and service programs. It allows debugging to be done in terms of the source associated with a program. It cannot be used with non-ILE programs which must be debugged using the system debugger (for Old Program Model

programs) or the EPM debugger (for Extended Program Model programs).

A debugger API is provided, allowing compilers and other pre-processors which contribute to module creation to create debug view information associated with a module object. The API allows source debuggers to be built for the AS/400 system.

The nonprogrammable workstation ILE Source Debugger is shipped with OS/400 and is therefore available to all AS/400 customers.

#### o ILE DYNAMIC SCREEN MANAGER

The ILE Dynamic Screen Manager (DSM) offers versatility and adaptability in generating screens during application execution with a set of bindable Application Program Interfaces (APIs). DSM enables ILE developers to create screens and windows dynamically, no longer requiring predefined static screens. This provides improved programmer productivity over using UDDS to perform low-level screen I/O operations and greater flexibility in controlling the screen appearance dynamically for the application. The DSM support falls into the following categories:

- Low level services - provides a simple API interface to the UDDS commands, greatly simplifying applications that require low-level control of the screen.
- Window services - supports the dynamic creation, drawing, selection, moving, and re-sizing of one or more windows on the screen. Data and fields can be defined inside the windows.
- Session services - provides support for dynamically placing data inside an area of a window and scrolling the data, similar in concept to subfiles.

#### SEAMLESS OPM/ILE DEBUG AND WATCH SUPPORT:

The OS/400 system debug support is enhanced to provide seamless debug across OPM (Old Program Model) and ILE (Integrated Language Environment) programs. OPM languages supported: COBOL, RPG, and CL. New support is also provided for OPM and ILE debug support to watch the contents of a variable and break when the variable changes.

The seamless debugger enhancements include:

- o A single user interface (SUI) for debug of both ILE and OPM
- o A single API for debug of ILE and OPM
- o New source-level debug support for OPM programs:
  - Display Module Source screen to set and display breakpoints, turn on step, and display variables using source and listing views of the OPM program the same as ILE source debug support
  - System-supported Step Into and Step Over in OPM programs
  - Step Into OPM from ILE and into ILE from OPM (mixed calls)
  - Expression evaluation support similar to ILE
- o Seamless Watch support across OPM and ILE

#### ENABLING TECHNOLOGIES:

## OPTICONNECT FOR AS/400:

OptiConnect for AS/400, a separate feature of OS/400, provides high-speed transparent access to data through fiber optic bus connections and performance enhancements to AS/400 Distributed Data Management (DDM). The major advantages of OptiConnect for AS/400 are realized by customers who are rapidly approaching system capacity limits, and/or who want to implement distributed database application servers within a data center or short-distance campus environment.

With OptiConnect for AS/400 customers can offload the database application CPU cycles of up to 13 AS/400 systems. Customers wishing to implement distributed application servers can also benefit from using OptiConnect for AS/400.

When used with the ObjectConnect for AS/400 facility, OptiConnect for AS/400 provides a high-efficiency migration aid for the AS/400 Advanced Series.

The mechanism used by OptiConnect for AS/400 to access database files on connected systems is modeled after DDM. Just as DDM uses a DDM file and APPC communications to redirect file access operations, OptiConnect for AS/400 uses DDM files and a specialized transport service to redirect file access operations to a target system. Because OptiConnect for AS/400 operates only among systems sharing the same bus (connected with fiber optic cables), it can achieve transport efficiencies not possible with more general purpose, wide-area communications protocols.

## OBJECTCONNECT FOR AS/400:

ObjectConnect for AS/400, an integrated function of OS/400, simply and efficiently moves individual objects, entire libraries, or entire Integrated File System (IFS) directories from one AS/400 system to another over a standard communications connection or over a high-speed fiber optic bus. Systems can be connected via standard APPC (using APPN), TCP/IP communications lines (using AnyNet), or a fiber optic bus (using OptiConnect for AS/400). The economy of not requiring intermediate savefile procedures and copies to distribution queues saves DASD and improves performance in a manner that is non-disruptive to system operations.

## ULTIMEDIA SYSTEM FACILITIES:

Ultimedia System Facilities extends the customer application interface into the world of multimedia. Multimedia capabilities added to existing or new applications can present real work information more effectively and make complex concepts easier to understand. Subtle differences in color, complex movements, and sounds can be more accurately described in multimedia. Ultimedia Facilities can provide the interaction of data with visuals or sound to enhance decision making and accuracy.

Client PC support is provided through AS/400 Client Access. Both OS/2- and Windows-based PC platforms can capture, store, and present multimedia objects. These objects can be text, image/graphic, audio, digital video, and analog video.

The AS/400 system registers and manages multimedia objects that can be stored on the user's client PC, on the AS/400 system in shared folders or on the

3995 optical library that is either host or Local Area Network (LAN) attached. Analog objects, such as laserdiscs, can be used also but are managed by the user, with the AS/400 system providing scheduling for these devices.

Ultimedia System Facilities also provides functions through APIs available to both AS/400 and client PC applications. The OS/400 Ultimedia System Facilities APIs use standard interfaces that are callable from high level languages (COBOL, RPG, and C). A subset of the APIs is available through the standard CL command interface. The Client Ultimedia Facilities APIs are callable from programs written in the C language using Dynamic Link Libraries (DLLs). The API requests are routed to either the AS/400 system or a client PC depending on which platform is best suited to perform that function.

OS/400 Ultimedia System Facilities APIs support:

- o Communications between the AS/400 system and the client PC
- o Shared folders
- o Multimedia extensions supplied by OS/2 and Windows
- o Standard graphical user interface support of the PS/2 Presentation Manager and Windows.

AS/400 Client Access must be installed on the client PC to utilize these facilities.

OPENNESS:

- o OS/400 SINGLE UNIX SPECIFICATION FUNCTIONS ENABLE APPLICATION PORTABILITY:

Through support of X/Open single UNIX specification (formerly Spec 1170) interfaces, AS/400 provides most of the commonly-used system interfaces used by commercial client/server applications today. The support includes functional enhancements that reduce the cost of porting applications to the AS/400 system.

These functions allow AS/400 C application developers to build applications using system interfaces and C runtime functions that are portable to other operating systems.

Functions included in OS/400 are:

- environment variables
- semaphores
- shared memory
- message queues
- signals
- process-related APIs including the "spawn()" function that provides an alternative to the "fork()" function (implementation based on POSIX 1003.4b draft 7)
- miscellaneous C runtime functions

Additional functions are available in the Common Programming API (CPA) Toolkit, a separate feature of OS/400:

- Threads (implementation based on POSIX 1003.1c draft 4)
- Thread support for ANSI C file I/O
- Thread support for OS/400 Integrated File System (IFS) I/O
- Thread support for sockets I/O
- Thread support for sockets network functions

The functions in CPA are based on industry standards from POSIX (Portable Operating System Interface) and the single UNIX specification. These standards enable source code portability of applications over platforms such as OS/400, OS/2, AIX, MVS and other, non-IBM, operating systems.

o DISTRIBUTED COMPUTING ENVIRONMENT (DCE) BASE SERVICES FOR OS/400:

DCE Base Services for OS/400, a separate licensed program offering (LPO, 5798-TBF), provides a comprehensive, integrated set of services to support client/server applications based on remote procedure call. DCE services include a network-wide security and naming facility for large scale distributed systems. DCE services enable a high degree of transparency across dissimilar platforms in terms of location in the network (services can be anywhere in the network), worldwide authentication (user identification and validation) and remote function invocation across system platforms.

DCE Base Services for OS/400 provides the key functions of OSF's Distributed Computing Environment (DCE) Version 1.0.2. It provides function for building DCE RPC distributed applications including OSF DCE Time Services, Security Client functions, and Cell Directory Client functions. Client/server application enabling is simplified with automatic data conversion between unlike systems and location independence for client applications. TCP/IP communications protocol is supported.

With these capabilities applications can transparently support the distributed client/server environments across a variety of systems including: OS/400, OS/2, AIX, MVS, and other, non-IBM, operating systems.

o PTHREAD (POSIX-BASED) APIS:

Pthread APIs, previously shipped as a separate product (PRPQ 5799-XTH), are now included in OS/400. They allow Business Partners or AS/400 application developers to take advantage of new system support for kernel threads. Creating an AS/400 thread is faster than creating an AS/400 job and is a more efficient way to spin off portions of application or server processing into parallel tasks.

The Pthread APIs are based on open APIs described in the ANSI/IEEE Standard 1003.1, 1996 Edition (also known as ISO/IEC 9945-1: 1996) and the Single UNIX Specification, Version 2, 1997 standards.

OPTICAL SUPPORT:

o 3995 OPTICAL LIBRARY DATASERVER SUPPORT

The 3995 Optical Library Dataserver is a direct- or LAN-attached device that can store up to 188GB of data on optical disks. Both Write Once Read Many (WORM) and Rewritable media are supported. It provides the high capacity, online storage required for image, data archive and retrieval, workflow, and microfiche replacement applications.

Hierarchical File System (HFS) APIs and the Integrated File System (IFS), integrated in OS/400, allow for easy integration of optical storage into existing or new AS/400 applications using the 3995.

In addition, objects may also be saved to and restored from the 3995 using system commands. HFS APIs support direct- and LAN-attached 3995s; IFS and the Save/Restore commands support only direct-attached 3995.

#### o CD-ROM DRIVE SUPPORT

CD-ROM technology is based on creating a CD-ROM master, and then stamping quantities at very low cost. Support of the system-attached CD-ROM drive allows AS/400 users and software vendors to support new applications or existing 3995 applications to access information stored on CD-ROMs, such as catalogs, educational materials, directories, and historical data. Applications can be written to access data directly from CD-ROM using Hierarchical File System (HFS) APIs or the Integrated File System (IFS).

OS/400 Restore commands support reading from CD-ROM so any AS/400 object that can be restored can be distributed on this convenient and inexpensive media.

#### HIGH SYSTEM AVAILABILITY:

The AS/400 system is one of the most reliable computers in the industry. However, to ease system management and minimize recovery, customers must follow a sound backup plan and choose some of the following functions as appropriate:

- o A BACKUP POWER SOURCE IS RECOMMENDED to avoid or reduce system downtime in the event of utility power loss -- either a battery backup feature on those models where available, or a vendor-supplied uninterruptible power supply. The battery backup feature on the system unit supplies power for a few minutes; for continuous operation in the event of longer power outages, a vendor-supplied uninterruptible power supply should be used. A feature of the operating system allows notification to a user program of a loss of utility power.
- o CONTINUOUS AVAILABILITY CLUSTERING (V4R4) enables you to set up an environment with availability approaching 100% for your critical applications and your critical data. AS/400 high-availability business partners and ISVs complete the solution with easy to use cluster management, robust data resiliency, and resilient applications that take advantage of the new technology.

AS/400 cluster architecture supports 128 nodes, using any combination of the existing OptiConnect WAN and LAN connectivity options to build the cluster.



- OptiConnect hardware, fully supported as an orderable system feature, is an attractive connectivity method for high-end and mid-range models.
- ATM provides a high-performance connection to remote systems in the cluster.
- Ethernet and token-ring LANs are ideal for connecting low-end AS/400 models into the cluster.

All systems are managed from a single workstation containing the high-availability business partner cluster management application.

OS/400 V4R4 must be installed on each node in the cluster.

- o DATABASE FILE CHANGES SHOULD BE JOURNALED to enable forward or backward recovery. "After" images are always journaled enabling forward recovery; an option is available to also journal "before" images enabling backward recovery. When a file is journaled, the system ensures that any changes to the data are written to the journal. It is possible to "mirror" a journal to a remote system. Possible benefits include:
  - Maintaining duplicate databases on separate systems
  - Reducing the time and effort required by customers to reconcile source and target databases following a system failure
  - Offloading journal save operations
- o ACCESS PATHS CHANGES SHOULD BE JOURNALED to enable faster recovery in the event of abnormal system termination. An access path being maintained at the time the system terminates is placed in an invalid state. Using the journaled changes, the system can quickly make the access path operational instead of requiring a rebuild of the entire access path.

System-Managed Access Path Protection (SMAPP) provides automatic system journaling of access paths to try to achieve a user-specified time for access path recovery in the event of abnormal system termination. Target recovery time may be specified either system-wide or by ASP.

With SMAPP enabled, the system estimates the time required to rebuild each access path and then automatically determines which access paths to protect to meet the user-specified recovery time. New access paths are automatically considered for protection.

SMAPP provides the most efficient means of journaling because it journals only what is necessary to protect access paths and it takes advantage of this information to reduce both CPU usage and the I/O associated with journaling. Customers who have employed little or no journaling support in the past will benefit from a dramatic reduction in the time it takes to recover their access paths.

Automating this chore and the associated responsibilities of creating and managing journals, allows the customer to concentrate on setting access path recovery policy and lets the operating system handle the burden of

putting this policy into practice.

- o A single transaction may involve several database changes. Use of COMMITMENT CONTROL allows the application program to treat all changes for a transaction as a single group - to be either committed in the event of normal completion or backed out in the event of abnormal completion. An application programmer can easily provide for recovery at a transaction boundary using HLL statement to request commitment or rollback. Commitment control requires journaling.
- o USER AUXILIARY STORAGE POOLS (ASPS) allow most object types to be confined to a user-defined set of DASD units. The objects can be recoverable quickly and completely after a DASD failure by reloading only the user ASP DASD units rather than the entire system.

Once a user ASP is established, disk units may be added to it dynamically, without having to stop normal business processing, including mirroring or RAID-5 protection, if specified.

Object types not supported in user ASPs include:

- Spooled output files
  - Selected printer objects
  - Unfiled mail documents
  - Filed documents that do not reside in a folder
- o CHECKSUM PROTECTION protects against loss of data in the event of a single disk failure within an ASP. The checksum facility automatically rebuilds the data on the failed disk unit for both system- and user-defined auxiliary storage pools.
  - o DISK MIRRORING, in most cases, allows the system to continue to operate after a disk unit or disk attachment failure occurs. Mirroring is specified on an ASP basis and requires duplicate disk devices of the same capacity. The entire system or one or more ASPs may be mirrored. If the entire system is mirrored, double the disk capacity is needed. When mirroring is started, the system automatically selects disk mirror pairs that provide the best path protection for the hardware configuration of the system. To increase the path protection, additional controllers and IOPs should be considered.

Mirrored protection is an alternative for checksum protection on an ASP basis; IBM recommends only one of these methods be used on a given ASP. Mirrored protection does not remove the need for a proper backup strategy to protect against catastrophes or the possibility that both units of the mirror may fail. When one unit of the pair fails, the system is exposed to a failure until the repair action occurs and mirroring is resumed.

Mixing of 9337 RAID and non-RAID DASD within a mirrored ASP is supported. DASD data loss protection for mixes of DASD that use RAID-5 array techniques, called "device parity", with other non-device parity DASD units is accomplished by allowing RAID DASD units to be configured into mirrored ASPs. When this is done, each of the non-RAID DASD units will have a mirrored partner while DASD with RAID will be self-protected. With this solution, the system will be able to continue running for any single DASD device failure. This OS/400 support is for the RAID

protected DASD as implemented on the IBM 9337 Disk Array Subsystem.

- o CONCURRENT DASD MAINTENANCE is supported only on a properly-configured AS/400 9406 mirrored system or mixed mirrored and device parity protected system. With a proper configuration, it is possible for the system to operate successfully while experiencing a DASD failure and subsequent repair action. Diagnosis and repair may require active mirrors to be temporarily suspended. Some users may prefer to defer maintenance until all normal operations are completed. In some conditions (for example an IOP failure), the repair action requires that the system be powered off.
- o In V4R3, CONCURRENT MAINTENANCE is included FOR I/O CARDS, POWER, AND OTHER COMPONENTS CONTAINED IN EXPANSION TOWERS. You can power off an expansion tower and add, remove, replace, upgrade, move, or swap a card or other component without stopping or powering off your system. Applications that use hardware resources in that expansion tower may need to be stopped and restarted. When the expansion tower is powered back on, new or changed hardware resources are automatically recognized and associated with existing resource names, if appropriate, to preserve existing configuration information and to allow applications to immediately use these resources without having to IPL.
- o SAVE-WHILE-ACTIVE (SWA) allows one or more libraries to be saved while operations, including changes, continue against the libraries. During a short period of quiesced operation, a checkpoint is taken of all libraries being saved before the first save operation begins, so that all libraries are in sync.

#### SYSTEMS MANAGEMENT:

OS/400 system management functions include Simple Network Management Protocol (SNMP) APIs and access to additional management information.

The new SNMP APIs for managing applications have the ability to manipulate management data via local or remote SNMP agents. Using AnyNet/400 support, information can be retrieved from systems on SNA or TCP/IP networks, thus making it easier to discover and manage potential problems anywhere within the network.

An SNMP agent responds to an SNMP manager's requests. Most SNMP agents are extendable, and APIs are provided that allow the dynamic addition of sub-agents to show additional information needed to make good management decisions.

OS/400 also supports a Host Resources Management Information Base (MIB) for hardware and software inventory of an AS/400 system. The APPN MIB includes APPN physical ports (APPC lines) and link stations (APPC controllers). These allow more AS/400 management information to be accessible to applications using SNMP.

Independent Software Vendors (ISVs) can use the SNMP APIs to write AS/400 management applications to collect inventory data, monitor and change resources in the network and a variety of other tasks. They can also write sub-agents that allow access to additional AS/400 management information from management applications running on other platforms.

Two APPC Applications Suite applications are included in OS/400: APING and APPC Remote Execution (AREXEC).

- o APING provides a simple way to test the connectivity between two APPN systems; it works like the TCP/IP PING command.
- o With AREXEC, commands can be run on another system supporting AREXEC, such as OS/2 or RS/6000, and commands from other systems can be run on AS/400.

#### ELECTRONIC CUSTOMER SUPPORT:

Electronic Customer Support is an integrated approach to helping users service and support single or complex systems and networks. It is menu-driven, supported by online help text, and includes locally available functions and access to remote marketing support systems and IBM service support.

Simplicity and ease-of-use characteristics mean that configuring and supporting systems requires limited data processing knowledge or experience. Additionally, electronic customer support enables third party software and support organizations to support systems and networks from a central site, providing business solutions and partnerships that improve service and support to IBM AS/400 customers. The following are the systems management capabilities of electronic customer support:

- o Resource management and configuration management
- o Problem management, network management, and change management
- o Online and remote technical support
- o Electronic hardware and software service support
- o Remote marketing support

#### COMPREHENSIVE SECURITY FOR SYSTEM RESOURCES:

The many levels of security available with OS/400 ease the job of system security management. The level of security is set simply using a System Value, as follows:

- o Minimal security (level 10): No passwords are used, any user can perform any function.
- o Password security (level 20): Passwords must be used. However, any user can perform any function.
- o Resource security (level 30): Passwords are required and object usage can be controlled. Users can be restricted to specific functions.
- o Resource security and operating system integrity (level 40): Passwords are required and object usage can be controlled. Users can be restricted to specific functions. Use of unsupported system interfaces is restricted.
- o Enhanced system integrity (level 50): Parameter validation into the

operating system and restrictions on use of user domain objects. This enables the AS/400 system to operate at the C2 level of trust as defined by the US Government publication DOD 5200.28-STD, "Department of Defense Trusted Computer System Evaluation Criteria" (Orange Book).

The OS/400 operating system is distributed with the security level set to 40.

You should verify with solution providers that their applications will run at security level 40. If applications do not run at this level, a lower security level can be set. For considerations on moving to security level 40, refer to the Security section in the manual "Tips and Tools for Securing Your AS/400" (SC41-5300).

Access to system resources is controlled by giving each user a tailored menu from which to select functions. It is also possible to secure individual system resources and user resources using a combination of public authority (for any user) and private authority (for specific individuals). Facilities are provided to:

- o Grant authority to a group of users who all have the same authority to a group of objects.
- o Exclude individual users from authority granted to the public.
- o Automatically sign off users after a specified period of inactivity.
- o Maintain an audit log of security-related events. Examples include:
  - Actions of a specified user
  - Actions against a specified object
  - Actions against spooled files
  - Actions against jobs
  - Invalid sign-on attempts
  - Attempts to access non-authorized objects
  - Changes in security-related System Values

The discrete object and data authorities are:

- o Object Existence (user can delete the object)
- o Object Management (user can change the object description)
- o Operational (user can use the object)
- o Read (user can read existing data)
- o Update (user can update existing data)
- o Add (user can add new data)
- o Delete (user can delete existing data)

## C2 EVALUATION

AS/400 has received a C2 security rating from the United States Department of Defense for V4R1 of OS/400 (including its integrated DB2 database) and selected other licensed programs. Hardware requirements and additional information are in reference manual "IBM AS/400 Security - Enabling for C2" (SC41-3303). To achieve a C2 rating, a system must meet strict criteria in the following areas:

- o Discretionary access control
- o User accountability

- o Security auditing
- o Resource isolation

The C2 rating was awarded after a rigorous, multi-year period of evaluation. AS/400 is the first system to achieve a C2 rating for a system (hardware and operating system) with an integrated, full-function database. IBM is currently pursuing C2 ratings for additional hardware and software releases, including V4R4. No prediction can be made regarding the results or timing of the evaluation by the U.S. Government.

#### INTERFACES TO SYSTEM FUNCTIONS:

- o Control Language (CL)

The control language provides a consistent interface to all system functions. Thus, a programmer can tailor solutions using system functions without the end user or operator seeing what is being executed. The control language provides rich function and a consistent set of terminology and syntax. User-written commands can also be created. Most commands can be executed interactively, in a compiled CL program, or in a high-level language program. The ease of using CL and its rich function make it a productivity aid for programmers. CL programs allow the use of variables, error handling and access to the database. Programming functions include reading and writing to a display or database file, IF/THEN/ELSE logic, calling or being called from another program, and so on.

- o Data Description Specifications (DDS)

DDS can be used to describe attributes of display, printer, database, and Intersystem Communications Function (ICF) files. These file descriptions can then be used in high level language programs.

- o User Interface Manager (UIM)

Most OS/400 display panels are coded in a tag-based language which enables description of the content of a panel without specifying the format of the panel; the UIM controls the format. This can enhance ease-of-use by enforcing consistency in panel appearance as well as matching the "look and feel" of most IBM-supplied AS/400 panels. The UIM tag language supports displays and printers, and the resulting panel groups can be used by all AS/400 high-level languages, including Control Language (CL), using CALL-level interfaces.

The UIM supports four common panel types: menus, information displays, list displays, and entry displays, and for these provides consistent placement and format for many panel elements, such as:

- Panel name
- Panel title
- Separator lines
- Column headings
- Entry fields
- Command line

- Message line
- Function keys
- Pop-up windows
- Menu bars
- Pull-down menus

It also provides automatic and consistent use of:

- Color
- Underline (input fields)
- Reverse image (error fields)
- Date and time
- Number pages (printer output)

#### o Consistent Program Structure

Programs can be written in either a high-level language or control language. Programs written in one language can call and pass parameters to a program written in the same or a different language. All system and user programs are re-entrant, and each user executes the same "read only" object code of a program with the system maintaining separate, unique work areas for each job and each program within the job. In addition, only those portions of the object code actually in-use are required to be in main storage. These two factors can increase the number of programs concurrently operating in the available main storage.

#### o Query Management

The SAA query common programming interface (CPI) can be used to import and execute queries generated in other SAA environments. Query management may also be used to imbed query and report writer function into AS/400 applications or send them to other SAA environments for execution. Query management is a productivity aid for the application programmer.

#### o Procedures Language 400/REXX

REXX is an easy language to learn. It facilitates writing clear, structured, interpreted procedures. REXX can provide the data manipulation and procedural logic framework for OS/400 commands and conventional calls to other high-level language and CL programs.

The REXX interpreter implements the SAA level 1 definition of Procedures Language and the SAA level 2 definition except for native language support for stream I/O. Thus, it provides a more portable procedural alternative to OS/400 CL programming. It reduces programming investment for users who require applications that execute in several SAA environments. REXX also helps protect the programming investment for users who have already developed REXX procedures for other SAA environments. They simply replace embedded environment commands with OS/400 commands to port procedures to an AS/400 system. Procedures Language 400/REXX also supports DBCS for Asian language users.

#### o Programming Interface to DIA Services and Office Functions

OS/400 office host support provides a programming interface designed

around the AS/400 control language to enable customer application development. The commands are provided for application programming interfaces (APIs) to the following AS/400 services.

- Calendar services (available only with IBM OfficeVision for AS/400, 5769-WP1)
- Directory services
- Distribution services
- Document library services
- Editor services
- Office enrollment (available only with IBM OfficeVision for AS/400, 5769-WP1)
- Security services
- Text search services (available only with IBM OfficeVision for AS/400, 5769-WP1, and the search function installed)
- Miscellaneous services

Most of the APIs are provided with OS/400; however, some are shipped with IBM OfficeVision for AS/400 (5769-WP1) and IBM AS/400 Client Access (5769-XW1 or 5769-XY1).

Many of the commands shipped with the OS/400 licensed program can be used without the IBM OfficeVision for AS/400 licensed program or any other licensed program installed. Some commands, however, provide more function when the IBM OfficeVision for AS/400 licensed program is installed. Most of these commands offer both interactive and batch options which allow customers to write and tailor applications for these services.

#### o Graphics Support

Graphics functions are supported using the Graphical Data Display Manager (GDDM), which may be accessed from a high-level language program or using the Business Graphics Utility for AS/400 licensed program (BGU, 5716-DS1). The following OS/400 interfaces to graphics functions are supported:

- Base support of GDDM 1.3 graphics functions plus substantial graphics management capability such as high-function drawing capability, windowing, clipping, rotating (on a plotter) and translating
- Presentation Graphics Routines (PGR) for easier construction and display of business graphs such as bar, line, pie and surface charts, histograms and Venn diagrams
- Graphics Data File (GDF) to allow exchanging graphics images with other compatible GDF-capable systems such as another AS/400 System, or a System/38 or a System/370
- Full support for Personal Computer, and Personal System/2 graphics resolution, with addressability up to 1024 x 768 display points
- Support of eight-color images for Personal Computer and Personal System/2 devices
- 6180 plotter support, providing high-quality eight-color graphics

#### o Sort

The sort utility supports sorting and merging of database files.



Selection and sorting using the sort utility has performance advantages over the use of database access paths for certain applications. The sort utility can

- Sort up to eight input files to produce a single output file containing record images (full record sort).
- Sort a single physical database input file with arrival sequence to produce an output file of four-byte binary relative record numbers that refer to the input file (address sort).
- Sort files and produce accumulated totals (summary sort).
- Copy up to eight input files to produce a single output file with records in the same order as they were encountered in the input files (merge).

o Application Programming Interfaces (APIs)

There are literally hundreds of OS/400 APIs providing access either to functions and data not available through any other interface, or levels of performance not available through other interfaces. These CALL-level interfaces are intended for use by independent software vendors and IBM Business Partners whose applications require these functions and data. A complete list is in "System API Reference", SC41-5801.

o Double Byte Character Set Support

o Euro Currency Support

AS/400 can input, display, print, and process the euro currency sign for both the host and PC client computing environments. This support includes, but is not limited to the addition of:

- Euro country extended code pages (CECPs) and CCSIDs.
- Euro keyboard types, including device configuration and device controller changes.
- Euro font and glyph support.

Updates to external display, print, and client function may need to be obtained from other vendors.

This phase of euro support is only for those countries that use the "Latin 1"-based alphabet. This includes those countries initially participating in the European Monetary Union and other selected countries.

For the latest available information and a roadmap to euro currency sign support on the AS/400, please see the following Web site:

[HTTP://WWW.AS400.IBM.COM/EURO](http://www.as400.ibm.com/euro)

PRINTED OUTPUT SUPPORT:

o PRINT SUPPORT

This integrated operating system function supports printing of text,

images, graphics, bar codes, electronic forms, multiple fonts, logos, signatures, and more, thus providing the basis for business solutions like business reports, preprinted forms, customer statements and invoices, and letters. Double Byte Character Set (DBCS) documents that enable printing of Chinese, Korean, Japanese, or Thai characters are also supported.

OS/400 supports IBM and non-IBM printers, which have a wide variety of price, function, speed, and use. Flexible connectivity options allow them to be attached:

- to the system
- directly to a Token-Ring or Ethernet LAN
- to a client (e.g., personal computer)

OS/400 can generate SCS, IPDS, AFPDS and S/390 line data natively, based on a user specification. The SNA Character String, or SCS datastream, is a text only data stream often used for printing job logs, program listings and OfficeVision for AS/400 documents. The IPDS and AFPDS datastreams provide support for graphics, barcodes and advanced page formatting. In addition, AFPDS allows natively-generated data to be printed using all points addressability (APA), host-resident downloadable fonts, and support for overlays (e.g., electronic forms) and page segments which can be merged with user data for printing.

OS/400 also provides facilities to allow system and client applications to create a spool file containing a user-defined datastream for printers whose characteristics are unknown to the system. These USERASCII print files can be directed to local or remote printers.

Utilizing AFP and SCS print drivers for Windows and OS/2, client applications can generate print output destined for system and production printers. OS/400 can also act as a print server to System/370 or System/390. This includes support of AFPDS and 1403 data for printing on an AS/400 system.

#### o HOST PRINT TRANSFORM

Most printers are designed to work with a specific datastream, so OS/400 includes a function to automatically transform the program-generated datastream to that required by the printer to which it is sent. It is not necessary for the application to generate the correct datastream; the system will automatically transform it as necessary at print time.

Host Print Transform (HPT), a key component of the AS/400 print server strategy, provides the ability to transform host-generated EBCDIC datastreams to ASCII-based datastreams accepted by many popular laser and impact printers commonly found in client environments. The transformation is based on user-definable workstation customization objects which provide a high degree of flexibility and control over the output generated. Workstation customization objects are provided for over 125 popular IBM and non-IBM ASCII printers.

The following datastreams can be transformed into ASCII:

- SCS, including imbedded IPDS images

- AFPDS, including barcodes, images, overlays, and page segments, can be transformed into:
  - Hewlett Packard PCL
  - Lexmark PPDS
  - HP LaserJet TIFF Packbit

An API brings the capabilities of Host Print Transform to the AS/400 application developer. For example, an application program can utilize the HPT API to convert an AFPDS spoolfile to a TIFF image, and then present this image on a IBM 3489 InfoWindow II display.

OS/400 HPT has been enhanced to generate the ASCII datastream for DBCS printers from a DBCS SCS datastream. Supported ASCII datastreams are IBM's PAGES, IBM non-PAGES, and Epson's ESC/P, Canon LIPS3, and NEC 201PL. The IBM PAGES datastream can also be printed from the AFPDS datastream. The ASCII datastream can be directed to LAN printers utilizing TCP/IP Line Print Requester (LPR) support. ASCII DBCS datastreams spooled via the TCP/IP Line Print Daemon (LPD) can also be directed to LAN- and workstation-attached printers without conversion.

Workstation customization objects are provided for a number of popular DBCS printers from various vendors, such as IBM and Epson, and support various languages including Japanese, Simplified Chinese, Traditional Chinese, and Korean. These objects can be modified to support unique language or datastream requirements.

#### o PRINT SPOOLING SUPPORT

Printing, a relatively slow process, can be done most efficiently when it is done independently from the application that created the output. Spooling (Simultaneous Peripheral Operations Online) provides this support with the following functions:

- Output can be queued until a printer is available, with user-specified priority
- Print writers transfer output from queue to printer
- Spool separator page format can be controlled by the user for specific printers
- Spool files can be held, released, deleted, re-prioritized, moved from one queue to another, and displayed (EBCDIC-based files only)
- Spool files can be sent to output queues on other AS/400 systems
- User can specify form type, number of copies, and subset of pages to print
- Spooling can be controlled from any work station and can be established as an environment for an individual
- With AS/400 Client Access, a separately-licensed program (5769-XW1 or 5769-XY1), spool files can be manipulated from a client workstation within a native client environment
- System security controls access to spool control functions, output queues and devices.
- Spooling environment can be started automatically when the system is started
- Printing can be restarted at a specific page in the event of printer failure
- Printer Load Balancing

Local and remote output queues permit more than one active writer, allowing spooled output on one output queue to be printed on multiple printers. In addition, a limit can be placed on the size of spooled files printed during a specified time period. With these features, large print jobs can be deferred to print during non-peak hours.

#### o NETWORK PRINTING SUPPORT

Distributed print support provides connection to LAN-attached ASCII printers and support for Advanced Function printers. It also facilitates the distribution of printed output throughout AS/400 networks.

The AS/400 system provides a seamless path for customers to direct printed output through an AS/400 network and to other print servers. An output queue can be specified as "remote", and output spooled to a remote queue is automatically sent to the specified destination system for printing. SNA or TCP/IP protocols (LPR/LPD) can be used to transport the spool file and its attributes to the remote system.

These remote print functions are integrated with the display passthru function to allow the customer to specify an output queue on the local system for use during the session. Spooled output generated at the target (remote) system is automatically sent to the output queue on the source (local) system for printing.

Output routed to IBM mainframe computers, which function as print servers, can be sent directly to a specified printer. The job class and a Forms Control Buffer (FCB) can also be specified from the AS/400, greatly improving the AS/400 systems capability as a System/390 print client.

Most of today's printing is done on printers attached directly to the LAN, so that they can be shared between client, LAN and AS/400 applications. LAN attached printers can also support high-volume electronic printing. Output files can be sent to:

- Client Access/400 attached ASCII printers
- LAN attached IPDS printers directly, with complete print management
- LAN attached ASCII printers
- IPDS and PCL printers attached to WARP and AIX Servers
- Printers managed by the Netware integrated Server
- Other printers using Network Print Server APIs.

#### o PRINT SERVICES FACILITY FOR AS/400 (PSF/400)

For many businesses today, the printed output from an application program is the primary way that business communicates regularly to its customers. Whether it's a well-organized, easily readable customer statement, or an insurance policy with customized information for each client, the printed document plays an important role in building and maintaining customer satisfaction.

IBM's Advanced Function Printing (AFP) is an architecture that integrates high-function page printers and print software to:

- Enable state-of-the-art documents that can give your business a competitive edge with electronic forms

- Provide sophisticated print formatting capabilities external to application programs
- Replace traditional labor-intensive print operations with a system-managed process

Print Services Facility for AS/400 is the AFP system software for AS/400 printers that use the Intelligent Printer Data Stream (IPDS) protocol. It has been an integrated component of the OS/400 operating system since V1R2. PSF/400 is functionally integrated into the operating system, but is enabled through a separately-billable feature of OS/400. PSF/400 allows AS/400 users and applications to take full advantage of IPDS printer capabilities, including:

- Replace pre-printed forms with electronic forms, called overlays
- Format multiple pages of output, or multiple records, onto a single printed page
- Include compressed image data from programs such as Workfolder Application Facility/400 and Facsimile Support/400, and have the images decompressed and printed by an IPDS printer
- Download fonts from AS/400 host libraries to printers for a greater choice of type styles, or to ensure font consistency across printers
- Process AFP applications that have been sent to the AS/400 from S/390 and other environments.

Access to many AFP capabilities has been incorporated into the familiar AS/400 print interfaces -- Printer Files and Data Description Specifications (DDS) for Printer Files. Using Printer File parameters you can:

- Include an electronic form on each page of a job, including different forms on the front and back sides
- Specify the names of a Page Definition or Form Definition to be used to format the print job. Page and Form definitions are the AFP resources used to format AFP print output in S/370 and AIX. Page and Form definitions are processed by PSF/400 from the spooled file, and so are completely external to the application program.

Capabilities that have recently been added to AS/400 Page Definition processing include the ability to specify fields of data to be generated as IPDS barcodes, and the ability to position print lines relative to one another on the printed page. This give applications that produce line data much greater flexibility in report formatting, and lets the application data drive the format.

- Select media handling options such as paper drawer, output bin and duplex printing
- Specify that output can be saddle-stitched, edge-stitched, or corner-stapled
- Print 2, 3, or 4 pages per side while by-passing OS/400's automatic page size reduction. This allows you to take advantage of printers with larger paper sizes than 8 1/2 x 11 inches.

Using DDS to format application output you can:

- Position "floating" overlays and page segments anywhere on a page to create sophisticated customer-oriented documents
- Include boxes and lines dynamically anywhere in the output
- Use "Invoke Medium Map" to change paper handling options such as

duplex/simplex, N-up (multiple pages per side) formatting, page rotation, selection of electronic forms, and input paper drawers anywhere in the print job

- Select different fonts and text rotations for different fields of data
- Switch between simplex and duplex printing within a spooled file
- Force printing on a new sheet of paper anywhere in a spooled file
- Direct pages of a spooled file to a specific output bin
- Include tabbed insert pages from a finisher anywhere in the spooled file available through the DRAWER keyword
- Specify z-fold options for any page within a spooled file
- Include an overlay and specify the orientation in which the overlay is printed

PSF/400 also provides data stream transforms and AFP print resource management to ensure that applications and their AFP resources print consistently on all of the printers managed by PSF/400. PSF/400 manages all printers whose device descriptions specify a device type of \*IPDS and AFP(\*YES). PSF/400 can transform and print the following data streams and formats on the AS/400 system:

- IBM's Mixed Object Document Architecture (MODCA) data stream, also called the Advanced Function Printing Data Stream (AFPDS)
- EBCDIC line printer data generated from a S/390 environment.
- SNA Character Stream (SCS) and IPDS
- Postscript Level I (plus color)
- Tag Image File Format (TIFF)
- Bitmap (BMP)
- Graphics Interchange Format (GIF)

PSF/400 includes an automatic interface to print data stream and image transforms in OS/400. PSF/400 detects the input data stream and transforms it for printing on any AFP printer.

PSF/400 supports the entire family of IBM IPDS printers and IPDS printers from other vendors. PSF/400 is required to provide full-function support for the following advanced printers:

- IBM 3112, 3116, 3812, 3816, 3912, 3916, 3930, and 4028
- IBM Network Printer 12, 17, and 24
- IBM 4224, 4230, 4234, 6400, 6408, 6412, and 4247
- IBM 3130\*, 3160\*, 3820\*, 3825\*, 3827\*, 3828\*, 3829\*, 3831\*, 3835\*, 3900\*, 3935\*, InfoPrint 20\*, InfoPrint 32, InfoPrint 60\*, InfoPrint 3000\*, and InfoPrint 4000\*

\* Require PSF/400 to attach to the AS/400 system.

The above list includes printers that can attach to AS/400 via Twinaxial, SNA or TCP/IP. For detailed information about printer attachments refer to the Sales Manual information for each printer.

AS/400 products that complement PSF/400 for developing AFP applications include:

- Advanced Function Printing Utilities/400, licensed program 5716-AF1.

AFP/400 provides the ability to print AS/400 database files in various formats with a wide range of fonts and bar codes on printers driven by PSF/400, and to create AFP overlays.

- AFP PrintSuite for AS/400, program offering 5798-AF4. PrintSuite is a collection of AFP application enabling tools that allow programmers and non-programmers to enhance the formatting of application output external to the application program logic.
- IBM AFP Font Collection, program product 5648-B45. Font Collection is a comprehensive suite of AFP fonts and font editing programs that allow customers to select from among the thousands of typefaces available in Adobe Type 1 format for their print application formatting.

For detailed information about AFP support in AS/400, refer to the following documents:

- AS/400 Printer Device Programming (SC41-3713)
- AS/400 DDS Reference (SC41-3712)
- AS/400 Printing III Redbook (GG24-4028)
- AS/400 Printing IV Redbook (GG24-4389)
- AS/400 Printing V Redbook (SG24-2160)
- Guide to Advanced Function Presentation (G544-3876)
- AS/400 Guide to AFP and PSF (S544-5319)

#### MULTIPLE OPERATING ENVIRONMENTS:

For most customers with an IBM System/36 or System/38 installed, the migration to IBM Operating System/400 can be accomplished using OS/400, in conjunction with separate System/36 and System/38 Migration Aids. In addition to running applications written specifically for the AS/400 system, OS/400 can execute many applications migrated from the System/34, System/36, and System/38 with few or no modifications. Data can be shared by applications written for OS/400, System/36, or System/38.

Multiple operating environments in Operating System/400 protect customer investment in data, applications, and training.

#### o System/36 Environment

Most System/36 applications can execute on the AS/400 system using the System/36 environment. When running in the System/36 environment all of the following can be executed:

- IBM supplied procedures, such as BLDFILE, SAVE, and RESTORE
- Operation control language (OCL) statements, such as LOAD, FILE, and RUN
- Procedure control expressions (PCE), such as substitution expressions and IF conditional expressions
- System/36 control commands, such as CHANGE, STATUS, and JOBQ
- System/36 RPG II and COBOL programs after they have been compiled on the AS/400 system

The OS/400 supports a set of commands designed to migrate data between the System/36 and the AS/400 system or the AS/400 system and the System/36. These commands save and restore library source, procedure members, and data files between the two systems. A separate licensed program, IBM AS/400 System/36 Migration Aid (5727-MG1), is available on the System/36 to assist in migration from a System/36 to the System/36 environment on an AS/400 system.

The end user should see only minor changes to user-written applications and screens. Some operational differences may be apparent to end users of applications, which use system functions. There is special support for the differences between the AS/400 system and System/36 handling of zoned and packed decimal data.

The AS/400 System/36 environment programmer can continue to maintain System/36 source for distribution to System/36s in a network. However, compilation of System/36 programs must be done on a System/36. OS/400 functions, not in System/36, are available for System/36 applications and for program development. For example, the interactive debug capability can be used regardless of whether the user is debugging an RPG II or RPG III program. Other functions, like journaling, can be added to applications without making any program changes.

Most System/36 Environment users can begin to use OS/400 functions by mixing System/36 and OS/400 functions. For instance, program-defined files can be converted to externally-defined files and the System/36 RPGII or COBOL programs can still process the files. System/36 RPGII programs or OCL can be replaced gradually with the AS/400 RPGIII and CL programs. When intermixing System/36 and AS/400 functions in the same System/36 environment job, architectural differences between the two environments can cause special programming considerations. These apply especially to situations where both programs do I/O. There are some special error handling considerations when mixing CL and OCL that need to be addressed in the System/36 Environment.

System/36 coexistence Helptext documentation interchange is provided for IBM Business Partners and customers who prefer to develop System/36 applications on AS/400 and send Helptext documents between systems.

The catalog function in System/36 Environment displays the same information for externally-described and program-described files. Additional information is shown to match the System/36 CATALOG function.

Some System/36 functions have been enhanced to make use of functions available on the AS/400 system. Some examples are:

- Support to change the default files library (FLIB procedure and FILELIB OCL statement).
- Support to search the job's library list when processing data files.
- Support to get the message ID of an error message sent by the last OS/400 command executed within a System/36 environment job (?MSGID? PCE expression).
- A DDS keyword that allows function keys to be associated with help records by passing indicators to the application program.



- o System/38 Environment

The System/38 Environment provides for:

- Migration from System/38
- Intermixing of System/38 and AS/400 functions
- Maintenance of System/38 applications on the AS/400 System

The System/38 Environment allows the execution of most programs written for a System/38. The same job can execute any combination of AS/400 or System/38 programs. The programmer menu supports new source types which enable the identification of System/38 syntax. The programmer can maintain either AS/400 or System/38 programs during the same job. Compilations of programs to be distributed to System/38s must be done on a System/38.

A separate licensed program, IBM AS/400 System/38 Migration Aid (5714-MG1), is available on the System/38 to assist in migration from a System/38 to the System/38 environment on an AS/400 system.

#### ADVANCED 36 RELEASE 7.5 SUPPORT ON ALL AS/400 RISC MODELS:

This support enables your System/36 applications to run on all AS/400 RISC models. The AS/400 Advanced 36 Release 7.5 licensed programs replace your existing System/36 programs, such as SSP, utilities, and languages. You do not need to recompile or change your System/36 applications. This allows an easy migration to the AS/400 RISC systems even if you do not have access to all of your System/36 application source code. Migration is accomplished by simply saving System/36 applications and data, then restoring them on the AS/400 system using tape, diskette, or the Transition Data Link (twinaxial connection).

The SSP Release 7.5 and OS/400 V4R2, or later release, run on the AS/400 RISC system concurrently. The ability to run both operating systems concurrently and access the function of the OS/400 operating system means you have support for increased memory, disk, workstations, and printers.

The following functions make running the SSP on the AS/400 system easier.

- o Host user profiles

This feature maps individual SSP jobs to the user's OS/400 profile for //RUN400 requests. This means your printed output will have your profile and will not default to the profile of the user who IPLed the system.

- o Soft-IPL

Stand-alone SSP environments can IPL the SSP and bypass IPLing the hardware and microcode (LIC). This is controlled by adding a new parameter on the IPL command that allows you to IPL the system (includes hardware, LIC, and SSP) or only the SSP.

- o SSP local support for OS/400 remote workstations

Remote OS/400 workstations will appear as local SSP displays. This provides full interoperability between SSP and OS/400 using any display.

- o Printer overlay support

This capability permits SSP data to be merged with an OS/400 overlay. You can include SSP data in your OS/400 reports.

#### CONNECTIVITY TO REMOTE DEVICES, SYSTEMS AND NETWORKS:

OS/400 offers many integrated capabilities and functions that enable communications with a variety of IBM and non-IBM systems either in batch or interactive modes. This integrated connectivity function provides customer solutions by enhancing integration of business systems. Traditional SNA hierarchical, emerging SNA peer networks and SAA standards are supported, thereby offering the user the greatest flexibility possible in network design now and in the future.

#### SUPPORTED PROTOCOLS AND NETWORKS:

Following is the list of protocols and networks supported by the Operating System/400. This support provides a basis for integration of customer business systems, and thus, business solutions.

- o Integrated Services Digital Network (ISDN)
- o T1/E1/J1 and Fractional T1 Networks (high bandwidth communications)
- o IBM Token-Ring (IEEE 802.5 and 802.2) LANs
- o FDDI/SDDI LANs (100 Mbps medium)
- o Ethernet Version 2 or IEEE 802.3 LANs
- o Asynchronous Transfer Mode (ATM)
- o Asynchronous Communications (Async)
- o Binary Synchronous Communications (BSC)
- o Synchronous Data Link Control Communications (SDLC)
- o X.21 Networks
- o X.25 Networks
- o IBM System/36 and System/38 supported Networks

Details about the protocols and networks available with OS/400 follow:

- o Integrated Services Digital Network (ISDN)

AS/400 communications support includes integrated services digital network (ISDN) basic rate interface (BRI) adapter, which can support two independent 64 kbps full duplex data channels and one 16 kbps signalling channel. The ISDN BRI adapter implements the ISDN data link control (IDLC) protocol. X.25 communications over the ISDN B-channel is also supported.

- o T1/E1/J1 and Fractional T1 Networks

T1/E1/J1 and Fractional T1 Network connections are supported using the V.35 line adapter and six-line communication controller at speeds up to 640k bps for one line per controller; 512k bps each for two lines per controller and 384k bps each for three lines per controller. SDLC protocol is supported allowing APPN and SNA networks to be connected. V.35 input is required on DSU, MUX or CBX type DEC equipment interfacing to T1 Network facilities.

- o IBM Token-Ring, FDDI/SDDI, and Ethernet/IEEE 802.3 LANs

The AS/400 system directly connects to the IBM Token-Ring LAN (either 4 or 16 Mbps), to FDDI/SDDI LANs (Fiber Distributed Data Interface/Shielded - twisted - pair Distributed Data Interface), and to Ethernet/IEEE 802.3 CSMA/CD LANs.

AS/400 LAN attachment features are configured and appear to the system as types of communication lines. OS/400 supports multiple concurrent SNA communication sessions with a variety of IBM products over both LAN types. TCP/IP sessions are also possible over both IBM Token-Ring and Ethernet/IEEE 802.3 LANs

The maximum number of local link stations supported per LAN attachment on each system is indicated below:

SYSTEM	MAXIMUM NUMBER OF LINK STATIONS/LAN
9406	256
9404	128
9402	64

- o Asynchronous Transfer Mode (ATM)

ATM is a communications technology that offers improved throughput, scalability in distance and speed, and a consistent protocol from the LAN to the global-area network. ATM provides a way to use the same hardware and LAN applications in local as well as wide area networking environments. Through multiplexing and switching of small, fixed length cells, ATM provides greater flexibility to accommodate current and future communications needs.

In V4R2, or later release, IBM is offering ATM LAN with the fastest connectivity available today, at up to 155 Mbps speeds.

- o Async, BSC, and SDLC Communications

BSC, Async, and SDLC support provides the user with the ability to communicate with other systems and devices that use the comparable protocol. Asynchronous communications to other systems and to Async/ASCII devices such as terminals, printers and plotters requires user-written application programs. Async support may be run on an X.25 packet-switched data network. An integrated PAD (packet assembler/disassembler) is provided that supports CCITT recommendations X.3, X.28, and X.29. Async communications supports full-duplex operation.

- o X.21 Networks

The AS/400 system provides an interface for attachment to an X.21 leased or circuit-switched network using either X.25 or SDLC communications.

- o X.25 Networks

The AS/400 system provides an attachment and support for full-duplex, X.25 packet-switched data networks, using either:

- Non-switched line, through an X.21 or X.21.bis (V.24 or V.35) interface, or
- Public switched telephone network (PSTN) facilities, on a V.25 bis autodial or V.25 bis/RS-366 parallel autodial interface. Bandwidths up to 256 Kbps are supported with a maximum packet size of 4096 bytes.

The OS/400, when used in conjunction with the AS/400 X.25 Communications Feature, is certified by the Department of Defense Data Network (DDN). The X.25 packet network is used by the TCP/IP protocols.

- o IBM System/36 and System/38 supported Networks

All networks currently supported by the IBM System/36 and IBM System/38 are also supported by the IBM AS/400 system.

#### NETWORK MANAGEMENT FACILITIES:

Several communications and systems management functions are available to manage the AS/400 system. Some are integrated into the Operating System/400 and some are separately-priced features. These functions help manage and control local systems and distributed systems that may operate within a network controlled by a host System/370 or by another AS/400 system.

Functions available for the AS/400 system are:

- o Systems Management in TCP/IP Networks
- o Alerts Support to NetView, System/36, System/38, AS/400
- o IBM Token-Ring Network Management Support
- o Distributed Host Command Facility (DHCF)
- o Link Problem Determination Aid (LPDA)
- o Distributed System Node Executive (DSNX)

More detail about network management facilities for AS/400 follow:

- o Systems Management in TCP/IP Networks

The protocol for systems management used in TCP/IP networks is Simple Network Management Protocol (SNMP). It is the industry standard for managing networks in the worldwide TCP/IP Internet environment. Support for SNMP protects the customer's investments in industry standard management applications and allows the AS/400 system to interoperate with other manufacturers' systems management products.

Elements provided with OS/400 include SNMP agent, SNMP framework, and TCP/IP protocol support. The TCP/IP communications protocol includes network management capabilities to support SNMP control.

The SNMP management function is split between two kinds of entities, named the "manager" and the "agent." The SNMP agent function runs on the AS/400 system and allows it to be managed by network management stations that have implemented the SNMP manager function.

The OS/400 SNMP agent provides configuration, performance, and problem management data concerning TCP/IP to an SNMP manager.

Management Information Bases supported include:

- MIB-II
- Transmission Groups
- APPN
- Private

The SNMP framework provides support for SNMP applications on the AS/400 system, including:

- Management applications that access SNMP management data throughout the network
  - SNMP sub-agent support, which provides the ability to dynamically add sub-agents that can supply additional management data
- o Alerts Support to NetView\*, System/36, System/38, AS/400

Alerts are messages that comply with System Network Architecture (SNA); they are sent from systems within a communications network to a central management site, called the problem management focal point. Alerts carry information about a problem and suggest corrective actions to the problem management focal point operator. Alerts can be used to monitor unattended systems and devices and control system resources.

Alerts may be sent to other AS/400 systems, System/36s, System/38s or System/370s. An AS/400 system can act as the generating and sending point for an alert, as a node that forwards alerts to the focal point, or as the problem management focal point that receives alerts.

When an AS/400 system is the problem management focal point for a network, the operator can display, delete, receive, forward, log, or hold alerts for forwarding. When operating within a network with a System/370 host system, alerts may be forwarded to the NetView(TM) licensed program on the System/370, which has focal point capabilities.

- o IBM Token-Ring Network Management Support

This integrated support aids the AS/400 operator in managing an attached token ring local area network. The support provides monitoring and active management for the token ring. Functions include:

- Notification of hard (permanent loss) or soft (impending loss) errors
- Query of individual LAN station for profile information
- Force a station off the ring if an unacceptable number of errors are occurring because of that station.
- Display and print of LAN topology.
- Generation of alerts for LAN errors.

- Display of the table for soft error conditions

Networks of multiple token ring LANs (bridged networks) may require more extensive network management support than these functions provide.

- o Distributed Host Command Facility (DHCF)

The OS/400 distributed host command facility allows the users of display stations of a System/370, using the host command facility (HCF) companion program under ACF/VTAM to:

- Interactively operate and control an AS/400 system as if attached as a remote AS/400 work station
- Use the operations and service facilities of any AS/400 system in the HCF/DHCF network to do remote problem analysis on any AS/400 system in the network
- Access and control applications, for which they have proper authority, on each AS/400 system in the network
- Perform problem determination and error diagnostics on any AS/400 system in the network. This includes interactive examination of the system's error log, running and displaying storage dumps and traces, and looking at and responding to unique system messages from the AS/400 system.

- o Link Problem Determination Aid (LPDA)

The OS/400 LPDA and LPDA-2 functions provide data about network components to aid in network problem determination. These architectural network commands are issued to determine which of the various network components might be causing an error. The commands include requests for modem and line status and receive tests for IBM signal converter products (modems).

The LPDA-2 commands are an extension to the standard LPDA commands. They can be initiated concurrently with other activity on the line. The commands include transmit and receive test and line analysis. The results of the LPDA-2 tests may be presented to the user's display or printer. The data presentation is similar to those panels available on the System/370 NetView(TM) licensed product.

- o Distributed Systems Node Executive (DSNX)

The OS/400 distributed systems node executive (DSNX) support allows the AS/400, System/36 and IBM PCs and PS/2s to be part of a SNA network in which distribution of data--including files, programs, IBM software, procedures--is centrally controlled by the System/370 focal point. The controlling System/370 product is NetView\* Distribution Manager (NetView/DM). Interaction between NetView/DM and DSNX provides the control functions required for change management within a network of distributed systems. AS/400 DSNX support operates with either NetView/DM on MVS or DSX V3R2 on VSE.

The interaction of NetView/DM and DSNX provides functions such as:

- Retrieval of data from the AS/400, System/36, PC, or PS/2
- Distribution of data objects (files)

- Distribution of user applications and application changes (programs)
- Distribution of IBM software (microcode, operating system and licensed program products)
- Messages from NetView to system operator
- Installation of all software and data on the distributed systems
- Distribution of jobs to the distributed systems
- Job initiation on the distributed systems

The AS/400 DSNX can act as an end node (the target system for an action) or as an intermediate node (gateway) between NetView/DM and other AS/400 systems, System/36s or IBM PCs and PS/2s. When acting as an intermediate node, AS/400 can distribute to a list of other systems on the network.

Once AS/400 DSNX support is activated, no operator interaction is required on the AS/400. The NetView/DM host system controls all transfers of information between the distributed systems and the NetView/DM host.

AS/400 DSNX support allows for either synchronous or asynchronous connection to the NetView/DM host. When acting as a synchronous node (referred to as DIRECT NODE support), the AS/400 keeps the line active (session established) until all requests are complete on the AS/400.

Centralized problem management is also available using SystemView System Manager for AS/400, a separately-licensed program, (5769-SM1).

#### COMMUNICATIONS FACILITIES:

Following are the supported communications facilities in OS/400. These facilities protect customer investment in equipment and applications by enabling communications between diverse resources.

- o TCP/IP Support
- o X.21 Short Hold Mode (SHM) and Multiple Port Sharing (MPS)
- o Remote Work Station Support
- o 3x74 Remote Attach
- o 5x94 Remote Attach
- o Intersystem Communications Function
- o Advanced Peer-to-Peer Networking (APPN)
- o Dependent Logical Unit Requester (DLUR)
- o Advanced Program-to-Program Communication (APPC)
- o SNA Upline Facility to System/370 IMS and CICS Hosts
- o Binary Synchronous Communications Equivalence Link (BSCEL)
- o ICF Retail Communications Support
- o ICF Finance Communications Support
- o Non-ICF Finance Communications Support
- o SNA Distribution Services (SNADS)
- o SNA Primary Logical Unit 2 Support
- o SNA/Management Services Transport
- o Distributed Relational Database Support
- o Object Distribution Facility (ODF)
- o Display Station Pass-through
- o Distributed Data Management (DDM)
- o SNA Passthrough
- o IBM Network Routing Facility (NRF) Support/400

- o Autodial Support
- o 3270 Device Emulation
- o 3270 SNA API Support for IBM 3278 Model 3, 4, and 5
- o ISDN Support
- o 5394/5494 SNA Backbone Support
- o File Transfer Support
- o Interactive Terminal Facility (ITF)
- o SAA Common Programming Interface for Communications (CPI-C)
- o IPX/SPX Communications
- o ATM LAN Emulation

Details about the communications facilities available with OS/400 follow:

#### o TCP/IP SUPPORT

TCP/IP for expanding Internet/intranet solutions:

TCP/IP is fundamental to the new network computing paradigm and much of the new AS/400 e-business infrastructure runs exclusively on TCP/IP including Lotus Domino, Java, Web serving and IBM Network Stations. AS/400 has excellent TCP/IP support built into its operating system and recent AS/400 TCP/IP enhancements make AS/400 an even more powerful e-business server.

Enterprise-class TCP/IP for real business networks:

TCP/IP has become an extremely popular protocol and can now be regarded as the de facto standard for computer networking. AS/400 comes with a complete and robust suite of TCP/IP protocols, servers and services. It is easy to implement full-featured intranets by simply cabling AS/400 systems and workstations together and starting the desired services. In most cases, no additional software or hardware is required.

TCP/IP is an internationally standardized protocol. TCP/IP and its constituent protocols are standardized by the Internet Architecture Board. The standards specifications are provided in documents called RFCs (Request for Comments). There are hundreds of RFCs available today. The AS/400 conforms to the appropriate RFCs for the protocols, servers and services listed below which are all included with AS/400 at no additional cost:

Performance of the TCP/IP protocol stack on the AS/400 continues to be improved. The result is significant improvements in capacity for TCP/IP users.

In addition, the AS/400 TCP/IP protocol stack contains two new performance-related TCP/IP Request for Comments (RFCs):

- RFC 1191 - Path MTU Discovery
- RFC 1323 - TCP Extensions for High Performance

The implementation of these RFCs improves TCP/IP performance in many environments.



#### TCP/IP Protocols:

- TCP/IP base protocol support
  - Transmission control protocol (TCP)
  - User datagram protocol (UDP)
  - Internet protocol (IP)
  - IP Security Protocol (IPSec)
  - Internet Key Exchange (IKE)
  - Internet control message protocol (ICMP)
  - Address resolution protocol (ARP)
- AnyNet
  - Sockets over SNA
  - APPC over TCP/IP
- Simple Network Management Protocol (SNMP)
- NETwork STATus (NETSTAT)
- Connection Verification (PING)
- Dynamic IP Routing (RIP)
- Proxy Address Resolution Protocol (Proxy ARP)
- Application programming interfaces (APIs) - SOCKETS and RPC
- Serial Line Internet Protocol (SLIP)
- Point-to-Point Protocol (PPP)
- Layer 2 Tunneling Protocol (L2TP)
- SOCKS proxy enablement
- UDP multicast support

#### TCP/IP Servers and Services:

- GUI configuration support
- File Transfer Protocol (FTP) client and server
- Simple Mail Transfer Protocol (SMTP)
- Post Office Protocol (POP) Version 3 server
- Internet Connection Server (HTTP) (V4R1 and V4R2 only)
- Internet Connection Secure Server (ICCS) (V4R1 and V4R2 only)
- HTTP Server (V4R3, or later release)
- Web-based Administration server
- Network File System (NFS) client and server
- Domain Name System (DNS) server
- Dynamic Host Configuration Protocol (DHCP) server
- IP Printing to HP-compatible network printers
- Line Printer Requester (LPR) and Line Printer Daemon (LPD)
- 5250/HTML Workstation Gateway (WSG) server
- TELNET client and server
- Remote EXECution (REXEC) client and server
- Remote IPL support
  - BOOT-P Server
  - TFTP Server

#### AS/400 also support a full range of physical interfaces:

- IBM token-ring LAN
- Ethernet LAN
- Ethernet 100Mb LAN
- Distributed data interface (DDI - fiber or stp)
- Frame relay
- Wireless (LAN)
- X.25 (PVC and SVC)

- X.25 over ISDN
- Integrated PC Server LAN
- Asynchronous support
- Synchronous support
- ATM (LAN emulation)
- Twinax

TCP/IP Protocol Descriptions:

- TCP/IP base protocol support

AS/400 natively supports all the base TCP/IP communications protocols. TCP/IP applications are typically implemented to the SOCKETS API which support both TCP (connection-based) and UDP (connectionless) applications. As an alternative to the SOCKETS API, applications can be implemented to Remote Procedure Call (RPC) which is based on SUN version 2 of NFS. The base protocols of IP, ICMP and ARP are fully supported as are the security protocols IPSec and IKE. AS/400 TCP/IP conforms to all relevant RFCs. Its communications performance characteristics are equal to or better than SNA in most cases.

- AnyNet

AnyNet/400 provides two API/protocol combinations:

-- Sockets over SNA

- o AnyNet/400 Sockets over SNA allows applications written to the sockets interface to communicate between AS/400 systems in an SNA environment. AnyNet/400 provides this with little or no change to application programs. AnyNet/400 Sockets over SNA is compatible with AnyNet/2 and AnyNet/MVS and thus provides connectivity to workstation and host environments.

-- APPC over TCP/IP

- o AnyNet/400 APPC over TCP/IP allows any OS/400 APPC application using ICF or CPI-C to communicate between AS/400 systems across a TCP/IP network. AnyNet/400 provides this with little or no change to application programs. AnyNet/400 APPC over TCP/IP is compatible with AnyNet/2 and AnyNet/MVS and thus provides connectivity to workstation and host environments.

- Simple Network Management Protocol (SNMP)

Simple Network Management Protocol (SNMP) provides a means for managing an Internet environment. SNMP is used in each node of a TCP/IP network that is monitored or managed by an SNMP manager. An AS/400 SNMP agent provides support for the exchange of network management messages and information among hosts. OS/400 supports Management Information Base II (MIB-II).

- NETWORK STATUS (NETSTAT)

NETWORK STATUS (NETSTAT) allows a system administrator to monitor and control the network status of an AS/400 system running TCP/IP or APPC over TCP/IP applications. AS/400 NETSTAT provides information about the status of TCP/IP network interfaces, routes, and connections on a local AS/400 system. Using NETSTAT, you can end TCP/IP connections, IP over SNA connections, and APPC over TCP/IP connections.

- Connection Verification (PING)

Connection Verification, also called PING (Packet INternet Groper), allows you to verify your connection to a remote system. These connection verification commands use the Internet Control Message Protocol (ICMP) to send data to an Internet address and wait for a response. On AS/400, you can use either the Verify TCP/IP Connection (VFYTCPCNN) command or the PING command.

- Dynamic IP routing (RIP)

Routing Information Protocol (RIP) is a dynamic IP routing protocol that communicates with adjacent routers, informing each other of their respective network connections. Dynamic routing protocols make network maintenance easier and improves network performance and reliability. AS/400 includes both RIP version 1 and RIP version 2. Version 2 of RIP adds security and efficiency features.

- Proxy Address Resolution Protocol (Proxy ARP)

Proxy ARP is an IP networking technique that allows one machine, the proxy agent, to answer ARP request on behalf of another machine. It is useful for SLIP, PPP and twinax connections because it can make devices appear to be all logically on the same local LAN subnet thus avoiding the need to implement either dynamic routing protocols or static route definition.

- Application programming interfaces (APIs) -- SOCKETS and RPC

Many times an enterprise has unique interoperability requirements for its private networks. The enterprise must provide its own applications to fulfill these unique requirements. AS/400 provides programming interfaces to accomplish this.

The SOCKETS API allows distributed applications to exchange data locally and over networks. Both connection-oriented and connectionless communications are supported by the Sockets API. In addition to IP, you use the Sockets API to write applications that communicate over Internetwork Packet Exchange (IPX) protocols directly.

Also, available to distributed application developers is the REMOTE PROGRAM CALL (RPC) interface. This approach views remote applications essentially as callable programs.

In addition, both JAVA and Lotus Domino provide various programming

options for implementing distributed applications over TCP/IP networks.

- Serial Line Internet Protocol (SLIP)

The TCP/IP SLIP provides TCP/IP connectivity over an asynchronous link, such as a simple modem pair over a telephone line protocol such as RS-232. Full-fledged asynchronous connectivity is supported rather than just terminal emulation. With SLIP, the more cost-effective, stand-alone dial-up servers can support a multiplicity of dial-up clients for single AS/400 installations. Also, the AS/400 system can dial attach to the Internet via the IBM Global Network (IGN) or other Internet access service provider.

- Point-to-Point Protocol (PPP)

Point-to-Point Protocol (PPP) is an open protocol for wide area network TCP/IP connectivity that can support both dial and leased lines. It can be used to extend an enterprise intranet across multiple locations. It is also the defacto standard for connecting to the Internet through an Internet Service Provider (ISP). When used as a dial-up protocol, PPP is a more robust alternative to SLIP (Serial Line Internet Protocol).

PPP's ISDN support enables AS/400 to attach to ISDN switched networks. This provides higher bandwidth access to networks than is possible with current modems over analog telephone lines.

Using PPP, the AS/400 provides an excellent integrated solution for REMOTE LAN ACCESS and as a REMOTE OFFICE GATEWAY into an organization's intranet.

- Layer 2 Tunneling Protocol (L2TP)

Layer 2 Tunneling Protocol (L2TP) is an enhanced link protocol that provides a multi-hop virtual circuit through the Internet. L2TP is also known as Virtual PPP since it creates a virtual circuit at a link layer and then utilizes Point-to-Point Protocol (PPP) to complete the connection at the network layer. L2TP is typically used in conjunction with Virtual Private Networks (VPN) to provide a secure connection over the Internet.

- SOCKS proxy enablement

With AS/400 Socks Client support, AS/400 TCP/IP client programs (e.g., TELNET and FTP client) will be able to communicate with server programs that are running on systems outside the IBM Firewall for AS/400. AS/400 client programs can use the Socks proxy support on the IBM Firewall for AS/400 to transmit data packets to external servers. By funneling these requests through the firewall proxy, the customer's secure internal network continues to be protected from data packets coming from an unsecure network. Once configured, AS/400 Socks Client support is transparent to TCP/IP client programs and works for all client programs written to a sockets interface.

- UDP multicast support

UDP multicast support is now enabled on AS/400. Applications written using this support will make better use of the bandwidth thus reducing network costs. This represents another improvement to the overall TCP/IP enablement package for AS/400 which can be accessed through the industry standard sockets API.

#### TCP/IP Servers and Services Descriptions:

- GUI configuration support

TCP/IP networking on AS/400 is now simpler than ever to administer. AS/400 TCP/IP configuration can now be managed through all new graphical user interfaces which are integrated with the popular AS/400 Operations Navigator. Included is a new graphical wizard that provides simplified step-by-step guidance for configuring TCP/IP. In addition, a new service to centrally administer all workstation configuration data for IP networks is included with OS/400. This service is based on an Internet standard called Dynamic Host Configuration Protocol (DHCP). AS/400 intranets have never been easier.

- File Transfer Protocol (FTP) client and server

File Transfer Protocol (FTP) allows users to send or receive copies of files to or from systems across a TCP/IP network. FTP also provides functions for renaming, adding, and deleting files.

OS/400 TCP/IP supports the following FTP functions:

- Transferring database files of up to one terabyte
- Transferring save files and members in physical files, logical files, distributed data management files, and source physical files
- Transferring hierarchical file system files including Client Access for AS/400 files and document library object files
- Transferring binary files "as is"
- Using exit points to pass control to exit programs for anonymous FTP and security controls
- Sending text files in EBCDIC format or converting them to ASCII (the default format)
- Creating and deleting libraries, files, and members using AS/400 FTP server subcommands
- Creating and deleting folders and directories using AS/400 FTP server subcommands

- Running FTP unattended in batch mode
  - Converting double-byte character set (DBCS) data from AS/400 EBCDIC code pages to and from Internet ASCII code pages
  - Using coded character set identifier (CCSID) support
  - Support for popular graphical FTP clients and Web server development tools. This enhancement includes support for UNIX format file listings from the AS/400 FTP server.
  - Ability to use directories other than database libraries as the initial working directory for the AS/400 FTP server.
  - Options to create new database files using the system or user default CCSID.
  - Ability to transfer files larger than 2 GB in all file systems that support these file sizes.
  - Ability to transfer database files containing null field data.
- Simple Mail Transfer Protocol (SMTP)

Simple Mail Transfer Protocol is used to send or receive electronic mail. For consistency with other AS/400 mail functions, SMTP interoperates with Systems Network Architecture (SNA) Distribution Services (SNADS) through AnyMail/400. SNADS and AnyMail/400 are part of OS/400.

SMTP supports the following functions:

- Sending and receiving mail objects up to two gigabytes
- SMTP as an intermediate TCP/IP hop on an SMTP distribution
- Support for MIME partial (fragmented) messages: splitting and re-assembly
- Support for sending Internet mail through a firewall
- Excellent mail exchange interoperability between SMTP and OfficeVision
  - o Converting data (including DBCS) from AS/400 EBCDIC code pages to and from Internet ASCII code pages
  - o Optional automatic enrollment of senders of incoming mail, in the system distribution directory and alias tables
  - o OfficeVision for AS/400 notes, messages and attachments
  - o MIME messages to and from OfficeVision for AS/400 documents: FFT and PC Files
- Sending and receiving documents and messages using AS/400 commands. (Even if OfficeVision for AS/400 is not installed,

users can send and receive SMTP messages by using the send, receive, and query distribution commands (SNDDST, RCV DST, and QRYDST), or by using the Post Office Protocol (POP3) server.)

- Increased simultaneous connection support; AS/400 SMTP is no longer restricted to a maximum of 16 inbound and 16 outbound simultaneous mail connections. You can tune SMTP depending on the mail load on your system, thus enabling greater scalability.
- Enhanced domain name system resolver support; the AS/400 SMTP client now processes all mail exchanger (MX) records returned by a domain name server query. This means less undelivered mail when sending to large Internet Service Providers.
- New option to enable journaling for mail delivery status tracking and mail statistics.
- New option to require all mail received by AS/400 SMTP to be processed by the AS/400 Mail Services Framework (MSF) to improve security.
- Enhancements for automated retry of mail when dial-up connections are established and finer granularity of mail delivery retry timing.

Like TELNET and FTP, SMTP supports both client and server functions on AS/400. AS/400 can serve as a mail gateway to Interconnect SNADS, and TCP/IP SMTP electronic mail networks.

- Post Office Protocol (POP) Version 3 server

The Post Office Protocol (POP) Server is the AS/400 implementation of the POP3 mail server. This server enables AS/400 to act as a POP server for any client that supports the POP mail protocol, including major e-mail clients, such as Netscape and Eudora, running in Windows, OS/2, AIX, and Macintosh. The POP server allows users to exchange mail, including Multipurpose Internet Mail Extensions (MIME) mail, between OfficeVision for AS/400 and POP clients through the AnyMail/400 mail server framework which is part of OS/400.

- Internet Connection Server (HTTP) (V4R1 and V4R2 only)

The Internet Connection Server (ICS), also known as the HTTP server, allows AS/400 systems attached to a TCP/IP network, such as the Internet or an intranet, to provide objects at the request of any local or remote Web browser. HyperText Markup Language (HTML) documents, index (directory) files, plain text, video, Java, graphics, and audio objects can be served from AS/400 file systems.

You can use IBM Net.Data for AS/400 (which comes with OS/400) to access DB2 UDB for AS/400 data using SQL and to create interactive Web applications by using "macros" to add logic, variables, program calls, and report writing to HTML.

- Internet Connection Secure Server (ICSS) (V4R1 and V4R2 only)

The Internet Connection Secure Server supports Secure Sockets Layer (SSL) security protocols for data encryption and server certificate authentication. The HTTPs secure server requires Internet Connection Secure Server (5769-NC1 for the U.S. and Canada, or 5769-NCE for International)

- HTTP Server (V4R3, or later release)

HTTP Server is the new name for the Internet server functions previously known as Internet Connection Server. Client support must be at HTTP1.1 or HTTP1.0 with 1.1 extensions.

The HTTP Server allows AS/400 systems attached to a TCP/IP network, such as the Internet or an intranet, to provide objects at the request of any local or remote Web browser. HyperText Markup Language (HTML) documents, index (directory) files, plain text, video, Java, graphics, and audio objects can be served from AS/400 file systems.

You can use IBM Net.Data for AS/400 (which comes with OS/400) to access DB2 UDB for AS/400 data using SQL and to create interactive Web applications by using "macros" to add logic, variables, program calls, and report writing to HTML.

The HTTP Server supports Secure Sockets Layer (SSL) security protocols for data encryption and server certificate authentication, which requires one of the following:

- Cryptographic Access Provider 40-bit for AS/400 (5769-AC1)\*
- Cryptographic Access Provider 56-bit for AS/400 (5769-AC2)\*
- Cryptographic Access Provider 128-bit for AS/400 (5769-AC3)\*\*

\* Approved for export by the U.S. Government

\*\* Available in the U.S. and Canada only

- Web-based Administration server

The Administration server is a special-purpose HTTP server that provides a browser-based interface for managing the AS/400 HTTP servers as well certain other products including the IBM Firewall for AS/400.

- Network File System (NFS) client and server

The Network File System (NFS) includes both server and client file serving support, as well as integrated file system file support. This file serving support enables broad multivendor file system interoperability.

- Domain Name System (DNS) server

DNS is the standard distributed naming service for intranets and the Internet. It is used by applications to map human-readable names into machine-readable IP addresses (e.g., the host portion of URLs



into the corresponding 32 bit IP address). This improves ease-of-use in referencing resources on the network. For example, it converts www.as400.ibm.com to 208.222.150.11.

OS/400 includes a full-function DNS server. It can be configured for primary, secondary and caching roles. DNS configuration data from other platforms can easily be migrated to the AS/400 DNS server. In addition, a migration utility that moves existing AS/400 host table information into the DNS configuration databases is provided.

- Dynamic Host Configuration Protocol (DHCP) server

Deploying DHCP to centrally control all TCP/IP workstation configuration tasks can dramatically reduce the cost of managing a TCP/IP network. DHCP is a standard protocol supported natively by most popular workstations including Windows 95/NT, UNIX and IBM Network Station. Using DHCP, all IP configuration data (IP addresses, subnet masks, default routers, etc.) are dynamically assigned when new workstations are added to the network. Furthermore, DHCP can automatically recover and recycle network resources when workstations are removed from the network. These capabilities eliminate the time-consuming and error-prone task of manual workstation configuration.

OS/400 includes a full-function DHCP server with an intuitive GUI administrative interface. OS/400 also comes with a DHCP relay agent (also called a BOOT-P relay agent) which can be deployed to route DHCP requests from multiple subnetworks to one or more central DHCP servers.

- IP Printing to HP-compatible network printers

The AS/400 has a built-in print driver for direct IP printing to HP PCL/PJL compatible network printers. Automatic conversion of SNA Character String (SCS) and Advacned Function Printing (APF) print data into HP Printer Control Language (PCL) is done using the AS/400 Host Print Transforms. In addition to direct support of a variety of network printers from HP, IBM and other vendors, the PJL support also can monitor status from those printers.

Printing for TCP/IP networks can also be implemented using the Printer Passthru function available in Client Access (see the Telnet description for more details).

- Line Printer Requester (LPR) and Line Printer Daemon (LPD)

Line Printer Requester (LPR) and Line Printer Daemon (LPD) allow users to print a spooled file from any system in a TCP/IP network. LPR is the sending or client portion of the spooled file transfer. LPD is the receiving or server portion of the spooled file transfer. On AS/400, the Send TCP/IP Spooled File (SNDTCPSPLF) CL command allows you to print a spooled file on a remote system, and specify appropriate printing operations. You can send files to AS/400 systems and non-AS/400 systems.

- 5250/HTML Workstations Gateway (WSG) server

The 5250/HTML Workstations Gateway (WSG) server is an application that automatically transforms AS/400 5250 applications to Hypertext Markup Language (HTML) allowing users to run AS/400 applications from any PC that has a WEB browser. You can incorporate image, audio, and video by modifying applications slightly.

- TELNET client and server

The TELNET protocol allows a system (the TELNET client) to access and use the resources of a remote system (the TELNET server) as if the TELNET client's workstation were locally connected to the remote system. AS/400 TELNET provides both the TELNET client and the TELNET server functions.

The TELNET protocol provides a mechanism for the client and server to negotiate options that control the operating characteristics of a TELNET connection. Among other things, these negotiations involve determining the best terminal type supported by both the client and server. Depending on the terminal type negotiated, the AS/400 TELNET client operates in one of the following full-screen modes: 3270, 5250, VT100 or VT220. The AS/400 TELNET server operates in ASCII line mode or in one of the following full-screen modes: 3270, 5250 or VT100. The functions available in a TELNET session depend on the operating mode.

Security and automation features are included in the AS/400 TELNET 5250 server:

- Registered TELNET server exits for both session initialization and session termination. These exits require only that a customer-written user exit program be registered at the proper exit point. No changes are needed for the connecting TELNET client emulator, so existing clients can immediately benefit from this feature.
- VIRTUAL DEVICE SELECTION by the attaching client (or a registered TELNET server exit program) provides for more traditional job-routing to preferred subsystems and allows for associated work management tuning. With Virtual Device selection, preferred code page, character set, and keyboard attributes can be established on a per session basis, thereby offering greater flexibility in national language support.
- PRINTER PASSTHRU support consists of two new terminal types (IBM-3812-1 and IBM-5553-B01) which provide additional printer support for the TCP/IP environment. This support allows the TELNET server to provide the client with the flexibility to dynamically create and/or select a virtual printer device through enhanced negotiation, or via assignment by the initialization exit program.
- TELNET Session disconnect/reconnect (QDEVRCYACN) is enabled for display sessions that use "consciously selected" device names.

- TELNET and Virtual Terminal API Connected Display sessions are subject to the settings of QINACTITV (INACTIVE Interactive job Time-out Value) which specifies when the system takes action on inactive interactive jobs.
- Automatic sign-on (optional bypass of the sign-on procedure) is enabled for TELNET display sessions which have specific settings for the QRMTSIGN system value.
- TELNET server supports secure TELNET sessions via SSL.

- Remote EXECution (REXEC) client and server

The REXEC server allows you to issue AS/400 commands from other systems across IP networks. REXEC is a standard TCP/IP protocol support by many other systems including UNIX. When you issue a command, that command along with authentication information (profile and password) are sent to the AS/400 REXEC server. The server authenticates the user, executes the command and returns the results. The AS/400 REXEC server includes exit points so additional security measures can be added if desired.

AS/400 also has an REXEC client capability so commands to other systems can be sent from an AS/400. The command RUNRMTCMD (Run Remote Command) is used to issue an REXEC client request.

- Remote IPL support

The AS/400 BOOTstrap Protocol (BOOT-P) server enables the central management of TCP/IP workstations such as the IBM Network Station. It can centrally manage workstation configuration information such as IP addressess, mask, default router address, etc. The DHCP server provides similar function but with more capabilities so it is generally preferable to use DHCP rather than BOOT-P.

The Trivial File Transfer Protocol (TFTP) is used by thin clients such as the IBM Network Station to receive their initial program load. The AS/400 TFTP server includes an extension called broadcast TFTP that dramatically improves load time when many Network Stations are requesting loads simultaneously (e.g., after a power outage).

- TCP/IP Packet Security

Selectively limits or journals network access to applications and services with additional protection for AS/400 systems that run sensitive applications or act as Web servers.

TCP/IP packet security also helps protect an entire subnetwork when the AS/400 acts as a casual router.

- TCP/IP Address Mapping and Hiding

When the TCP/IP addressing schemes of networks conflict, or you need to hide all or part of the network topology, network address translation (NAT) capabilities provide a solution. In addition,

TCP/IP masquerading allows all the computers on one network to access servers on another network by sharing a single TCP/IP address. Masquerading is particularly useful when connecting to another network, such as the Internet, using a dial-up link.

- TCP/IP Dial-on-Demand (DOD) Networking

Connections are made only when there is a need to communicate. Dial-on-Demand is supported on all switched network types and is particularly well-suited to ISDN with its fast call setup time. It is also valuable for burst and infrequent traffic patterns -- especially if you have more remote locations than physical lines. With Dial-on-Demand, modem and telephone line resources are not committed until an application attempts to communicate with a remote site. Thus, a small number of physical resources can dynamically serve a large number of remote networks.

- TCP/IP Integrated Load Balancing

Virtual IP Addressing creates a virtual TCP/IP address that is not associated with a physical network interface. This virtual address on the AS/400 system can be reached from the network through all installed physical interfaces. This allows use of a single IP address with load balancing over multiple physical interfaces and can dramatically increase capacity for high-volume AS/400 e-business servers.

- o X.21 SHORT HOLD MODE (SHM) AND MULTIPLE PORT SHARING (MPS)

SHM and MPS are supported to take advantage of the fast call set-up and clearing characteristics of X.21 SHM/MPS.

- o REMOTE WORK STATION SUPPORT

Work stations from the 5250 family of displays and printers (as well as programmable work stations that emulate the 5250) are supported by 5250 remote controllers. Programs written for interactive applications need not be aware of the work station location (local or remote).

- o 3X74 REMOTE ATTACH

The 3x74 remote attach protects customer investment by allowing IBM 3270 remote control units or IBM Personal Computers executing PC 3270 Emulation Program, Version 3 (59X9969 or feature number 9969 of licensed program 5875-MMA) to attach to the AS/400 system using an SNA/SDLC and X.25 communications port (3174/3274), or IBM token-ring network (3174-3R or -53R). The 3x74 remote attach gives any 3x74-attached IBM 3270 display access to most 5250 applications with essentially 5291 or 5292-1 functions. Major 5250 function exclusions are the word processing function of IBM OfficeVision for AS/400, 5250 graphics, and 132-column display. The 3270 printers are provided 3287/5256 level of function as well as 3286/5575 (DBCS) level of function.

- o 5X94 REMOTE ATTACH

The IBM 5294 Remote Control Unit can be used to attach up to eight 5250-type displays and printers to an AS/400 System using a communications link. The function provided is equivalent to that available on the System/36 and System/38 with the exception that access by AS/400 Client Access to attached personal computers is not supported.

The IBM 5394 Remote Control Unit attaches up to 16 5250-type displays and printers to an AS/400 System using a communications link. The function provided to the remotely-attached work stations is identical to that provided to local work stations.

The IBM 5494 Remote Control Unit supports the attachment of remote workstations to the AS/400 system. It manages the operations of these workstations and the communications to the AS/400 system. There are two models of the 5494:

- Model 001 manages the operation of up to 28 twinaxial-attached workstations and allows the workstations to communicate with the AS/400 system through a type 2.1 connection.
- Model 002 can communicate with an AS/400 system over a Token-Ring network while supporting up to 28 twinaxial devices. Model 002 can support token-ring attached devices while communicating with an AS/400 system over an SDLC, X.21, or X.25 connection. In this configuration the 5494 supports up to 40 devices of which up to 28 can be twinaxial-attached, and the rest token-ring attached.

Personal computers attached to a 5394 or 5494 Remote Control Unit are supported using AS/400 Client Access, a separately-licensed program (5769-XW1 or 5769-XY1).

#### o INTERSYSTEM COMMUNICATIONS FUNCTION

The intersystem communications function provides the application interface for the AS/400 system communications support. The following communication types are supported through this interface:

- Advanced program-to-program communications/advanced peer-to-peer networking (APPC/APPN)
- SNA upline facility (SNUF)
- BSC equivalence link (BSCSEL)
- Asynchronous communications
- INTRA for intra-system communications and testing of programs

The application program uses high-level language operations and communications functions to communicate with a remote system. Either externally described data or system-supplied formats (compatible with System/36 SSP-ICF operations) can be used.

Support functionally equivalent to that known on the System/36 as ICF INTRA support is also provided. This intrasystem communications function allows communications between applications running on the same AS/400 system as if they were using a communications line. This allows:

- Developing and testing ICF communications applications before communications facilities are installed.
- Breaking up an application into more manageable pieces by having some of the work done in independent processes.

o ADVANCED PEER-TO-PEER NETWORKING (APPN)

APPN provides a way to easily establish and maintain a network of AS/400 Systems, System/36s, and other IBM systems. The AS/400 user can install and maintain a complex network of interconnected systems without requiring highly skilled programmers. Configuration and maintenance of the network is done by the controlling nodes that make up the network. Systems that use CPI-C, APPC, DDM, display station pass-through, SNA distribution services (SNADS), SNA backbone, file transfer support, electronic customer support, and AS/400 Client Access can take advantage of APPN networks.

APPN support allows LAN-based AS/400 systems to establish a direct LAN session without being defined to one another. The configuration of 2.1 type PCs on a LAN is significantly reduced using APPN and auto configuration support. An APPN network may be established spanning LAN and remote communication facilities while providing a seamless appearance to nodes in the network.

APPN multi-network connectivity provides APPN session paths between adjacent APPN networks of dissimilar network identifications. Therefore, established APPN networks having unique network identifications can be connected, a large APPN network may be partitioned for operational control, and service providers may connect to client APPN networks. The SNA Network Registry is available to register customer network names. To prevent name conflicts between attached networks, the networking customer can obtain a unique, registered network identifier (NETID) from their IBM branch office representative.

Back-up APPN network node support provides dynamic switching of an AS/400 APPN end node to a back-up network node server upon link failure for sending network management alerts to the network management focal point.

High Performance Routing (HPR) includes three significant enhancements to APPN to improve network reliability and performance for customers with medium to large SNA networks.

- HPR automatically reroutes around failures.
- HPR automatically increases network throughput by recognizing and using underutilized links.
- HPR automatically adjusts to network congestion, lowering and raising the rate at which it sends your data to avoid timeouts.

o DEPENDENT LOGICAL UNIT REQUESTOR (DLUR)

AS/400 DLUR support provides existing SNA end users the benefits of subarea APPN migration without changing their existing SNA devices and applications on the AS/400 system. This is a cost savings allowing hundreds of device and application sessions to be converted with a single system upgrade. No application rewrites, no device upgrades, and no rewiring is required.

Additional AS/400 benefits include the ability to distribute intelligence (applications) to AS/400 DLUR nodes. Controllers and routers do not have the capability to handle application as well as an AS/400 server. PC servers do not have the capacity to handle the number of devices/applications you can distribute to an AS/400 system. In addition, the AS/400 system supports a broader mix of downstream connections, applications, and devices than other servers.

Upgrading subarea SNA to APPN provides significant advantages to current and potential users connected to subarea SNA networks including:

1. APPN supports existing subarea SNA based applications and devices, the cost to move to APPN is much less than converting their networks to other protocols which require application rewrite and often replacement of existing hardware.
2. Greatly reduces configuration requirements in complex networks with auto-configuration of dependent LUs and bound sessions in VTAM domain and cross-domain networks.
3. Greatly increased network management (session tracking extends well beyond current subarea boundary connections)
4. Combined with APPN HPR towers, you can see significant network performance improvements and link outage error recovery

#### o ADVANCED PROGRAM-TO-PROGRAM COMMUNICATION (APPC)

APPC allows a program on one system to communicate with a program on a remote system so that users can run applications and have access to functions not available on the local system. AS/400 APPC is based on SNA LU-6.2 and PU Type 2.1 and is designed to provide a common session protocol for both document interchange and distributed data processing.

Customers using APPC/ICF, CPI-C, DSPT, DDM, SNA/DS, or any other application using APPC LU-6.2 have the option to enable session level compression which significantly reduces traffic on the slower speed communications lines such as SDLC and X.25.

APPC uses one of two compression algorithms, Run Length Encoding (RLE) or Lempel-Zev (LZ). RLE uses String Control Bytes (SCBs) to encode duplicate repetitive bytes of data. LZ assigns codes to represent unique character strings which are stored in tables.

For security reasons, user passwords are not transmitted in clear text. Protected passwords are built based on the real password and sent to a peer system when the peer system supports the password substitution function.

#### o SNA UPLINE FACILITY TO SYSTEM/370 IMS AND CICS HOSTS

The SNA upline facility provides the AS/400 user with communications to:

- CICS/VS (as LU-0) and IMS/VS (as LU-P)
- CICS/DOS/VSE (as an IBM 3790)
- CICS/OS/VS (as an IBM 3790)

This provides for program-to-program communication between AS/400 and

System/370 programs and supports customers migrating from SNA upline facility on System/36.

o BINARY SYNCHRONOUS COMMUNICATIONS EQUIVALENCE LINK (BSCSEL)

BSCSEL provides systems management on the AS/400 system by enabling one program to start another program on another system, also having BSCSEL support. The other system can be IBM AS/400 System, IBM System/36, or IBM System/34.

BSCSEL support also allows a program to communicate to other systems and devices using the binary synchronous communications (BSC) protocol. It is a program-to-program function.

o ICF RETAIL COMMUNICATIONS SUPPORT

The user interface for retail communications support is the intersystem communications function (ICF) file interface used by high-level languages. The ICF retail communications support provides business solutions through the capability to attach retail controllers (3651, 3684, 4680, and 4684) to the AS/400 system with the following connectivity:

- 3651, 3684 -- SNA LU-0 LU-1 LU-2 / SDLC
- 4680 -- SNA LU-0 and LU-6.2 / SDLC and X.25.
- 4684 -- SNA LU-0 LU-2 / X.25 and Token-ring

Communication with the remote change management server on a 4684 Retail Controller is enabled by the ICF retail communications support, which allows a maximum of 32 logical units active concurrently through a 4684 Retail Controller description.

ICF retail communications support includes a retail pass-through utility and retail point-of-sale data translation routines. When the AS/400 system is functioning as an in-store processor, the retail pass-through utility is an application that bridges the SNA LU-0 secondary session with the host system (e.g. System/370 running NDM, CICS, or ADCS using VTAM/NCP) and the LU-0 primary session with the retail point-of-sale controller. The retail pass-through utility uses the AS/400 SNA upline facility (SNUF) for the SNA LU-0 secondary session to communicate with the host (e.g., System/370).

o ICF FINANCE COMMUNICATIONS SUPPORT

The user interface for finance communications support is the intersystem communications function (ICF) file interface used by high-level languages. The ICF finance communications support provides business solutions with its capability to attach finance controllers (3601, 3694, 4701, and 4702) to the AS/400 system with the following connectivity:

- 4701, 4702 -- SNA LU-0, LU-2 / SDLC
- 3601, 3694 -- SNA LU-0 / SDLC
- 4701, 4702 -- SNA LU-0, LU-1, LU-2 / X.25

The ICF finance communications support enables the AS/400 user to explicitly configure a financial branch system services (FBSS)



controller, thereby providing the following connectivity:

- SNA LU-0, LU-6.2, LU-1, LU-2 / SDLC
- SNA LU-0, LU-6.2, LU-1, LU-2 / X.25
- SNA LU-0, LU-6.2, LU-1, LU-1 / Token-Ring LAN

The ICF finance communications support provides the capability for the attachment and configurability of the IBM Personal Banking Machines (4730, 4731, 4732, and 4736 and the IBM Self-Service Transaction Station (4737) on the AS/400 system. The Personal Banking Machines can be attached to the AS/400 system with the following connectivity:

- 4730, 4731, 4732, 4736 -- SNA LU-0 / SDLC

Indirectly through a 4702 Controller.

The Self-Service Transaction Station (4737) is configured on the AS/400 system as a financial branch system services (FBSS) controller, thereby providing the following connectivity:

Directly using

- SNA LU-0, LU-6.2 / SDLC
- SNA LU-0, LU-6.2 / X.25
- SNA LU-0, LU-6.2 / Token-Ring LAN

Indirectly through a 4702 Controller

#### o NON-ICF FINANCE COMMUNICATIONS SUPPORT

The finance support provides an application programming interface and the capability to attach to AS/400 Systems:

- The 4701/4702 Finance Communication Controllers using SNA/SDLC and SNA/X.25 communications lines, and
- The 3694 Document Processors using SNA/SDLC communication lines.

Ease-of-use features are provided that allow communication with the IBM finance communication system online terminal support, IBM finance communication system advanced branch controller system (ABCS) or equivalent support, in the 470X controller. This finance support is based on System/38 Finance. The 470X Control Unit can be programmed to perform 3270 emulation. IBM 4704 devices can be used to emulate 3270 displays, or IBM 3278, 3279, and 3287 devices can be attached to the controller using device cluster adapter (DCA) ports.

#### o SNA DISTRIBUTION SERVICES (SNADS)

The OS/400 SNADS support is an integrated queued asynchronous connection to a SNADS network and remote document libraries. It provides routing, sending, and receiving operations for users to exchange distributions containing documents, messages, data, or objects with other users in the SNADS network. SNADS uses a system distribution directory to direct distributions to users in a local system or to other systems in a SNADS network.

- o SNA PRIMARY LOGICAL UNIT 2 SUPPORT

SNA Primary LU-2 (3270 type terminal) support improves the AS/400 participation in an SNA backbone network. It enables any LU-2 terminal user in the network to access either any AS/400 system or any S/390 (R) system in the network with the same user and network interface. AS/400 application programs written for 5250 displays may also be accessed by a LU-2 terminal through the network with this new SNA Primary LU-2 support.

This will protect the investment in the SNA backbone network, installed AS/400 systems, and installed S/390 systems. It also provides a central point of control for network management and distribution. The IBM Network Routing Facility licensed program is not needed with this support.

SNA Primary LU-2 support enhancements provide for attachment of more than one Network Control Program (NCP) Communication Controller. Each controller may be in the same or different subarea. Previously, some customers were restricted by a limitation of 253 sessions. Now theoretically up to 60,000 SNA LU-2/1 application primary sessions may be configured on an SDLC link between an AS/400 system and an NCP Communications Controller, and up to 6000 SNA LU-2/1 application primary sessions may be configured for each IBM TR/LAN attaching an AS/400 system and NCP Communications Controller.

In addition, the AS/400 shared line support is enhanced with this new SNA Primary LU-2 capability. LU-2/1 application primary sessions, APPN/APPC sessions, SNUFs sessions, 3270 Device Emulation sessions, and DSNX sessions may all share the same SDLC link between an AS/400 system and an NCP Communications Controller.

The AS/400 system's ability to connect 3270 work stations to an APPN network is greatly improved. AS/400 systems with APPC, CPI for communications and using APPN networking may now add OS/400 application primary sessions to the AS/400 system in the SNA subarea network environments. This increases use of the AS/400 system as a distributed system and/or a central site processor.

At least one VTAM host using VTAM V3R4 and its companion release of NCP V5R4 is required for OS/400 SNA Primary LU-2 support. Included with this is support for DBCS displays and printers.

Also, with SNA Primary LU-2 support, user and network interface routing is handled directly by NCP and the controllers in the network.

OS/400 SNA Primary Logical Unit (PLU) support in Version 2 Release 3 significantly improves the initial and ongoing configuration effort for large networks. It exploits the use of dynamic LU definition and independent LU extended bind capability in attached NCP controllers which significantly reduces NCP configuration of AS/400 systems. Furthermore, OS/400 allows auto-create and auto-delete of configuration control blocks needed by the AS/400 application program for its LU-2 terminal and LU-1 printer sessions. Auto-create/delete are selectable device configuration options of OS/400 configuration support allowing for flexible application and network design. LU-2 terminals of 24x80 screen size are supported.

Also, there are several LU-1 (3270 type printer) operational enhancements. LU-1 SCS printer sessions are supported by OS/400 for application initiation, a terminal's associated printer, an auto-LOGON printer, and a designated network printer thru terminal input to an application. Printing may be done directly by the application program or spooled using the AS/400 spool writer facility. In addition, LU-1 SCS session primary applications may have printer output directed to an AS/400 system printer.

- o SNA/MANAGEMENT SERVICES TRANSPORT

The SNA/Management Services Transport support, enables the OS/400 licensed program to send and receive management services data with other systems in an SNA network that provide support for the SNA/Management Services architecture. This includes other systems using OS/400, NetView and OS/2 licensed programs. An Application Programming Interface (API) is also provided to enable AS/400 customers and business partners to use this support in their network and systems management applications.

- o DISTRIBUTED RELATIONAL DATABASE SUPPORT

The Remote Unit of Work function described in Distributed Relational Database Architecture (DRDA) is a function of the operating system that supports distributed relational access to data on remote systems. These remote systems must be connected by a communications network and must also support DRDA. The Remote Unit of Work also supports SAA Character Data Representation Architecture (CRDA) and is used with Distributed Data Management (DDM) architecture to provide distributed relational access to remote databases. DRDA compliant access is provided by other DB2 family members.

- o OBJECT DISTRIBUTION FACILITY (ODF)

The object distribution facility gives users or applications the capability to distribute objects across a network. Information such as data files, source code, and print files can easily be exchanged between peer-connected systems (AS/400 system, System/36 and System/38) using SNA distribution services (SNADS). This capability protects customer investment in systems, data, and applications, while providing improved productivity through data access.

When coupled with DSNX, ODF can redistribute files and programs received from a System/370 host to another system. For example, a DSNX distribution from a System/370, using NetView distribution manager, can be sent to an AS/400 system, which in turn can forward the distribution to System/36s or other AS/400 systems.

- o DISPLAY STATION PASS-THROUGH

Display station pass-through allows a user attached to a local AS/400 system to be connected to a remote System/36, System/38 or another AS/400 system, to sign-on to that system, and to execute applications or perform network management functions as if connected directly to the remote system. An options is provided to eliminate the requirement to sign on at the target system. System/36 and System/38 users can also sign-on to an AS/400 system and perform the same functions.

AS/400 users passing through to a remote AS/400 can have their printed output automatically printed on their local system. Exchange of printed data for System/36 and System/38 users passing through to a remote AS/400 may be accomplished using the object distribution facility and a user-written program.

#### o DISTRIBUTED DATA MANAGEMENT (DDM)

DDM is a function of the operating system that supports distributed file and distributed relational access to data on remote systems. These remote systems must be connected by a communications network and must also be using DDM. For example, distributed file access is provided by System/36, IBM System/38, CICS/VS, or another IBM AS/400 System. SAA Distributed Relational Database Architecture (DRDA) and SAA Character Data Representation Architecture (CDRA) are used with DDM to provide distributed relational access to remote databases.

#### o SNA PASSTHROUGH

SNA Passthrough provides SNA controllers and T2.1 nodes attached to AS/400 system an unedited unaltered session to S/390 system. VTAM signon screen is displayed on supported devices attached to AS/400 system. The following sessions can be established using this support.

- LU-6.2 sessions; to the AS/400 target or a passthrough session
- LU-0 thru LU-3 sessions; passthrough sessions only

#### o IBM NETWORK ROUTING FACILITY (NRF) SUPPORT/400

IBM NRF Support/400 is programming that enables connectivity between AS/400 system and the Network Routing Facility LPP operating on the IBM 3745 Communications Controller. LU-2 (3270-type) terminals and LU-1 SCS printers attached to an NRF node may be session partners to an AS/400 application host.

Session partner routing using NRF gives the appearance to the AS/400 application host that the terminals attached to NRF are directly connected. The NRF session between the terminal and the AS/400 application host is routed thru the SNA subarea without going to the System/390 host.

#### o AUTODIAL SUPPORT

Autodial support is provided on the AS/400 system so that users can communicate with other systems by automatically dialing remote systems under control of an application program or procedure. Serial autodial using the V.25 bis command set is available for synchronous, bisynchronous, and asynchronous communications using one communication line. The IBM and attention command sets are also available for asynchronous communications. The IBM 5853 modem, the IBM 7855 modem, and other equivalent V.25bis modems can take advantage of this autodial support.

#### o 3270 DEVICE EMULATION

3270 device emulation allows any AS/400 printer or 5250 display to emulate an IBM 3278 (Model 2 or 5) or 3279 model S2B display station, or IBM 328x printer. Host DBCS applications also can be accessed using an SNA connection. Up to 254 concurrent sessions can be active to the System/370 per SNA connection. The 3270 extended field attributes are translated into the appropriate AS/400 5250 display attributes. Up to 255 input fields per 3270 application screen can be active when displayed on local 5250s. Any remaining 3270 input fields can be accessed by a scrolling function.

o 3270 SNA API SUPPORT FOR IBM 3278 MODEL 3, 4, AND 5

This support enables System/370 application programs that were written for IBM 3270 Model 2 thru 5 display stations to be accessed at the 3270 data stream interface level by AS/400 application programs. In addition, 3270 data stream extended attributes are supported by the AS/400 3270 SNA API for 3278 Models 2 thru 5.

o ISDN SUPPORT

OS/400 supports attachment of devices to the AS/400 that enable the ISDN data link control (IDLC) communications protocol and X.25. This ISDN support includes

- AS/400 APPN--APPC
- attachment of a PS/2 running OS/2 or DOS using 3270 remote attach support
- attachment of the 3174 using a downstream ISDN basic rate interface (BRI) adapter to enable 3270 device emulation
- use of Teleos to obtain primary rate access services.

o 5394/5494 SNA BACKBONE SUPPORT

OS/400 SNA support provides connectivity for 5250 sessions between an AS/400 system and a 5394 Remote Control Unit (with RPQ 8Q0775), a 5494 Remote Control Unit, and with a System/370 subarea using a subarea controller (37XX). Customer investment in SNA backbone networks is protected because no changes are required to AS/400 applications programs to use the 5x94 SNA support. The LU-4 and LU-7 sessions are encapsulated with LU-6.2. APPC sessions are supported as parallel LU-6.2 sessions on the same link as the LU-6.2 encapsulated sessions.

o FILE TRANSFER SUPPORT

The AS/400 user can access file transfer to exchange System/36 data and library members and AS/400 database file members with other AS/400 systems and System/36s. This can be accomplished by using async, BSCEL, or APPC/APPN support. The user interface to this support is callable subroutines from RPG and COBOL programs.

o INTERACTIVE TERMINAL FACILITY (ITF)

ITF allows an AS/400 user, using asynchronous support, to send and receive data through applications such as electronic message services. ITF also exchanges files and library members with other ITF users. ITF can also send DW/36 documents, but it cannot receive documents from other

ITF users.

o SAA COMMON PROGRAMMING INTERFACE FOR COMMUNICATIONS (CPI-C)

SAA CPI-C support provides for program to program communications in the SAA environments of OS/400, OS/2, VM/ESA, VSE/VSA, and MVS/ESA (IMS, CICS, TSO). Because it is an architected, call level interface, applications written to it are portable and protect customer investment in communications programming. The CPI-C is accessible from every SAA language (RPG/400, FORTRAN/400, C/400, and Procedure Language/400 REXX).

Communications support architected for CPI-C is provided by communications logical unit type 6.2 (LU-6.2). On an AS/400 system, the CPI-C provides an application with transparent access to LU-6.2 session services (commonly known as APPC), to low entry networking (LEN) nodes (type 2.1 nodes), to all APPN networking function, and to data link controls (SDLC, Token Ring, and X.25).

The source or target for SAA CPI-C applications may be MVS/ESA, VM/ESA, VSE/ESA, CICS/ESA or IMS/ESA nodes. The CPI-C program-to-program session is supported across the SNA subarea and onto APPN networks using any LEN node and APPN application system.

The AS/400 CPI-C implementation provides the following CPI-C conformance classes, as defined by X/Open's "Developer's Specification for CPI-C":

- Conversations
- LU-6.2
- Recoverable Transactions
- Data Conversion Routines
- Security

o IPX/SPX COMMUNICATIONS

IPX (Internetwork Package Exchange\*\*)/SPX (Sequenced Package Exchange) communications over LAN and WAN protocols provides a framework for an AS/400 system to be an application server and IPX router in a Novell (IPX) network. Native IPX/SPX communications enables AS/400 applications to directly communicate with PC applications written to an IPX API and adds IPX as an option for any application written to an API that runs over AnyNet.

IPX (Internetwork Package Exchange) / SPX (Sequenced Package Exchange) communications over LAN and WAN protocols provides a framework for an AS/400 system to be an application server and IPX router in a Novell (IPX) network. Native IPX/SPX communications enables AS/400 applications to directly communicate with PC applications written to an IPX API and adds IPX as an option for any application written to an API that runs over AnyNet.

With IPX/SPX support:

- Server or client IPX applications can be written via the Sockets API that interoperate with an AS/400 system.
- IPX traffic can be routed through an AS/400 system.
- A NetWare Loadable Module\*\* (NLM\*\*) running on the FSIOP can be

written to interoperate with an AS/400 application.

- Application investment in APPC and TCP/IP is protected with AnyNet support.

IPX/SPX communications solutions include:

- IPX/SPX protocol stacks supporting Token-Ring 802.5, IEEE Ethernet 802.3, Ethernet Version II, X.25, and Frame Relay.
- IPX and SPX native sockets API supporting customer written applications.
- AnyNet support for CPIC, ICF and AF\_INET sockets applications.
- IPX routing support for transporting packets from one IPX network into another IPX network for both LAN and WAN networks.

Routing Information Protocol (RIP) and NetWare Link Services Protocol (NLSP) are supported, as well as IPXWAN Version 2.0.

- Service Advertising Protocol (SAP) support which provides the ability to advertise services and addresses of applications on the AS/400 system.
- Support for Simple Network Management Protocol (SNMP), IPX, RIP, SAP, and NLSP Management Information Bases (MIBs) APIs allows customers to write sub-agents and surface additional information for managing applications. SNMP management data can be manipulated either locally or remotely.

#### o ASYNCHRONOUS TRANSFER MODE (ATM) LAN EMULATION

ATM LAN emulation enables current LAN applications to run over ATM networks without modification by imitating the operation of a traditional LAN. ATM offers better productivity for LAN applications owing to faster access to information at a comparable technology cost with no changes to existing code required (initial system configuration is required). ATM also positions users for new multimedia applications and new ways of viewing and using information. ATM is the beginning of a new communication protocol technology standard.

#### OFFICE HOST SERVICES:

The AS/400 system provides host services for document interchange architecture (DIA) and IBM OfficeVision for AS/400. As a host for DIA, OS/400 supports document distribution and document library services.

DIA host services are available to the IBM 5250 family of work stations through the OfficeVision for AS/400 licensed program (5769-WP1), to IBM 6580 Displaywriter, and to IBM Personal Computers through the IBM AS/400 Client Access licensed program (5769-XW1 or 5769-XY1).

#### o Document Distribution Services

DIA distribution services provide support for sending and receiving documents among office systems hosts in an SNA LU6.2 network. DIA provides a business solution because it helps manage the flow of information in an enterprise. Document interchange uses the OS/400 SNADS support. Office users can distribute documents and messages to one or

many recipients on either the local system or remote systems. Remote distribution services are provided for the IBM AS/400 System, IBM System/36, IBM System/38, DISOSS/370, and IBM 5520. Documents can be sent to:

- IBM System/36 Personal Services/36 (PS/36) licensed program (5727-WP3 on 5360 or 5362, or 5727-WP8 on 5364 or 5363)
- IBM System/38 Personal Services/38 (PS/38) licensed program (5714-WP3)
- IBM Distributed Office Support System/370 (DISOSS) Version 3, Releases 2, 3, 4 (5665-290 for OS/VS2 MVS, 5666-270 for VSE)
- Electronic Document Distribution (EDD) licensed program for the IBM 6580 Displaywriter System (5608-GR8)
- IBM 5520 Administrative Processing Program (5611-SS2)

IBM AS/400 documents can be interchanged with the following systems:

- System/36 (PS/36)
- System/38 (PS/38)
- AS/400 System
- 5520 (Administrative Processing System)
- Displaywriter (EDD)
- DISOSS
- 8100 (DOSF) using DISOSS
- PROFS using DISOSS or the IBM MVS/VM bridge (using BSC or SNA) included in the IBM Communications Utilities for AS/400 licensed program (5769-CM1)

#### o Document Library Services

Document library services allow local and remote systems office users to store and control access for documents in the local AS/400 document library and search for them by using the descriptions stored with the documents. When OfficeVision for AS/400 and the search function are installed, local office users may use the text search services allowing full text retrieval of documents that have been indexed. This control, management, and access to information improves user productivity.

OS/400 supports DIA document library services for remote users of OfficeVision for AS/400, System/36 Personal Services/36, and Displaywriter (using Electronic Document Distribution). The local AS/400 office user may also use document library services in remote libraries on another AS/400 system, System/38, or DISOSS on a System/370.

#### - Folder Management

Folder management services and transforms are provided on the local AS/400 system. Functions include create, delete, list, authorization list, archive log, security, save, restore, copy, shared folders and data transforms.

Shared folders are designed to handle text documents from both the word processing function of OfficeVision for AS/400 and IBM Personal Computer DisplayWrite programs. In addition, the shared folders can be used to store data and applications from IBM personal computers.



Transformations between personal computer ASCII and AS/400 EBCDIC are completed only when necessary to allow data sharing between IBM personal computers and the AS/400 system.

Through the use of data stream transformations provided with the OS/400 host office support, the word processing function of OfficeVision for AS/400 (in conjunction with OS/400 document distribution) supports Final Form Text-Document Content Architecture (FFT-DCA) and Revisable Form Text-Document Content Architecture (RFT-DCA) data streams for interchange between the AS/400 system and users of other IBM word processing programs or systems supporting FFT-DCA and RFT-DCA, including DISOSS, another AS/400 System, PROFS, System/36, System/38, Displaywriter, and the IBM Personal Computer DisplayWrite programs.

- Text Search Services (AS/400 library only)

AS/400 users can take advantage of the text search function when OfficeVision for AS/400 and the search function are installed, by indexing their documents when filing them. Applications could be written to handle tailored searches when contextual text retrieval is a major requirement. Likewise, OfficeVision for AS/400 users have access to the search function. The document analyzing process for indexing is done by OS/400 natural language processing services, and uses the separately licensed program, Language Dictionaries for AS/400 (5716-DCT).

The text search function is a compute-intensive application; customers must consider whether the interactive search performance meets their needs or whether they can request the search and receive the results later for review.

- Print and View Services

OS/400 supports print and view services for documents. Print services include draft and letter quality support with special handling options for certain printers. View services include support for viewing final form documents and the text portions of a compound document.

- Creation of Spelling Aid Dictionaries

Spelling aid dictionaries may be created on OS/400 for use with proofreading aids in the OfficeVision for AS/400 licensed program (5769-WP1) and the Text Management/38 utility (included in the System/38 Utilities for AS/400 licensed program, 5769-DB1).

## NATIONAL LANGUAGE VERSIONS AND MULTILINGUAL SUPPORT:

- o Overview

The AS/400 system is a worldwide product that addresses many country-unique requirements. For the following countries/languages,

specific support is provided, either with translated machine-readable information (MRI), such as screens and messages, or with keyboards and displays on the local or remote workstation twinaxial controller.

o National Language Versions and Multilingual Support

The following national language versions are available from the program libraries indicated.

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-----
|| Program Library Supported | | | | |
||-----|
|| SMS- | SMS- | SMS- | SMS- | SMS- |
|| B | E | C | J | A |
|| USA | EURO | CAN | JPN | AUST | |
|---|---|---|---|---|---|---|
|o Albanian      || -- | *P/S | -- | -- | -- |
|o Arabic        || -- | *P/S | -- | -- | -- |
|o Belgian Dutch || S | *P/S | -- | -- | -- |
|o Belgian English || S | *P/S | -- | -- | -- |
|o Belgian French || S | *P/S | -- | -- | -- |
|o Brazilian     || -- | *P/S | -- | -- | -- |
| Portuguese    || | | | | |
|o Bulgarian     || -- | *P/S | -- | -- | -- |
|o Canadian French || S | P/S | *P/S | -- | -- |
|o Chinese       || S | S | S | S | *P/S |
| Simplified DBCS || | | | | |
|o Chinese       || S | S | S | S | *P/S |
| Traditional DBCS || | | | | |
|o Croatian      || -- | *P/S | -- | -- | -- |
|o Czech         || -- | *P/S | -- | -- | -- |
|o Danish        || S | *P/S | -- | -- | -- |
|o Dutch         || S | *P/S | S | -- | -- |
|o English U/L SBCS || *P/S | P/S | P/S | P/S | P/S |
|o English U/C SBCS || -- | *P/S | -- | -- | P/S |
|o English U/L DBCS || P | P/S | -- | P/S | *P/S |
|o English U/C DBCS || P | P/S | P- | P/S | *P/S |
|o Estonian      || -- | *P/S | -- | -- | -- |
|o Farsi         || -- | *P/S | -- | -- | -- |
|o Finnish       || S | *P/S | -- | -- | -- |
|o French        || S | *P/S | S | S | S |
|o French MNCS   || -- | *P/S | S | -- | -- |
|o German        || S | *P/S | S | S | S |
|o German MNCS   || -- | *P/S | S | -- | -- |
|o Greek         || -- | *P/S | -- | -- | -- |
|o Hebrew        || -- | *P/S | -- | -- | -- |
|o Hungarian     || -- | *P/S | -- | -- | -- |
|o Icelandic     || -- | *P/S | -- | -- | -- |
|o Italian       || S | *P/S | S | S | S |
|o Italian MNCS  || -- | *P/S | S | -- | -- |
|o Japanese DBCS || S | S | S | *P/S | S |
|o Korean DBCS   || S | S | S | S | P/S |
|o Lao           || -- | -- | -- | -- | P/S |
|o Latvian       || -- | *P/S | -- | -- | -- |
|o Lithuanian    || -- | *P/S | -- | -- | -- |

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|| Program Library Supported | | | | | |
||-----|
|| SMS- | SMS- | SMS- | SMS- | SMS- |
|| B | E | C | J | A |
|| USA | EURO | CAN | JPN | AUST |
||-----|
|o Macedonian || -- | *P/S | -- | -- | -- |
|o Norwegian || S | *P/S | S | -- | -- |
|o Polish || -- | *P/S | -- | -- | -- |
|o Portuguese || S | *P/S | S | -- | -- |
|o Portuguese MNCS || -- | *P/S | S | -- | -- |
|o Romanian || -- | *P/S | -- | -- | -- |
|o Russian || -- | *P/S | -- | S | S |
|o Serbian || -- | *P/S | -- | -- | -- |
|o Slovakian || -- | *P/S | -- | -- | -- |
|o Slovenian || -- | *P/S | -- | -- | -- |
|o Spanish || S | *P/S | S | S | S |
|o Swedish || S | *P/S | S | -- | -- |
|o Thai || -- | -- | -- | -- | *P/S |
|o Turkish || -- | *P/S | -- | -- | -- |
|o Vietnamese || -- | -- | -- | -- | P/S |
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```

## LEGEND

- o SMS-B Software Manufacturing Solutions - USA
- o SMS-E Software Manufacturing Solutions - Europe
- o SMS-C Software Manufacturing Solutions - Canada
- o SMS-J Software Manufacturing Solutions - Japan
- o SMS-A Software Manufacturing Solutions - Australia
  
- o '\*' This is the primary library for this NLV.
- o PRI Primary language feature number
- o SEC Secondary language feature number
- o P/S Primary and secondary language supported
  
- o DBCS Double-Byte Character Set
- o SBCS Single-Byte Character Set
- o MNCS Multinational Character Set

Multilingual support allows multiple users on the same system to be operating in different languages. This means that system messages, displays and help information as well as user applications can be presented to the end user in his national language.

Not all licensed programs are translated into all languages nor are all

national language versions available from all program release support centers. Contact your IBM representative for more information.

- o Information about Secondary National Languages

The national language in which the licensed programs is ordered is considered the primary national language. Any other languages are secondary languages. Users can switch among the languages as necessary.

The executable code is shipped with the primary language. When a secondary language is ordered, a separate tape containing only the translated machine-readable information (MRI) is sent to the customer. The primary language MRI and the national language MRI are installed in separate libraries on the AS/400 system. Each secondary NLV is shipped on a separate tape. Multiple NLVs can be installed on a single AS/400 system.

Each secondary language is ordered only once per system, not for each licensed program. The secondary language is selected by a feature code of the Operating System/400 (5769-SS1). The secondary language tape contains national language MRI for the products that have been translated for customers by the country translation centers. For products not translated, US English MRI is included. All of the MRI is contained on a single tape volume.

The Language Dictionaries for AS/400 licensed program (5716-DCT) includes the available national language dictionaries used by IBM OfficeVision for AS/400, and therefore it is not included in secondary national language tapes. AS/400 Client Access installation diskettes are not included with the secondary national language versions. All other support and service activities are only in US English. Regardless of the NLV, all system commands are in US English. Thus, a single set of system commands works in all national language environments.

To properly display all of the national language characters, the workstation (display and keyboard) must be capable of supporting the desired national language. When a personal computer is used as a workstation supported by the AS/400 Client Access licensed program, its keyboard can be redefined for a national language, specifying the language keyboard type, so that a special language keyboard is not required.

Each secondary language NLV is shipped from the program library without publications. It is the user's responsibility to determine whether the information in the data base is English or the secondary language. The system does not automatically know which device was used to enter the data. For example, if Spanish information is displayed by an application on an English work station, not all of the Spanish characters are shown correctly. For this reason, it is recommended that Spanish information be kept in one data base and accessed by a Spanish work station, and English information be stored in a separate data base and accessed by an English work station. This example applies also to the other national languages.

Although translated MRI for multiple products is included on the distribution tape for a secondary language, the customer may use the MRI

only for the products for which he is licensed.

o Universal Coded Character Set Support

Many customers are doing business in a worldwide environment. It is too costly and time consuming for them to redesign and rewrite an application each time they need to support users in another national language or culture. These applications require the ability to store and process character data from more than one national language. For example, a database file may need to contain customer names in English, German, Greek, Arabic, Japanese and Thai characters. Also, this capability must be available in a client/server environment and in a network of heterogeneous systems that are exchanging character data via customer applications.

The Universal Coded Character Set (UCS) is an emerging global character encoding, developed jointly by the industry (UNICODE 1.1) and the International Organization for Standardization (ISO). ISO/IEC 10646-1 defines a code page (UCS-2) encompassing the characters used by all currently significant languages, a rich set of scientific and publishing symbols, and a variety of script languages. This common code page, spanning the character sets of many languages, can ease the application development and management issues historically found in multiple code page system environments and networks. This capability is provided in OS/400 with the UCS2 Level 1 support for database that permits characters of any national language to "coexist" in database files.

UCS2 support also includes character and UCS2 compatibility in comparisons and assignments in SQL, Query for AS/400, and Query Manager. Query for AS/400 and Query Manager also implicitly convert UCS2 data to EBCDIC before displaying and printing so that it can be displayed and printed on existing devices.

o Locale Support of Cultural Values

There are also "cultural values" that change from one national language to another, and OS/400 simplifies the tasks that an application must perform to provide local cultural values. This support can be used whether or not a National Language Version (primary or secondary) is installed for that language on the AS/400. Examples of cultural values are:

- date and time format
- currency symbol
- sort (collating) sequence

Locale support allows for the creation, deletion, and access of locale-based information. C-applications can access locale information via C-runtime functions. Non-C applications can retrieve locale information via APIs.

o Bidirectional Language Support

A series of routines transform physical order to logical order. Culturally correct BiDi language support requires that the flow of text, left to right or right to left, be determined by the character entered or

displayed at the workstation or printer device. However, the data must be stored in DB2 UDB for AS/400 (or any file system) in the sequence the characters were entered and not how they were displayed.

## TEXT

### TECHNICAL DESCRIPTION

### OPERATING ENVIRONMENT

### HARDWARE REQUIREMENTS

Any RISC model of the IBM AS/400 system except Model 236.

For Version 4 a minimum of 1.6GB of disk storage is required for OS/400 and licensed internal code. A minimum of 64MB of main storage is required. OS/400 Version 4 and related components use more disk space and main storage than CISC releases. Contact your IBM marketing representative for assistance in determining disk and memory requirements.

Before installation of OS/400 refer to the "Memorandum to AS/400 Users", shipped with OS/400.

### HARDWARE REQUIREMENTS FOR WINDOWS 95/NT CLIENT:

#### o AS/400 SERVER REQUIREMENTS

- The Windows 95/NT client can be used with all RISC models of the AS/400.
- AS/400 disk storage required for AS/400 Client Access for Windows 95/NT is:
  - 50MB for base code
  - 4MB for each additional national language version

#### o CLIENT WORKSTATION REQUIREMENTS

- Windows 95/NT client supports selected desktop PCs compatible with Microsoft Windows 95 or Microsoft NT 4.0, Contact your IBM Representative for a specific list of supported workstations
- Depending on the number of other Windows applications used:
  - Minimum PC memory for the Windows 95 operating system is 12MB; 16MB is recommended.
  - Minimum PC memory for the Windows NT operating system is 24MB; 32MB is recommended.

- The minimum PC processor
  - Windows 95 operating system requires an Intel 486
  - Windows NT operating system requires a Pentium 100 mhz or faster base processor

#### HARDWARE REQUIREMENTS FOR INTEGRATION WITH WINDOWS NT (VERSION 4.0):

##### o AS/400 SERVER REQUIREMENTS

- Integration with Windows NT can be used with all RISC models of the AS/400 system.
- Integration with Windows NT requires an Integrated PC Server feature using a Pentium Pro processor.

#### SOFTWARE REQUIREMENTS

Some OS/400 functions are separate OS/400 features, and some OS/400 functions are optionally installable.

#### SOFTWARE REQUIREMENTS FOR WINDOWS 95/NT CLIENT:

##### AS/400 SERVER REQUIREMENTS

- o The Windows 95/NT client can communicate with any AS/400 system that has V4R1, or later release, OS/400 installed.
- o The OS/400 Host Servers must also be installed on the AS/400 system for the Windows 95/NT client to communicate with OS/400.

##### CLIENT WORKSTATION REQUIREMENTS

Any of the following can be used with the Windows 95/NT Client:

- o Microsoft Windows 95 or later compatible versions
- o Windows 95 J or later compatible versions for DBCS systems
- o Microsoft Windows NT 4.0 or later compatible versions
- o Windows NT 4.0 J or later compatible versions for DBCS systems

#### NOTES

- o AS/400 Client Access for Windows 95/NT is designed to run in a single user desktop environment, not in a multiuser environment. AS/400 Client Access can be installed on Windows NT Server 4.0 and used by the signed on desktop user, but it is not supported for server types of applications, such as Windows NT services.
- o Applications written to SNA/APPC protocols (such as EHNAPPC, CPI-C, or 16-bit Client Access DLLs) cannot run over native TCP/IP or IPX protocols.
- o On Windows NT 4.0 workstations, the automatic fax sending support provided via the Client Access AFP printer drivers for network print is not available.
- o The AFP Printer Driver for network print for Windows NT Version 4.0 does not support font substitution or APIs.
- o The SCS Printer Driver for network print for Windows NT is provided via AS/400 Client Access Service Pack SF37523. For Windows 95, the SCS driver is included with the AS/400 Client Access for Windows 95/NT client.

#### BACKWARD OBJECT SUPPORT

Supported objects created with OS/400 V4R3 can be saved and subsequently restored and used on the following OS/400 releases: V3R2, V3R7, V4R1, and V4R2. Standard TGTRLS support is used to implement this function.

Program objects must be created as observable. However only a single instance of the program is required in order to run on all releases from V3R2 through V4R3.

#### SOFTWARE REQUIREMENTS FOR OS/400 SUPPORT FOR NOVELL NETWARE:

##### AS/400 ADVANCED SERIES REQUIREMENTS

- o OS/400 V4R1, or later release, is required.
- o To run NetWare 4.10 or NetWare 4.11, the Integration Services for FSIOP feature and the OS/400 Integration for Novell NetWare feature are required for each IPCS.
- o If the IPCS is used as a LAN card, Integration Services for FSIOP is required for each IPCS.
- o NetWare 4.1x must be acquired from an authorized NetWare distributor.

##### WORKSTATION REQUIREMENTS

The installation documentation for NetWare 4.10 provides the information on NetWare attached device requirements.

The approved software platforms for installation of NetWare 4.1x with Integration Services for FSIOP are:



- o DOS (and Microsoft\*\* Windows\*\*) Operating Systems

OS/400 Integration for Novell NetWare supports appropriately-configured hardware platforms supported by Microsoft DOS 6.2 or IBM PC DOS 6.3 operating systems, Windows 3.1, IBM-approved OEM equivalents, and later compatible releases.

- o DOS (and Microsoft Windows) Operating Systems (DBCS)

OS/400 Integration for Novell NetWare supports appropriately-configured hardware platforms supported by IBM DOS Version J4.0, J4.0/V, J5.0, J5.0/V, J6.1/V operating systems, as well as MS-Windows J3.0 and J3.1.

For information on the approved PC platforms for installation of NetWare 4.10 with NetWare Integration on the FSIOP, contact your IBM representative.

#### SOFTWARE REQUIREMENTS FOR EZ-SETUP WIZARD:

EZ-Setup Wizard requires Windows operating system component Dial-Up Networking Version 1.2, or later. The Wizard checks for the presence of the correct version of Dial-Up Networking and provides details on obtaining and installing it, if necessary. However, to prepare ahead of time, follow these instructions:

- o WINDOWS NT: Remote Access Service from the Windows NT CD; then apply Windows NT Service Pack 3, or higher. Download this software from the Microsoft home page at:

[HTTP://WWW.MICROSOFT.COM](http://www.microsoft.com)

- o WINDOWS 95, older versions before OSR2:

Download the Dial-Up Networking upgrade from the Microsoft home page at:

[HTTP://WWW.MICROSOFT.COM](http://www.microsoft.com)

- o WINDOWS 98, or newer versions of WINDOWS 95 (OSR2, or later):

Use Dial-Up Networking from the Windows CD.

#### PLANNING INFORMATION

##### CUSTOMER RESPONSIBILITIES

Refer to the "Memorandum to AS/400 Users" (shipped with the machine readable material and available from your IBM representative) for information necessary to plan the installation process, including estimation of the time required.

##### OS/400 CPA TOOLKIT:

The OS/400 CPA Toolkit Feature provides functions implemented to various drafts of the corresponding POSIX, XPG, and single UNIX specification standards. In future releases of OS/400, IBM will replace the CPA Toolkit

functions with new implementations compliant with the approved versions of these standards. Applications written using these interfaces will require source code modification for upgrade to the new release and approved standards. These incompatibilities tend to be minor updates or simple replacements. Developers using these functions should monitor the appropriate standards bodies for new drafts and approved standards.

#### TAATOOLS:

Beginning with V3R6, all of the TAATools (about 300 tools) in the QUSRTOOL example library are no longer shipped with OS/400. The TAA Tools examples provided in earlier releases of OS/400 may still be used on V3R6, or later release. These earlier versions of the TAATools were provided on an as-is basis, and some may need code alterations to operate correctly on V3R6, or later release. If you wish to bring an earlier version of TAATools forward to V3R6, or later release, and they were created with the default of no observability, you will need to either recompile with observability on your current release or restore the source and recompile on the desired release.

#### LIMITATIONS

##### o OS/400 SUPPORT FOR NOVELL NETWARE

Installation of NetWare on the Integrated PC Server (IPCS) is limited to NetWare 4.10 or NetWare 4.11 (intranetWare). NetWare Loadable Modules (NLMs) which have dependencies on hardware that is not supported by an IPCS, are not supported. For example, NLMs that support FAX or CD-ROM devices are not supported.

The parallel port supports a hardware plug license that is used by some NetWare NLMs. The parallel port is not supported for printing from NetWare. The serial port is not supported by NetWare.

##### o OS/400 SUPPORT FOR LOTUS NOTES

Lotus Notes is supported on the IPCS. The serial port supports a single modem that is used by the Notes server. The parallel port is not supported by Notes.

#### PUBLICATIONS

Internet publications for AS/400 can be displayed and ordered from the AS/400 Online Library on the Internet. Portable Data Format (PDF) files are available for most V4R4 publications. For more information, visit URL:

[HTTP://AS400BKS.ROCHESTER.IBM.COM](http://AS400BKS.ROCHESTER.IBM.COM)

Some Hardcopy Publications may be shipped with each AS/400 licensed program. Additional hardcopy publications are available for a fee -- contact your IBM representative to order.

#### SECURITY, AUDITABILITY, AND CONTROL

This program uses the security and auditability features of the OS/400 operating system.

The customer is responsible for evaluation, selection, and implementation of security features, administrative procedures, and appropriate controls in application systems and communication facilities.

#### TRADEMARKS

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