INPUT

MARKET FORECAST

U.S. Systems Software Market, 1994-1999

U.S. Market Analysis Program

U.S. Systems Software Market

1994-1999

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Abstract

This annual report provides an analysis and five-year forecast of
the U.S. systems software products market for the period 1994-
1999. The forecasts contained in this report divide the market into
systems control products, applications development tools and
operations management tools. The market is also segmented into
three platform categories: mainframe, minicomputer and
PC/workstation platforms.

The report considers the underlying trends and issues that impact
the sale of systems software products in the information services
market, and based upon these considerations, projects growth
patterns for the next five years.

This report contains 94 pages, including 31 exhibits.

U.S. Information Services Market
Analysis Program

*U.S. Systems Software Markets,
1994-1999*

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Appendix   A.

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I

Introduction

This report is one of a series of market analysis reports prepared each year by INPUT for the key product/service sectors of the U.S. information services industry. These sectors are:

1. Professional Services
2. Systems Integration
3. Outsourcing/Business Integration
4. Processing Services
5. Network Services
6. Systems Software Products
7. Applications Software Products
8. Turnkey Systems
9. Equipment Services
10. Client/Server Markets

A
Purpose and Organization

1. Purpose

This report analyzes the systems software products segments of the U.S. information services industry:

- The report includes five-year forecasts, an assessment of market drivers, analysis of competitive trends and identification of leading vendors.

- The report assesses trends and events within the U.S. economy, the U.S. information services industry, and the systems software market to provide the reader with a comprehensive foundation for understanding this market sector and for anticipating future directions.

The report provides readers with insights and information that will help them:

- Review the forces shaping the market

- Develop internal corporate financial projections

- Identify new markets and product and services opportunities

- Assess the competitive trends

- Determine potential market directions

- Assist in prioritizing investments

2. Organization

This report is organized as described in Exhibit I-1. Each product/service sector report within the Market Analysis Program follows this format. The industry and cross-industry sector reports, described below, follow a very similar format.

Exhibit I-1

Market Report Organization

I. Introduction

- Introduction and definition of the product/service sector and its substructure or segments.

II. Executive Overview

Synopsis of the entire report written at the end of the year.

III. Information Services Market Forecast

- Presentation of the information services market forecast by product/service sector and subsector.

IV. Issues and Trends

- An assessment of significant issues and trends in systems software markets.

V. Competitive Environment

- Discussion of the competitive environment for information services within the product/service sector with vendor profiles.

VI. Conclusions and Recommendations

- Summary of changing market environment and opportunities.

A. Forecast Database

- A detailed forecast by product/service sector, subsector and industry/cross-industry sector. Contains a reconciliation to the previous year's Appendix B.

B
Scope and Methodology

1. Scope

This report addresses the U.S. information services industry for the systems software sector. It includes user expenditures that are noncaptive and generally available to vendors. Many large organizations have portions of their information services requirements satisfied by internal divisions. The resulting expenditure is not available for competitive bid by the general vendor community and is not included in INPUT's projections.

The noncaptive distinction is important and is addressed in more detail in INPUT's *Definition of Terms*.

a. Information Services Industry Structure

Exhibit I-2 defines the structure of the information services industry as used by INPUT in its market analysis and forecasts. The industry consists of nine product/service sectors, each of which contains a number of subsectors.

Exhibit I-2

Information Services Industry Structure – 1994

- Systems Software Products
  - Mainframe
  - Minicomputer
  - Workstation/PC
- Applications Software Products
  - Mainframe
  - Minicomputer
  - Workstation/PC
- Turnkey Systems
  - Equipment
  - Software Products
  - Professional Services
- Professional Services
  - IS Consulting
  - Business Process Re-engineering
  - Education & Training
  - Software Development Maintenance
- Systems Integration
  - Equipment
  - Software Products
  - Professional Services
  - Other
- Outsourcing
  - Platform Operations
  - Applications Operations
  - Desktop Services
  - Network Management
  - Applications Management
- Processing Services
  - Transaction
  - Utility
  - Other
- Network-Based Services
  - Electronic Information Services
  - Network Applications

- *Product / service sectors* are specific products and services that satisfy a given user's need. *Market sectors* specify who the buyer is and *Product / service sectors* specify what the user is buying.

- INPUT develops a five-year forecast for the product/service sector and each of the subsectors.

INPUT also publishes market sector reports analyzing fifteen industry and seven cross-industry market sectors. These reports, published annually by INPUT, analyze the information services opportunities in industry sectors such as insurance, transportation and discrete manufacturing and in cross-industry sectors such as accounting, human resources and office systems.

The relationship between product/service sector forecasts and market sector forecasts is shown in Exhibit I-3.

Exhibit I-3

Product/Service Sectors versus Market Sector
Forecast Content

Product/Service Sector	Subsector	Market Sectors		
		Industry Sectors	Cross-Industry Sectors	Other
Processing Services	Transaction Utility Other	✔	✔ 	 ✔ ✔
Turnkey Systems		✔	✔	
Applications Software Products		✔	✔	
Systems Operations	Platform Applications	✔ ✔		·
Systems Integration		✔		
Professional Services		✔		
Network Services	Network Applications Electronic Info. Services	✔ ✔		 ✔
Systems Software Products				✔
Equipment Services	Equipment Maintenance Environmental Services			✔

For a more complete discussion of INPUT's information services industry structure and market sector definitions, please refer to INPUT's *Definition of Terms.*

b. Product/Service Sector Description

Systems software products enable the computer/communications system to perform basic machine-oriented or user interface functions. The systems software products product/service sector, as shown in Exhibit I-4, is composed of the systems control products, operations management tools and applications development tools subsectors.

Exhibit I-4

Systems Software Products' Market Structure

```
                        ┌─────────────┐
                        │   Systems   │
                        │   Software  │
                        └──────┬──────┘
          ┌────────────────────┼────────────────────┐
   ┌──────┴──────┐      ┌───────┴──────┐     ┌───────┴────────┐
   │   Systems   │      │  Operations  │     │  Applications  │
   │   Control   │      │  Management  │     │ Development Tools│
   └─────────────┘      └──────────────┘     └────────────────┘
```

Systems Control	Operations Management	Applications Development Tools
• Access Control • Communications Monitors • Micro-Mainframe Links • Network Control • Operating Systems • Security Systems • System Library Control • Other	• Capacity Management • Computer Operations Scheduling • Data Center Mgt. • Disk Mgt. • Downtime/Repair Monitoring Mgt. • Job Accounting • Performance Monitors • Tape Mgt. • Utilities • OLTP Monitors/ Managers • Software Dist. Tools • Asset Mgt. • Network Mgt. • Security Systems • Other	• Applications Generators Assemblers • Automatic Documentation • Configuration Mgt. • Debugging Aids • Languages (All Generations) • Systems Control • Retrieval Systems • Translators • 4GL • CASE • Database Mgt. Systems • Data Dictionaries • OLTP Monitors/ Managers • Other

The attributes of each subsector are described below:

• *Systems Control Products*—Software programs that function during application program execution to manage computer system resources and control the execution of the application program. These products include operating systems, emulators, network control, library control, windowing, access control and spoolers.

- *Operations Management Tools*—Software programs used by operations personnel to manage the computer system and/or network resources and personnel more effectively. Included are performance measurement, job accounting, computer operation scheduling, disk-management utilities and capacity management.

- *Applications Development Tools*—Software programs used to prepare applications for execution by assisting in designing, programming, testing and related functions. Included are traditional programming languages, 4GLs, data dictionaries, database systems, case tools and other development productivity aids. Also included are system utilities (e.g., sorts) that are directly invoked by an applications program.

Systems software involves user purchases of software packages for in-house computer systems. Lease and purchase expenditures are included, as well as expenditures for work performed by the vendor to implement or maintain the package at the user's site. Vendor-provided training or support in operation and use of the package, if bundled in the software pricing, is also included.

Systems software that is sold as part of other product/service sectors' turnkey systems, professional services, systems operations and systems integration is not included with systems software purchases, but is considered with each of these other product/service sectors.

Systems software products are not specialized by industry. Thus, the forecasts for the systems software products product/service sector and its subsectors are provided in total rather than separately for each of the industry or cross-industry sectors.

2. Methodology

INPUT's methodology for market analysis and forecasting is summarized in Exhibit I-5. As in past years, INPUT has continued to survey information services vendors to determine their U.S. information services revenues, and to query information systems organizations about expenditures and outside services acquisition plans.

INPUT Research Methodology

I-10
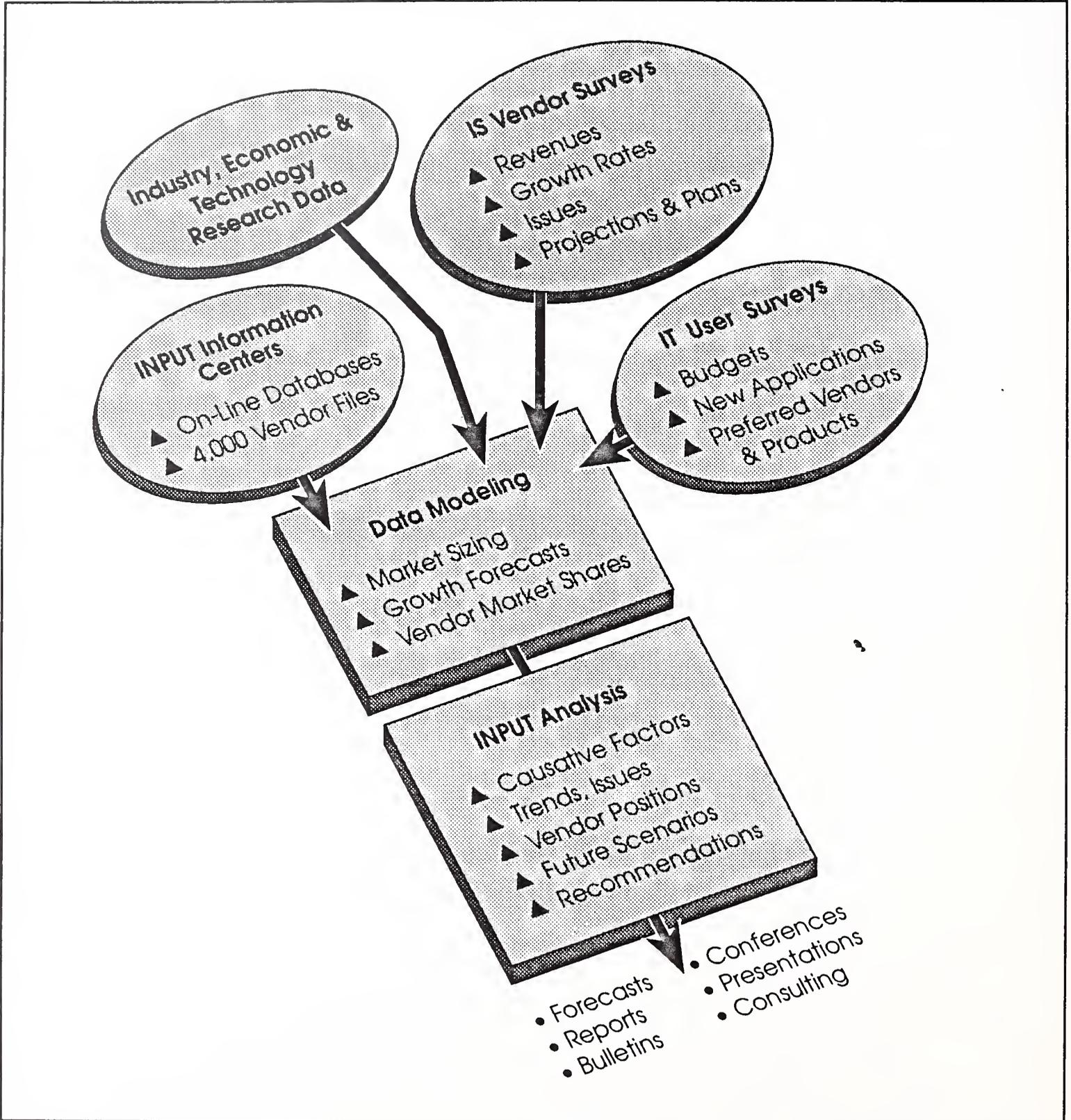
INPUT's annual forecasting process is broken into two major parts: base-year expenditure calculations and market forecasts. Following is a brief description.

a. Base-Year Expenditure Calculations

- INPUT determines previous-year information services revenues for the eight product/service sectors and twenty-two industry and cross-industry sectors for hundreds of vendors. Estimates rely upon interviews, public data and INPUT's own estimates.

- The initial data is projected to represent the entire information services industry.

- Adjustments are made to eliminate duplications due to distribution channel overlap and to assure captive information services
expenditures are not included.

- The result is a base-year (1993) user expenditure for each of the twenty-two vertical and cross-industry sectors and the eight product/ service sectors.

b. Market Forecasts

- In the forecasting step, INPUT surveys information systems executives to determine their projected expenditure levels in aggregate and for each of the outside information services categories.

- The result is a five-year forecast for each of the twenty-two vertical and cross-industry sectors and the eight product/service sectors. The product/service sector and market sector forecasts are correlated according to the diagram in Exhibit I-3.

To complete the process, INPUT reconciles its new forecasts with those from the previous year. Differences due to market restructuring and other factors are explained. One may use these projections to track INPUT's forecasts from year to year.

INPUT forecasts are presented in current dollars (i.e., 1999 market sizes are in 1999 dollars, including inflationary forecasts).

In developing the five-year forecasts, INPUT has incorporated economic assumptions for the U.S. economy as a whole.

The GDP and GDP Deflator growth rates used in INPUT's market projections for 1994 through 1999 are from the CONSENSUS™ forecast, a product of Blue Chip Economic Indicators of Sedona, Arizona. The Blue Chip CONSENSUS forecast is derived from a leading panel of economists representing leading financial, industrial and research firms across the U.S. and has an impressive track record of balanced and accurate projections.

The 1994-1999 assumptions are contained in Chapter III, Systems Software Market Size and forecast.

C
Related Reports

Related reports of interest to the reader are:

1. U.S. Markets

- *U.S. Applications Solutions Market Analysis Report, 1994-1999*

- *U.S. Processing Services Market Analysis Report, 1994-1999*

- *U.S. Business Integration Market Analysis Report, 1994-1999*

- *U.S. Systems Integration Market Analysis Report, 1994-1999*

- *U.S. Systems Operations Market Analysis Report, 1994-1999*

- *U.S. Industry Sector Markets, 1994-1999* (fifteen reports on all major industry sectors e.g., insurance, banking and finance)

- *U.S. Cross-Industry Sector Markets, 1994-1999* (seven reports on information services markets that serve all vertical industry sectors e.g., accounting)

2. European Markets

- *The Western European Market for Computer Software and Services, 1994-1999*

- *Systems Software Products Western Europe, 1994-1999*

- *Trends in Processing Services Western Europe, 1994-1999*

- *Systems Integration Market Forecast Western Europe, 1994-1999*

- *Systems Operations Market Forecast Western Europe, 1994-1999*

- *Western European Network Services Markets, 1994-1999*

The European markets are also analyzed on a vertical basis for discrete and process manufacturing, insurance, banking and finance, and retail and wholesale distribution.

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II
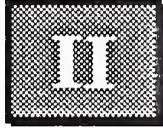
Executive Overview

Systems software encompasses systems control products, operations management and applications development tools.

In this Executive Overview, INPUT provides a summary of trends and issues impacting information systems users and vendors that will shape the demand for particular systems software products over the next several years. The overview also presents overall growth projections for systems software products, draws conclusions and makes recommendations about product and marketing strategies that systems software vendors should consider.

A
Systems Software Product Market Size and Expenditures

As noted in Exhibit II-1, the overall U.S. systems software product market will grow from $23.7 billion in 1994 to $35.1 billion in 1999, at a compound annual growth rate (CAGR) of 8%.

Exhibit II-1

U.S. Systems Software Products Market, 1994-1999
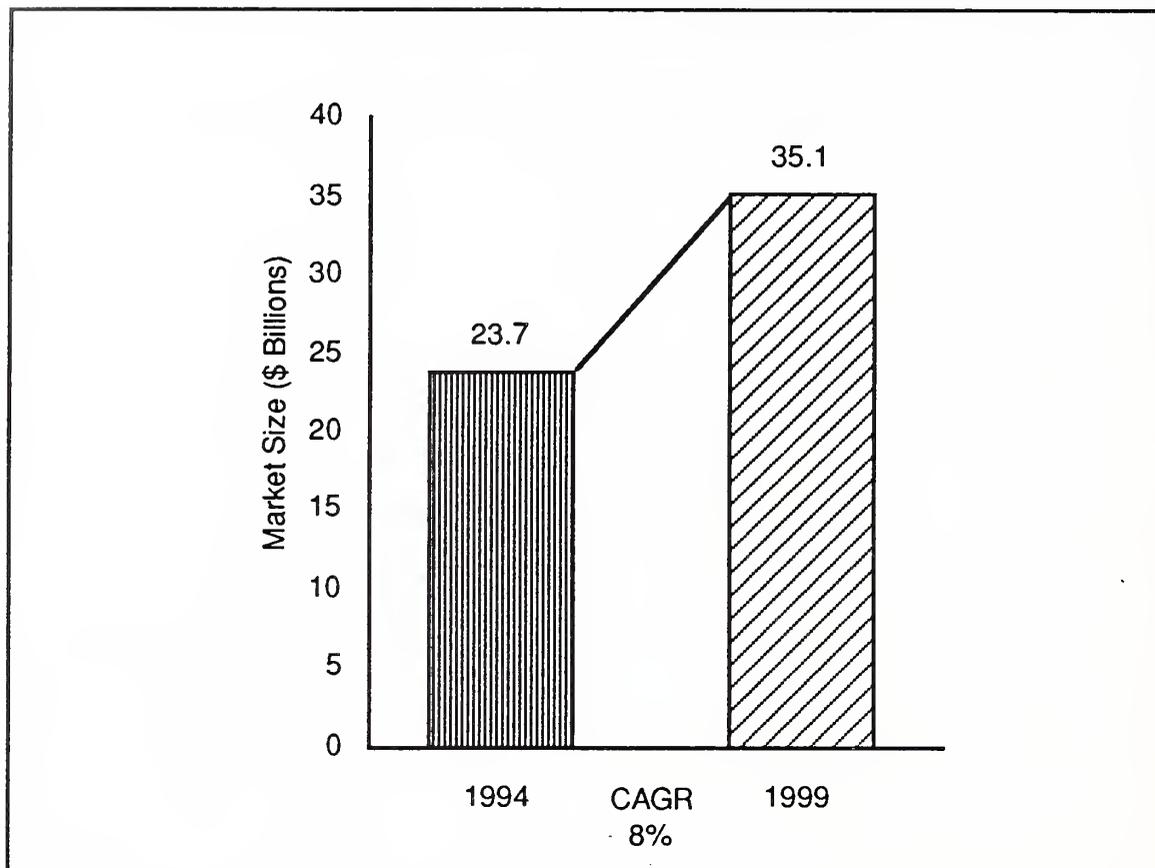
This projection is in line with INPUT's five-year growth rate expectation made in its 1993 Systems Software Products Market report.

The fastest-growing subsectors will be applications development tools and operations management tools. Demand for more sophisticated application development tools that provide a higher level of programming abstraction, as well as cross-platform integration, could significantly expand the applications development tool market size over the next few years.

The operations management systems software market should also be a beneficiary of products that address the need for integrated systems and network management across multiplatform, distributed processing environments.

The systems control market, primarily operating systems and related network access software, will continue to show modest, if any, growth over the next several years. This is due to the downsizing of IS models and significant price reductions

occurring in this area. An interesting new product area will be object-oriented operating systems, expected to be available in the 1995-1996 time frame. INPUT believes object-oriented technology will be central to future application development platform tools and to systems and network management products. However, the value to the vendor will be primarily in the integration of object-oriented technology within bundled solutions.

In the client/server operating systems database market, the trend continues toward UNIX and Windows NT for the database server environment, with Windows dominating the client or desktop part of the solution. For client (desktop) applications that currently require 32-bit multitasking capabilities, OS/2 is also an alternative. UNIX on the desktop is still a question mark. However, UnixWare from Novell may help stimulate the UNIX desktop market. The battle for the desktop/client environment over the next few years will be determined, in large part, by the acceptance level of Windows 4.0 (Chicago) with its 32-bit architecture that will provide pre-emptive multitasking and also include OLE 2.0-based document integration that should significantly improve ease of use.

The object technology operating systems battle will begin sometime in 1995 with the expected release of Cairo, Microsoft's version of object technology in an operating system. The principal competition for Cairo is still likely to be Taligent. However, UNIX operating systems may change dramatically over the next few years, with a more modular structure based on object components. The battle is really for the application server operating system platform in a distributed processing environment. Clearly, it will have a strong element of object technology, essential in reducing the current high cost of providing multivendor platform interoperability.

Much more unity on enterprise-wide operating systems is expected within the next five years. Systems developers, at least for the next few generations of software development, will need to provide cross-platform application development tool technology in their product portfolios to be major players in the systems software products and services markets.

A major market opportunity is customized applications development and implementation. This services-type market represents a much larger potential market opportunity than does

systems software products. Eventually, the markets for standard and customized application software solutions will converge. Companies with strong application development tool technology (that provide easy-to-customize applications solutions), are expected to be strong competitors in the applications solutions market. This could happen at the expense of applications software products vendors, unless the two software products groups engage heavily in strategic partnering. In this environment, industry and interindustry, specific knowledge on the part of the applications software products vendor will provide a key value-added contribution to the partnership.

B
Trends and Issues

Exhibit II-2 outlines key trends and issues impacting the software products industry.

Exhibit II-2

Systems Software Products Industry—Trends and Issues

- Client/Server (distributed processing)

- Object-oriented technology

- Middleware

- Partnering

- Integrated application development environments

- Distributed processing complexities

- Licensing and pricing

Client/Server(distributed computing—INPUT's most recent user and vendor surveys indicate an accelerated movement to the client/server architectural paradigm in 1993. Close to 50% of users indicate an intended move to client/server implementations over the next five years.

However, many issues concerning the benefits of client/server computing continue to raise questions about the value of current forms of implementation. Many of the application development tools used to build client/server-based solutions are not suitable for cross-vendor platform implementations. Substantial cost savings

of client/server implementations versus traditional host-based systems are still arguable for many types of applications. Distributed systems management products for providing database synchronization with a high level of database integrity is still lacking. Also, network administration and user training costs continue to be major problems.

Many of these issues are being addressed with second-generation application development tool environments and a gradual rollout of newly distributed systems and network management products. Key elements of these new products are object-oriented solutions based on emerging industry standards (CORBA), with partnerships of vendors providing integration of products through support for open interfaces.

Object-oriented technology—Object-oriented technology is no longer being primarily endorsed by niche systems software vendors. It has achieved major support by the large computer systems and systems software vendors with significant usage of object-oriented technology in their newer products. In particular, large computer systems vendors such as IBM and Hewlett-Packard have become major endorsers of the technology. At this stage, it is still a systems developer technology, with the incorporation of object-oriented technology in application solutions still to come.

Object-oriented technology has the potential for creating major structural shifts in the entire software products industry. Applications software products vendors will need to focus on product customization (incorporating business rules and processes) and provide in-depth knowledge of particular industries in order to remain competitive with the application development capabilities of competitors from other industry segments.

Middleware—Middleware is an evolving product area without a clear definition. Essentially it represents an additional layer of systems software that provides development of interoperable and portable distributed applications solutions within a multivendor environment. In some ways, it represents a transition solution, particularly in the area of object-oriented technology, until a standards consensus is reached. Middleware is currently an enabling software technology for building distributed applications across a number of operating systems, database management

systems and GUIs. Particular types of middleware products include gateways and layered solutions based on APIs and 4GLs.

Middleware software is being produced by standards groups through Request for Proposals as well as from individual application development tool vendors.

Partnering—A major change is occurring in the competitive environment in the information technology industry. Strategic partnering on product development and marketing is definitely becoming a trend. This is occurring among competitors in particular markets as well as among companies that provide complementary product solutions. The latter is evident, for example, in recent partnerings of Novell with database management companies. The partners combine individual products to develop a solution for a new market niche. Marketing and support costs of the product are sometimes divided among the partners.

A newer, emerging area of partnering is the evolution of integrated application development platforms that provide multivendor distributed processing solutions. Novell is partnering with a number of other vendors with its AppWare product in this area. Computer systems vendors, such as Hewlett-Packard, IBM, Digital Equipment and others are working with a number of systems software companies to develop *integrated application development platforms*. A key element in such relationships is an emphasis on open systems interfaces.

Another factor impacting such partnering relationships is the development of competitive vendor consortiums that attempt to reinforce particular industry interoperability standards.

Distributed Processing Complexities—For the most part, the distributed processing elements in client/server computing do not address the complexities of interdepartmental, enterprise-wide computing. This requires more consensus on a vast complexity of *de facto* and *de jure* standards than exist today. Much of the currently installed database technology is used for decision support, not mission-critical, OLTP solutions.

More consensus on a variety of distributed processing architectures and standards will be required to drive the market for production level, OLTP solutions.

Licensing— There has been considerable pressure to change traditional software product licensing practices for users migrating to lower-cost platforms or to outsourcing solutions. As a result, the established tiered-pricing model seems to be passing in favor of user-based pricing models, such as concurrent or metered usage along with other types of more flexible pricing models. At present, this is creating a great deal of user confusion in determining the best product alternatives. Licensing is a particularly important issue for systems software vendors in maintaining long-term, revenue-producing relationships with customers.

Pricing—Software pricing that held up for many years when hardware pricing did not, has come dramatically down, particularly at the PC-level. One important impact of the Windows NT, UNIX, NetWare and alternative object-oriented systems under development, is the continued softening of operating systems prices. This means systems software companies deriving an important component of their revenues from operating systems software, will have to look to other types of systems software, professional services and systems integration for revenue growth and better margins.

C
Conclusions and Recommendations

Exhibits II-3 and II-4 summarize the major conclusions and recommendations of this report for systems software vendors.

EXHIBIT II-3

Conclusions

- Object-oriented technology will be an increasingly important component of application development tool technology in a distributed computer environment.

- Vendor consortiums on application development tools currently represent new, major competing object technology *de facto* standards (OLE, and OMG). Developers working with the desktop and server/enterprise environments might want to keep an "oar" in competing vendor alliances, at least for the next generation of applications.

- The cost and reliability of distributed processing should ease when future software applications are built with integrated application development tool platforms, based on standards-based middleware, including object-oriented development frameworks.

- Applications development and other types of professional services will be the major "potential" markets for computer systems, systems software and systems integration companies with integrated, standards-based application development tool strategies.

- Systems management tools, for a distributed processing environment, provide a significant new market opportunity with no dominant vendor at this stage.

Exhibit II-4

Recommendations

- Form strategic alliances across software products markets to be part of a coalition of vendors that provide cost-effective, innovative distributed processing solutions

- Develop expertise in object-oriented technology

- Support industry standards, particularly those that provide interoperability within a multivendor distributed processing environment.

- Computer systems and systems software product vendors should partner with applications software vendors to leverage particular capabilities in providing product and product support for more complex distributed processing in enterprise-wide environments.

- Partner with cross-platform application development framework providers, to leverage research and development resources.

- Use newer, enterprise-wide workstation/PC-based project management software tools to establish metrics for newer software development approaches.
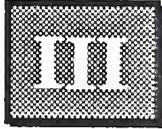
Systems Software Products Market Size and Forecast

A

Market Forecasts

1. Systems Software Products Market, 1994-1999

a. Definition of Systems Software Products Market.

INPUT divides the software product market into two principal categories—applications and systems software product markets. INPUT further divides these market segments by hardware platform. The applications software products market (analyzed in a separate report) is further subdivided into fifteen industry-specific and seven cross-industry market segments by hardware platform.

The systems software products market is analyzed by the following subsegments: Systems Control, Operations Management, Applications Development Tools and hardware platform. Each of these subsegments is defined by particular product groups in Exhibit I-4 of this report.

b. Systems Software Products Market Growth, 1992-1993

The actual market for systems software products grew by 10% in 1993, reaching $21.9 billion. These 1993 expenditures were in line with INPUT's 1992-1993 10% growth rate, forecast in its 1993 Systems Software Market report. Systems control product was the one subsegment that came in below forecast, at 4% actual growth compared to a 5% forecast. This reflects, pricing pressures in the operating systems environments and competition for mainframe software products from downsized hardware platforms.

Operations management products' 1993 growth of 14%, exceeded the 13% forecast. Systems management software product growth was slightly stronger than expected for the mainframe platform environment and reflects continuing IS investments to extend the life of installed mainframe systems until there is a more secure migration path to a distributed processing solution. In addition, network management software products revenues for the LAN-based workstation market are on an accelerated growth path. Strong growth in systems and network (operations) management software products is projected over the next five years, as a number of vendors are expected to introduce new operations management products for distributed processing in the late 1994 and 1995 time period.

The applications development tools market, the largest systems software product segment, grew at a 13% annual rate in 1993, in excess of INPUT's 11% growth rate projection. This reflects the strength of newer "middleware" software products, such as 4GLs, other types of gateway software product solutions and implementations of transaction processing monitors for a broader number of platforms. Client/server development software also showed stronger than expected growth.

The overall CASE software products market continued to show modest growth in 1993. INPUT's 1993 systems software report indicated a U.S. market of $1.5 billion for CASE software products. This figure includes CASE product and services that have become increasingly bundled as systems integration and professional services companies, in particular, combine the product and services areas of CASE implementation. The software product segment of CASE tools is estimated to represent approximately 60% of the total CASE market. A principal area of strength in CASE software product sales in 1993 was in software re-engineering CASE tools, used for implementing mainframe migration strategies as well as enhancing mainframe-based applications maintenance productivity. Applications development tools represented 42% of the total systems software products market in 1993. INPUT's model of the size of the various software product subsectors of the applications development tools software products market are included in Exhibit III-1.

U.S. Application Development Tools Market by Subsegment—1993

Application Development Tool	$ Millions
DBMS	4,140
3GL Compilers	1,800
4GL	1,200
CASE	840
4GL/RDMS	500
Transaction	303
Client/server tools	250
OOD Tools	60
OOOB	40
AI	40
Total	9,173

Object-oriented technology is increasingly being incorporated into application development tools and tool frameworks along with systems and network management software products to enhance cross-platform software program interoperability and reduce the cost of software product development. What appears to be different in 1993 is the endorsement of object-oriented technology by many of the large computer systems and systems integration companies—companies that develop new middleware solutions and those more focused on customized software product solutions. In past years, the level of interest has been concentrated in smaller, niche companies providing specific object-oriented development tools.

The current U.S. market for full-fledged object-oriented software development tools, continues to be relatively small—in the $100 million range. However, this market is expected to show strong growth, particularly in the post-1995 period as standards groups such as OMG and X/Open provide generic object technology software product foundations which should greatly facilitate the interoperability of object-oriented products now under development.

c. U.S. Systems Software Product Market Forecast

i. Overall Market Growth Rate Forecast

As indicated in Exhibit III-2, INPUT forecasts the U.S. systems software product market will expand from $23.8 billion in 1994 to $35.1 billion in 1999, for a compound annual growth rate (CAGR) of approximately 8%. This is in line with INPUT's systems software product market forecast in 1993.

The continuing 8% CAGR forecast reflects INPUT's growth predictions for the domestic real GDP over the next five years of approximately 2.6%. This is the same as its 2.6% growth rate predictions in 1993. INPUT's economic GDP growth rate assumptions are based on the Blue Chip CONSENSUS forecast derived from a leading panel of economists representing leading financial, industrial and research firms across the U.S. The forecast has an impressive track record of balanced and accurate projections. Price-based competition is expected to be intense, reflecting increased product standardization. New product introductions in the operations management and application development tools markets, that address multivendor distributed processing solutions, will offset pricing pressures in other product sectors, particularly operating systems software.

Exhibit III-2

U.S. Systems Software Product Market, 1994-1999
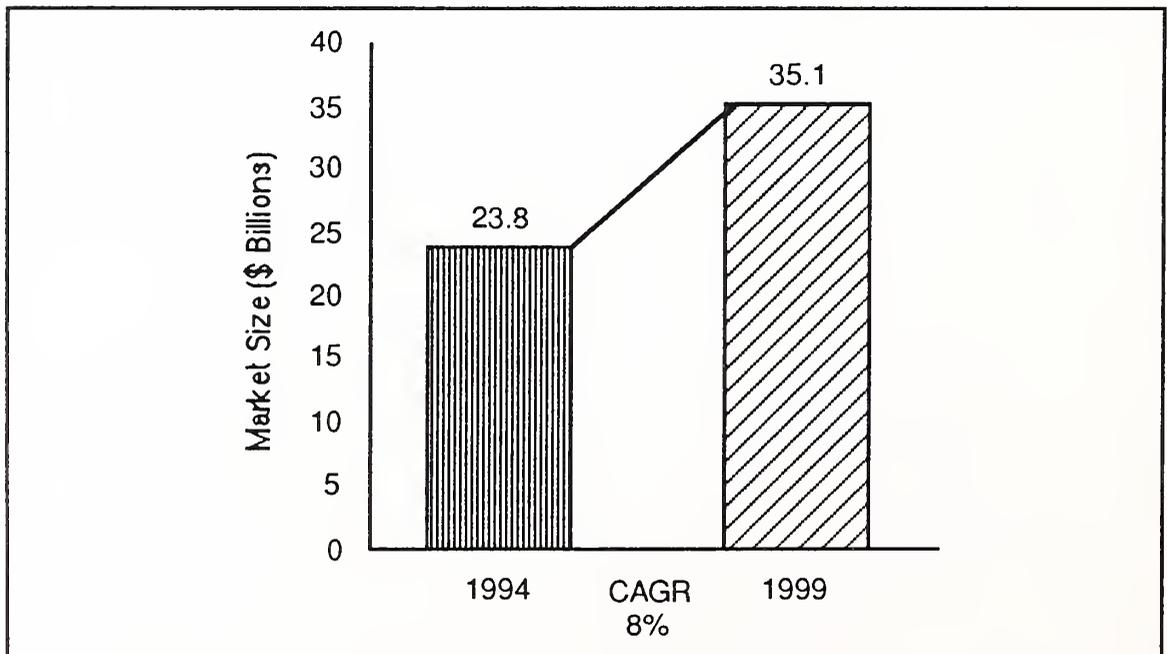
Exhibit III-3 outlines the historical growth of the systems
software products market from 1985 to the present, along with
INPUT's projections for specific market size each year, from 1994
through 1999.

Exhibit III-3

Systems Software Market, 1995-1999
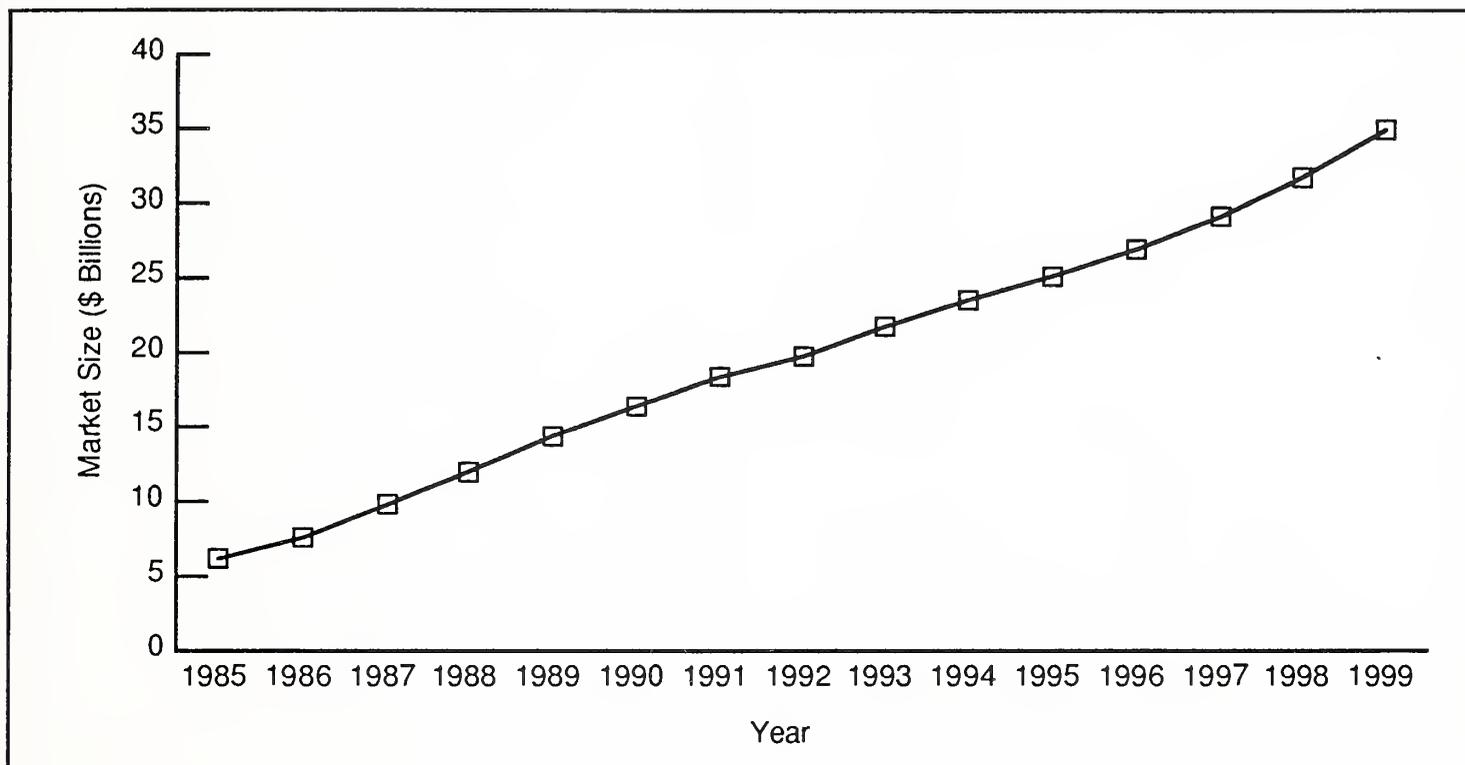
Of the projected total U.S. information services market of $150.5
billion in 1994, the systems software products are projected to
represent 16%, as shown in Exhibit III-4. In 1999, the U.S.
systems software product market is projected to represent only
13% of the total information services market. The market for
applications development tools is expected to grow at a signifi-
cantly faster rate than the other two segments—systems control
and operations management. This reflects the potential for value-
added features of application development tool products. As
object-oriented technology becomes a more fully developed
application development paradigm, INPUT expects integrated
application development tool platforms/frameworks could
eventually include many systems and network management
components.

Exhibit III-4

System Software Products as a Percentage of U.S. Information Services Market, 1985-1999

$ Billions

	1985	1990	1994	1999
System Software Products	6.3	16.4	23.7	35.1
Total Information Services	49.0	100.0	151.0	266.0
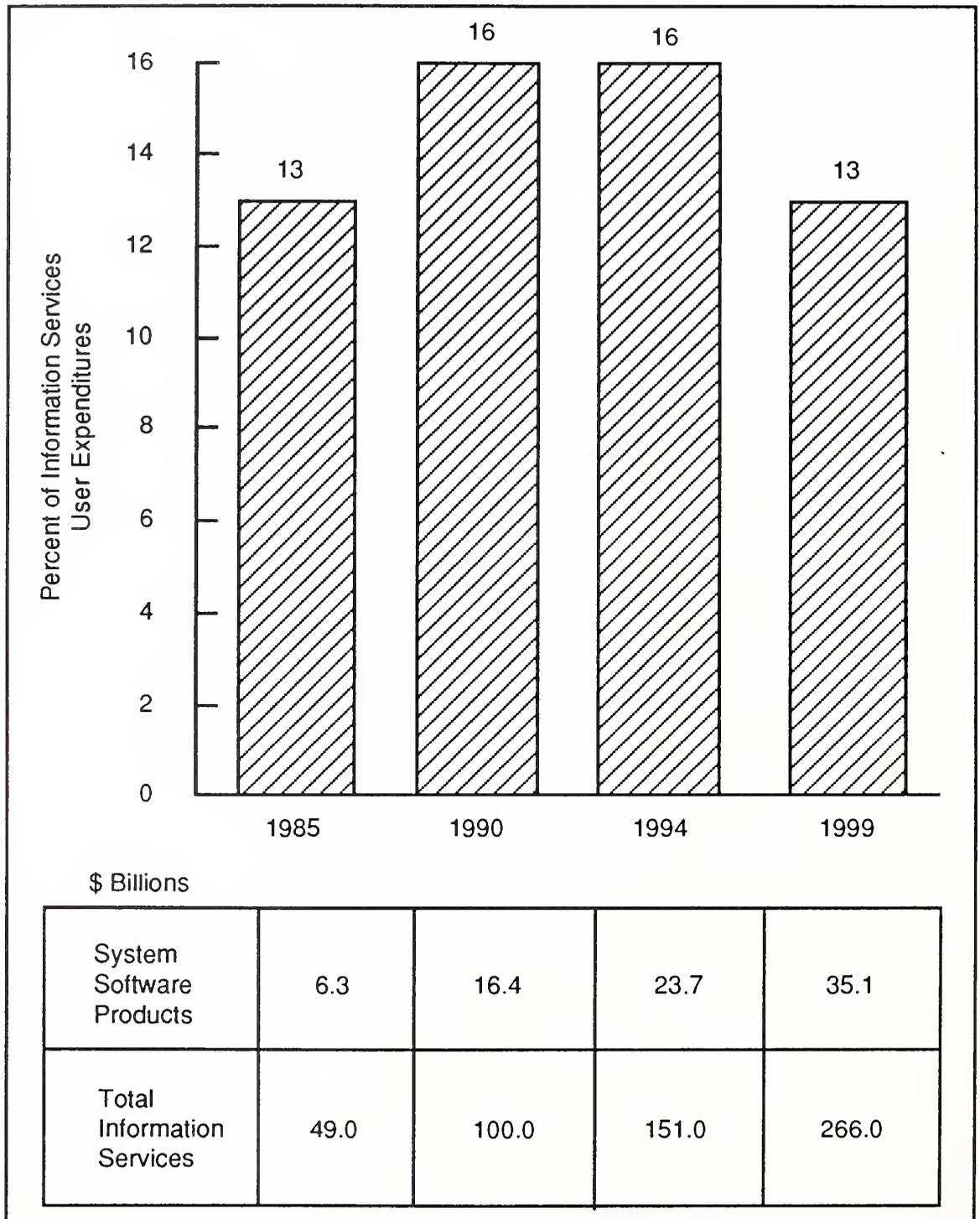
Another market direction will be the bundling of application development tool technology with specific application software product solutions, as process management and business rules become more central elements of application software solutions. This will occur as object-oriented application development

technology matures and application software solutions become much more integrated into object-oriented development paradigms.

The services segments of the information services markets are expected to gain the most from IS computer paradigms shifting to distributed processing and integrated object-oriented application development tools. Applications and systems software solutions are expected to become much more individualized over time and entry barriers into the application software product markets will be lowered with object-oriented class libraries and other programming tools. Companies able to provide a combination of integrated application development tools and application development and support services will be beneficiaries. The independent application software products companies are expected to be in a less competitive position if they do not partner with key providers of cross-platform, integrated development platforms.

Computer systems and systems software companies should rapidly expand their capabilities in integrated (cross-platform) application development tool technologies and reorient their product focus to services markets such as application development, implementation and maintenance. These areas represent the major market opportunities for systems software products companies in the second half of the 1990s. An important way of achieving this type of product and servicing capability is by partnering with other technology leaders in complementary systems software technologies. Also, support for standards (such as those of OMG and X/Open) will become increasingly important to facilitate cross-function benefits of partnering.

ii. Systems Software Forecast by Market Subsegments
Slow growth in the systems control market primarily reflects the reduction in the overall cost of computer platforms as measured by the MIPS cost parameter, with system control software product having traditionally been priced more in proportion to the cost per MIPS of processing power. Also the transition from proprietary operating systems pricing to more open systems product pricing will make operating systems software more of a commodity product.

Exhibit III-5 defines the forecast for the U.S. Systems Software Products Market by delivery submarkets.

Exhibit III-5

U.S. Systems Software Products Submarkets , 1994-1999
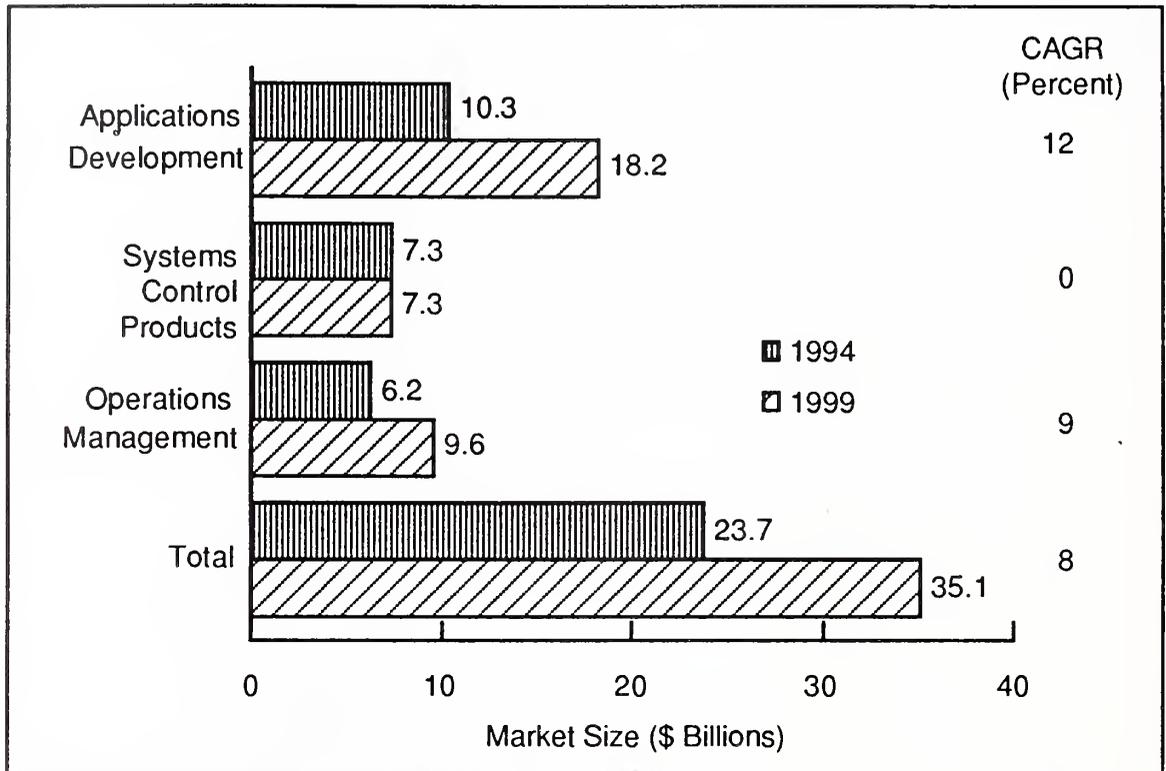
The struggle for the client/server operating systems environment between Microsoft's Windows 4.0, Windows NT and Cairo along with major competing alternatives (UNIX, object-layered UNIX and/or OS/2 and possibly Taligent), should be of major interest to the entire information services industry. Vendors who define such *de facto* standards in operating systems for database and application servers, could be in a preferred position for providing new application development tools and applications on a timely basis. Eventually, operating system and application development tools are expected to be much more integrated within an object-oriented programming environment.

It will be best for the customer if industry standards are broadly based and competition is focused on value-added elements (i.e., customer support and an in-depth knowledge of a customer's industry and markets, in order to provide innovative solutions).

Exhibit III-6 provides INPUT's forecast of systems software products by platform size. The bulk of current expenditures is for

software products that run on mainframes, generally because of the greater per-unit software product cost. Workstation/PC systems software product currently represents approximately 25% of the total systems software product market. This proportion is expected to dramatically increase to 45% by 1999.

Exhibit III-6

U.S. Systems Software Products Market by Platform, 1994-1999
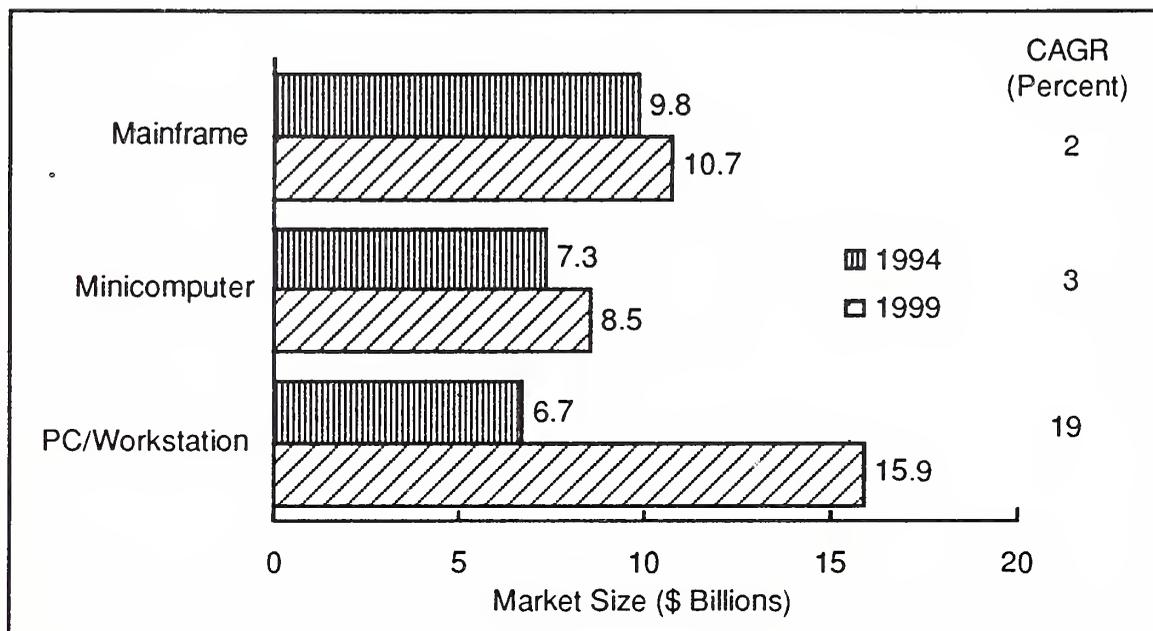
With the downsizing trend and expected continuing decrease in platform prices, mainframe-based systems software products will continue to grow at a modest rate, well below the average for the entire system software products industry. However, mainframe vendors are expected to continue to reduce the cost structure of their mainframe products, making them more competitive with midrange platforms.

The advent of mainframe-equivalent commercial parallel processor product in the 1995+ period, could have the impact of preserving market share for traditional mainframe computer manufacturers, particularly for database servers. Parallel-processor products from large mainframe companies, are also expected to be able to use much of the sophisticated mainframe systems software product which currently makes the mainframe environment a preferred platform for high-performance OLTP and other types of mission-critical applications.

Innovative pricing approaches to systems software products for the new machines, will become increasingly important for mainframe vendors to improve market share in systems software product. In addition, maintenance pricing will also need to be unbundled with separate cost components for product support (helpdesks, etc.) and product upgrades. User-based pricing should also be considered, along with metered pricing and pricing based on the improved price/performance of the CPUs in parallel processors.

Eventually, the terminology for traditional mainframe and midrange (minicomputer) platforms will change to reflect more specialized product usage, such as enterprise-wide and departmental applications and database servers. If the price/performance of mainframes and minicomputers can significantly improve over the next few years, the market size, at least in number of units sold, could show growth acceleration—a positive for systems software product vendors providing innovative new products for the changing midrange to high-end computer architectures.

The greatest beneficiary of the move to distributed processing, however, is expected to be those software companies that early on, provide truly distributed (cross-platform) systems and network management products with integrated application development tools. These are areas where optimal product solutions are currently lacking. The large, traditionally mainframe and minicomputer computer systems and systems software vendors are expected to launch innovative and more effective products in these areas in late 1994 and 1995.

We have mentioned several of these companies in Chapter V on Competitive Environments. Another company to be mentioned in this context is Legent. A rollout of its distributed systems management solution is expected in mid- to late 1994, with a number of product components expected in 1995. A key architecture of Legent's is its Cross-Platform Environment (XPE). XPE will increasingly enable customers to manage whole systems environments including cross-platform management of disk drives, CPUs, software distribution, performance monitoring, etc., across a combination of operating systems and network protocols.

Other, younger companies that also provide innovative new product for distributed systems management, based on object-oriented solutions, include Tivoli Management Systems and OpenVision.

iii. Leading Independent Vendors in Systems Software Product Market Segments

The largest vendors in each of the principal systems software product divisions are the large computer systems companies such as IBM, Hewlett-Packard, Unisys and Digital Equipment.

Exhibits III-7 and III-8 show the leading independent vendors in two of the larger segments of the systems software products industry. These represent INPUT estimates and do not include revenues for maintenance and professional services that, for many companies, represent more than 50% of total revenues. Also, the product revenues are for the U.S. market. On average, approximately 53% of U.S. vendors' information technology revenues are from the U.S. market.

Exhibit III-7

Leading Independent Database Management Systems Software Vendors—U.S. DBMS Software Products Revenues 1993

Company	Revenues ($ Millions)
Oracle	330
Sybase	215
Informix	207
Computer Associates	180
Software AG	130
Ingres	130
Cincom	40
Progress	30
PC Vendors (Borland, Microsoft, etc.)	350

Source: INPUT estimates

Leading Independent Systems Management Software Vendors—
U.S. Software Product Revenues, 1993

Company	Revenues ($ Millions)
Computer Associates	340
Sterling Software	190
Legent	110
Candle	90
Boole and Babbage	85
BMC	80
Cheyenne	45
Landmark	40
4th Dimension	20
Others (BGS, Tivoli, OpenVision)	80

Source: INPUT estimates

B

Driving Forces and Inhibiting Factors

The key driving forces and inhibiting factors for the systems
software products market are listed in Exhibit III-9.

Systems Software Market Driving/Inhibiting Forces

- Slow growth economy

- Mature software market segments

- Interoperability requirements

- Make versus buy decisions

1. Slow Growth Economy

The CONSENSUS economic forecast published by Blue Chip
Economic Indicators, combined with a growing array of real data
points collected by the U.S. government, suggests a real GDP
growth rate of 3.6% for 1994. This is compared to an estimated
real GDP growth rate of approximately 3.4% in 1993.

INPUT's five-year average (1994-1999) GDP growth rate assumption is 2.6%—below the average annual 4% growth rates achieved in recent decades.

The assumption on the GDP deflator is that the U.S. inflation rate will average approximately 3.1% over the next five years. The number is well below more recent historical growth rates, but is not necessarily a positive for the information technology industry. In past years, for example, it was common for system software products companies to be able to raise prices, partly based on the anticipation of a continuing strong inflation rate. The low expectations for continuing inflation will be another negative influence on software pricing in the second half of the 1990s.

In addition, recent federal tax legislation that increases taxes on U.S. corporations, could have a dampening effect on corporate capital spending in the short term. Also, many European countries, including Japan, are principal export markets for U.S. information technology products and remain mired in recession.

The Far East economies offer a bright spot along with strong economic growth being exhibited by many companies in the Pacific Rim. This region, along with Latin America, should be major targets for U.S. software products companies.

2. Mature Software Market Segments

A number of U.S. software markets are showing signs of maturing. The overall growth rate for the U.S. systems software market, for example, has slowed from the 20% growth rate level five years ago to an estimated 8%, projected for the next five years. The mainframe software products area is one obvious area of slower growth. PC systems software product price declines have also reflected the major drop in hardware prices in this area in recent years.

What is really needed to drive the U.S. systems software products market is major product breakthroughs. Short-term, there will be growth benefits in the application development tools and systems management market for the move to distributed, cross-platform computing. However, object-oriented technology, that will drive the market for new types of integrated application development tools over the next few years, will eventually lead to software product commodity pricing.

The more sustainable, strong growth, over the longer term is in value-added services—custom application development, implementation, maintenance and support services.

3. Interoperability Requirements

Distributed processing solutions are now moving into a production phase, and a number of *de facto* standards are beginning to emerge to solve enterprise-wide interoperability and application portability problems. However, the cost of putting together the current client/server architecture for distributed processing is still high enough to frequently require justification of rightsizing IS moves more on qualitative than quantitative reasons. There will need to be more consensus on standards from groups composed of both multiple vendors and users, such as OMG and X/Open, in order to solve the costly problem of a lack of interoperability in a multivendor distributed processing environment.

Partnering on cross-platform middleware and other application development tools will also become an increasingly important factor for addressing interoperability issues.

Partnering is accelerating and could eventually lead to particular vendor consortiums setting interoperability *de facto* standards. Members of these strategic alliances should be beneficiaries of increased market share for their products.

4. Make Versus Buy Decisions

INPUT surveys over the past year indicate a growing trend toward outside spending for third-party application software solutions, versus in-house development. As software vendors develop more sophisticated cross-platform application development tools that address the need for customized products on a more cost-effective basis, the market opportunity for application software products should expand. Companies (as part of consortiums) that provide cost-effect application development technologies, are going to have a decided advantage in addressing the application solutions market.

IV

Trends and Issues

A

Software Products Markets—Structural Changes

1. General Overview

The pace of change in the three principal systems software product market segments: systems control (i.e. operating systems, communications monitors and access control products); operations management (systems and network management products); and application development tools (programming languages, CASE, DBMS) continues to accelerate. The client/server (distributed) architectural paradigm is becoming a mainstream data processing alternative as companies seek to downsize/rightsize their information systems solutions. INPUT's 1993 vendor and user surveys indicated close to 50% of the respondents had either developed client/server applications or intended to do so over the intermediate term of three to five years.

The increasing acceptance of the client/server information systems architecture has also led to a plethora of new systems software product introductions that specifically address the programming and operational requirements of distributed data processing. The complexity of the application development process in a distributed processing environment, particularly the element of cross-platform interoperability, is greatly expanding the requirement for new application development tool technology. These tools need to eliminate the developer's need to code numerous interfaces for cross-platform configurations by providing a higher level of programming abstraction, that includes much prewritten code support for software interfaces.

Among the first client/server systems software products were RDBMS platforms designed to work with desktop-based client front-ends. To develop applications that work in this computing

environment of shared processing across client/server platforms, a number of new application development tools have been introduced. The most successful have been the visually-oriented programming tools for building graphical user interfaces (GUIs) as well as the 4GLs with "middleware" enhancements that provide client to database access across heterogeneous environments.

The era of distributed processing and the development of new systems software products that address distributed applications requirements, are in the early development stages. As such, there is a great deal of risk for vendors and users working with the initial distributed processing paradigms. There could be a considerable "shakeout" in the market of systems software companies that have provided many of client/sever systems software solutions. A company's products could run the risk of becoming obsolete by solutions leapfrogging current application development tools over the next five years. Thus, independent software vendors and corporate IS application developers are in the position of having to implement distributed/rightsizing solutions that may have performance limitations in a few years. This is compared to application development technology that may be developed from second- and third-generation application development tools frameworks.

Approximately 85% of current data processing transactions still reside on mainframe platforms. However, INPUT expects the movement off the "traditional" mainframe platform to continue to accelerate as enabling software tools (based on open systems solutions) mature. Yet the mainframe will continue to have a significant role in many corporate data processing environments as a data warehouse repository—for archiving and distributed data backup storage and as an optimized platform for certain specialized high transaction-oriented OLTP applications. In addition, the price of mainframes architectures, as measured in dollars per MIPS of processing power is rapidly declining—a trend expected to continue over the next few years. Mainframe companies are anticipated to substantially reduce their manufacturing costs (to remain competitive) through the use of lower-priced CMOS semiconductor technology, massively parallel machines based on newly architectured, lower-cost multiprocessor solutions, as well as with clustered computer systems that share system resources.

B
Alternative Distributed Processing Paradigms—Trends and Issues

1. Introduction

The current, most popular distributed processing architecture, the first-generation client/server model, has particular strengths and weaknesses, based on the application environment where it is deployed. Second- and third- generation distributed processing paradigms involve more peer-to-peer or cooperative processing where the client can also act as a server, and the network, in effect, becomes a virtual computing environment. The third-generation will likely include much more of an object-oriented architectural paradigm, with shared objects distributed across multiple platforms. The second- and third-generation distributed processing paradigms will also include significant enhancements to systems and communications management tools and utilities and bring the unique performance benefits of mainframe systems software to the distributed processing environment.

Of particular significance to the independent software vendor or corporate applications developer, is the major change that has occurred in the applications/systems development infrastructure as a result of the move to the distributed, multivendor IS paradigm. In moving to a cross-platform development environment with distributed applications, the programmer deals with a multiplicity of interoperability issues. This is very different from the monolithic world of mainframe programming where multiple protocols, APIs, portability, interoperability and intersystems management did not have to be high priority issues for the applications developer. Traditional mainframe-based development involved a *de facto* standardized integrated systems environment.

The optimal solution in developing solutions for the distributed processing environment is to work with a single integrated set of (open) applications development tools and management utilities software that minimize issues such as interoperability, portability, scalability, cross-platform systems and network management. (See Exhibit IV-1 for a prototypical open systems-based integration model).

Exhibit IV-1

IHewlett-Packard Integrated Development Model
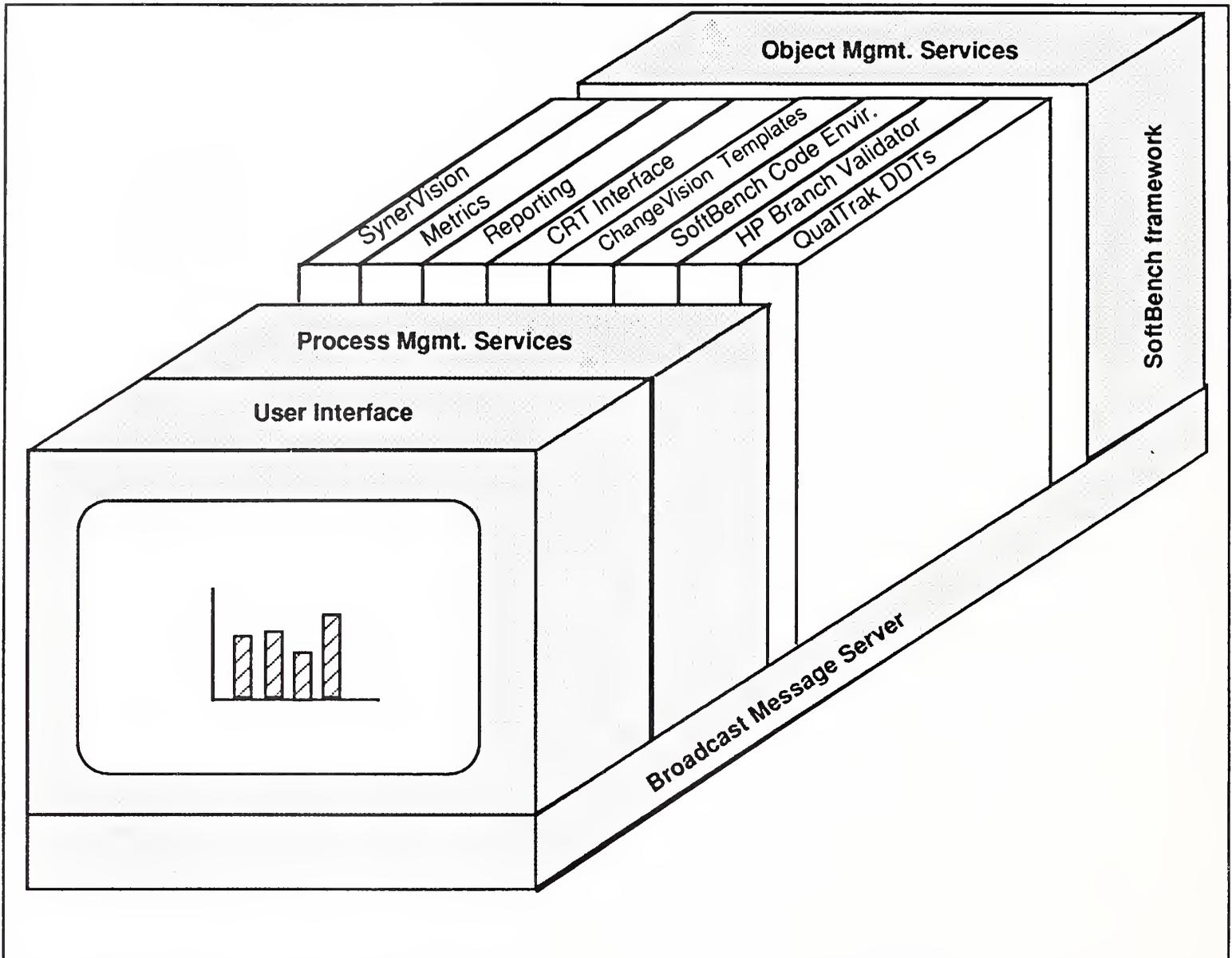
Coalitions of vendors appear to be in the early stages of developing such integrated development environments or frameworks. Examples of some of these early stage frameworks, usually based around a particular vendor's core application technology strength, are highlighted in Chapter V (Competitive Environment). For many of these frameworks to provide enterprise-wide, OLTP solutions, elements of Object CASE technology will likely need to be part of the core solution.

A summary of the various emerging distributed processing paradigms is provided, along with the emerging application

development frameworks that enhance the efficiency of application development within each of the particular distributed IS paradigms.

2. Client/Server Distributed Processing Paradigm

INPUT's view of the current client/server paradigm is based on a three-tiered architecture that includes an enterprise-wide server shown in Exhibit IV-2.

Exhibit IV-2

C/S Network Paradigm
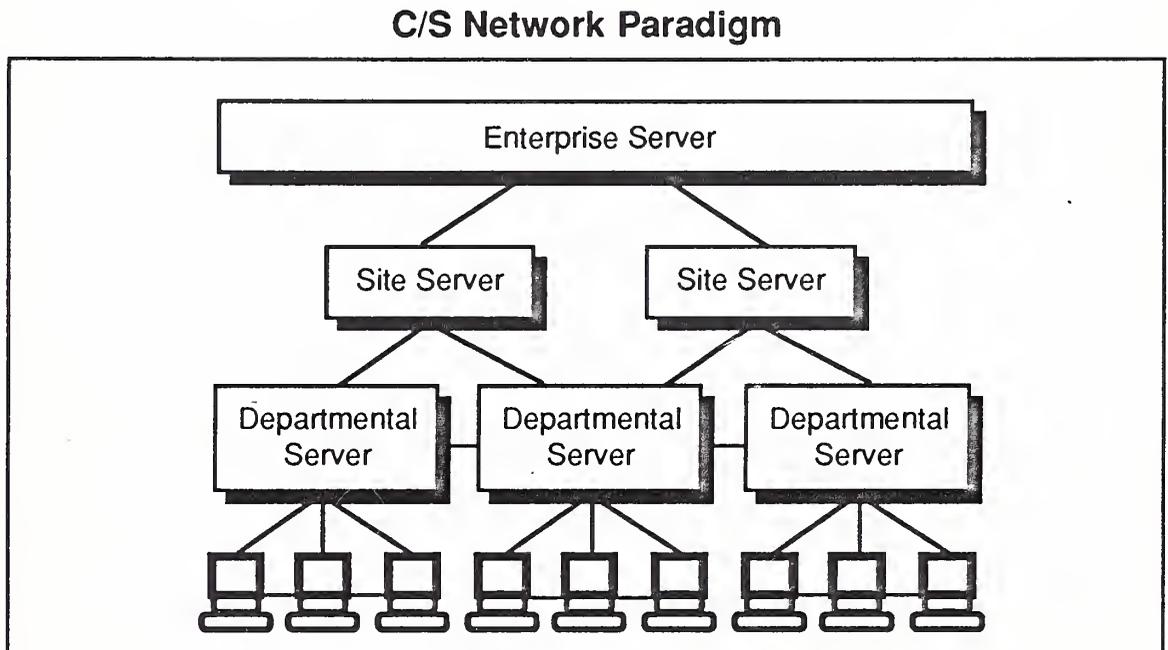
The distributed architecture associated most specifically with client/server computing is: the Remote Data Access (RDA) Model (ISO defined), where much of the presentation and application logic processing takes place on the client/front-end and most of the data processing takes place on the Database Server—implemented through the use of such protocol standards as SQL and ISO's RDA. Distributed data synchronization is maintained through the use of technologies such as two-phase commit and database replication.

Many of the applications of this first generation of distributed processing are based on departmental-type solutions where enhanced decision support activity for corporate users is a primary, qualitative benefit.

To date, corporations downsizing/rightsizing data processing projects have been associated with this client/server model. Unfortunately, the level of success of many such downsizing projects has been disappointing. While quality improvements, such as more efficient decision support have been somewhat of benefit, the cost of maintaining client/server networks has been higher than normal with the more traditional legacy architectures. Network maintenance and user training costs have been major offsets to any costs savings from the use of lower-cost hardware.

Another benefit (in addition to enhanced decision support) of the client/server architecture is enhanced application development flexibility. Many visually-oriented application development tools for writing client/server applications have significantly enhanced the writing efficiency of GUI-based client/server interfaces that address the ease-of-use issues for program users. These usually involve some form of visual programming tools based on object technology. In addition, the capabilities of high-level (nonprocedural) fourth-generation languages have been enhanced with the use of "middleware" gateways. These gateways significantly decrease the complexity of building decision support application programs for accessing data across heterogeneous platforms.

Some of the better known client/server application development tools have been developed by companies such as: Powersoft, Gupta Technology, ParcPlace, Information Builders, Uniface, Progress, Unify and Microsoft. Novell's new AppWare integrated development platform, to be introduced in 1994 in conjunction with a number of partners, also provides a framework for easing the development of network-service enabled applications.

Current "state-of-the art" cross-systems and network management tools, as well as transaction processing and communication performance monitors providing managed integration of client/server applications, are also in the process of being written for client/server computing. These represent new systems software products not developed in parallel with the original client/sever application development tool platforms. A significant problem in the development of such management tools is that the vendors, with expertise in systems software products, most often work traditionally with a limited number of operating

systems and hardware platforms. In addition, these vendors primarily address the mainframe environment. It has only been within the past year that integrated (inter and intranetwork) systems software solutions for managing client/server network environments have emerged in the commercial systems software market.

With such cross-platform management tools, many of the early criticisms of the client/server computing paradigm are beginning to be addressed. However, a number of negative factors are still associated with the client/server distributed computing paradigm as indicated in Exhibit IV-3.

Exhibit IV-3

Current Negatives of Client/Server Data Processing Architecture

- Frequent systems crashes from multiple sources of potential systems failure

- High network maintenance costs

- Lack of comprehensive distributed tools for mission critical applications development

- User training--a major new computing cost component

- Lack of "standard" client/server applications

- High cost of implementation with lack of interoperability, portability standards

- Weak legacy application linkages

- Lack of OLTP-based solutions

These negatives, however, also provide product opportunities for systems software vendors. Within the past six months, a number of product announcements have been made by leading vendors, that address many of the cost and reliability problems of the first-generation of distributed computing. However, many of the solutions are still statements of product direction, with late 1994 and 1995 as target dates for product rollouts for a number of companies.

Potential solutions will require more consensus on standards, often based on vendor consortiums, that address integration issues of working with heterogeneous platform environments. Object-oriented systems software products that are becoming

much more mainstream, can potentially solve many of the costs and reliability problems cited in Exhibit IV-3.

3. Second Generation Distributed Processing Paradigms

Second-generation client/server distributed processing paradigms include: distributed, mission-critical processing in an OLTP environment and the linking of OLTP-based legacy applications to the distributed relational database environment. The latter model provides a transition to the use of the mainframe as primarily a database server with the application logic to the distributed lower-cost platforms. Another more specialized legacy integration model is that of high speed OLTP involving applications, such as airline reservation systems. Much of the application logic is still retained on the mainframe. However, the presentation interface, resource managers and transaction monitors, along with some of the data, can be distributed across high speed networks.

For distributed processing solutions to be truly considered industry models, they should be based on open systems standards. As Exhibit IV-4 summarizes some of the key industry *de facto* and *de jure* standards emerging to help ensure the stability of more complex, mission-critical distributed processing application development.

Exhibit IV-4

Emerging Distributed Processing
DeFacto and *DeJure* Standards

• DCE RPC	• DOMF
• CORBA 1.1, 2.0	• Tivoli Management Environment
• Encina's Transarc	• CICS/OS/2, Tuxedo/USL/UNIX
• X/Open's DPT Model	• OLE 2.0
• Smalltalk	• Microsoft Windows
• C++	• Microsoft's Visual Basic
• ISO RDA	
• DRDA	• ANSI SQL
• DOE	• ODBC
• DSOM	• EDA/SQL

Second-generation distributed processing implementations many times use leading-edge (object technology) application development tool platforms for creating mission-critical, OLTP solutions. Some of these tools can provide near real-time (based on asynchronous communications) processes across a number of distributed platforms and have the usage potential of developing enterprise-wide applications.

Some of the more advanced application development tools that address the market for these types of applications include: Visix's Galaxy; Inference's Art Enterprise and NeXtStep Developer. One of the leading prototype applications for such tools is investment securities trading. Visix' Galaxy product is one of the more unique tools for providing such near-real time application performance in a distributed environment. It has been in development for a number of years, and is particularly well-suited for distributed communications across real-time graphic display devices.

Included in the object-technology solution, is a C++ object storage facility "dedicated" to a particular application. Data is then backed up to a relational database using two-phase commit technology. Visix Galaxy also represents a transition to higher levels of distributed processing, as well as a tool for tying in the OLTP functionality of legacy systems with the distributed computing model.

Another advanced tool technology provides integrated support for on-line transaction processing that is being migrated from the mainframe operating systems environment. OLTP monitors can improve management of data integrity and regulate system performance for both query and data updates. At this stage they generally support a particular mainframe operating environment, but some have also been ported to distributed operating systems platforms such as OS/2 and UNIX. A few of the leading transaction processing monitors that are being incorporated into the distributed processing model are: CICS from IBM, Encina from Transarc, Tuxedo from USL, Top End from AT&T Information Solutions and DTP from X/Open, as part of the X/Open Portability Guide (XPG). Gateways are also gradually being developed to provide interoperability between various transaction processing monitor environments.

The most advanced of the distributed processing application development frameworks are now incorporating more of a full-life cycle CASE solution. These tools provide for version control, change management debugging and testing, application generation (coding), code re-engineering and are often based on a object-oriented repository. The more flexible of these integrated tools for distributed processing application development, provide open interfaces that offer a back plane for integrating a number of tools from other vendors. Some of these integrated tools are written in an object-oriented language and can provide a transition to the third-generation of distributed processing application developments—a more object-oriented environment.

The larger computer systems and systems integration vendors have been some of the key developers of new application development tools and frameworks for this second-generation of distributed processing application development. A key factor in their success to date appears to be in their use of open systems application development technologies, including cross-platform development technologies such as middleware and more portable programming languages such as C, C+ and Smalltalk.

Vendors are working with distributed processing communications and security standards, such as those associated with OSF, OMG and X/Open, as well as positioning their own distributed software APIs as open solutions. The open systems approach is also positioning them to build a group of strategic partners who can provide complementary solutions to their core technology, particularly in systems management and CASE tools. In addition, many companies that have relatively strong mainframe CASE technologies are transitioning these into the distributed processing application development environment. The CASE technology provides a strong base for a migration strategy off the mainframe with CASE-based re-engineering tools.

Some of these application development platforms (increasingly being referred to as frameworks) for this second-generation of distributed processing application development include: HWP/SoftBench; Andersen Consulting/Foundation for Cooperative Processing, Computer Associate's Realisa-II; Oracle's Cooperative Development Environment (CDE); Digital Equipment's COHESION worX and EDS' Software Products Group.

Most of these emerging application development frameworks (that combine the various individual components of complete application solutions) are designed to provide cross-platform application development, a key benefit of their use. Historically, application development tools have been used more for a single platform application development environment. The ability to provide cross-platform application development functionality comes from the use of open systems solutions, the incorporation of middleware and strategic partnering.

Some of the independent systems software vendor partners for these application development platform solutions include companies such as Computer Associates, Legent, Encina, Tivoli Management Systems, ParcPlace/Smalltalk, Information Builders, Unify, Powersoft, Visix/Galaxy, Inference/Art* Enterprise; XDB-Workbench (SQl Engine for supporting transaction processing); Easel's Enfin, Forte Software, Oracle, Sybase, Informix, Ingres RDBMS and vendors providing a variety of CASE tools, particularly those providing re-engineering, version control and configuration management and debugging and testing capabilities.

Many of the application development platforms for the integration of legacy applications into a distributed processing environment are coming from the "legacy" computer systems and systems software products companies, such as IBM, Unisys, AT&T Information Solutions, Bull H.N. Information Systems; Computer Associates and Legent. Key elements of application development platforms for these environments include re-engineering tools, expansion of transaction processing monitors to distributed platforms, support of open systems distributed interfaces, transitioning to support a peer-to-peer networking protocol architecture and rewriting or porting proprietary solutions to a multiplatform interoperable environment.

Object-oriented CASE technology is also used to provide for the encapsulation of legacy data in developing enterprise-wide OLTP solutions.

Companies such as Unisys and Bull H.N. Information Systems provide a niche-oriented application development environment with a focus on certain industries with high transaction processing demands within the world of legacy migration to distributed processing. Hewlett-Packard is also providing a

legacy migration platform with its COBOL and C SoftBench CASE framework environment.

The third-generation distributed application development processing environment will likely be heavily based on object technology, with open interfaces (established by OMG and other types of industry consortiums). Progress in industry acceptance of the object-oriented development environment will likely accelerate with industry coalescence, particularly around emerging OMG standards on object interface specifications. At this point, industry coalitions appear to be building around Taligent (Apple, IBM, HP) and OLE.2.0 and Cairo from Microsoft. Current *de facto* programming language standards include C++ and Smalltalk. COBOL+ is also likely to be popular among the large, traditional base of commercial mainframe programmers.

At this point in time, it appears object-oriented technology represents the best bet for reducing the cost of software application development. The inability to lower the cost of software, even in a distributed processing environment, has been a major negative in a move toward lower-priced hardware platforms. With the reuse of software objects and the ability to turn software into an engineering discipline through the use of object technology, software product cost could become significant. Also, the ability to incorporate business rules into objects will be a plus in providing more specific, customized solutions for individual companies.

For maximum development efficiencies, CASE design tools will need to be incorporated into object development frameworks. Object CASE technology capabilities could become a key differentiator for suppliers of object-oriented application development tools.

As object-oriented technology matures, it is likely the layers of the operating systems and application software in today's information systems model will eventually merge. This trend has already begun in the merging of systems and network management utilities and eventually the object-oriented systems will become highly modular, based on a small operating systems kernel.

An interesting issue for independent applications software products companies is how to provide value-added product and pricing in a computer programming world, based on modular, best of models, applications. Eventually, there will be no need for

companies to produce similar software applications. Value-added, from independent software vendors, will come from the company's in-depth knowledge of certain industries and its ability to provide highly customized industry-specific solutions, based on business work rules that provide a competitive advantage to a particular company. In addition, application software companies will need to concentrate more on providing service-oriented products, such as consulting and systems design, in order to obtain value-added pricing. Strategic partnering for both product development and reselling with key application development platform suppliers, could also help leverage development costs.

C
Software Product Segment Trends and Issues

1. Middleware

The definition of middleware is still evolving, but essentially represents an additional layer of systems software that provides for the development of interoperable and portable distributed applications solutions within a multivendor environment. It is also a significant enabling software technology for building distributed applications across a number of operating systems, database management systems and GUIs. Particular types of middleware products include gateways and layered solutions based on APIs and 4GLs.

Middleware software product is being produced by standards groups through Request for Proposals from individual vendors, as well as from individual application development tool vendors.

Some of the initial middleware products have come from 4GL vendors providing interoperability across diverse database management systems architectures. Information Builders' EDA/SQL, the Unify ACCELL/SQL and VISION development product are examples of such middleware solutions. Also, high-level, nonprocedural languages from oriented development tools companies, such as Visix Software, Easel and Interference have been designed to shield the programmer from having to work with a number of APIs of various systems environments. An additional benefit of many cross-platform object-oriented development tools is that they can generate compiled code for application logic distributed across multiple platforms.

Novell's AppWare development environment could also be considered to be a middleware application development platform for implementing a number of network services across diverse platforms and operating systems using Novell's Message Handling Services middleware solution.

Integrated CASE frameworks, such as Hewlett-Packard's SoftBench, incorporate tool elements for creating middleware type solutions for cross-platform interoperability in a distributed environment.

Several of the computer systems vendors have developed middleware tools/platforms for providing multiplatform client/server (or distributed processing) solutions. IBM, for example, has its Distributed Application Environment (DAE). See Exhibit IV-5. DAE middleware provides a buffer from the underlying operating systems and allows applications to be developed, once, for any of the DAE supported environments.

DAE, which embodies several types of middleware solutions consists of integrated modular components providing services, such as:

- *Messaging Services* among applications across a variety of operating systems, connected by a wide range of protocols and LANs. Applications communications is based on named objects

- *System Management Services* to start, top and control application task and manage resources in various integration networks (e.g., NetView)

- *Database And File Services* to access a variety of database management systems. Transaction/file interfaces to CICS, IMS, and DEC-based and Windows-based applications

- *Presentation Services* to window into X Window and Presentation Manager controlled displays

- *Device And Data Collection Services* to capture and control a broad category of controllers, devices, equipment and sensors

Exhibit IV-5

IBM's DAE Middleware

Applica-tions	A	B	C	D	E	F

	Application Program Interface (API)				
DAE Middle-ware	Network Communication	Data Management	Device Management	Operating System Services	Display Management

Operating Systems   (OS/400, AIX/6000, OS/2, VM, DOS)

Hardware
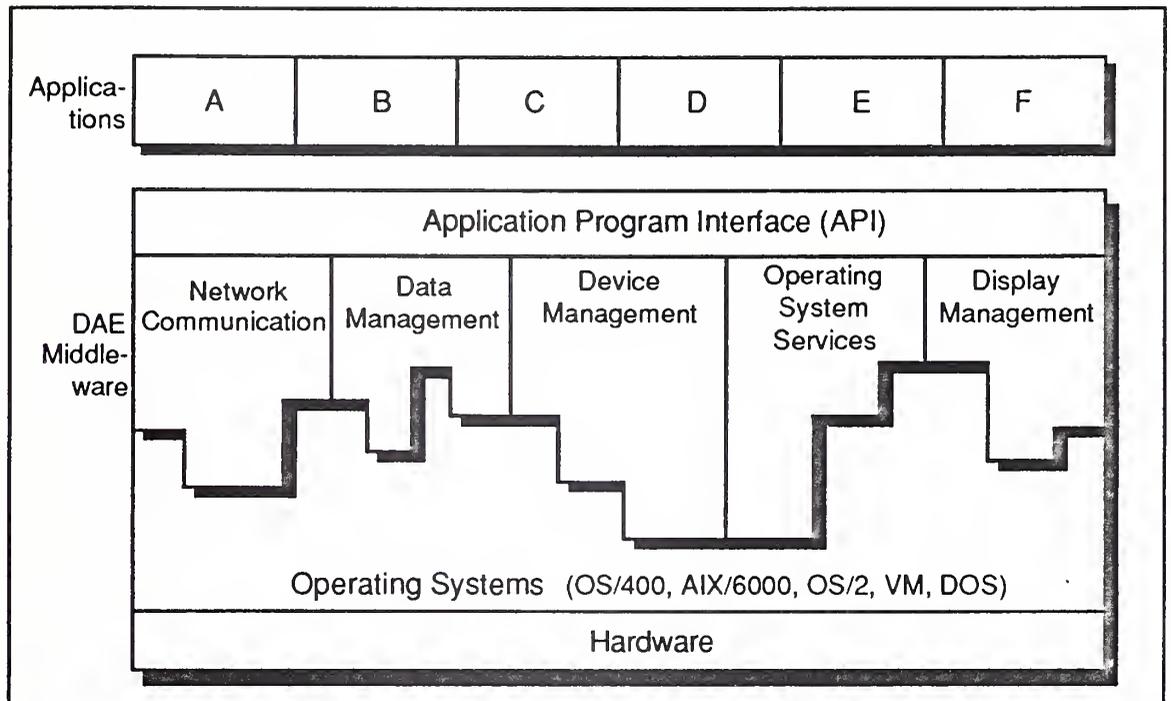
Source: IBM

DAE will also incorporate industry standards such as elements of the Open Software Foundation Distributed Computing Environment (OSFDCE).

Middleware systems monitoring and management solutions also include on-line transaction processing (OLTP) monitors, such as X/Open's DTP XA-compliant OLTP monitor/transaction manager, Transarc's Encina Transaction Processing Monitor based on the Open Software Foundation's, Distributed Computing Environment (DCE) and Computer Associate's distributed UNICENTER systems management product.

The DCE distributed processing model, from OSF, is a cross-platform, middleware software product model providing communications systems management functionality across a variety of hardware and operating systems platforms based on a common Remote Procedure Call model. A number of systems software product vendors are implementing their solutions with OSF DCE specifications and services, which essentially ties then into a multivendor middleware open systems development environment.

The Object Management Group (OMG) provides object interfaces
for producing messaging interoperability across a variety of
object-oriented distributed

Current object-oriented systems management products are also
being designed to provide a common interface solution for
procuring much more comprehensive integrated systems
management performance monitoring and remote management
of systems and network platforms and components.

2. Integrated Application Development Tool Platforms

An end-goal of information systems architecture for many
corporations will be enterprise-wide distributed applications and
database environments, to provide support for decision support
and mission-critical, OLTP solutions.

INPUT estimates that at least two-thirds of current client/server
(distributed applications) are used in a decision support
environment. Principal application development tools for this
environment include 4GLs, RDBMS and Visual client interface
builders. These application development tools are adequate for
building decision support applications.

However, the next generation of distributed processing solutions
involving mission-critical, OLTP-based solutions, will require
much more sophisticated, integrated application development tool
sets. These types of integrated development tool frameworks or
environments are in an evolving stage with companies, just now,
beginning to articulate their integrated application development
tool strategies.

Key elements of these integrated development frameworks or
environments are middleware software products targeted for
mission-critical or enterprise-wide applications are:

• Support for cross-platform distributed transport

• Cross-platform transaction processing and messaging
  solutions, such as OSF's DCE and OMG's CORBA ORB
  technology and cross- platform database management
  gateways

• The use of object-oriented application development
  programming languages

- An open-CASE framework that supports the integration of a variety of CASE-based solutions as well as (mainframe-strength) integrated systems and network management solutions.

Many of the large computer systems, systems software and systems integration companies are beginning to develop these highly integrated cross-platform development frameworks. Examples of these will be further outlined in Chapter V.

Only with the use of such integrated application development platforms will the second- and third-generation of distributed processing paradigms become widely adopted and real quantitative, as well as qualitative, returns be realized.

One of the initial requirements for companies providing such integrated tool sets, is support for leading *de facto* scalable OLTP manager monitors across multiple platforms.

Distributed OLTP managers are required to close a performance gap in distributed relational database management systems. OLTP monitors are currently being incorporated into some RDBMS products. One of the principal functions is to improve upon the synchronization of database updates and allow for real-time data updates in mission-critical applications where data often remains on mainframes. OLTP manager monitors can function somewhat like a multiplexer to allow for optimizing load balancing across databases and other computer resources and enable multiple concurrent database access.

Examples of vendors developing cross-platform transaction processing solutions include:

- Novell's integration of the Tuxedo distributed transaction processing monitor into its NetWare network operating system.

- A Tuxedo Application Loadable Module (ALM) currently available for Novell's AppWare application development environment that enables the development of OLTP applications.

- Transarc Encina's open, distributed on-line transaction processing system, that supports a number of hardware platforms, and primarily the principal flavors of UNIX operating systems and also a number of leading RDBMS.

- Integris's (from Bull H.N. Information Systems) UniKix OLTP monitor (which includes support for the most widely used OLTP monitor, CICS) can be used with various operating systems and be combined with various RDBMS products to support high-volume production processing for a large number of concurrent users.

- AT&T GIS is also partnering with Integris to develop an interface to its TOPEND OLTP monitor that unites the UNIX environment with CICS applications.

- IBM's porting of its transaction processing monitor, Customer Information Control System (CICS) to various platforms, including AIX, HP's PA-RISC, OS/2 and Windows NT. CICS emulators are also provided for Integris and VISystems. IBM's CICS/6000 involves the uses of CICS interfaces as a reimplementation on top of the Encina distributed OLTP system from Transarc.

- Increasingly, independent database vendors are adding OLTP features to their relational database management systems. Oracle 7.0, Sybase's OpenClient for CICS and Parallel Database Query (PDQ) from Informix Software include OLTP features.

- Digital Equipment recently began shipping the first 64-bit implementation of the Tuxedo transaction monitor for its Alpha workstations and servers running the OSF/1 version of UNIX. Tuxedo will be Digital's OLTP monitor for supporting multiple database and networking protocol distributed processing environments.

- Hewlett-Packard has introduced HP Encina/9000 in addition to HP DCE/9000 as key elements of its distributed-computing software strategy. HP Encina/9000 also supports two-phase commit distributed database synchronization. Most relational database management systems use two-phase commit protocols to perform many of the functions of an OLTP monitor. However, most of the two-phase commit technologies do not work across heterogeneous database management systems.

- IBM, Transarc and Retix have created an alliance to integrate the Open Systems Interconnection (OSI) networking into transaction processing environments. The companies will integrate the transaction management features of Retix's OSI/TP component with Transarc's Encina toolkit on an IBM CICS/6000 platform. IBM's CICS product uses the transaction management and communications facilities of Transarc's Encina toolkit, structured file server and peer-to-peer communications services. IBM will demonstrate how OSI/TP can complement the OSF/DCE and SNA-based communications abilities of CICS/6000 and Encina.

- Transarc is also working with Micro Focus to provide support for Encina's application development with COBOL. This will allow COBOL-written programs to connect to the UNIX CICS monitor, that will, in turn, enhance the process of porting mainframe software to UNIX.

Encina addresses the need for an OLTP monitor in a distributed processing environment. The application partitioning, distributed OLTP monitor model of Encina uses the remote procedure call (RPC) mechanism defined for the DCE for transactional operations. In particular, it uses the DCE Interface Definition Languages (IDL) for transactions. Under Transarc's transaction IDL implementation, each IDL procedure can be identified as to whether or not it is under the control of the transaction monitor. The Encina monitor can also implement a network resources load balancing function, where it can route transactions to the least busy node executing a request.

OEM support for Transarc's Encina includes IBM, Hewlett-Packard, Stratus, NEC and Hitachi, among others. Hewlett-Packard has also indicated it will have its own Encina-based CICS implementation on its HP 9000 and HP 3000 systems, based on

licensing the software from IBM. IBM also owns a portion of Transarc shares.

Transarc is also working with the X/Open Standards group. Transact supports the XA interface developed for X/Open to support RDBMS interoperability. XA is currently supported by Sybase, Informix, Oracle and Ingres, among others. Thus, the implementation of the Encina transaction processing monitor could significantly benefit cross-DBMS implementations on an OLTP application environment. It also allows for interoperability of various stored procedures implementations proprietary to particular DBMS companies.

Competing OLTP monitors for Encina in the UNIX environment include: Tuxedo (Novell), Top End from ATT&T GIS and Applied Control Management Systems (ACMS) from Digital Equipment.

The OLTP systems software products market should experience significant growth over the next several years. INPUT estimates the current domestic market for transaction processing systems software is close to $2 billion. INPUT currently places most of the revenues for this market into the category of operations management system software. However, as DBMS vendors integrate OLTP monitoring technology into their database management systems solutions, much of the market for OLTP monitors in future years will be part of the Application Development Tools systems software market segment.

3. Object Technology

Object-oriented application development technology is increasingly being integrated within the development environments of leading computer systems, systems integration and systems software companies. Its use is for implementing enterprise-wide, mission-critical applications as well as providing systems software and applications software product interoperability. Originally it was a niche technology, confined more to the development of client presentation interfaces and to a number of small-sized object-oriented database companies.

Another major value of the use of software objects is in their ability to be used to incorporate individual business rules and procedures, involving work flow processing—easily re-engineered compared to existing procedural language coding requirements.

The construction of an object (as shown in Exhibit IV-6), is key to its flexibility of use and its ability to be easily adapted to customized computer applications. An object contains a collection of related procedures and data. The procedures are called methods, and the data elements are referred to as variables, in that the values can change over time.

Exhibit IV-6

Characteristics of a Software Object Solution
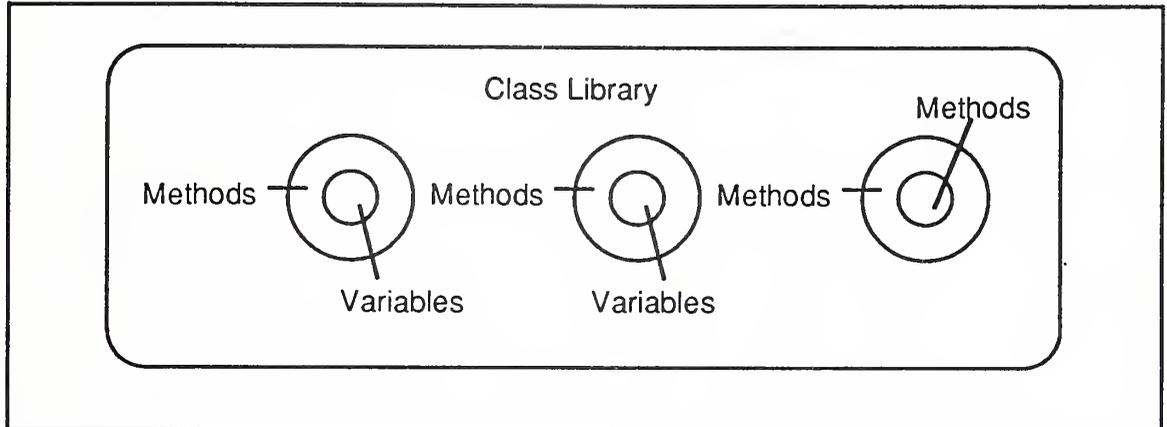
Packaging-related data and procedures combined is called, encapsulation. Objects interact with each other by sending messages asking them to carry out particular methods. A message involves sending a request to an object along with the name of a method the senders want executed.

The other principal terminology of object technology is, classes. A class defines the methods and variables included in a particular type of object. Objects belonging to a class are called instances of the class and contain only their particular values for the variables. Interoperability among objects, particularly at the communications level now used for building distributed systems development platforms, is by Object Request Brokers, and provides a common messaging interface environment at the applications/communications level.

Many questions remain about how this radically different, new, application programming paradigm can be moved into the mass market of application development in a cost effective manner, as well as how the characteristic of "openness" can be enhanced to make the object-oriented solution the most cost-effective method for implementing cross-platform, distributed applications.

With the recent investment in Taligent by Hewlett-Packard, evidence of coalitions of support for particular object-oriented application development platforms is emerging (IBM being one supporter). HP is integrating Taligent in its distributed application development platform and along with Sun Microsystems is also supporting the NeXTStep object-oriented technology. Another major vendor coalition is based on Microsoft's object-based solutions including: OLE 2.0 API—for integrating applications within a common desktop environment, and the forthcoming Cairo object-oriented operating system from Microsoft—with expected availability sometime in 1995.

A key factor for promoting interoperability in the object-oriented market will be the middleware CORBA 2.0 interface specifications being defined by the Object Management Group (OMG). Many leading computer systems vendors have developed their own distributed object messaging platforms, based on their own Object Request Brokers (ORBs). Through the mediation of OMG there appears to be considerable effort among several leading vendors to make their various ORBS interoperate. CORBA Release 2.0 will likely represent a coalescence of the leading *de facto* ORBs from various computer systems vendors.

In addition to being a viable solution and providing more of a tightly integrated interoperable distributed processing solution, objects and class libraries have the promise of greatly reducing the cost of software development and maintenance by enhancing software developers' productivity. The use of object technology in building network and systems management products also promises to greatly enhance distribution management capabilities, particularly in a distributed environment. Systems management companies such as; Tivoli Management, Computer Associates, Legent and Open Vision, are incorporating object technology as the solution for integrated, multiplatform systems management.

1993 really marked the beginning of deployment by certain large corporations of distributed mission-critical applications based on object-oriented technology. Until recently, object technology has been appreciated primarily in the development community. Various estimates exist on the current size of the object-oriented software market including systems software products and applications (primarily customized) built from object-oriented

tools. The U.S. market in 1993 was in the range of several hundred million dollars. Clearly, object-oriented systems software products and applications (generally customized) products, will be one of the fastest growing IT product markets over the next several years.

At present, there are still several concerns about the object-oriented programming paradigm that need to be addressed such as:

- The technology is still somewhat unstable. New versions of object-oriented languages are being developed that may obsolete solutions written with alternative object languages.

- There are still multiple methodologies for building object-oriented systems. Some type of agreement on a common Object CASE environment will be needed.

- Adherence to common standards will become increasing important as the number of vendors producing "application level" object building blocks begins to proliferate. The Object Management Group will play in an important role, at least for creating interfaces for messaging among objects. However, for companies building application level reusable object code, vendor specific class libraries and development procedures could be a major problem. Consortiums of leading vendors of application development tools will likely need to lead the way in establishing methodology for building object class libraries.

- Object CASE solutions, based on open interfaces, will likely be required to enhance the quality of object-oriented development tool technology and enforce development standards.

- There will need to be extensive new training for programmers to work with the new object technology paradigm. However, languages such as C++ and possibly COBOL+ will likely be effective programming tools for a number of years, and transitioning to such tools for existing programmers should help reduce the potential training cost factor.

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Competition

A
Overview

Consolidation in the systems software products market will continue to accelerate over the next several years. Mergers and acquisition activity in the operations management market segment have been particularly evident in recent years and the trend is expected to continue. The applications development tools market has been an emerging growth market in recent years. Several smaller companies that have entered the applications tools market for client/server application development, have achieved well-above industry growth rates. ·

The applications development software products market environment is going to show dramatic change over the next five years. This will parallel the rollout of distributed processing applications by corporations, applications software vendors and systems integration companies. As companies move beyond decision support, single-application and client/server solutions, the need will become apparent for much more sophisticated, integrated application development toolsets.

The next generation of distributed, enterprise-wide, mission-critical applications that would represent real migration off the centralized mainframe environment, will require integrated application development frameworks, involving technology contributions from a number of vendors. In recent years, there has been a transition in the systems software products market from single vendors. These vendors delivered an integrated application development environment for a proprietary application development platform to a matrix of vendors providing various layers or modules of the systems software application

development solution for a multivendor, distributed processing application development solution.

This newer generation of application development tools solutions has remained generally limited to singular application development requirements. The corporation or ISV application developer working in a client/server, distributed environments is increasingly having to choose among a matrix of software application development products no longer providing an integrated solution.

An incipient trend in systems software product, however, is that of the integrated application development framework environment with teams of vendors creating integrated development tool environments for the multivendor, distributed/networked programming environment. This phenomenon involves significant new strategic partnering initiatives.

A core technology of either middleware and/or integrated CASE tools, with an emphasis on supporting an open systems philosophy, appears to be central to some of the alliances. Such partnerships also can also help leverage an individual systems software company's marketing effort, with each of the partners also helping to market complementary IS solutions of its partners.

INPUT interviewed a number of systems software vendors on their product strategies in an distributed/network application development environment. In particular, INPUT asked vendors to articulate application development strategies that provided an integrated, broadly-based solutions capability. A principal conclusion of the survey is that many of the traditional leaders in the industry are in the initial stages of articulating their strategic vision in this area and realize the importance of developing and "marketing" such capabilities aggressively.

For the single-purpose application development tool vendor, particularly those that provide an early stage solution to client/sever development, there is likely to be a significant "shakeout " over the next few years. Pricing, particularly in client development tools, has dropped rather dramatically over the past year.

The smaller, independent applications development tools vendor benefiting from the newer market trends are those working with object-oriented technology that enhance mission-critical application development within a multivendor, distributed processing environment.

Computer systems and systems management software products vendors are incorporating and accelerating their usage of object-oriented technology to provide integrated, multivendor solutions. Many are implementing this through coalitions of application development tools suppliers with complementary systems solutions.

Systems control software products (operating systems) will become increasingly price competitive and particularly impacted by the lower prices of hardware platforms in a distributed environment. However, being able to contribute to the newer generations of operating systems will be crucial to the relative degree of success of the vendor coalitions.

Hopefully, the number of *de facto* standards for the enterprise operating systems will diminish over the next few years which would promote more cost-effective application development and support for distributed network data processing solutions.

The current desktop operating systems *de facto* standard is clearly that of Microsoft Windows. The acceptance level of Chicago (Windows 4.0) will be a significant deciding factor on what operating system will dominate the desktop in the latter part of the 1990s. The "wild card" is the world of object-oriented operating systems as it evolves over the next few years. A principle battle in this arena appears to be between Taligent (IBM, Apple, Hewlett-Packard) and Microsoft's Cairo/OLE 2.0 operating system.

Which operating system will dominate in the distributed, enterprise environment is still a major speculation for application developers and operations management software products vendors. Windows NT, to date, has not made significant inroads in that market. It appears at this stage, the integrated application development tools vendors will play a major role in shaping the evolution of the operating system environment in the latter part of the 1990s. The principal alternatives appear to be an object-oriented layered or modular software product solution integrated with a UNIX-flavored microkernel and/or the future Cairo

product from Microsoft. Enterprise-wide systems software environment will continue to evolve until a more integrated, standards-based, object-oriented solutions is developed through vendor cooperation, in some form.

The implication for application software developers is that they should partner, within an application development tool vendor team, in order to keep pace with the rapidly changing development world of multivendor, distributed/network processing. This partnering should also extend to product reselling and product support, that is also becoming much more complex and costly in a multivendor, distributed application environment.

ISVs, corporate application developers and systems software vendors, should work in integrated partnerships for development, marketing and other types of product support to remain competitive in the emerging world of distributed, multivendor computer processing. Such partnering should also help provide, over the longer term, more stable application development environments and lower cost solutions.

Exhibit V-1

Profiled Companies and Standards Groups

- Hewlett-Packard
- Andersen Consulting
- IBM
- Unisys
- Digital Equipment
- Novell
- Computer Associates
- Taligent
- Tivoli Systems
- Integris-Bull
- Open Software Foundation
- Object Management Group

1. Selected Integrated Development Tool Platforms for Distributed Processing Applications Development

a. Hewlett-Packard

Hewlett-Packard's overall distributed computing strategy is designed to meet the needs of companies in such complex and highly distributed infrastructured industries as telecommunications, utilities and financial services. These are company/industry solutions that require a distributed computing infrastructure as manageable, robust, secure and highly available as a mainframe.

Hewlett-Packard provides:

- A distributed processing solution based on standards and open systems that offer high performance and interoperability

- A gradual approach to distributed computing with legacy integration, by surrounding the mainframe with servers rather than rehosting everything

- A strong, stable partner that is also a technology leader

Hewlett-Packard's application development strategy is designed to provide the high-quality tools and languages that ease the development process in the distributed-computing environment. The company's application development platform strategy also includes a high degree of emphasis on standards compliance.

Key standards supported:

HP DCE/9000 provides a complete implementation of the DCE services with additional tools to facilitate the development, debugging, management and distribution of DCE-based applications. DCE application development requires programs to include remote procedure calls (RPCs), that allow multiple processors to work together over a network to perform a common task. The following are CORBA-based:

- HP Distributed Smalltalk (HP's strategic Smalltak environment for rapid application development for the distributed environment).

- HP ORB Plus (HP's C++ development for enterprise-wide application deployment in a distributed environment). This product integrates DCE and CORBA making enterprise-wide deployment possible.

A key element of Hewlett-Packard's integrated application development environment is its SoftBench Framework, a *de facto* standard for CASE environments. It is available on the leading UNIX-system-based workstations and is supported by more than 50 independent software vendors with more than 70 complementary CASE development tools. In addition, the SoftBench Encapsulator, a tool for customizing and extending software-development environments, has been designated a key component of the Common Open Software Environment and supported by some of the industry's largest vendors of UNIX system-based products.

The SoftBench Toolkit Standard, with open communications linkages with other development tools and process control development solutions, is a *de facto* integrated development platform for developing enterprise-wide distributed processing solutions, migrating legacy systems to open systems and a platform for moving to object-oriented applications development.

The SoftBench development environment also encapsulates development tools into a common framework. Another encapsulation tool of Hewlett-Packard's is Open ODB that can encapsulate all legacy data throughout a company and incorporate it as objects into Open ODB-based applications. Open ODB's Graphical Browser and Interactive object-oriented, structured-query-language tools are also encapsulated into SoftBench.

There are several programming language implementations of SoftBench, including:

- COBOL SoftBench
- C SoftBench
- C++ SoftBench
- COBOL and C SoftBench
- Distributed Smalltalk

The combination of the Softbench Framework with the various programming language SoftBench tools and other integrated tools

of partnering vendors, such as the UIM/X graphic user interface (GUI) builder and the SynerVision process-management engine, enables software-development teams to build CASE environments with capabilities that span the complete software-development life cycle.

Another significant portion of Hewlett-Packard's own application development tool technology is its DCE and CORBA-based middleware implementations. These also provide Hewlett-Packard support for the NeXTstep object-oriented programming environment. NeXT has indicated it plans to make this product CORBA compliant so it can eventually interoperate with HP Distributed Smalltalk, HP ORB Plus and Other CORBA-compliant offerings.

SoftBench is essentially an evolving Object CASE shell, that supports a number of object technology standards as they evolve, including the UNIX-based COSE initiative. It also supports distributed transaction processing monitors such as Transarc and CICS-HP/UX.

b. Andersen Consulting

Andersen Consulting delivers its integrated application development technology through its FOUNDATION software development toolset. FOUNDATION is composed of three core product areas: FOUNDATION for host-based systems, FOUNDATION for Cooperative Processing (FCP) for development of client/server applications and Designware for building industry-specific applications based on business models.

In May 1993, FOUNDATION released its next-generation of FOUNDATION for Cooperative Processing application development software. With this release, FOUNDATION expanded its platform-base to include server support for Digital's VAX/VMS, Hewlett-Packard's HP-UX, IBM's OS/2 and CICS, as well as client-side support for IBM's OS/2 and Microsoft Windows.

FOUNDATION incorporates an advanced messaging system and industry standard communication protocols and interfaces. With its LAN-based relational repository, work groups of developers can centrally store system design components as business and application objects. This promotes reuse throughout development and allows for future system modifications.

Partially written in Smalltalk, FOUNDATION is positioned to deliver object-oriented technology through even process and data modeling capabilities built into its client/server methodology. An object-oriented feature of FOUNDATION Design is the Rapid Application Builder that allows the developer to assign logic to window and widget events using an easy, point-and-click object-action interface. This simplifies the development process by saving time, eliminating duplicate efforts and assuring application quality.

FOUNDATION has formed joint development initiatives with Andersen Consulting's most advanced technology units. It is through this joint initiative that FOUNDATION will be able to expand its object-oriented technology offering and provide leading-edge application solutions.

Andersen Consulting is putting a great deal of focus on application development object-oriented technologies. In particular, the messaging architecture of object-oriented technologies enhances the company's ability to provide process logistics applications within companies and across companies and industries, that are easily reprogrammable as business processes evolve. In the area of object-oriented development technology, Andersen Consulting also focuses on transactional processing solutions, cross-industry in nature and is able to incorporate particular interbusiness process knowledge.

A major new functionality will be to provide object interfaces to communications processes across vertical industry, including, for example, a NeXT-generation of object-based EDI.

Andersen is partnering with companies such as Visix Software and its enterprise-wide, object-oriented development tool, used for mission-critical application development. It also uses Inference Corporation's ART* Enterprise object-oriented Expert Development System. One type of applications being developed with such tools is OLTP solutions for manufacturing shop floors and financial services institutions.

A major strength of Andersen's application development capability is in its flexibility. In not being tied to a particular operating systems vendor consortium, for example, it combines in its toolset *de facto* standards across vendor consortiums based on a limited number of operating systems and hardware platforms.

The company is in the early stages of a new application development environment rollout from its Eagle Technology Advanced Development group, that will more fully integrate its consulting application development strengths with newer, object-oriented technology concepts. Andersen has already begun incorporating elements of Eagle's advanced development into key client engagements through its internal tools and methodology pipelines. Complete applications built in this new ADE are not expected until 1995.

c. International Business Machines

With its large user base of mainframe technology, a major development strategy focus for IBM is in helping customers maintain and/or redeploy traditional applications. Most of these applications have been written in COBOL, C, Pascal and other 3GL variants. An application development CASE tool technology is provided for wrapping legacy applications to object-oriented class libraries and frameworks.

A much more integrated environment will become available from IBM over the next few years, along with sophisticated object-oriented paradigms based on standards. The current environment for application development suites for client/server application development is viewed as a temporary solution for distributed processing applications, primarily for a departmental application development.. This is where the introduction of new development technologies for client/server applications has been most rapid and supplied, in large part, by smaller, independent application development tool companies.

IBM's participation in Taligent Systems is an early start in the direction of an integrated application development tool paradigm. It is a set of frameworks that present a new metaphor and programming paradigm to the customer and client/server application development technology. Legacy applications from Taligent are not quite there. The product is currently addressing application development for the desktop environment.

Longer term, the emphasis will be on frameworks and class libraries, representing higher levels of abstraction for the programmer. Buying separate tools from many individual vendors will not provide the interaction required in working with the newer objected-oriented paradigms, based on standards.

IBM is very active in the Object Management Group. Currently OMG is providing a lower-layer generic object architecture. The CORBA standard of OMG is currently supported by IBM through SOM and DSOM emulation products. IBM, to shield users, will build on this by developing a higher-level of object abstraction and continue to support OMG standards as they emerge. IBM's current DSOM model addresses today's heterogeneous world of RPC calls.

CICS represents an alternative model for remote processing in an environment using distributed CICS transaction processing based monitors. In general, transaction processing-based distributed processing is viewed as a better solution today than RPCs. This solution can provide a similar level of integrity to the host world, with a single-view point-of-contract. However, the company must work with the real world.

IBM's proprietary CICS transaction processing monitor is currently supported in the MVS, OS/2 and UNIX environments. IBM is also selling distributed CICS/DB2 as a principal middleware solution, however, it currently does not apply to a heterogeneous database environment. IBM also uses CICS MVS/DCE to translate from other transaction processing monitors to CICS. IBM has also implemented CICS as an API on top of Transarc's distributed Encina transaction processing monitor for compatibility with the UNIX operating system environment.

In terms of distributed database solutions, IBM's state-of-the-art solution is to layer a transaction processing monitor on top of a DCE (2-phase commit) approach based on a common RPC protocol. Gateway tools provide an interface between IBM's mainframe and distributed CICS transaction processing environments to other vendors. In a world of transaction monitoring standards, a multiple phase commit approach is considered a superior solution for truly distributed OLTP update access to mainframe legacy systems and other distributed systems. This is based on application logic partitioning across platforms.

IBM believes it is a leader in distributed systems and network management, with NetView host to LAN integration, based on "best of breed" software solutions from other vendors. One such partner in distributed systems management is Legent.

IBM is also working closely (as well as competing) with Hewlett-Packard, particularly on COSE, Distributed Object Architectures and Taligent.

IBM's application development tools, i.e. Distributed Application Environment (DAE) (see Exhibit IV-5), are particularly appropriate for customers developing multitiered transaction processing-based architectures and/or migrating applications to this environment from the mainframe.

IBM and Hewlett-Packard are driving one version of standards for object-oriented technology that IBM believes will be the enabling technology of the future. This partnership, in the future, could involve the creation of common class libraries that could set *de facto* standards, rather than libraries that exist in more specific development frameworks and compilers today.

d. Unisys

Unisys integrated application development technology is based on its strong middleware application development tools, including; 4GLs, LINC and MAPPER, its systems management products and transaction processing monitor technology based on the X/Open DTP model that also interfaces to the Tuxedo transaction processing manager. Approximately 25 vendors support the DTP Model.

Unisys targets the high-volume, distributed OLTP market for particular vertical markets as: finance, telecommunications, government and airlines where it provides a unique niche application solutions strategy. Unisys views DTP-based transaction solutions as enabling technology for providing global transaction capability where application programs can access different types of database managers and other systems components, including those of other vendors. Unisys is also adding open interfaces to proprietary transaction monitors. Systems can also be constructed with hardware and software from a multiple vendors.

The X/Open DTP Model is an emerging industry standard for distributed transaction processing. It is being developed by X/Open, a consortium primarily of vendors, who define open systems standards. These standards are described in a set of documents called the X/Open Portability Guide (XPG). The

objective of the X/Open DTP model is—to define a DTP environment that can process global transactions using heterogeneous components across a network. The model specifies components and interfaces between the components. The components consist of:

- An Application Program: the program logic developed by applications programmers to perform one or more specific tasks

- A Transaction Manager: vendor-supplied software that coordinates global transactions and ensures database synchronization

- A Resource Manager: vendor-supplied software that manages part of a system's shared resources, such as databases

- XA: the interface between the resource manager and the transaction manager that enables them to coordinate global transactions. This interface enables a two-phase commit capability for ensuring database synchronization.

The Unisys implementation of these X/Open transaction processing managers, includes support of OSI, TCP/IP, DCA and BNA networks. The Unisys distributed computing approach, while primarily X/Open based, allows for remote data access technology and RPC technology from OSF's DCE, as well.

Unisys is essentially working with high-end UNIX solutions. It also provides a resource manager for high integrity applications with strong performance monitoring capability integrated with its systems management platform.

With its strategy of providing open systems based transaction monitors, Unisys provides an evolutionary strategy (involving a lower-risk approach to leveraging existing systems investments), by hooking up lower-cost platforms and supporting open systems OLTP monitoring technology.

Unisys has also developed its own database management structure that integrates its hierarchical and relational database systems product, optimized for the high transaction OLTP market. The company also has its own OODB and is building

object development tools to enhance its ability to provide object encapsulated migration strategies.

The principal operating systems supported are, UNIX and its own proprietary OS/2200 and MCP/AS operating systems.

Unisys is also stressing open systems management along with open systems- based application development tools with a distributed systems management approach, based on multiple uses for a single platform.

e. Digital Equipment

Digital Equipment's DECset suite of software development products are designed to meet full software life-cycle requirements. DECset is a component of COHESIONworX, Digital's CASE application development environment.

COHESIONworX 2.0 is a distributed UNIX software development environment that includes an object-based desktop interface and an integrated set of graphical UNIX code-edited debug tools based on widely used utilities. COHESIONworX includes control services based on a CORBA-compliant environment and OSF/DCE as well as a message-passing technology to support tool use and data across a multivendor network, including Sun OS, HP-UX and Digital Alpha OSF/platforms.

COHESIONworX for C++ v2.0 is an option that adds tools to support C++ development. COHESIONworX EnCASE v1.0 is an option to COHESIONworX v2.0 that provides integration tools and documentation for easily adding new tools to the environment without source code modification. COHESIONworX is the foundation for the COHESION Team/SEE, a software engineering solution addressing the process management of medium-to-large software projects.

COHESIONworX is based on industry standards that support distributed computing, including conformance to POSIX, X/OPEN, CORBA, OSFDCE and OSF/Motif.

COHESIONworX provides a flexible client/server environment across multivendor platforms "out of the box" without customization.

A key element of Digital's application development platform strategy is to provide enabling integrated software tools making it possible to integrate client/server applications across multiple platforms using open standards. Digital's objective is to simplify client/sever implementation by providing independent software developers, value-added resellers and systems integrators open software frameworks based on their enabling software. These frameworks will consist of the application program interfaces, methodologies, tools and facilities to solve basic integration problems between different data, applications, management and control functions on multiple platforms. Elements of this framework approach are outlined below:

Digital Equipment is helping to extend Microsoft's Object Linking and Embedding (OLE) object-oriented technology beyond the Microsoft Windows platform. Digital is linking OLE with its Object Broker technology (CORBA compliant) to extend the Microsoft technology across networks of multivendor computers, as well as providing a link between two *de facto* object-oriented standards environments.

A key middleware strategy of Digital Equipment's is the provision of a common user interface under the Microsoft Windows NT and Digital Equipment's OSF/1 operating systems. The common interface will enhance a customer's ability to integrate a wider variety of third-party software applications as well as custom software with Digital's client/server product solution.

Digital Equipment also recently announced it plans to support IBM's and Transarc Corporation's transaction monitors on the Alpha AXP systems. It will layer CICS/6000, Encina and its own Application Control and Management System (ACMSxp) transaction monitor on top of Transarc's Encina Core Services toolkit and the Open Software Foundation's Distributed Computing Environment (DCE). This middleware software solution is scheduled to ship in the latter half of 1994. The three transaction monitors will be able to access common databases via X/Open's XA data interface standard. Digital is also working to allow interoperability with X/Open's Transactional Remote Procedure Call (TxRPC) specification Digital initially developed as part of a multivendor architecture for NTT Corp. TxRPC support is expected to be available in early 1995, for at least, ACMSxp and Encina.

Other elements of Digital's middleware application development environment for distributed processing application development include:

- *COHESIONworX*—A new version of Digital's open, standards-driven distributed software engineering environment for UNIX applications. This version of COHESION is designed to improve productivity and management of complex development projects based on OSF/1 DCE (Distributed Computing). COHESION also includes standard interfaces between CASE tools. It is based on open CASE and applications interface standards, that allows for the integration of multiple tools for a complete applications development solution.

- *DECADMIRE for the DEC OSF/1, Open VMS AXP and Open VMS VAX server*—Supports client application development for Microsoft Windows clients. This allows a 3GL application to be developed once and then deployed on a choice of platforms and application styles with a consistent look and feel to all code and applications that are generated.

- *Object Broker*—Allows for the encapsulation of legacy applications in order to continue working together with new client/server applications. It is based on open CORBA and DCE standards.

- *Distributed Application Program Management (DAPM)*—A new programmer productivity solution for improving the efficiency of application development for mainframes, without using mainframe resources. DAPM allows large COBOL programs to be edited, compiled, and unit-tested in an open client/server environment.

- *Reliable Transaction Router for DEC OSF/1*—Extends continuous client/server computing for business-critical applications to open, UNIX-based environments. Used in the Open VMS and desktop environments since 1990, this client/server middleware provides business with scalable, fault-tolerant applications across global networks with ease of management.

- *LinkWorks*—Supports 27 languages, OS/2 clients and Open VMS servers, for development object-oriented groupware for departmental and line-of-business managers. It also provides for the integration of Lotus cc:Mail, Microsoft Mail, TeamLinks Mail and Lotus Notes along with access to the ALL-IN-1 file cabinet, as well as the Team Productivity Solution using LinkWorks from Digital Consulting.

- *POLYCENTER*—Digital's framework for integrating client/server management and control functions. It also allows for the integration of management tools from other vendors and is based on such open system and network management standards such as DME, EMA, OSI and SNMP.

- *DECnet/OSI*—Digital's network and integration framework, supports a number of major protocols including; TCP/IP, OSI, IPX, AppleTalk, DECnet, IBM's SNA, APpN and NetBEUI, and well as LAN protocols such as Ethernet, Token Ring, LocalTalk, FDDI and ATM.

- *PATHWORKS*—Digital's PC client/server networking software solution provides support for LAN services from the leading network operating systems platforms such as Novell NetWare, Microsoft LAN Manager and Apple's AppleShare, as well as wide-area connectivity across DECnet and TCP/IP networks.

- *DEC DBA Workcenter*—Provides an integrated set of tools for single-point management of multiple, heterogeneous database management systems distributed across client/server networks.

- *A new packaging of ACESSWORKS with Digital's DB Integrator software*—Enables production client/server applications to transparently access and integrate new and legacy data, located across platform from a single structured query language (SQL).

Application development partners of Digital Equipment include: Andersen Consulting, EDS, Cincom, Cognos, Information Builders, Netron, Powersoft, Progress, Software AG, Texas Instruments, Uniface and Sapiens, among others. Digital has recently partnered with Forte Software to become a worldwide distributor of Forte's enterprise-wide object-based 4GL development environment. Forte is used to develop mission-

critical production applications across a wide variety of platforms: EDS and Digital Equipment also recently expanded its partnership in application development tool technology to include cooperation in developing standards-compliant framework technology.

f. Novell

Novell application development environment, AppWare, is an application development framework based on the fifth-generation programming language, Visual AppBuilder. It incorporates object-linked ALMs, such as AT&T's Telephony ALM, that involve workflow, imaging or telephony-type applications. AppWare is a general applications builder for message-enhanced applications that enhances Novell's ability to sell its market services solutions, such as its X.500 directory services. AppWare also connects to higher-level application development tools from Powersoft and Gupta Technology.

AppWare is a rapid application development tool that includes ORBS from a number of other vendors as well as well as the CORBA standard. DCE capability can be added as a ALM. Several thousand AppWare toolkits have been shipped to date. The product will come out in stages, with the first commercial release expected in May 1994. AppWare is competitive with the application development tools for building OLE 2.0 and Open Doc compound document capabilities.

g. Computer Associates

Computer Associates application development environment includes solutions from two of its principal product areas: Application development Tools and Systems Management.

The company's product for managing distributed processing applications, CA-UNICENTER, has been ported to a number of platforms. It is designed as an open architecture that includes SNMP-based smart agent messaging, built-in SQL support, POSIX conformance and support for object-oriented messaging. Computer Associates has strategic development relationships with a number of vendors, including: Hewlett-Packard, IBM, Sun, Data General, AT&T GIS, Sequent, ICL, Microsoft, Pyramid, Novell and Siemens. The company is also working with COSE and has submitted an API for its kernel instrumentation.

Various types of systems management functionality across Computer Associates' various platforms includes: backup, file archiving, tape management, problem management, resource accounting and charge back, event management, report distribution and security

Computer Associates' base of products, over time, could likely provide for more integration between its three product layers of distributed management (systems, network and data management). CA-UNICENTER works with a relational database engine.

CA-UNICENTER is currently more tightly integrated with database backup functions. Computer Associates is partnering with third-party vendors to provide security-level enhancement with an application that can monitor database architectures to the table- and row-level. CA-UNICENTER has recently been SNMP enabled that allows it to broadcast network alters as well as function with various network-based systems. Its security software also supports systems management of a number of object request brokers.

The company is also extending the capability of CA-UNICENTER with the incorporation of DCE RPC technology.

Computer Associates distribution channels include a large number of resellers as well as OEM partners such as Hewlett-Packard and Data General.

With its strong mainframe legacy, Computer Associates application development tool environment can integrate application development technology or new applications with existing programming languages and database management systems. It is combining, for example, COBOL with object-oriented technology for working with applications in a variety of database management systems. It is also currently working with the ANSI standard committee to define the COBOL+ language.

Current emphasis is on creating application usage flexibility for the user, with its CA-Visual Express client/server products that provides dynamic and object linking ODBC connectivity from the workstation to mission-critical databases.

With its CA-Realia II Workbench application development platform, Computer Associates provides the ability to develop mission-critical applications with full-life cycle management within a client/server environment. Key features include repository-based version management, parallel development control, reporting capabilities, change and configuration management and direct host integration with CA-PANVALET, CA-LIBRARIAN and PDS libraries. Computer Associates will provide APIs to other vendor's development tools. In addition, it will be integrating analysis and design process prototyping into the client/server development architecture. The company is also integrating is Telon application generator technology into is client/server-based Visual application development technology that will include the ability to develop CICS applications on Windows and OS/2 platforms for the OLTP environment.

Eventually, the systems management and applications development technology of Computer Associates should come together with increasing incorporation of object-oriented technology throughout its base of distributed development and management products.

h. Taligent

Taligent, a partnership of IBM, Apple and Hewlett-Packard is developing an application development model based 100% on an object technology. Comments of the various partners would suggest that each is intending to incorporate the Taligent object technology into their core distributed application development platforms. A benefit of the Hewlett-Packard partnership could include the incorporation of the DCE and its object request broker distributed technology.

There are three parts to the Taligent product development schedule. The first part is the Taligent Application Environment—an application framework for providing a complete distributed programming model, including graphics and middleware.

The Taligent Application Environment—Being developed in C++, includes application frameworks and class libraries that include APIs to provide a subassembly code to help developers provide customized applications.

Initially, application development products will address the client/desktop segment of the market, with framework tools for accessing existing database systems (through object encapsulation) as well as various object database management systems. This could also involve encapsulation of networking protocols in networking frameworks used on top of UNIX or other operating systems. Apparently, Taligent has no current plans to develop its own OODBMS.

Release 1.0—Will include some elements of a systems and network management solution. Plans for Release 2.0 are for the inclusion of a more full-blown systems and network management systems using such standards as SNMP.

Current plans are not to develop user applications. Taligent could provide sample code for applications or small programs for creating program building- blocks.

At this stage, frameworks for Taligent and Nextstep are incompatible, but the shipment of CORBA 2.0, later this year, should help provide an initial level of integration. This will include a common method for creating inheritance as well as ORB compatibility.

Early users of Taligent are expected to be systems programmers at ISVs and corporations who will use the libraries of the basic levels of the system. Developers will license the framework or instrument code.

The application development environment is likely to be particularly helpful for custom developers and work group application development.

Later stages of the product rollout will likely include application development tools and an object-oriented operating system, likely based on a microkernal technology. The Taligent Development System will include compilers, brousers, etc. for writing applications to the Taligent operating systems environment. The toolset could also include cogenerators, as in a CASE environment. Taligent may also provide native object-services solutions. Early systems and OEM implementors could initially layer the systems frameworks over other operating systems, such as UNIX and OS/2.

Taligent is also working with OMG as a standards partner and with X/Open for a branding solution along with several systems integration vendors.

Competing object frameworks include: Smalltalk, Object Windows (Cairo) and NeXTStep.

i. Tivoli Systems

Tivoli is an object-oriented software-based solution for developing a distributed object systems management platform. Tivoli also provides a set of systems applications that include: software distribution, configuration management, systems monitoring, distributed database monitoring, etc. With its systems application development framework, it is currently working with a number of different software vendors. At this point in its development, it is more appropriate for companies that want to implement client/server, distributed processing off the mainframe.

The Object Management Group (OMG) currently provides somewhat of a generic object-oriented technology for Tivoli. The OMG's current ORB technology is more appropriate for building systems management rather than for network management solutions. However, as OMG moves forward on new releases, its technology could also become a base for development network management development frameworks. Tivoli's ORB is currently not compatible with CORBA 1.1. Particularly helpful would be an OMG release of an object-oriented base for a transaction monitor that could be used to complement Tivoli's two-phase commit rollback service. Eventually, database systems administration development frameworks could also be provided by Tivoli Systems.

Tivoli has several types of partnerships. For example, it is currently working with IBM and its Distributed Object Broker Technology. Tivoli has also submitted to X/Open the APIs for its systems applications. Tivoli was originally a UNIX solution. It will also be supporting other operating systems, such as Windows NT. It has also recently extended its solution to the PC LAN, to be used for systems management from the desktop throughout the enterprise.

j. Integris-Bull

Integris specializes in software products and services for migrating/transporting programs from CICS transaction processing to UNIX for very high performance applications. To provide this, Integris has implemented a CICS application programming interface.

The product is marketed particularly to mainframe users who are downsizing. The application development environment also works in conjunction with COBOL and various CASE tools.

The company is also working with Sybase, Oracle and Ingres.

2. Standards Groups Providing Distributed Application Development Software Solutions

a. Open Software Foundation (OSF)

DCE
An independent software developer can buy much of the OSF DCE development product from particular vendors that provide royalty payments to DCE. Also, some independent software companies have licensed the technology directly from OSF, including several database management software companies. A prime user may also separately license the technology.

Professional consulting services for developing DCE cell-based solutions can also be obtained from a licensed DCE hardware or software vendor.

The initial release of OFS' basic level of distributed services includes: the Mach Kernel and layered on this, network file services, RPCs and security management.

Many of its major partner/vendors have implemented DCE in their systems solutions as have a number of users. There are more than 1,000 currently installed user sites with workstation server platforms among the most popular platforms.

DME
DME 1.0 was brought to market in November 1993. It includes a set of five distributed services: license management, software distribution, PC services to connect PCs to DCE, subsystems

management (various startup services following a systems crash, for example) and event management, to monitor and track significant occurrences and actions at various locations (nodes) in a distributed systems management environment (providing both trouble-shooting and remote problem resolution).

The DME 1.0 source code is licensed from the Open Software Foundation..

Transarc's Encina is also considered part of the DME solution. Other transaction monitors have also been layered on top of DCE for client/server implementations.

The second release of DCE/DME Release 1.1, is expected late in 1994. However, with the recent organizational change at OSF, future plans on DME could change. It is intended to provide the Network Management Option component. The Network Management Option (NMO) will handle the incorporation of legacy systems by supporting existing network management protocols (SNMP and CMIP-ISO) in distributed environments that also include the X/Open Management protocol-XMPGroup. DME will allow for the integration of network applications and services using the two alternative network management protocols.

The third portion of DCE/DME is still in an early definition stage. It will likely work with the CORBA 2.0 specification where the Object Request Broker messaging solution would run on top of DCE to provide interoperability. Transarc's Encina can also be incorporated on top of DCE. Hewlett-Packard has recently announced the DCE Encina 9000 product with the news that Encina/CICS gateways are also available.

b. Object Management Group

The Object Management Group (OMG) was founded in April 1989, with vendor partners including Hewlett-Packard, Data General, AT&T and 3Com, among others.

The basic concern of the organization is the unique compatibility issues associated with object technology.

Essentially, DCE represents a lower-level of integration where remote procedure calls represent a low-level of communications code that is not a complete solution for true distributed processing.

However, for smaller client/server implementations in a homogeneous environment, RPC technology can be faster.

The object request broker technology of OMG provides a messaging communications system to remote databases. The CORBA 1.1 messaging system operates at the application level of a traditional protocol stack (level 8). By implementing ORB technology, application developers do not have to deal with the lower layers of communications protocols.

At the communications level, object request broker technology can be used to translate file systems and network protocols and various types of objects. In distributed computing solutions, it provides a method of getting interface objects to communicate. It can also facilitate the development of document architectures. By the end of 1994, the OMG expects its technology to provide 10 network/applications-based services.

OMG is a nonprofit organization and operating system independent. Other standards groups have generally been built around UNIX.

OMG is currently working with Novell, an active member of OMG. The total member of OMG includes 300 companies with more users now joining.

Microsoft is a member, but is still using its own approach to object technology—OLE 2.0. However, Digital has mapped OLE2.0 to CORBA.

Cairo is expected to be much more comprehensive than the OMG model, but more than likely, specific to the Windows environment.

OMG is also working on OODB compatibility and a SQL-like solution that could provide a standard to help promote the use of OODBs. Currently, many developers do not want to bet on a proprietary object database solution.

OMG is also developing an Object Model that provides a specific foundation for representing an object inheritance model to define the implicit functionality of an object and achieve a much higher level of compatibility among objects.

Such compatibility could ultimately lower the barriers of entry into the software development market. However, within a

software engineering (software application development) scenario, larger companies could have an advantage.

Class libraries for vertical applications are also likely to come from industry consortiums, with vendors providing more of the horizontal process-based class libraries.

Currently, a major barrier to object-oriented application development is the incompatibility of current development tools. As OMG releases more of its generic framework for object-oriented interface standards, the incorporation of such standards by vendors of object-oriented application development tools, could be the route to greater acceptance of object-oriented technology. Programmers today, in many cases, are writing their own tools.

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VI

Conclusions and Recommendations

Software products vendors should carefully evaluate the structural changes now occurring in the software products markets. In the latter half of the 1990s, users will have more sophisticated needs and procurement practices will require more complex products, distribution and product support approaches than in prior years. In addition, a significant international marketing presence will be required to maximize product growth potential.

The increasing complexity of multiplatform application development and network is taxing the resources of central IS departments and ISVs to implement and support distributed, multivendor solutions.

To date, the migration off the mainframe has been slow, even though client/server networking at the departmental level has experienced strong growth in recent years. The mainframe continues to be used, often in a dual architecture context to help insure the continued integrity of distributed data.

This is particularly true for mission-critical and/or OLTP-based applications that require near real-time updating involving the maintenance of a high level of data integrity.

To date, most client/server implementations have been single applications solutions designed to provide more timely data access for accurate decision support.

Many of the desired benefits, from downsizing to smaller platforms in a distributed, networked environment, remain elusive. INPUT's surveys indicate implementation and protracted support costs can often make the movement off the

mainframe, a less than cost-effective solution. In addition, "hidden" cost factors, such as data integrity loss for mission-critical applications, can be significant.

However, INPUT's 1993 surveys showed approximately 50% of users are intending to implement client/server applications over the next three to five years. In 1993, this caused some delays in purchasing third-party application software as users waited for more standard client/sever applications to be released from the applications software vendor community.

Vendors have been generally slow to provide new product releases based on the client/server architectural paradigm. To date, it appears the major third-party software products and services company beneficiaries, of the move to client/server computing, are the independent client/server application development tool vendors and systems integrators.

However, a major driving force for moving to a downsized, distributed processing environment is application development tools improvement. The tools are being developed to provide multivendor, mission-critical applications, with the use of middleware products, such as transaction processing monitors and increased sophistication of object-oriented development tools.

Computer systems, systems integration and professional services companies are developing much more sophisticated middleware along with other application development tool strategies. These strategies will help them provide lower-risk, more gradual migration off the mainframe to lower-cost platforms. For example, companies such as CompuWare, Unisys and the Integris Division of Bull H.N. Information Systems, have been making use of transaction processing monitor gateway technology, object encapsulation, and re-engineering (CASE) tools to extend the benefits of OLTP processing to a network environment of lower-cost platforms.

Another major trend in 1993 has been the acceleration in partnering among systems and systems software companies to develop *de facto* standards for providing multivendor distributed application development tool framework environments. They are also increasingly using standards for distributed processing, developed by independent standards organizations such as OSF, OMG and X/Open. A key element for actually achieving

significant cost savings in applications development and for developing applications with the performance and data integrity of mainframe applications is the continuing evolvement of object-oriented technology interoperability standards. For example, the progress of the Object Management Group, would appear to be a significant element in creating an object technology interoperability standards agreement.

Such integrated application development frameworks involving vendor consortiums, are just beginning to emerge as strategic platform architectures. These partnership alliances, being built around core vendors, are just beginning to articulate the strategic advantage of such integrated application development platforms to potential customers, such as ISVs an corporate developers.

For ISVs and corporate application developers, among others, working in a partnership of companies within an integrated application development, will be key to success in developing applications in a multivendor, distributed processing environment. This report has briefly summarized a number of these platforms and some of the partnership relationships in Chapter V on the Competitive Environment in the U.S. systems software products market.

This partnering among information services companies should also extend beyond partnering in application development. It should also include partnering in marketing (with the computer systems, systems software or systems integration company as a product reseller) and product maintenance—based on the partner's strong CASE tool capability, as well as to other components of application software product support. Product support (help desk, etc.) is becoming increasingly complex for application software companies selling their products into mixed vendor environments. Ultimately, large computer systems companies could have much more clout as information power brokers in being able to work with other vendors in cross-support-type networks.

Younger systems software companies, with innovative application development in addition to systems and network management tool technologies, should also look to partnering with large computer systems, systems software and systems integration companies to leverage their sales and marketing capabilities. This tactic is already evident in recent partnerships

among a number of object-oriented application development tools, systems management companies, large computer systems and systems integration vendors.

Survey conclusions and recommendations for systems software vendors, in the second half of the 1990s, are included in Exhibits VI-1 and VI-2.

Exhibit VI-1

Conclusions

- Object-oriented technology will be an increasingly important component of application development tool technology in a distributed computer environment.

- Vendor consortiums on application development tools currently represent major competing object technology *de facto* standards ((OLE and OMG). Developers working with the desktop and server/enterprise environments might want to keep an "oar" in competing vendor alliances, at least for the next generation of applications.

- Cost reduction and reliability of distributed processing should be realized when future software applications are built with integrated application development tool platforms based on standards-based middleware, including object-oriented development frameworks.

- Applications development and other types of professional services will be the major "potential" markets for computer systems, systems software and systems integration companies with integrated, standards-based application development tool strategies.

- Systems management tools, for a distributed processing environment, provide a significant new-market opportunity with no dominant vendor, at this stage.

Exhibit VI-2

Recommendations

- For strategic alliances, across software products markets, to be part of a coalition of vendors that can provide cost-effective, innovative distributed processing solutions

- Develop expertise in object-oriented technology

- Support industry standards, particularly those that provide interoperability within a multivendor distributed processing environment

- Computer systems and systems software product vendors should partner with applications software vendors to leverage particular capabilities to provide product and product support for the more complex distributed processing in enterprise-wide environments.

- Specialized niche systems software products companies should partner with cross-platform application development framework providers to leverage research and development resources.

- Software developers should use newer, enterprise-wide workstation/PC-based project management software tools for establishing metrics for newer software development approaches.

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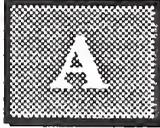
Forecast and Database Reconciliation

EXHIBIT A-1

Systems Software Products
Market Forecast by Subsector, 1994-1999

Delivery Modes	1993 ($M)	Growth 93-94 (%)	1994 ($M)	1995 ($M)	1996 ($M)	1997 ($M)	1998 ($M)	1999 ($M)	CAGR 94-99 (%)
Delivery Mode Total	21,848	9	23,721	25,284	27,135	29,298	31,914	35,046	8
Systems Control Products	7,076	3	7,271	7,240	7,231	7,205	7,237	7,295	0
- Mainframe	2,774	-5	2,635	2,451	2,279	2,119	1,971	1,833	-7
- Minicomputer	2,267	4	2,357	2,319	2,282	2,246	2,210	2,174	-2
- Workstation/PC	2,035	12	2,279	2,470	26,70	2,840	3,056	3,288	8
Operations Management Tools	5,599	10	6,156	6,655	7,225	7,885	8,651	9,551	9
- Mainframe	2,967	8	3,204	3,364	3,532	3,709	3,894	4,089	5
- Minicomputer	1,849	8	1,997	2,097	2,201	2,311	2,426	2,548	5
- Workstation/PC	7,83	22	955	1,194	1,492	1,865	2,331	2,914	25
Applications									
Development Tools	9,173	12	10,294	11,389	12,679	14,208	16,026	18,200	12
- Mainframe	3,713	5	3,899	4,055	4,217	4,386	4,561	4,744	4
- Minicomputer	2,814	5	2,955	3,103	3,258	3,420	35,92	3,771	5
- Workstation/PC	2,646	30	3,440	4,231	5,204	6,402	7,873	9,685	23

Exhibit A-2

Systems Software Products
Market Forecast by Platform, 1994-1999

Platform	1993 ($)	Growth 93-94 (%)	1994 ($)	1995 ($)	1996 ($)	1997 ($)	1998 ($)	1999 ($)	CAGR 94-99 (%)
Total	21,848	9	23,721	25,284	27,135	29,298	31,914	35,046	8
Mainframe	9,454	3	9,738	9,870	10,028	10,214	10,426	10,666	2
- Systems Control Products	2,774	-5	2,635	2,451	2,279	2,119	1,971	1,833	-7
- Operations Managem'nt Tools	2,967	8	3,204	3,364	3,532	3,709	3,894	4,089	5
- Applications Developm'nt Tools	3,713	5	3,899	4,055	4,217	4,386	4,561	4,744	4
Minicomputer	6,930	5	7,309	7,519	7,741	7,977	8,228	8,493	3
- Systems Control Products	2,267	4	2,357	2,319	2,282	2,246	2,210	2,174	-2
- Operations Managem'nt Tools	1,849	8	1,997	2,097	2,201	2,311	2,426	2,548	5
- Applications Developm'nt Tools	2,814	5	2,955	3,103	3,258	3,420	3,592	3,771	5
Workstation/PC	5,464	22	6,674	7,895	9,366	11,107	13,260	15,887	19
- Systems Control Products	2,035	12	2,279	2,470	2,670	2,840	3,056	3,288	8
- Operations Managem'nt Tools	783	22	955	1,194	1,492	1,865	2,331	2,914	25
- Applications Developm'nt Tools	2,646	30	3,440	4,231	5,204	6,402	7,873	9,685	23

Exhibits A-3 and A-4 provide INPUT's reconciliation of the 1993 and 1998 U.S. market forecasts by subsectors and platforms as noted in the 1993 Systems Software Product report.

Exhibit A-3

Systems Software Products Market Forecast
1994 MAP Database Reconciliation by Subsector

	1993 Market				1998 Market				93-98 CAGR per data 93 Rpt (%)	93-98 CAGR per data 94 Rpt (%)
	1993 Market Fcst. ($M)	1994 Market Actual ($M)	Variance From 1993 Forecast ($M)	Variance From 1993 Forecast (%)	1993 Market Fcst. ($M)	1994 Market Actual ($M)	Variance From 1993 Forecast ($M)	Variance From 1993 Forecast (%)		
Delivery Mode	21,702	21,848	146	1	31,186	31,914	728	· 2	8	8
Systems Control Products	7,158	7,076	-82	-1	7,660	7,237	-423	-6	1	0
- Mainframe	2,830	2,774	-56	-2	2,190	1,971	-219	-10	-5 ·	-7
- Minicomputer	2,310	2,267	-43	-2	2,400	2,210	-190	-8	0	-1
- Workstation/PC	2,018	2,035	17	1	3,070	3,056	-14	0	9	8
Operations Mgmt Tools	5,536	5,599	63	1	7,623	8,651	1,028	13	7	9
- Mainframe	2,900	2,967	67	2	3,362	3,894	532	16	3	6
- Minicomputer	1,863	1,849	-14	-1	2,493	2,426	-67	-3	6	6
- Workstation/PC	773	783	10	1	1,768	2,331	563	32	18	24
Applications Devmt Tools	9,008	9,173	165	2	15,903	16,026	123	1	12	12
- Mainframe	3,686	3,713	27	1	4,485	4,561	76	2	4	4
- Minicomputer	2,814	2,814	0	0	3,765	3,592	-173	-5	6	5
- Workstation/PC	2,508	2,646	138	6	7,653	7,873	220	3	25	24

Exhibit A-4

Systems Software Products Market Forecast
1994 MAP Database Reconciliation by Platform

	1993 Market				1998 Market				93-98 CAGR per data 93 Rpt (%)	93-98 CAGR per data 94 Rpt (%)
	1993 Market Fcst. ($M)	1994 Market Actual ($M)	Variance From 1993 Forecast ($M)	(%)	1993 Market Fcst. ($M)	1994 Market Actual ($M)	Variance From 1993 Forecast ($M)	(%)		
Delivery Mode	21,702	21,848	146	1	31,186	31,914	728	2	8	8
Mainframe	9,416	9,454	38	0	10,037	10,426	389	4	1	2
- System Control Products	2,830	2,774	-56	-2	2,190	1,971	-219	-10	-5	-7
- Operations Mgmt Tools	2,900	2,967	67	2	3,362	3,894	532	16	3	6
- Applications Devmt Tools	3,686	3,713	27	1	4,485	4,561	76	2	4	4
Minicomputer	6,987	6,930	-57	-1	8,658	8,228	-430	-5	4	3
- System Control Products	2,310	2,267	-43	-2	2,400	2,210	-190	-8	0	-1
- Operations Mgmt Tools	1,863	1,849	-14	-1	2,493	2,426	-67	-3	6	6
- Applications Devmt Tools	2,814	2,814	0	0	3,765	3,592	-173	-5	6	5
Workstation/PC	5,299	5,464	165	3	12,491	13,260	769	6	19	19
- System Control Products	2,018	2,035	17	1	3,070	3,056	-14	-0	9	8
- Operations Mgmt Tools	773	783	10	1	1,768	2,331	563	32	18	24
- Applications Devmt Tool	2,508	2,646	138	6	7,653	7,873	220	3	25	24

The 1993 and 1994 market forecasts noted in Exhibits A-3 and A-4 indicate variances for platform and subsector values for the 1993 market ranging from -2% to +6%, with the total systems software products market running 1% above prior forecasts. The operations management market is 1% above and applications development tools market is 2% higher than in the 1993 report.

The principal factors, positively impacting the applications development tools market in 1993, were the introduction of additional product, particularly in the category of middleware

product, as well as an acceleration in the growth rate of migration to lower-cost development and implementation platforms.

The figures projected for 1998 in this report (compared to the 1993 report) show more pronounced variances—from -10% to +32%. These variances reflect an upward adjustment in the growth rate for operations management tools, with a faster than expected move to client/server computing projected over the next few years.

The beginning of a major rollout of new operations management tools for the distributed environment in late 1994 and early 1995, will help expand the size of the market. The pricing pressures for operating systems products have been more severe than previously anticipated, and INPUT expects these pressures to be an influencing factor in the evolvement toward commodity pricing in this market over the next 5 years.

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