INTEROPERABILITY INSIGHTS

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OpenEdition MVS: The System, the Strategy, the Significance: Part II — The Technology

IBM's ultimate goal for OpenEdition MVS is to attract additional application development from all industry sectors to its flagship S/390 platform. The strategy is to position MVS as the most powerful and appealing alternative in the high-end UNIX server market. By addressing so many concerns and exposures of traditional UNIX, OpenEdition MVS opens the door of opportunity for IBM to re-establish MVS as a growth platform.

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Jim Porell is a senior technical staff member at IBM and a spokesman regarding OpenEdition MVS. He has been working with the OpenEdition MVS design almost since its inception, and discussed the strategy with ACTS explaining, "Our main goal is to revitalize the ability to deploy new applications on MVS, and to improve access to the data and transactions that are resident there already."

OpenEdition MVS is not UNIX on top of MVS, but rather re-written components forming an integral part of IBM MVS Version 5.2.2.

Porell estimates that 60 percent of MVS has been enhanced since 1992 to support IBM's open edition and parallel processing initiatives.

The OpenEdition MVS environment embraces widely implemented "dejure" and "de facto" standards for UNIX. As a result, IBM expects to have OpenEdition MVS, or rather OS/390, officially branded as UNIX by late 1996.

Such branding attests that OpenEdition MVS performs in complete accordance with designated UNIX standards. This is determined via a battery of controlled tests regulated by the OPEN GROUP, formerly X/Open Company Ltd. of Reading, England.

MVS OpenEdition was first released in March 1994, and its inclusion in MVS/ESA Version 5.2.2, released in third quarter 1995, represents the third release of OpenEdition services. IBM has offered detailed specifications down to the level of the system call and is providing documentation accordingly. Timely and accurate documentation, which has often been lacking in the UNIX-world, will make it easier for UNIX application developers to write more reliable software.

UNIX branding for MVS represents an important milestone toward a much broader IBM objective to reinvigorate application development on MVS. "UNIX branding is nice because it makes skills portability recognizable," Porell states, "but as I've said many times, the deployment of applications is the true measure of success for a platform. OpenEdition MVS offers a tremendous advantage to customers who already have UNIX platforms to continue to use their full range of in-house programming skills without expensive retraining." In addition, Porell predicts that UNIX application developers will jump at the opportunity to exploit MVS strengths in the area of scalability, data management, and workload management.

WHERE IT BEGAN

Forget the images of corporate visionaries working around the clock to formulate sophisticated product strategies. The impetus for this system was provided by the U.S. government. Yes, the U.S. government! The year was 1991, and IBM was bidding to retain its position as a major contractor for the multi-billion dollar National Aeronautics and Space Administration (NASA) Space Station contract. IBM had to incorporate support into MVS for popular UNIX interfaces to comply with requirements spelled out in Federal Information Processing Standards (FIPS) document 151. Failure to comply with FIPS meant NASA would have thrown out MVS along with millions of dollars of IBM hardware that it ran on.

It was during this development effort that IBM strategists had another realization. They recognized that adding support for UNIX would greatly enhance the overall attractiveness of MVS as an application development platform. So from these efforts a technical foundation was laid that has since become OpenEdition MVS.

OPENEDITION MVS: THE SIGNIFICANCE

Since Tandem owns the lion's share of the Automatic Teller Machine market, they have demonstrated their ability to run commercial applications on UNIX. Using fault-tolerant servers to differentiate from competitors, Tandem has indeed made some inroads into the highly demanding worlds of finance and banking. From the operating system side, it offers the NonStop-UX operating system and bills it as the industry's most reliable implementation of UNIX System V. NonStop-UX runs on Tandem's fault-tolerant Integrity FT systems which are targeted at customers who require very high levels of system availability. To go after larger applications, Tandem added a UNIX personality to its well established NonStop Kernel (NSK) operating system, formerly known as Guardian, for its high-end Himalaya line of NonStop servers. Support for the Open Software Foundation's (OSF's) Distributed Computing Environment (DCE) was also added. Tandem calls the new operating system capability the Open System Services (OSS) environment. From a reliability standpoint, even though Tandem stands head-and-shoulders above most of the other UNIX-servers on the market, neither of its UNIX environments can match the robustness of OpenEdition MVS feature by feature.

DEC and HP have been down a similar path,adding substantial UNIX support to their proven and reliable VMS and MPE operating systems, respectively, calling the enhanced versions OpenVMS and MPEix. Both companies also offer fully UNIX-based operating systems, but wanted to give VMS and MPE customers an alternative to stay put and access UNIX applications without having to migrate to UNIX. Reliable sources at both DEC and HP admit that their adapt-a-UNIX strategy hasn't attracted as many UNIX application ports as they would have liked.

What makes OpenEdition MVS different? While DEC and HP each have large customer bases, neither can rival IBM's base of large customers, nor the extent to which these customers rely on MVS to run their businesses.

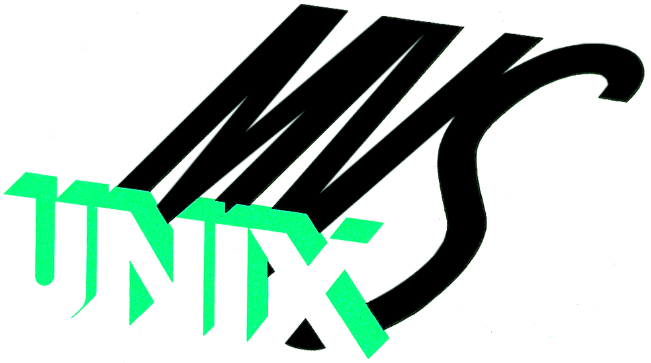
Naturally, competitors are unwilling to concede the high-end UNIX market to IBM. David Scott, HP Software Product Line manager, contends "OpenEdition MVS lacks the ability to swap operating system vendors. Customers are still likely to be using the proprietary MVS APIs (Application Program Interfaces), keeping them locked in to the operating system. We don't see OpenEdition MVS affecting the strong momentum for evolving away from mainframes onto leading open-systems platforms like the HP 9000."

While HP's view is predictable, it is important to recognize that Amdahl and Hitachi Data Systems offer plug-compatible hardware alternatives to IBM for running MVS. If avoidance of vendor lock-in is a primary concern, MVS is the only ingredient a company must obtain from IBM when putting a S/390 mainframe environment together. S/390-compatible hardware, security software, database software, and hundreds of program products are available from other vendors.

Is it worthwhile for small companies to port applications to MVS? UNIX applications will be ported to OpenEdition MVS in ever-increasing numbers as UNIX software suppliers pursue the multi-million dollar mega-deals with large IT shops. A manager at Aetna Life and Casualty, based in Hartford, Conn., confided that they were looking to buy one software application, and were surprised to learn that the deal was so big it would have cost less for Aetna to buy the entire software company than to buy their software! That's right — one deal exceeded the total value of the company. Few environments offer small companies such growth potential! Furthermore, association with OpenEdition MVS will give smaller vendors important credibility as well as enhancing the scalability of their products, making them a more serious contender when competing for large commercial accounts.

HP's Scott suggests an altogether different scenario. "Though the availability of UNIX APIs on MVS means ISVs can theoretically support the MVS platform, the reality is they will only support the leading revenue-generating UNIX platforms, not wanting to incur the additional costs of supporting OpenEdition MVS."

Current trends, however, indicate ISVs are very interested. OpenEdition MVS applications already announced include those shown in Figure 1, which proves there are numerous companies more than willing to incur the additional support cost. Further good news for OpenEdition is that vendors are finding the conversion straightforward, which minimizes the cost to port. For example, Oracle teamed with IBM at a recent meeting of Oracle users in Philadelphia to demo an IBM 9672 CMOS processor running a C program under OpenEdition MVS making calls to Oracle7 databases located on both MVS and an IBM RS/6000 workstation running AIX. Oracle7 already runs native on MVS, but now Oracle reports applications designed for UNIX run unmodified on OpenEdition MVS as a client accessing the databases. Oracle says the internal logic of its database manager component is the same across different platforms,so there is no need to even port a UNIX version of Oracle to MVS.



Vincent Re, vice present of research and development, Computer Associates (CA), is another early user of MVS OpenEdition. According to Re, CA markets a rather sizeable UNIX application to handle software distribution across large networks. A customer, who he declined to name, came to him with an urgent need for a software distribution product, but wanted to use it in support of its many MVS-based mainframe images. CA didn't want to develop a mainframe-specific version, so it looked into porting the server logic for their UNIX product to OpenEdition MVS. Using an OpenEdition MVS beta copy, CA did a straight port of half-a-million lines of C code and completed the task in what Re thought was a reasonable time frame. CA reported that compiles took longer than expected, but after completing the port, the server application performed just fine.

Early indications are that IBM's strategy to re-invigorate MVS is off to a strong start.

OPENEDITION MVS: THE SYSTEM

What makes OpenEdition MVS so attractive is its robust functionality. MVS has been changed from the inside out to accommodate UNIX application software. In so doing,

Figure 1: Applications for OpenEdition MVS

Vendor	Application	Availability
Abraxas	CodeCheck	Now
Advanced Software Products Group (ASPG)	RA/2	Now
Allen Systems Group	JCL/PREP	Now
Boole & Babbage	CMF Monitor	Now
Compuware	Uniface Polyserver	Being ported
Dassault	Catia V4.1.3 to V4.1.5	Now
Diversified Software Systems, Inc.	JOB/SCAN DOCU/TEST	Now Now
Hudson-Williams, Inc.	Enterprise Chargeback	Now
IBM	DCE, AS/IMS, AS/CICS Internet Connection Server for MVS	Now Now
IMC	IMC TUXEDO/T Open Transport	Now Now
Interlink	TCPaccess TCPaccess w/sockets TCPaccess Fault Tolerant	Now 1Q96 Now
ISE	Eiffel family	8/96
Isis Distributed Systems	Isis SDK Orbix+Isis Isis Database Isis Availability Manager	1996 1996 1996 1996
J.D. Edwards	C/S Multinational Apps.	Intent to port
masc ag	masc-cao masc-mua masc-vtm	Now
Merrill Consultants	MXG	Now
MKS	Code integrity	Beta
Momentum Software	Xipc	Now
New Dimension	Control Family	Now
Open Environment Corp.	Encompass Entera/Trans Access Appl. Designer	Now Now Now
Open Horizon	Connection	4Q96
Oracle	Oracle Cooperative Applications Oracle 7	Now
SAP America	R/3	Feasibility Port
SAS Institute	SAS/C SAS/C C++ Development Sys. SAS/C Connectivity Support Library	4Q95 (test) 1H96 1H96
Softool	CCC/Harvest	1H96
Sybase	Open Client on MVS Open Client/Open Server C/COBOL precompliers	Now 3Q96 3Q96
Sysdeco	Systemator 4GL/DATAMODELLOR	beta
Tech-Beamers	unxSHELL S/390 Appl System	Now

OpenEdition MVS does not just mimic UNIX, rather it natively executes the UNIX commands and does so in accordance with technical standards that have been widely accepted for UNIX platforms. An analysis of system internals reveals that this is not some superficial MVS make over, but a real, in-depth UNIX integration. "OpenEdition MVS is different from other UNIX-like front-ends to proprietary operating systems," observes Louis Sellincourt, senior director of the MVS Product Line at Oracle. "Its predecessor emulated UNIX functionality, but OpenEdition MVS is tightly integrated into the MVS kernel, thereby allowing far stronger UNIX integration into the MVS environment."

UNIX additions, object technology support, CMOS hardware, and other enhancements have transformed the MVS environment to the point IBM has renamed MVS OS/390. In a nutshell, OS/390 will integrate functions of more than 25 program-products and subsystems from the MVS environment into a single operating system.

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STANDARDS COMPLIANCE

While MVS has always supported numerous industry standards, OpenEdition MVS expands this effort by conforming to POSIX,XPG4 Base Profile, and a subset of the X/Open Single UNIX Specification. Readers not familiar with this jargon should read the sidebar "The Search for UNIX Standards" before continuing.

IBM staff overseeing OpenEdition MVS are also proactively involved in official efforts to develop the specification for a 64-bit UNIX standard. The 64-bit UNIX standard does not require a 64-bit hardware architecture for program execution, rather it deals with support of APIs. When these additional interfaces are selected, OpenEdition MVS will add support as appropriate.

Official X/Open UNIX-branding for OpenEdition MVS is expected by late 1996. X/Open XPG 4.0 branding was received in November 1995. OpenEdition MVS has added more than 1,100 UNIX APIs. It has even added those APIs designed for GUI and cursor controls, obviously for the sake of form (100 percent compliance) rather than function.

DISTRIBUTED COMPUTING ENVIRONMENT (DCE)

DCE provides an additional capability to use MVS as the server for DBMS or information warehouse data, and to gain access from a wide range of distributed client machines. DCE is a set of services on which to develop multi-platform applications. Simply stated, DCE is being positioned to be the software-glue used to knit together systems from multiple vendors into a cohesive network. The popular RPC (Remote Procedure Call) is implemented and forms the basis of the DCE programming. DCE provides directory services,security services,services to coordinate wall-clock time between systems (to assure time stamps on one machine match those on another), and a thread service that allows DCE to do multi-tasking, essentially allowing the code to handle more than one request concurrently. DCE's Distributed File System (DFS) makes file systems on different servers appear as one file system to the client. This greatly simplifies multi-vendor environments because DFS allows file sharing across systems that are essentially incompatible with one another.

LEVERAGING TECHNICAL SKILLS

OpenEdition MVS expands a company's ability to manage, control, split, optimize, and continue to make effective use of the S/390 environment. And it's not just exploiting MVS; it's protecting the company's programmer skill set for both MVS and UNIX.

Generally speaking, a shell is a command interpreter that provides an interface between a user and a system. Allowing users to access the system from the environment they already know, as well as providing the means to easily switch between TSO and the UNIX shell interface, is key. The advantages are obvious: Both types of users — the TSO/CICS/IMS/DB2 person and the UNIX-trained professional — are catered to. TSO-experienced users would most likely continue to use familiar TSO structures to access OpenEdition, thereby leveraging their existing skills, while at the same time helping them bridge to the UNIX environment. Likewise, UNIX-experienced users would most likely "rlogin" or "telnet" to OpenEdition without ever having to see MVS or TSO, although, eventually, UNIX shell users may want to expand their horizons and learn how to use the TSO interface.

One now has the UNIX face integrated as part of the MVS kernel. The shell, called "oe" shell, is more than just a Korn shell, it's the complete environment. The "oe" shell allows casual users to use the mainframe to build batch files, run and test programs, and, in general, control the computer using only UNIX commands. Use of the mainframe means MVS looks after management of DASD, tape, and other peripherals, something UNIX did not always do so well. Also the UNIX "tar" (tape-archive-restore) command, a key UNIX utility embedded in many scripts, is available within the UNIX shell. When using "tar", OpenEdition MVS makes a file that can be backed up via the standard MVS utilities. OpenEdition MVS also includes the ubiquitous UNIX editor "vi" as well as the Network File System and OSF's DCE software.

As those who have failed trying to migrate off of MVS can readily attest, MVS is also much more efficient than UNIX in handling symmetrical multiprocessing (SMP), logical processor partitioning, hierarchical storage management (archiving), system managed storage, and continues to lead the industry in these areas. Take the SMP comparison, for example. Various studies show that SMP overhead for S/390 hardware consistently averages between 1 percent and 2 percent per processor. In other words, customers using a high-end mainframe with 10 processors running under a single copy of MVS would suffer 10 percent to 20 percent performance degradation. By comparison, high-end servers from HP and DEC can experience from 40 percent to 60 percent degradation for SMP, depending on workload. In other areas, the seamless integration between MVS and UNIX means OpenEdition supports UNIX Message Queues, semaphores, and shared memory.

Terminals such as the present IBM 3270 series can be used to communicate with the UNIX shell. In the UNIX environment there are the ASCII terminals that do character-by-character interaction, and they have also been incorporated via special communication front-end processors. Such integration of both software and hardware allows for a seamless application environment.

This special communications processor is in fact an IBM RISC System/6000 which is networked or channel-connected to the IBM mainframe and obtains its control program from the MVS machine. Now scores of users can access the MVS machine via this route and be TSO, CICS, or UNIX users. On the RISC machine, while using the X-Windows (AIX-windows) application, one can open many different windows, called AIX-terms, with each on a different application into the mainframe at the same time.

MVS has defined an additional data set called Hierarchical File System (HFS) and this now means the UNIX view of data — a master or root directory with other data in sub-directories — is supported by MVS. Long file names are allowed.

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SECURITY

Traditional UNIX security offers only two levels of administration, namely someone is either root (king) or a user (pleb). In contrast, DCE's security services are based on MIT's Kerberos security scheme, where a single machine which is known to be secure is called a "trusted third-party" and provides security information that governs access to other systems on a local area network (LAN). DCE actually offers five security levels to supplement the normal Group/User/Owner definitions. IBM RACF has been updated to include OpenEdition MVS at user and file levels, and future plans call for RACF to cooperate and communicate with the supplied DCE layers.

IMPROVED CONNECTIVITY/FLEXIBILITY

OpenEdition MVS supports single login over interconnected MVS systems. Also called Single System Image, single login means a user may login anywhere, retaining the exact view of data, environment, and messaging from all points of access.

To become more competitive in the server market, IBM is not just changing its software, it is also changing its hardware. For example, IBM has integrated an Open Systems Adapter (OSA) into selected S/390 hardware models, bringing LAN attachment directly to the MVS server. This means that mainframe applications, using either SNA or TCP/IP, can communicate directly with Ethernet, Token Ring, or Fiber Distributed Data Interface (FDDI) LANs. Consequently, customers can cast MVS in the role of a disk, print, and central administration server for LAN-connected users. Amdahl is offering similar enhancements for its hardware.

OpenEdition MVS can manage multi-vendor environments in a streamlined manner while significantly reducing the amount of network hardware otherwise needed. For example, OSA allows MVS to become a large-scale disk server to users under Novell NetWare, or OS/2 LAN server, via IBM's LAN Resource Extension and Services/MVS (LANRES/MVS) software. This also applies to TCP/IP Network File System (NFS) clients via IBM's LAN File Services/ESA (LFS/ESA) software.

APPLICATION PROGRAMMING SUPPORT

The UNIX debugger, called "dbx", is also included. It has always been especially powerful for C and Fortran interactive debugging. "Dbx" is commonplace on the majority of UNIX variants, so now OpenEdition MVS programmers can use the same type of debugger they were using on their UNIX workstation.

Object-Oriented Programming (OOP) is a programming method allowing more modular and usually simpler programs to be quickly constructed. OpenEdition MVS will support Objects through C++, OO Cobol, SOM, and DSOM. This broad range of support allows customers to develop applications in the language of their choice, and allows those objects to interoperate through SOM and DSOM.

Where did all of this alphabet soup come from? Very briefly, System Object Model (SOM) is IBM's primary OOP model introduced in OS/2 Release 2. SOMobjects MVS are for SOM-based CORBA-compliant, object-oriented application development capabilities, and the run-time component has been integrated into MVS version 5.2.2. The Distributed System Object Model (DSOM) is on the way, and will support objects distributed across a network using

The Search for UNIX Standards

Efforts to unify a fragmented UNIX market have resulted in activities such as IEEE POSIX, COSE Spec1170, and X/Open's XPG 4.2. A review of this activity should help provide some perspective regarding the technical and political complexities involved.

By the early 1980s, customers watching chasms between different UNIX versions grow wider finally demanded standardization across versions. IEEE responded to the call and began work on UNIX standards in 1984. More than 25 different committees were formed under one common banner: Portable Operating System Interface for UNIX (POSIX), dividing the UNIX pie along boundaries by interfaces, security, data base, networking, languages, etc. Eventually UNIX was dropped from the official name, and POSIX became just Portable Operating System Interface.

The work on POSIX has been heavily influenced by the National Institute of Standards and Technology (NIST), a U.S. government agency within the Commerce Department. Some POSIX committees were more successful than others, and POSIX became a long drawn out process. Seven committees actually completed their projects (published standards), including POSIX.1, which defined an API to call basic operating system services from a C program; POSIX.2, which defined the command line interface for shells and utilities; and POSIX.3, which defined common test methods. Several POSIX committees that eventually withdrew their work groups include POSIX.11 to define transaction processing applications; POSIX.16 to define C language bindings; and POSIX.19 to define Fortran 90 language interfaces. Therefore, the whole POSIX effort to standardize UNIX is largely viewed as a failure.

COSE

During the many years POSIX committees spent deliberating, a new competitor was setting its sights on the UNIX market: Microsoft. Now highly motivated by the very real threat of encroachment by Microsoft's Windows NT operating system, UNIX vendors decided to get more serious about standardizing UNIX. In March 1993, UNIX competitors HP, IBM, SCO, Sunsoft, Novell, and AT&T's UNIX System Laboratories, formed a consortium called the Common Open Software Environment (COSE), and many other vendors quickly announced their support.

COSE was created to bring some consistency across all areas of computer systems, including the network, the operating system, and the user interfaces. An early and highly visible COSE initiative identified common APIs across UNIX variants. It was named SPEC 1,170 because the first draft of the specification listed 1170 UNIX APIs. Other areas COSE is focusing on include graphics, multi-media, systems management, Objects, Common Desktop Environment, naming standards, data management, and distributed computing. In a political move designed to force Microsoft's hand, COSE has also announced its commitment to develop specifications for a Public Windows Interface (PWI). PWI is an attempt by the COSE alliance to force Microsoft to put Windows messaging standards into the public domain.

Also in September 1993, a contingency of more than 70 vendors appointed X/Open to manage the evolution of a set of common APIs to bring UNIX systems closer together and to certify, or brand, products that complied. Soon after, SPEC1170 was incorporated into the X/Open Portability Guide (XPG) specification, and more recently was renamed as the X/Open Single UNIX Specification. Some call this Universal UNIX. UNIX 93 and UNIX 95 are specific certification levels within the X/Open branding process.

X/Open

X/Open was founded in 1984, and recently merged with the Open Software Foundation (OSF) to form the "OPEN GROUP", which, in its own words, is a "not-for-profit, vendor-independent, international consortium dedicated to the advancement of open systems throughout the world." Under this mission statement, X/Open, with many prominent vendors active in its membership, has attempted to integrate selected industry standards and facilitate users, vendors, and standards bodies being able to work closer together in the pursuit of open systems. X/Open standards are agreed to by votes of its directors, and votes of its paying members who might pay as much as $500,000 yearly for the right to vote. In contrast, the International Standards Organization (ISO), limits membership to other standards organizations from different countries. The American National Standards Institute (ANSI) is a voluntary body in the United States and represents U.S. interest in international standards organizations. Both ISO and ANSI work in many other areas in addition to their active roles insetting standards for information technology. IEEE allows both members and non-members to participate in standards activities and oversees and referees the committee activities. IEEE ensures documentation and published standards meet ANSI specifications.

X/Open promotes its branding service "as an open systems procurement tool by commercial and government users around the world who find that it significantly reduces cost, reduces time, and increases the level of quality of systems purchased." The main purpose of X/Open-branding is to provide the buyer with some assurance; X/Open calls it a guarantee that certain applications will run as promised by the vendor.

common transport protocols, such as TCP/IP, IPX, and NetBIOS.

The Common Object Request Broker Architecture (CORBA), is an architectural standard that assists object-oriented languages and tools to bridge incompatible technologies. CORBA came out of the work of the Object Management Group (OMG), an international non-profit organization founded in 1989 by 3COM Corp.,American Airlines,Canon, Data General, HP, and SUN, to promote the development of software based on object-oriented technology. OMG's stated mission is to maximize the portability, reusability, and interoperability of software.

WEB EXPANSION

IBM announced on October 31, 1995, an Internet web server product for OpenEdition MVS called IBM Internet Connection Server. It allows users to use MVS as a gateway to explore the Internet as well as introduce host Web home pages to promote company products. The World Wide Web (WWW) is that portion of the Internet which allows information to be provided via a series of interconnected pages of text, graphics, video, and sound. As the Internet expands to include commercial activity, there is more and more need to store pictures, movies, and data in browsable (non-compressed) style in a common format to be readily accessed from anywhere in the world by network-browser software products, such as Mosaic and Netscape.

Supporting these data and rapid-response-time requirements will require the fast disk and large data storage techniques found in MVS. UNIX systems heretofore have done a lot with CPUs, but UNIX applications too often have a tough time getting at the data. MVS offers powerful server capabilities with the I/O bandwidth necessary to make it all work.

CHECK IT OUT

No matter how promising a system looks on the surface, check out vendor claims first-hand. OpenEdition MVS is no exception, especially since its performance has yet to be demonstrated and proven. The technical aspects of building and integrating UNIX applications into MVS will only become apparent through rigorous pilot testing. For example, the performance of UNIX pipes, the efficiency of forks, threads (fork is similar in MVS to creating an address space), and the IBM C/C++ compiler should all be verified. With the system in its infancy, customers are advised to benchmark their own applications and not rely on benchmark data supplied by vendors.

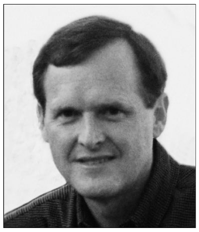
UNIX networking is different from traditional System Network Architecture (SNA), and VTAM specialists will have to adjust somewhat to handle TCP/IP support. Like SNA, TCP/IP is a well-established protocol, and a broad range of TCP/IP education courses, workshop manuals, and experience is available. The load on a network is always an important consideration, and SNA is designed to handle traffic differently than TCP/IP.

The "oe" shell should be carefully examined and tested for behavior. Through the years, some of the most arcane behavior of UNIX occurred in the handling of special characters, syntax rules, and differences in execution between different shells. This is true regardless of whether it is the C-shell, Bourne shell, Korn shell, tsh shell, csh shell, or ksh shell, all of which can cause compatibility problems when moving between UNIX platforms.

Even though the "oe" shell will rigidly adhere to POSIX standards, a customer's old shell scripts may have been written in the absence of such rigidity, and therefore might not work. The syntactical behavior of the dot (.), slash (/) and exclamation point (!) should be thoroughly examined for consistency when porting between any two UNIX platforms. Apart from large chunks of C code that can be recompiled, any application is usually surrounded by different shell scripts and methods of starting the application. Verify that these things work properly in the OpenEdition environment.

UPCOMING

The concluding article in this series will examine observations about OpenEdition MVS and present some projections as to its destiny. ts



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