HP IT Program to Eliminate Mainframes

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1. Hewlett-Packard's Mainframe Elimination Program (MEP)

After 40 years of relying on mainframes to help conduct a large majority of its business processing, Hewlett-Packard unplugged its last mission-critical mainframe on May 17, 1996. This move makes HP the largest company worldwide to run its business solely on open systems-based hardware and software.

Some observers have wondered why and how HP chose to make this move. Was it a grand plan to eradicate a competing vendor's products from its data centers? Did it take a horde of systems consultants to complete? Were there any major setbacks along the way? The answer to all these questions is a resounding "no." Quite simply, over time, HP has repeatedly assessed its business needs and ensured its information technologies (IT) systems were designed to meet those needs. This paper details what those business drivers were and are, how they've shifted as HP has experienced its growth and how its IT evolution has led to a mainframe-free $32+ billion company.

1.1 Brief Overview of HP

At its inception, HP's primary business centered around test and measurement equipment, for which it achieved world-wide respect. However, the company didn't channel its formidable engineering resources into building computers until the early '70s, when it introduced the HP 3000. At this time, combined with sustained growth, HP's product line began what has become a 20-year trend of increasing variety.

Now with over 80,000 current products and services, HP deals daily with flux from a number of sources:

- o Types of products: HP delivers everything from products such as its HP DeskJet 600C printers to sophisticated HP 9000 enterprise servers to polarization analyzers, protein sequencers and coronary angiography workstations.

- o Rapid turnover of product lines: As with many other companies' product lines, HP has seen rapidly decreasing product life cycles and the need for faster development cycles. In fact, 80% of HP product sales are currently derived from products less than two years old.

- o Business operations: A very different business model for manufacturing, inventory control and distribution is required by consumer products from the printer division than that of fully-loaded HP 9000 Enterprise Parallel Servers.

- o Geographical distribution: HP currently employs over 100,000 people across 110 nations. Forty percent of the employees are outside the United States, presenting a huge challenge to simply track who's gone where.

- o Global competition: Doing business in over 110 nations, from China to Finland, means opening up to a whole new realm of competitors.

Despite this challenging business climate, HP has repeatedly been picked as one of the most admired companies in America. Clearly, the company has been able to successfully address the business issues related to its dramatic growth.

1.2 Resulting Business Issues

The technology marketplace is changing at an ever-increasing rate. Time-to-market requirements continue to shorten. Efficient just-in-time manufacturing and distribution practices are critical to remaining competitive. For example, HP now deals with thousands of trading partners, hundreds of customers, over 300 suppliers and many banks via electronic data interchange. Continual shifts in delivery channels are

the norm. And improved technologies are continually being developed. In fact, HP has cannibalized its own successful products in order to deliver newer products with more capabilities and better performance.

These shifting dynamics require companies to have increasing flexibility and functionality to support change. HP has not been immune to such fluctuations in its business. In fact, quite the opposite is true.

Consider some of the facts. HP's annual spending on research and development reached $2.3 billion in 1995, almost double what it spent only six years prior. This allows HP to stay on the forefront of technology and product advances. HP's strong market position now, for example, is partially the result of bold decisions made during the 1980s: RISC, open systems and commercial UNIX(R), distributed architectures, client/server computing and personal desktop printers. Such decisions were made before these concepts became popular and pervasive in the industry.

1.3 Resulting IT Issues

What has HP's success in dealing with a dynamic business arena meant for its own IT organization? Other companies experiencing strong growth have found their IT environments inflexible, costly and restrictive, hampering their ability to quickly respond to the ever-shifting competitive landscape. HP's own IT strategy has always been to use the most effective information systems available to support the needs of the business. Because HP actually operates as a collection of dozens of relatively independent business units, independent IT purchasing decisions regularly occur. HP Corporate IT, in working with the business units, encourages choosing the best available platform for the application, regardless of manufacturer. That strategy helped produce, by 1993, an IT environment that spanned desktop PCs, workstations, mid-range platforms, high-end servers and proprietary mainframes.

Such freedom of choice created fundamental incompatibilities at the most basic IT level for HP, making collecting and reporting company-wide information difficult and hampering inter-departmental communications. For example, company re-organizations, requiring different roll-ups of data across different product lines, had historically been very difficult. Most significantly, the vast amounts of data used to run HP's core business functions required the use of mainframe-class computers. But the data was not always available to the people who needed it to make timely business decisions.

Meanwhile, internal issues drove HP to consider mainframe replacement and increased open systems adoption. Rapid revenue and order growth drove the need to improve the company's flexibility and expand performance and capacity, while increasing competition drove HP to reduce its IT costs. But upgrading existing mainframes would have been prohibitively expensive. For example, the last large mainframe in HP's Palo Alto, California Data Center had already been upgraded five times in the last four years. Replacing it with a higher-performing mainframe would have cost millions more, and HP would have remained locked into a proprietary, inflexible system that was expensive to upgrade.

These mainframe problems were augmented by those occurring at the desktop. By 1990, HP desktop maintenance and support costs from the PC "islands" that had developed throughout the company were climbing. There were issues with desktop incompatibilities. Many had to carry floppies containing application software and files from desk to desk in order to share work and data with other employees. In summary, HP needed a flexible IT infrastructure to stay competitive and continue to grow.

2. The World of HP IT: Prior to 1993

In 1956, HP installed its first mainframe--a UNIVAC--for applications such as payroll. In 1968, HP upgraded to an IBM 360. During the early 1970s, while HP was on a steep growth curve, regional data centers emerged throughout the company and mainframe usage was pervasive. By 1975, HP had mainframe computers in over 100 data centers located around the world, supporting all parts of the business, from order entry to manufacturing control. These applications were primarily batch-oriented: collecting data, processing it and distributing print-outs to end users. COBOL was the programming language of choice and sequential files were the primary access method.

2.1 The HP 3000

HP introduced the HP 3000 minicomputer line in 1972. As successive models of the HP 3000 became more powerful, HP IT staffers began to use them as mainframe "clients," putting data capture and analysis closer to the user and giving them more control over their applications. The HP 3000 provided the technology to more closely mirror business processes, provide data more quickly with greater accuracy and reduce data processing costs compared to mainframe-based systems. So, in some ways, the HP mainframe elimination program began--perhaps unconsciously--as early as the late 1970s, via the use of the HP 3000s.

In addition, application migrations began taking place, with early COBOL sequential file applications being recompiled for execution on the HP 3000. As more powerful models were installed, more and larger applications were migrated, with improved price/performance being an early benefit. Next, as old batch IBM applications came to the end of their useful lives, new on-line or batch applications were written for the HP platforms. Ultimately, the HP 3000s became the favored platform for HP branch offices' online workloads. This included providing electronic mail and local office automation software. Mainframes were relegated to the large batch processing loads that came with applications like order entry and payroll.

The role of the HP 3000 in HP's mainframe elimination process is important from two perspectives. First, as the number of data centers within HP rose, the reliance on IBM-style mainframes did not: the HP 3000s carried a fair amount of the increasing processing loads. Second, as IT began rewriting IBM-based COBOL applications for the 3000 platform, many of the re-writes included moving to client/server architectures. This meant HP IT was becoming familiar with client/server as early as the late 1980s.

2.2 The PC Revolution

Echoing a trend HP saw at many of its customer sites, PCs began working their way onto HP employees' desktops in the late 1980s. Early connectivity was via proprietary networks to HP 3000s and employees used the PCs mainly for electronic mail, spreadsheets and word processing. However, in 1990, HP made a key strategic decision that would again, like the early use of HP 3000s, ease the subsequent move to a mainframe-free company. The company chose to standardize on TCP/IP as a corporate-wide networking standard. The decision was a fairly easy one. The new HP 9000s were emerging with the HP-UX operating system and, along with it, Ethernet networking. It is this TCP/IP backbone that later became the foundation of HP's intranet.

The growing use of desktop PCs on a TCP/IP backbone created several benefits for HP:

o Users became familiar with graphical application interfaces via the PCs. When it later came to creating graphical applications on HP 3000s and HP 9000s, users already had PCs to act as clients.

o Migration away from 3270 terminals and SNA environments could begin long before the last mainframe was due to be unplugged.

o Migration away from other character-based terminals could also begin.

o Different office automation packages could co-exist until de facto standards could be established.

o Early deployment of PCs allowed for a more gradual depreciation of PCs over time.

However, even though the PCs were connected via a TCP/IP backbone, HP experienced "islands of information" forming due to the proliferation of user-chosen applications. Employees were doing work creating information isolated to their individual PCs. This work was not accessible or "sharable" with other employees. There were also the expected issues of managing and supporting the PCs from a more standardized approach. These issues would eventually be resolved by the PC Common Operating Environment (COE), which will be discussed later.

2.3 The Corporate Business Servers: The HP 9000

In 1986, HP introduced the HP 9000 Corporate Business Server line. In early benchmarks, HP IT found the HP 9000 could hold up under projected application processing loads for mission-critical applications. In order to take advantage of the more affordable and open HP 9000 computing horsepower, therefore, more and more applications were moved off the mainframes. The decisions of whether or not to migrate applications to an HP 9000 were eased by the growing commercial capabilities of HP's version of UNIX, HP-UX. The migration decisions also included issues such as the availability of software and IT staff with the appropriate skill sets. Early examples of transitioned applications were order configurations and sales quotations, decision support, manufacturing control and what was to become the PC COE environment.

2.4 PC Common Operating Environment (PC COE)

Another building block for HP's mainframe elimination effort was the corporate-wide PC standardization effort. PC COE was created as a mechanism for standardizing and distributing client/server applications to over 75,000 PCs throughout HP. Employee desktop PCs became elements of the PC COE system, no longer exclusively personal. Common PC software, such as word processing, spreadsheets and presentation software, was loaded from centralized servers.

PC COE has helped manage basic PC services and provided employee productivity tools. And its use has given HP lowered maintenance costs per PC and a more reliable environment than standalone solutions. For example, in the nine months after PC COE was launched, internal support calls for PC configuration problems went down by almost 100% and calls related to software support decreased by 70%. PC COE initially provided reliability savings of over $10 million in 1993. And because HP can upgrade, manage and support PCs from a central location, it no longer need hundreds of people supporting those PCs.

Central management of the TCP/IP network has also proven to be critical. Ensuring that employees are using the same databases, tools and information has been key. That central management has also contributed to the reduced PC support costs. With over 84,000 users today, savings related to PC COE have reached $25 million per year.

3. The World of HP IT in 1993: The Unplug Becomes Official

In many ways, HP had some typical problems from an IT perspective in 1993. Some application code was over 25 years old. On the other hand, some applications were already using object-oriented code. HP's dramatic growth created some challenges, however. The size, number and complexity of applications had dramatically increased. However, because HP was continually moving applications onto client/server platforms, the amount of mainframe computer power used by HP grew at a much slower rate, and then

began to decrease. The mainframe applications that remained in HP prior to the introduction of the Corporate Business Server line were very large mission-critical batch applications that required too much system capacity to migrate to the client/server platforms then available. While some may have expected HP to have been off mainframes by then, it had not been possible to move the largest batch applications until the arrival of the new, more powerful generation of open computer systems.

In 1993, HP IT was dealing with three objectives of: 1) using the best available technology, 2) cutting IT costs and, as before, 3) keeping up with company growth. In the meantime, the HP 9000 developed more processing power and a more robust operating environment. With the business units needing improvements to the remaining mainframe-based applications and the progress being made on the HP 9000, it seemed time to tackle the last remaining proprietary systems.

Transitioning applications to a new platform was one issue. Transitioning the IT staff and their skill sets was another. HP realized early on that a technology migration would have significant impact on the people affected by the transition. From the beginning, HP established a human resources strategy, including an education plan, to address anticipated fears and resistance to change. HP understood that a successful transition needs to address people issues as well as technology and processes.

3.1 The Downsizing Trend

Other factors made eliminating all operational mainframes from HP seem feasible:

o Number of commercial applications available on UNIX. With the cost of re-writing applications so high, it was important that a wide choice of open systems applications be available. By 1993, the HP platform had well over 2,500 applications from which to choose.

o Improvement of mainframe-class management tools and solutions.

Close to the IT staff's hearts was the issue of being able to replicate a mainframe-class execution environment on open systems.

o Executive-level management support. Given the significance of the change effort, management sponsorship was critical for success.

o Capabilities of the HP Professional Services Organization (PSO). HP's PSO had developed a suite of skills and migration tools as they helped HP customers through smaller mainframe migrations. Those resources could be tapped as HP tackled its enterprise-wide Mainframe Elimination Program.

However, the biggest facilitator may have been the performance of the HP 9000s. At the time, for many customers dealing with downsizing from mainframes, the first question was whether or not UNIX-based systems could provide enough processing horsepower for legacy applications. The HP IT team did some preliminary benchmarks on the HP 9000 and found that performance would definitely not be an issue as the MEP got seriously underway.

3.2 Hardware Inventory, Circa 1993

In 1993, HP had six large remaining mainframes representing hundreds of MIPS involved in production and in test efforts. However, as noted earlier, there was also a preponderance of HP 3000 and HP 9000 systems. There were also 30,000 UNIX workstations and, by then, 60,000 desktop PCs. The TCP/IP network was already in place. The stage was set for change.

3.3 Application Inventory, Circa 1993

There were over 36 applications that had to be migrated. They ran in the Colorado Springs, Colorado and Palo Alto, California mainframe data centers. Combined, these applications provided the core mission-critical business processing for HP:

    o OMNI: Large order management application system.

    o GPSy: Global product and pricing system.

    o HEART (called COCHISE in Europe): The company's central order management system.

    o WIN: Decision support application based on data from the HEART/COCHISE application and other data sources.

    o EXPRESS: Application system for data analysis and decision support needed by many different business and planning groups.

    o CAIS: Corporate administrative information systems including payroll and human resources.

    o PATSY: Application system that tracked all orders against customer purchase agreements.

In addition to these major applications, over 30 smaller ones--ranging from customer support warranty systems to quota reporting and tax and licensing systems--would also have to be migrated.

3.4 State of IT: The Staff

The decision to migrate would have significant impact on the existing HP support staff as well as for its application development teams. Their expertise and commitment would be critical to the success of the migration. Several elements helped ensure a successful transition:

    o A focused organizational change management initiative supported the transition by communicating the business case for change, providing a forum for discussions and reinforcing management's commitment to the transition.

    o As part of the education strategy, skills assessments helped define the future required skills and an understanding of skill gaps based on current capabilities.

    o Education to reskill application programmers, applications support staff, and operations and abend recovery personnel was identified. A customized education program was designed, and a training plan for each of the key job categories was defined that supported the overall project schedule. HP's Customer Education provided the training including transition courses to help build the "bridge" from the MVS world to UNIX.

Over 300 jobs were directly impacted by the transition, and many more were indirectly affected. Good communication, management support and education were critical success factors that would contribute to meeting the project goals on time. HP felt it important to use a sound training program to help alleviate some of those negative feelings--people were assured that their skills would be updated to meet the challenges of the new environment.

3.5 Rehosting, Re-Engineering, Surrounding, Consolidating

Given the seven different application environments that had to be moved, the next question was how to approach each migration effort. In the end, the answer was simple: the business units each drove unique requirements for their respective applicationneeds. The result was HP IT used four different approaches to migrate applications off the remaining mainframes. The next sections detail how each application environment was moved.

4. Rehosting Order Management

OMNI was a large order management application system supporting the former Computer Manufacturing Group from the Colorado Springs Data Center. Written in COBOL, it ran on the IBM 3090-200J with IMS/DB, DB2 and CICS under MVS/ESA. In 1992, the entire order fulfillment process went under review.

4.1 OMNI Order Management: The Business Needs

Sometimes the first area to suffer in a rapidly growing company is the order fulfillment process. HP had also been experiencing some growing pains in this area. Configuration turnaround times were not as short as the field needed. The overall costs associated with order fulfillment were rising, inventory levels were high and receivables were overdue. To a company focused on customer service above all, these realities were unacceptable. The first step toward a solution was to establish a long-term vision for order fulfillment that included three key constituents: HP's customers, HP's employees and its shareholders.

4.2 OMNI Order Management: The IT Needs

To better satisfy customers, HP IT, along with the business unit, decided the solution was to overhaul the entire order fulfillment process. While this would eventually mean re-engineering several application subsystems, IT decided that order management would simply be rehosted, as quickly as was practical, to the lower cost HP platforms, without any re-engineering or functional enhancements at that time. Therefore, the IT requirements were a cost-effective platform that could meet the throughput and online transaction processing (OLTP) needs of the order management application.

The team chose the HP 9000 Corporate Business Server as the platform for the rehosted order management application. They used a relational database for both the operational OLTP as well as the management query decision support applications. They also used an integration business partner to accomplish the migration. The partner selected a conversion tool that allowed the first IMS and DB2-to-ALLBASE port to be done. The team chose a pilot project, tested out the rehosted code and went into production with the new application eight months after starting.

4.3 The First Rehost: The Results

HP's order management is a major, business-critical application. Although rehosting such an application was challenging, the results have been extremely positive. HP end-users, located around the world, have experienced the same-to-better response times and same or better systems service levels as they had on the mainframe. In addition, operational costs were reduced by several million dollars per year. Given those results, the Colorado Springs mainframe elimination project broke even in less than one year. The IBM was shipped out of the Data Center in early August 1994, making it the first official "unplug" within HP.

5. Re-Engineering the Product and Pricing System

The Corporate product file and pricing system, called PRIME, was migrated next. As mentioned earlier, one of the first pressure points in a company with rapid growth is the order fulfillment process. Pricing the various product elements is part of that process. Again, the business unit drove the decision for a solution. This time, instead of rehosting, it was decided that PRIME needed a total overhaul.

5.1 Product and Pricing System: The Business Needs

PRIME needed to provide up-to-the-minute prices for everything from heart monitors to calculators. And it wasn't just the current product list (CPL) that needed to be tracked through PRIME. The business unit needed to track everything from replacement parts to obsolete support products. Given HP's worldwide presence, the application needed to provide that up-to-the-minute pricing in the local currency or the pricing set by a current government contract. For HP, this meant maintaining prices in about 250 different currencies or contract rates. And HP had millions of pricing elements to manage, including the following:

87000 active CPL items x 250 different currencies =	22,000,000 elements
232,000 active replacement parts x 120 currencies =	28, 000,000 elements
o 260000 active support products x 120 currencies=	32,000,000 elements
50000 service completions x 250 currencies =	12,000,000 elements

The grand total was over 90,000,000 different pricing elements to manage--in real time and in a fast-moving competitive market. However, not all products actually contributed to profit margins. So, the more efficiently the non-profitable pricing elements were managed, the better.

5.2 Product and Pricing System: The IT Needs

With that many pricing elements to track, IT decided to not store all 94,000,000 records in any one database. First, a single database would suffer performance issues in areas such as query seek times, backups and restores. Second, from an availability standpoint, creating a replicated database would mean no single point of failure for the application. Therefore, the IT team created a world-wide distributed database to support a client/server-based application.

HP IT chose a 4GL and a system integrator to create the new client/server application from scratch. They also selected a UNIX-based relational database management system (RDBMS) that had replication capabilities. The team chose to use the PC COE environment to support client access. From a topology standpoint, the team decided on two different styles of databases: a "work" database that gets the daily local processing updates and an operational database that contains one centralized copy of all records.

5.3 The First Re-Engineering Effort: The Results

Now, the product and pricing system, called the Global Pricing System (GPSy), consists of a database client module that is installable on employee PCs via PC COE. The updates generated by over 200 worldwide users from these clients are run against any one of four "work" databases. While the database sizes would not be considered large in a decision support application, they are large from the perspective of supporting an OLTP application. The databases are currently sized at:

o A 25 GB database in the United States that is mirrored for 7x24 availability.

o A 200 GB database in Europe.

o A 100 GB database in Singapore.

o An 80 GB database in Japan.

These are entered into the read-only operational database. Once a day, the Palo Alto and Atlanta production centers get updated. The main product file is replicated through a multi-tier architecture to regional sites. GPSy is capable of scheduled major pricing and ad hoc updates, depending upon product needs.

6. Rehosting HEART

The international corporate marketing systems organization (CMIS) had two very large batch systems that ran on an Amdahl 5990/1400 under MVS/ESA in the Palo Alto Data Center. The central corporate order management system, called HEART, was written in COBOL and had very large data files. It was run several times a day and used a significant portion of the Amdahl's capacity. The other CMIS application, a corporate decision support system called WIN, will be discussed in the next section.

From many perspectives, the HEART application put the "critical" in "mission-critical." While the application contained some code that had been originally written in 1968, it was through this application that every single order placed by every HP customer had to be processed. However, changes were needed. Orders needed to better match up with forecasts, cycle times needed to be reduced, customer delivery commitments needed to be improved and suppliers needed to be managed more efficiently. From an IT perspective, flexibility was also an issue. For example, simply changing an information field on an invoice could take several staff years to complete. Data contained in older formats such as IMS or VSAM required hiring specialized programmers. In short, the environment was inflexible and it was difficult to access business information.

6.1 HEART Order Management: The Business Objectives

The CMIS business unit took overall responsibility to manage migrating all applications from the Amdahl and IBM mainframe in Palo Alto. The main objectives in rehosting the HEART application were reducing the costs per transaction for processing orders, creating no disruptions to the business and facilitating the move to client/server.

Executing on those objectives was not an easy task for several reasons. For one, the business units owned the applications, but HP IT owned the Data Centers, the networks and the infrastructure. So a cross-functional project team was needed. Second, the processing loads that HEART generated continued to increase. It was like trying to hit a moving target when it came to capacity planning and platform sizing.

The first decision was whether or not to re-engineer HEART. Because re-engineering complicated both development and testing cycles, CMIS decided to rehost HEART rather than tackle another re-engineering cycle. Then they decided any functional enhancements to the mainframe would be limited to only those that were considered absolutely critical. Otherwise, they were freezing the mainframe configuration.

6.2 HEART Order Management: The IT Objectives

HP IT's goals for rehosting HEART order management were to:

o Minimize disruption to existing IT commitments. HEART would not be rehosted at the cost of other ongoing strategic HP initiatives.

o Organize a cross-functional project team to address common issues and coordinate efforts.

o Leverage experience in supporting mission-critical applications. Existing MVS programmers would be asked to make the move to open systems.

o Obtain outside conversion expertise where needed. There was a fair amount of EBCDIC-ASCII conversion that needed to occur.

o Eliminate waste. After 30 or so years, there was a fair amount of "junk"--unused, undocumented code--on the system that needed to be handled.

o Handle increased loads.

The team felt that outsourcing the project would have exorbitant ongoing. Therefore, they decided to use the HP PSO as the engagement manager. The PSO assisted in evaluating the IT management environment and recommended technologies and processes that should be in place for a successful migration; these lessons learned fueled the HP IT Management Service

6.3 How: Moving the Application

It has taken less than three years to complete migrating HEART order management off the remaining mainframe in the Palo Alto Data Center. The following details may provide insight into the critical success factors of a migration of this magnitude.

The Project Team

The first task was to assemble a cross-functional team of both business unit and IT managers. The group brainstormed on the topics that needed to be addressed and split into smaller groups, comprised of HP IT staff and the HP PSO, focused on the following areas:

o High availability systems

o Networking

o Production job control

o Operations

o Disaster recovery

o Code and data conversion

o Development environment and application interfaces

o Human resources

o Applications

o Training

The first five areas could be grouped under the topic of recreating a mainframe execution environment on the HP platforms. The next two areas could be viewed as the actual mechanics of converting the application. The third group addressed the "human" factors involved in the migration.

A Mainframe Execution Environment for HP Platforms

In tackling this area, the first issue was capacity planning: how much horsepower would be needed? The team ran a preliminary benchmark of the most resource-intensive HEART application module and found that one HP 9000 T500 could handle the processing loads at a faster rate, even as CPU cycles increased. For addressing high availability needs, it was decided to use another HP 9000 as a mirrored backup machine; the business unit had indicated they wanted redundancy for the HEART application.

The networking decision was next. The decision to use fiber connectivity was based on an assessment of the file sizes that would need to be transferred between systems and the frequency with which they'd be transferred. Between batch file transfers of over 250GB of data and UNIX "ftp" file requests, the network was going to be very busy.

Production job control and operations were the next areas to be addressed. In 1993, without the wealth of systems management tools available on UNIX today, this turned out to be challenging. The team used a combination of off-the-shelf products and home-grown code. The following software packages were used:

- o HP OpenView. Provides overall system and network management.
- o HP OmniBack II. Provides system backups. With the current environment already using over 800GB's worth of files, backup is a crucial issue.
- o Third-party software. For overall job scheduling.
- o Third-party software. In the days of the mainframe, tools such as UUC7 were used to schedule jobs involving the mounting of tapes. The team needed to simulate scheduling through Reel Librarian.
- o SyncSort. A fair amount of effort was dedicated to migrating the sort routines from the mainframe to the HP platforms via the SyncSort product.
- o OCS Librarian. Provides software configuration management.

The Data Center team created the remaining tools they needed from scratch. If the team were beginning the migration with today's HP-UX capabilities, they would not have had to create all of the following tools. And since 1993, open systems ISVs have made great strides in this area as well; customers can choose from several individual tools or management tool suites. However, the team had to deal with the operating system capabilities and tools that existed then. The following were created via HP-UX-level utilities such as the ksh, cron, tar, perl and various file management commands:

- o GDG. To equate the Generation Data Group (GDG) capabilities on the mainframe, GDG provides versioning for the HP platforms.
- o PJC. Production job control environment for HP-UX written in ksh that allows step-restartable and step-independent jobs to be executed.
- o DMAN. Disk manager written in perl that acts as a rule-based tool for various file backup, archive and scratch activities.
- o Fixed record editor. Needed to parse mainframe-based records and speed file reads for larger files.
- o FF. A "fat" file utility for reading, writing, sort, merging and cataloging files.
- o Expect. A precursor to FTP for file transfers between systems.

Being able to equate or surpass a mainframe-level execution environment was important. In the area of disaster recovery and planning, IT got an unexpected benefit. HP had previously outsourced its disaster recovery and prevention services. In its evaluation, the team found it a more cost-effective approach to house the disaster recovery and prevention effort in-house at the HP Colorado Springs Data Center. The team was able to develop better recovery procedures because it was cheaper to test various fail-over scenarios using internal resources.

Converting the Application

There were over 2,000,000 lines of COBOL code that needed to be converted to the HP platforms. And that wasn't counting the DB2 data that needed to be moved to an HP-UX-based RDBMS product. It was during these conversions that HP refined its best practices for mainframe code migrations. Then there was the application development environment. Programmers with 20-plus years of experience with IBM 3270s

and ISPF were uncomfortable with the HP-UX vi editor. So, the team chose a product called uniSPF that closely mimicked the ISPF environment so there was one less thing for the IT staff to learn.

Human Resources, Applications and Training
Involving Human Resources on the team was wise because there were many issues of managing change in various IT staff jobs as the migration progressed. As it turned out, many of the MVS system programmers looked at the mainframe elimination project as a way to become familiar with open systems and update their skill sets. And their backgrounds with mission-critical applications became invaluable. UNIX programmers were used to doing things like rebooting machines, for example--something the MVS system programmers knew would not be acceptable in high application availability situations. And training was constant, from training application end users to operations staff and systems administrators. The PSO Customer Education course, "Bridge to Open Systems: MVS to HP-UX," was leveraged and improved during the Mainframe Elimination Project.

6.4 Migrating HEART Order Management: The Results

In any application re-hosting effort, success can be partly measured in terms of how transparent the move was to the end-users. In the case of both the domestic and international versions of HEART, the team has succeeded. Both applications moved from the mainframe to the new host platforms without a single user being aware the move took place. The cost to process each order has been cut by 66% and users see same-or-better application response times.

7. The WIN Decision Support Environment: Surrounding the Mainframe

The other major application for which CMIS was responsible was the WIN decision support system. In 1986, this application collected data from the HEART/COCHISE application and other sources, restructured it and placed it in a large relational DB2 database running on an IBM mainframe working in conjunction with an Amdahl 1400. The information was accessed by many users and systems for a wide variety of data warehouse applications running on different HP platforms, making WIN HP's first world-wide decision support application. Combined with WIN was a third-party end-user application called EXPRESS. EXPRESS was used for data analysis and decision support functions by many different business and planning groups within HP. EXPRESS ran under IBM's VM operating system on a 3090-200J in Palo Alto.

7.1 The WIN Surround Effort: The Business Objectives

The WIN decision support effort has been evolving for the last 10 years. Over that time span, the business objectives have stayed relatively constant: increase HP's profitability and gain additional market share through timely marketing and customer analysis. However, the mainframe environment was somewhat inflexible when it came to ever-increasing demands for application-level changes. Upgrades were getting expensive. And the costs incurred by the application users were becoming prohibitive. In one case, a business unit was receiving monthly bills for $40,000 from a single user running queries against a data warehouse. Eventually, these needs dictated migrating from the IBM and Amdahl mainframes to HP 9000 Corporate Business Servers.

7.2 The WIN Decision Support Surround Effort: The IT Objectives

While the business objectives associated with WIN stayed fairly stable from 1986 to 1996, the IT objectives around the EXPRESS/WIN project showed more activity. In the beginning, objectives were:

     o Create an end-user ad-hoc reporting tool

     o Require no incremental training for the end-users

     o Provide consistent worldwide information

     o Evolve a flexible environment for growth/change

     o Use an evolutionary approach

     o Monitor information usage

     o Provide a data infrastructure

     o Use a warehouse approach

The WIN/EXPRESS development team decided on a multi-host distributed client/server application to replace the current monolithic system. However, the IT goals and tasks changed as HP's business grew.

7.3 Surrounding the Mainframe: How HP Did It

Migrating the WIN data warehouse away from the Amdahl occurred in conjunction with the HEART application migration effort because HEART was the data source for decisions being supported by WIN. HP turned to its own PSO as the engagement manager for the effort. Given the way the associated data warehouses were expanding, it made sense to begin offloading as much of the WIN processing and data from the Amdahl as early as 1990. But the history begins prior to 1990.

1988-1992

In 1988, an IBM mainframe was being used for the EXPRESS reports and an Amdahl was being used to maintain order and shipment data. Batch extracts from the Amdahl occurred nightly to provide current information for the EXPRESS report routines. HP orders were on the upswing and associated database sizes and processing cycles increased hand-in-hand with the orders. So, the IT objectives were to cover larger amounts of data with improved performance. This, in turn, meant upgrading the Amdahl to 312 MB of memory to cover the now 300GBs of data being used. Users had dumb terminals on their desks and found response time to be acceptable.

By 1990, the IT objective was avoiding expensive mainframe upgrades by taking advantage of inexpensive UNIX workstations. The application processing demands and associated database sizes were still increasing. So, the first 2 HP 9000 Model 735 workstations entered the picture as data servers, each with 13GB disk capacity. The application programming team chose an RDBMS to host "snapshots" of data that represented the most frequently accessed data ranges from the mainframe.

By 1992, the application team decided to conduct performance tuning by using data sum-mary management routines. The focus was on encapsulating the user queries within a shell, or middleware layer, that worked like an RPC mechanism to fetch data from the mainframes to the HP 9000s. In accordance with the business goal of never impacting the end-user, the team also provided an intuitive interface through use of business metadata.

1993-1996

By 1993, the needs were clear: the logical database size on the HP 9000s had grown to 250GB and the number of desktop users was up to 1,500. Performance and capacity increases were required and more hardware didn't seem to be the optimal answer. To compensate, the team wrote software to partition the data. At this point, there were 13 different HP 9000 Model 735 workstations working as data servers. One year's worth of data was spread across the 12 primary machines, one month per machine, with the 13th machine acting as a mirror of the current month for heavy use. The team created a software design that allowed smaller database tables to resolve the bulk of the user requests. There were four additional

workstations, each with its own summary tables. An HP 9000 Model T500 housed the RDBMS operational data store and an additional HP 9000 Model T500/6-way housed the software that represented the "intelligent" hub for the WIN application. This software, combined with the evolving middleware, became the HP Intelligent Warehouse product that HP has now installed at many customer sites to help them with their own data warehouse efforts.

Today, there are over 3,000 desktop users of WIN decision support, most of them with MS Windowsú clients, some still with ASCII terminals. The Intelligent Warehouse product provides an ODBC-compliant client and through this interface, users now access over 600GB of data. The HEART application had finally moved from the Amdahl mainframe. So the stage for "unplugging" the Amdahl was set.

1996: The "Surround" Strategy Becomes a "Replace" and "Consolidate" Strategy
By early 1996, the Amdahl was completely offloaded and was ready for removal. WIN was already a success. At 1995's year-end, HP saw the smoothest end-of-year close in its history-based on data coming from WIN--and actually had fiscal data five hours earlier than ever before. And this was with all marketing reports running on HP-UX. The last step for WIN, however, was to reduce the physical number of machines participating in the application. The team consolidated the 17 machines onto four HP 9000 Model T500s in a cluster configuration to reduce overhead. The four Enterprise Parallel Servers are networked to the three other T500s, one for the operational data store and two serving as Intelligent Warehouse hubs.

7.4 Implications for HP's Own Open Warehouse Program

HP has gained much more than an efficient data warehouse based on the HP 9000, however. Along the way, the HP PSO and IT application team created an entire solutions program. Drawing on what they learned while helping HP through its own warehouse, the HP PSO now delivers Open Warehouse consulting and implementation methodologies. Based on the best practices used with WIN decision support and other internal data warehouses, HP has the most sophisticated approach to open systems data warehousing in the industry. HP has over 150 data warehouses in progress and over 300 PSO consultants trained and capable of delivering warehouse solutions. And it has its own internal project to thank.

8. The Amdahl: Replacing the Rest of the Applications

With order management rehosted, product pricing re-engineered and decision support eventually consolidated onto the HP 9000, there were still applications left to move off HP's last mainframe. Remaining were several different Human Resources, Corporate Payroll, Accounting, Marketing and Treasury applications. The decision here was to replace these mainframe-based applications with open systems software packages wherever possible.

And that's what the team has done. For the payroll and human resources needs, the team chose a packaged solution. The move from the mainframe to the HP 9000 was so transparent that many of the involved employees didn't know payroll was running on HP-UX until months after the application was moved from the mainframe.

9. The Results

The results of HP's efforts to unplug its last mainframe aren't limited to the floor space created by rolling CPUs out of the Data Center. MEP hasn't just been about unplugging mainframes. It has been about creating a flexible IT infrastructure that lets HP stay as competitive as possible. Consider this sole fact: HP

has been able to double its revenue in just three short years, from $16.9 billion in 1992 to $31.5 billion in 1995, while holding headcount relatively flat. Increasing revenue per employee on that scale has to come from more than selling higher-margin products. For HP, it has partly come from turning IT into a competitive advantage.

With 90 percent of all desktops on a LAN and all PCs with Internet access, HP has created the world's largest private Intranet. From this basis, HP has seen the following advantages:

o Through the corporate-wide TCP/IP network and PC COE, HP was able to bring 78,000 employees to its intranet in one month.

o Distributing all new application clients without a single floppy: HP IT uses the PC COE environment to distribute new application interfaces to authorized users.

o While order growth has followed revenue growth, time to process orders has been driven down 63%, and the cost to fulfill orders has been driven down 41%.

o Product development for HP is very interactive and collaborative. The company's database architecture has HP's design, parts procurement and manufacturing teams using the same database. That's allowed HP to avoid DRAM shortages that have tripped up competitors, for example.

o HP had reduced the number of manufacturing design iterations from as many as eight to a single design. All of this technology has increased the company's ability to bring products to market more quickly and drive down costs. HP's South Queensbury, Scotland, manufacturing facility is an example. There, they cut the time it took to bring a new product to market in half over a two-year period. The unit produced four times as many products and was five times as profitable.

The uniting theme behind all these benefits is flexibility--to change both business processes and the applications that support them--as the business needs demand. For those who emphasize quantifiable results, however, there have been cost savings along the way.

9.1 Cost Savings

HP has seen savings from several areas related to its mainframe elimination program. With the HEART order management re-host, the cost savings have reached over $8 million annually, even in the face of increasing application loads. Much like the OMNI order management migration, which provided over $1 million in savings, the return on the HEART migration investment was realized in the first year. HP will also be able to avoid ESA hardware upgrade costs that would have been incurred if the MVS mainframe had remained. There are also software savings. HP was able to eliminate certain software license fees, such as for DB2 on the mainframe. The software cost for UNIX-based software products has also been much lower than mainframe-based equivalents. Add to this the annual $25 million saved through PC COE and the dollars saved becomes quite significant.

9.2 The IT Staff

HP has been able to reduce its Palo Alto, California mainframe operations IT staff from 30 to 14. As a result of the mainframe migration, many jobs changed and some jobs were eliminated. Education plus on-the-job mentoring helped reskill many employees and reduced their fears regarding employment. Both technical and soft skills training were provided, including customer service training.

10. Where HP IT Is Headed

In many ways, even though the mainframe elimination project is complete, the work is not over. The migration is over, but the cycle of re-evaluating business processes and changing IT to meet new demands

will never end. For example, HP is already looking at accessing the WIN decision support application over the Intranet. And the order management is already scheduled to be re-engineered to UNIX for better application and tool availability, flexibility and price/performance. The IT team is looking at updating management tools with newer technology. Fiber channel interfaces will be needed soon, as will more extensive use of the HP 9000 in cluster configurations. HP is also positioned to further incorporate the Internet into its IT strategy and leverage its strengths.

Predicting what HP's overall IT environment will look like in the year 2000 is a difficult task, given the current rate of change. But, because of HP's current successes and accumulated experiences, it does know its IT world will be based on an open client/server-based infrastructure. With no mainframes