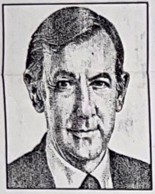
APPLIED INTELLIGENCE

AS/400's Design Expedites Application Development



JAMES MARTIN

This is the fourth part of a series on IBM's midrange computer family, the AS/400.

The AS/400 design incorporates a number of advanced concepts that contribute to highly productive application development. These include a high-level machine interface, object-oriented design, single-level addressability, highly integrated system functions, an integrated relational database and advanced engineering.

These architectural features effectively hide the complexity of the system from programmers, operators and users through the use of a single system interface. This results in a substantial reduction in the cost of ownership of the system, particularly in support areas such as systems programming, database support, network management, operations and software.

The architecture of the AS/400 defines a logical machine instruction set at a very high level, as illustrated in the figure. This high-level instruction set is called the machine interface. Many functions traditionally performed by mainframe operating systems are supported as basic instructions in the machine interface. For example, "Create Object" is a single machine-interface instruction.

The high-level interface isolates applications developers from machine implementations. The approach accommodates changes in the machine's underlying technology without any impact on applications.

No Conversion Necessary

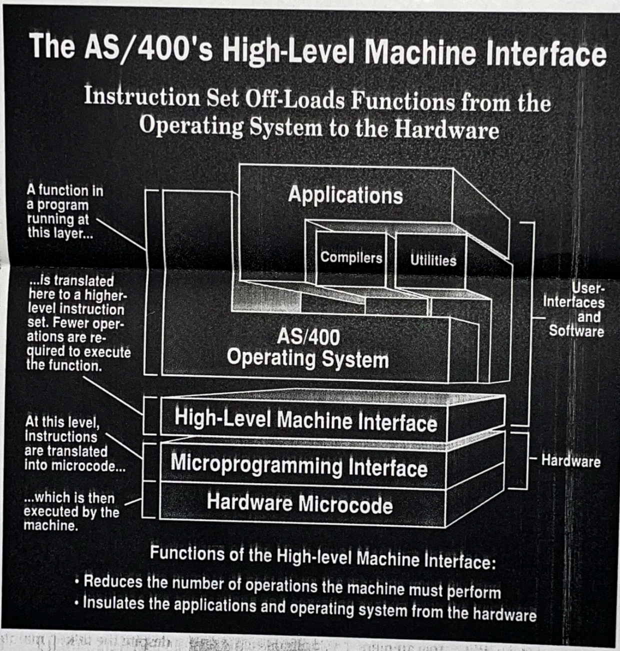
In effect, applications developed on current models of the AS/400 will be able to take advantage of new technologies without requiring conversion.

The AS/400 is an object-oriented system. Programs, data files, queues, libraries, device descriptions, user profiles—all are autonomous objects that interact by passing messages to one another. Access to objects is by object name rather than object location—a key characteristic of object-oriented systems. The object-oriented design of the AS/400 frees the applications programmer from low-level concerns with information retrieval and storage. It also provides a uniform interface to all objects, a high degree of data protection and integrity, and powerful security features.

An object can be visualized as a container holding information. Objects consist of a functional portion and an associated storage space. The functional portion of an object stores a definition of the object, which includes the object name, object type and object authorization. In this way, the AS/400 ensures that only operations valid for the object type are performed against the object, and only authorized users gain access to the object.

On the AS/400, single-level addressability makes main memory and mass storage appear to the programmer as a single, enormous pool of memory. All objects are accessed by name; programs and database objects are shared rather than having individual copies for each user, and all objects appear to be permanently resident in a single large memory. Single-level storage frees the applications developer from disk- and memory-management constraints, and allows an application to be independent of the configuration of the target platform.

Single-level addressability requires a very large virtual-memory address to accommodate all the primary and secondary storage on the system. The AS/400 supports a 48-bit address that allows more than 281 trillion bytes of information to be individually addressed. This is significantly larger than the maximum 31-bit address supported on IBM's System/370 mainframes.



The AS/400's High-Level Machine Interface

Instruction Set Off-Loads Functions from the Operating System to the Hardware

A function in a program running at this layer...
...is translated here to a higher-level instruction set. Fewer operations are required to execute the function.
At this level, instructions are translated into microcode...
...which is then executed by the machine.
Applications
Compilers
Utilities
AS/400 Operating System
High-Level Machine Interface
Microprogramming Interface
Hardware Microcode
User-Interfaces and Software
Hardware

Functions of the High-level Machine Interface:

- Reduces the number of operations the machine must perform
- Insulates the applications and operating system from the hardware

John Avakian

The AS/400 was designed from the ground up to be an interactive, multiuser machine. Architectural features such as single-level addressability are well-suited to that environment.

IBM intends to expand the AS/400 even more. Already the AS/400 design supports expansion to a 64-bit address that can access more than 18 quintillion bytes of virtual memory. Thus, the AS/400 is positioned to exploit new high-capacity storage technologies as they become available during the 1990s.

Single-level addressability does have a serious disadvantage. If one storage device fails and the data on it cannot be recovered, it may be necessary to reload all the data on all the storage devices on the system, because a segment of nearly every object on the system may well have been resident on the damaged device. Very long recovery times are the inevitable result.

IBM has sought to address this problem on the System/38 and AS/400 by improving the reliability of direct-access storage devices, providing recovery-support aids such as journaling and checksum protection, and introducing specialized data-recovery utilities to its technical-support personnel. Facilities to maintain mirror-image copies of files online are a logical next step.

Focus on Integration, Simplicity

Integration and simplicity are the central elements of the AS/400 design. Many functions implemented with separate systems-software products on traditional mainframe systems are integrated into the AS/400 hardware and operating-system software. These integrated functions include transaction processing, database and resource management, system security and communications.

In contrast, the layered software components of conventional mainframe systems result in an overlap of functions and inconsistencies. Because each software component in conventional systems is a self-contained entity, functions found in one component may be repeated in others. In addition, highly trained support personnel with specialized skills are needed to manage and control each specialized software component.

The AS/400 was designed from the ground up to be an interactive, multiuser machine. Architectural features such as single-level addressability are particularly well-suited to an interactive, multiuser environment.

All application programs on the AS/400 are automatically compiled as re-entrant modules, so one physical copy of the code is shared by multiple users of the program. This provides efficient use of storage, and transaction-processing support is fully integrated with the operating-system software. No expensive specialists or laborious tricks of coding are required. Most significantly for users, interactive processing on the AS/400 does not "go down." The norm is 100 percent reliability.

Integrated Relational Database

The AS/400 database-management system is based on the relational model, and is integrated with both the operating system and the machine. This provides efficient performance for the information system because operations are performed below the machine-interface level in a combination of microcode and hardware. Moreover, the integrity of the data is guaranteed because of the integration of security at the object level.

The database implementation supports two kinds of files: physical and logical. A physical file is a data structure consisting of rows (or records) and columns (or fields), each having the same field attributes and record length. Logical files provide alternative views of the database and may be created dynamically. This flexibility of function, in combination with the performance and integrity of the AS/400, provides strong support for user information-retrieval systems and contributes to a reduction in data redundancy.

The AS/400 hardware incorporates a number of sophisticated engineering features not usually found in midrange computer systems. The main processor in high-end AS/400 models incorporates IBM's fastest bipolar chip technology, with a cycle time of 60 nanoseconds, and megabit memory chips.

The AS/400 has been called the SAA machine. Next week I'll examine the extent to which the AS/400 has been integrated with IBM's Systems Application Architecture. ■

The James Martin Productivity Series, an information service updated quarterly, is available through High Productivity Software Inc., of Marblehead, Mass. (800) 242-1240. For information on seminars, please contact (in the United States and Canada) Technology Transfer Institute, 741 10th St., Santa Monica, Calif. 90402 (213) 394-8305. In Europe, contact Savant, 2 New St., Carnforth, Lancs., LA5 9BX United Kingdom (0524) 734 505.