August 11, 1992

Dear Colleague:

INPUT has completed research on client/server architectures and recently published its report, *Client/Server Applications and Markets*.

In appreciation for your participation in our research, enclosed is an executive summary of the report.

Thank you again for giving INPUT the benefit of your knowledge and experience.

Sincerely,

John McGilvray

John McGilvray
Principal Consultant

Enclosure

P.S. If you would like more information about this study or are interested in purchasing the complete report, please call Mark Drisko at (415) 961-3300.

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CLIENT/SERVER APPLICATIONS AND MARKETS

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U.S. Information Services
Market Analysis Program
(MAMAP)

Client/Server Applications and Markets

Abstract

This report provides an analysis and five-year forecasts of the U.S. markets for software products, services and computer equipment used for client/server architectures for the period 1992-1997. Factors driving the market from the user and vendor perspectives are discussed and provide a framework for the forecasts. Client/server architecture is defined and examples of vendor and user implementations are discussed.

Client/server architecture has the potential to impact all user organizations and the vendors that sell to them during the 1990s. It will have a significant effect on IS and end-user organizations that will have to absorb new knowledge about using and maintaining complex new products. It will have major impacts on the applications development process, how software products are priced and distributed, and what it takes to succeed in the marketplace. The industry is in a state of major transition and client/server architecture is one of the key drivers behind this transition.

The report contains 58 pages and 20 exhibits.

Table of Contents

Table of Contents (Continued)

Exhibits

Introduction

A
Objectives

Client/server architecture is one of the key trends of the 1990s and touches upon fundamental software product and market issues. It has implications for other information services delivery modes such as systems integration and professional services, as well as for the internal IS organization. The purpose of this report is to put client/server architecture into perspective—from both the user and vendor points of view—and to present a baseline from which to begin to understand its implications.

Specifically, this report has the following objectives:

- Provide a framework for understanding the impacts of client/server architectures on the information services market
- Forecast expenditures on client/server architected hardware, software and services for the period 1992-1997
- Describe users' buying and implementation experiences
- Describe leading vendors' approaches to client/server architectures
- Draw conclusions and make recommendations from both the user and vendor points of view

B
Scope and Methodology

1. Scope

The primary focus of this report is the market and vendor dynamics impacting expenditures for client/server computing environments. The report forecasts expenditures on applications and systems software prod-

ucts, computer equipment, and services (systems integration and professional services) that are for client/server architectures.

2. Methodology

The report draws on in-depth telephone interviews with IS and project managers who are implementing or have implemented client/server architectures and interviews with vendors that are or will be key client/server participants.

Specifically:

- INPUT conducted in-depth telephone interviews with IS managers, project engineers and other professionals directly involved in the implementation of client/server architectures within their corporations. Corporations represent a cross-section of vertical industries and company sizes.

  The interviews explored issues and questions primarily of a qualitative nature. INPUT asked specific questions about client/server expenditures. Areas of discussion with IS management were:

- Current IS environment
- Client/server definitions and expenditures
- Client/server configurations and applications
- Reasons for implementing client/server technology
- Client/server purchase decisions and vendor selection

- Additional interviews were conducted with IS managers in corporations that were not implementing client/server architectures and had no plans to do so. Their motivation and reasoning offered insight into many of the complexities surrounding client/server perception and implementation.

- A combination of in-depth telephone and in-person interviews were conducted with computer equipment vendors, applications software products companies that already possess or have plans for client/server product lines, several large professional services and systems integration firms, and systems control products and applications development tool companies.

An ongoing library data gathering and analysis effort was also part of the research for this report. This report utilizes information from several previous INPUT reports—including *Putting Downsizing in Perspective* (published in February 1992)—listed in Section D below.

C
Report Structure

Client/Server Applications and Markets is organized as follows:

- Chapter II is an Executive Overview providing a summary of the research findings, analysis, and conclusions and recommendations.
- Chapter III presents a definition of client/server computing.
- Chapter IV describes user experiences and motivations. The bulk of this chapter is based on interviews with IS management of corporations that are implementing client/server technology or have plans to implement it, as well as those that do not plan to implement it over the next several years.
- In Chapter V INPUT presents the strategies and product offerings of various broad vendor categories: applications and systems software products vendors, computer equipment vendors and professional services firms. The intent is to provide examples and present issues that have yet to be addressed by these vendors as the market begins to migrate to client/server solutions.
- In Chapter VI—based on the analyses of Chapters III, IV and V, as well as its knowledge of the IS industry as a whole—INPUT presents market forecasts for client/server architected software products, services and computer equipment. All assumptions are clearly documented. The forecast is presented within the context of a forecast for the information services industry as a whole.
- In the final chapter, Chapter VII, the study's findings are summarized, and user and vendor recommendations are presented.

D
Related INPUT Reports

Recent INPUT reports as well as reports planned for 1992 that are of direct relevance to this study are listed below.

1992 Publications:

- *Open Systems Opportunities* (January 1992)
- *Putting Downsizing in Perspective* (February 1992)
- *Impact of Downsizing on IT Vendors*
- *Systems Architectures for Downsizing*
- *Methodologies for IT Downsizing*

1991 Publications:

- *U.S. Systems Software Market, 1991-1996*
- *U.S. Application Solutions Market, 1991-1996*
- *U.S. UNIX Market, 1991-1996*
- *Western European UNIX Market Opportunities, 1990-1995*

In addition, INPUT offers the following ongoing programs:

- U.S. Information Services Market Analysis Program - Individual reports on information services use and spending by industry sector (e.g., wholesale, retail, discrete manufacturing) and cross-industry sector (e.g., accounting, human resources). Separate reports cover sectors in the U.S. and European markets.

- Information Services Vendor Analysis Program - Over 300 profiles of prominent U.S. software and services vendors. Includes regular updates and new profiles. Also available are profiles on over 300 European vendors.

- Downsizing Information Systems Program - Analyzes the downsizing revolution in the 1990s and its impact on users and vendors of information systems and services. In-depth research probes the methods by which organizations are downsizing. Critical issues, such as open systems and data security, are addressed.

Executive Overview

A
Client/Server Definition

Client/server is an architecture that assembles applications software and data bases, systems software, and computer and networking equipment into a usable form for the purpose of leveraging information technology investments.

Broadly defined, it can include any kind of server, such as file servers and network servers, that are accessed by any kind of client, including a nonintelligent terminal. INPUT has elected to use the narrower and newer definition, by which application and data processing is shared between a client and a server. It is through the act of sharing that the greatest benefit is derived in terms of leveraging information technology investments. It is also the cause of the greatest change for vendors and users.

A client/server functionality continuum is shown in Exhibit II-1. Options 2 and 3 encompass that which is new about client/server architectures. INPUT identifies those software architectures that meet the criteria of options 2 or 3 as "client/server". Those architectures that meet the criteria of 1 or 4 are not client/server.

The intent behind providing this continuum and selecting the narrower definition (options 2 and 3 only) is to be able to "put one's arms around" an otherwise ambiguous term and to be better able to analyze and quantify it. These parameters define a computing environment that is very different from traditional computing. Because of its differences, it has far-reaching implications not only for software products and how they are developed, but also for systems vendors, service providers, IS organizations, departmental end users, and the very way in which corporate business functions are carried out.

EXHIBIT II-1

Client/Server Application Functionality Continuum

Option	Client Functionality	Client	Server	Server Functionality
1	Less	• No application code resident at terminal	• All application code at server	More
2		• No application code normally resident at terminal - Require load modules	• All application code at server, but some designed to be downloaded to client	
3		• Some application code *always* resident at terminal - Require code	• Some application code resident at the server, most resident at client	
4	More	• All application code resident at terminal	• No application code at server	Less

An example of a client/server application is a Strategic Warehouse and Tracking System implemented by a food processing company where the server, a 486-based PC running UNIX, runs the network software, data bases and print management utilities. The server manages and updates the data base and does high-volume specialized batch transaction processing that the clients lack the power to handle.

The clients, which are 386- and 486-based PCs running DOS and Windows, collect inventory data—such as physical inventory counts, shipping and receiving—and process the bulk of the inventory records and purchasing transactions. Terminals talk to a radio frequency controller on the server, which allows anyone to input and extract information to manage the warehouse.

Using the same example of a warehouse and tracking system, this system would not be considered client/server if the DOS- and Windows-based "clients" had a GUI (Graphical User Interface) front end and all they did was access and feed information from a server over a LAN. True client/server computing requires that elements of the application be executed on both the client and the server.

B

User Experiences and Expectations

A diverse range of companies is implementing a variety of applications using client/server architecture. However, most of the implementations are not yet employing the newer type of client/server architecture.

At the very least, these early implementations are a first step in separation of applications and data across a distributed network. This scenario is an eventuality, but has barely begun to take place.

The firms INPUT interviewed are implementing production-level applications that they are calling client/server. However, the applications were not purchased or developed with the intent of being client/server architectures. They were implemented because they were the best response to a Request For Proposal in terms of both features/functionality and cost. Thus client/server architectures are not being sought out; rather, they are evolving.

INPUT is concerned that client/server architectures may be evolving in a piecemeal fashion. As systems and applications selection are made at least in part by end-user organizations, there is the possibility that purchases will be made without regard to an overall strategy. In fact, in companies INPUT interviewed, no one person or department was spearheading the move to a client/server architecture.

Among the benefits users hope to obtain from implementing client/server architectures are computer equipment cost reductions, more efficient methods of data access and sharing, and easier systems support. However, it is difficult to generalize about actual cost reductions. INPUT believes that cost justifications should be made on a per-site and per-application basis.

Another anticipated client/server benefit is the provision of better application development tools. There is a misperception on the part of many users that some application development tools, including 4GLs, CASE tools and GUI application development tools, represent the implementation of the "client/server" concept. However, there is nothing inherently "client/server" about them. It would appear as though all technologies and products related not only to downsizing but also to GUIs, open systems and UNIX imply "client/server" to users. It is this misconception that makes it necessary to define the term "client/server" before entering into a discussion of experiences, expectations and issues.

C
Vendor Perspective

INPUT speculates that, if polled, 90% of all software products vendors would say that they had or were developing client/server solutions. Using the newer and narrower definition given in Section A, however, INPUT believes the actual percent to be very small.

Regardless of the percentage, INPUT believes that all vendors eventually need to develop software products for client/server architectures. The timing of their product introductions depends on the extensiveness of the rewrites that must take place and the extent to which they believe their customers will switch to another vendor while this is taking place.

Although the newer client/server architectures have advantages over more simplistic forms of client/server architectures and more traditional architectures, the majority of users are not in a hurry to implement, given the complexities and as-yet unprovable results. Much of the software currently deployed for client/server architectures is being developed internally. Therefore, a window of opportunity of at least 2-3 years exists for vendors.

Aggressive price/performance improvements in computer equipment are driving the move to client/server architecture, and at the same time, software is increasingly driving the computer equipment purchase decision. It is therefore imperative that computer equipment and software vendors work together. All product vendors need to be proactive in providing integration and support services for client/server architecture; product vendors need to align themselves with systems integrators and professional services firms as well. These services firms will become an important indirect distribution channel for products for client/server architectures.

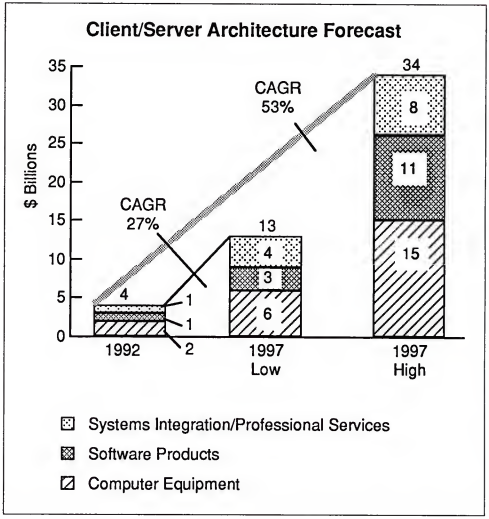
Several product "battles" will take place during the 1990s. These will occur between computer equipment vendors who will be caught between users' desires to downsize and upsize, between RDBMS vendors and applications software products vendors who vie for account control as dominant client/server providers, and between applications software products vendors who take different approaches to client/server architectures.

Application development tools vendors will play a leading role in client/server architectures as well, as other types of software vendors seek out alliances with them in order to enhance the market appeal of their own products. It is unclear which operating system will be the server operating system of choice—UNIX, OS/2, Windows NT or others. They will all have to co-exist, however, and vendors will need to provide interoperability solutions.

D
Market Forecast

INPUT estimates that total spending on client/server software products, services and computer equipment will be $4 billion in 1992, as shown in Exhibit II-2. As a low estimate, expenditures will reach $13 billion by 1997. As a high estimate, expenditures could be between two to three times more, or $34 billion. This higher forecast encompasses options 2 *and* 3 definitions of the functionality continuum of Exhibit II-1, whereas the low forecast estimate only encompasses option 3.

EXHIBIT II-2



Options 2 and 3 represent hierarchical increments of complexity and expense. Client/server option 3 will not only be the most challenging to develop from a vendor point of view; it will also be the most challenging to implement and maintain from the user standpoint. Thus, option 3 expenditures are estimated to be only about one-third of total expenditures on client/server architectures by 1997.

Outside services firms will be heavily used, as internal staffs resist change and lack client/server expertise. INPUT believes that a very strong market opportunity exists here for professional services firms, and in fact, growth of client/server architectures is dependent on an aggressive stance by services vendors.

Expenditures on computer equipment will continue to account for the largest portion of client/server expenditures, as users will not only be purchasing new client computer equipment platforms; they will also be purchasing new server platforms.

E
Conclusions and Recommendations

Software products for the newer client/server architectures—where application and data processing is distributed across a network and among platforms—are just beginning to be available and implemented; and services are just beginning to become available to support and educate users. INPUT estimates that only 1% of total information technology spending, including people, computer equipment, software, services and facilities, will go toward client/server architectures in 1992. INPUT further estimates that client/server's share of total IT spending will grow to between 5% and 10% of total expenditures by 1997.

Thus the development and implementation of client/server architectures will be a relatively slow evolution. It will, nonetheless, be accompanied by revolutionary changes, from both vendor and user perspectives. Not only will vendors' products change, but the manner in which they market, sell and support them will change as well. Users need to learn more about the implications of client/server, what its benefits really are, how to use it and how to support it. Of critical importance to the success of products within a client/server architecture is vendor provision of systems integration and professional services.

Client/Server Definition

This chapter describes client/server as an architecture and as a functionality continuum. Examples of client/server definitions and implementations from the vendor and user perspectives are provided. Conclusions are drawn about these varying definitions.

A
Client/Server As an Architecture

An architecture assembles technology into some useful form. The two primary technologies a client/server architecture assembles are applications software and data bases. Other technologies, however, are also included within a client/server architecture.

These other technologies or products—just as with any other computer architecture—can include graphical user interfaces (GUIs), LANs and electronic mail services, application development tools, operations management and network administration products, and systems control products such as security and backup and recovery products.

There is also a computer equipment component to any architecture. A client/server architecture implies that two separate computer equipment platforms are present: a client platform where a request is initiated and a server platform that responds to the request.

The benefits of a client/server architecture over a self-contained or peer-to-peer architecture are that client/server:

- Reduces computer equipment costs through use of smaller platforms, as a result of sharing application functionality
- Reduces software costs by sharing resources
- Provides faster and easier data access
- Allows for and enables standards compliance

- Provides the ability to mix and match various applications and data bases regardless of where they reside

- Enables downsizing. Although client/server is not synonymous with downsizing (the client and server can be any size of platform), client/server architecture *enables* downsizing. For example:

  - The server can be a centralized computer that continues to be operated and maintained within the IS organization; the client function can be distributed to end-user organizations on smaller platforms.

  - The server function can be outsourced to a systems operations or processing services vendor, with the client function being retained within the organization by the IS department, operating units or end-user departments.

  In either case, internal IS resources are reduced.

- Client/server can also enable integration. A department that previously ran all of its applications on standalone personal computers and had no central computer facility can now afford to centralize systems management functions, as well as data bases and other resources, through implementing a client/server architecture. Thus the server becomes the central computer.

The degree to which any of these benefits is obtained depends on the type of client/server architecture that is implemented. Types of client/server architectures are described within a functionality continuum in Section B below.

B

Client/Server As a Functionality Continuum

Client/server can be defined in terms of an application functionality continuum (see Exhibit III-1) that describes application architectures. This continuum depicts four ways to divide functionality between a client and a server.

Conceptually, where the data resides and where the data processing takes place can be substituted for applications residency and processing. In either case, the client/server continuum defines multiple levels of resource and responsibility for application functionality. Typically, however, most of the data resides on the server and most of the application logic resides on the client.

EXHIBIT III-1

Client/Server Application Functionality Continuum

Option	Client Functionality	Client	Server	Server Functionality
1	Less	• No application code resident at terminal	• All application code at server	More
2		• No application code normally resident at terminal - Require load modules	• All application code at server, but some designed to be downloaded to client	
3		• Some application code *always* resident at terminal - Require code	• Some application code resident at the server, most resident at client	
4	More	• All application code resident at terminal	• No application code at server	Less

Considering the normal residency and possible distribution of function under a client/server architecture, the following paragraphs expand on the concepts diagrammed in Exhibit III-1:

- In the first example, option 1, the client *never* has application code or data resident at the terminal; all application code and data reside on the server. This is traditional mainframe computing with dumb terminals accessing a centralized host.

- In the second example, option 2, the application code is not normally resident at the client, but it can be retrieved from the server and brought back to the client. The data continues to reside on the server.

- In the third example, option 3, at least some of the application code is *always* resident at the terminal or client, and some is resident at the server. The client requests additional code, if needed, and may request data.

- In the fourth example, option 4, *all* application code is resident at the client. The client is an intelligent workstation or a personal computer and the server has no applications intelligence. The server runs network software or is a physical storage place, for example, and the client performs all data access and updates and all calculations.

The first and the fourth examples, although they do represent client/server computing in a broad sense, are not new.

The second and third options, however, are relatively new and have been made possible through LAN and personal computer capabilities.

In the second and third options, the application processing is divided between a client and a server. The second and third examples can be thought of as two end points of a continuum of shared application processing.

The application functions that can be divided between a client and a server in the second and third examples are depicted in Exhibit III-2.

EXHIBIT III-2

Client/Server Functionality Distribution

Function	Client Only	Shared	Server Only
Fixed functions	• Presentation logic		• Non-data base server
Variable functions		• Business rules/logic • Data management • Data base	

The presentation logic of the user interface will typically always reside on the client and resources such as LAN software and management will typically be on the server. All other functions can be either on the client or on the server.

Where and how the division takes place is in part dependent on the attributes of the application under consideration. Exhibit III-3 provides examples of the kinds of attributes to be considered when dividing application functionality between a client and a server. As will be discussed later, however, the method of dividing the processing also depends on the orientation of the firm designing the application.

Examples of the variety of definitions for the client/server concept, from both vendor and user perspectives, are provided in the following two sections.

Exhibit III-3

Application Attributes Influencing Distribution of Client and Server Functions

Representative Application Attributes	Favors Client Residency	Favors Server Residency
Size of Code	Small application code	Large/modular application code
Frequency of data update	Rarely	Frequently
Where application or accessed from	Few locations	Many locations
Confidentiality of data	Not sensitive	Highly sensitive
Number of people accessing	Not many	Many people
Degree of collaborative work	Little collaboration	Much collaboration

C

Client/Server As Defined by Vendors

From the vendor perspective, a wide variety of client/server definitions exists. In fact, INPUT believes that many vendors' client/server definitions are self-serving and that the definitions often merely restate current product architectures in client/server terms so as to present an apparent offering to this growing market.

Below are examples of how vendors are defining client/server architectures. Note that these definitions do not all reflect shared application processing as defined in this report. They do reflect how these vendors are adapting their existing software products to the market's request for distributed functionality.

- *RDBMS vendor* - Client/server computing allows a separation of client applications programming from the data base server, using SQL to pass transactional information between the two. The application processing is done on the client and the server satisfies the client's request, passing the data to the client.

- *PC applications software products vendor* - Client/server divides a computer system into a front end and a back end. The front end (or client) performs calculations and screen displays, and the access and updates are done by the back end, or server.

- *Mainframe applications software products vendor* - In client/server applications, the desktop unit does simple edits and the mainframe server does sophisticated edits, runs I/O programs, validates transactions, updates the data, maintains the data base, and sends transaction results back the client.

- *Systems integrator* - Client/server is an environment in which the business need is satisfied by an appropriate allocation of the application processing between the client and server processors. The environment is typically heterogeneous. The computer equipment and software of the client and server processors will usually be different. Communication between client and server uses a set of well-defined standard Application Program Interfaces (APIs) and Remote Procedure Calls (RPCs).

INPUT believes it is important to make a distinction between the first and fourth options of the functionality continuum of Exhibit III-1, where there is no shared processing, and the newer second and third options in the exhibit, where the processing responsibility is shared. Because this distinction has not been adequately made in the marketplace, users are confused about what a client/server architecture really is.

Within the framework presented in Section A—in which the processing is divided and shared between the client and server—vendors' methods of accomplishing a client/server architecture vary. Two contrasting examples are shown in Exhibit III-4.

For vendors with an existing installed base of customers, how they divide application processing is likely to depend on their original orientation. For example, vendors that have traditionally offered mainframe-based software are more likely to emphasize server processing functionality (the second example in Exhibit III-1, Client/Server Functionality Continuum). Newer vendors, or vendors with a workstation or PC orientation, are likely to emphasize client functionality (the third example in Exhibit III-1).

In the Dun & Bradstreet model, the client does simple edits and the server does sophisticated edits, runs the I/O programs, validates and sends transactions back to the client. Server-enforced integrity uses triggers and stored procedures to guarantee that business rules are followed no matter how a table change is initiated. The server also manages the executable code. One of the advantages of this type of model is minimization of network traffic.

EXHIBIT III-4

Client/Server Architecture Implementation Vendor Examples

Vendor	Application		Client Function	Server Function
	Name	Description		
PeopleSoft	PS/HRMS	Cross-industry Human resources (payroll, personnel, benefits)	Data access graphical presentation reporting options, most of the application logic, some data management, customization tools	Data base, some data management
Dun & Bradstreet	Financial	Cross-industry accounting	Data access, graphical presentation, reporting environmental executes some of the application logic, distribution, custimzation tools	Data base, all data management, high volume transaction processing

In the PeopleSoft model, the resident presentation layer and most of the business rules and logic are on the client. The data base is on the server, while data management resides on both client and server.

Employee data is interactively entered from the client and the client processes validation logic and other functions relative to the data being updated. The server handles only the heavy processing functions such as batch payroll processing. The advantage of this type of client/server model is in being able to use a lower cost platform for much of the processing.

The difference between these two examples is one of perspective. If you start with a mainframe application, you can distribute some of the processing (and data) to a more appropriate (cost-effective) level in the processing hierarchy, but essentially still retain central control. If you start with a desktop computer application that needs data, you get the data you need and retain control of both your application and the desktop unit.

This is a non-trivial difference of perspective that can lead to both technical and political definitional difficulties, because a significant part of a client/server implementation is essentially a power struggle. Generally, there is a best, pragmatic design solution. Frequently, however, there are competing control (or political) alternatives. Neither position is necessarily correct or incorrect.

D
Client/Server As Defined by Users

The variety of definitions that users have for client/server is even more diverse than vendors' definitions. INPUT believes the reason for the diversity is that users reflect the definition of client/server provided by their vendors and at the same time they incorporate their own orientation and biases.

Below are examples of user definitions of client/server. As is true with the vendor definitions, users' definitions do not all reflect shared application processing. Users define client/server as:

- Applications residing on a central server along with data bases and print files
- A computing environment where data is centralized and processing happens on a decentralized PC
- A central data base on a mainframe, minicomputer or central PC; clients run applications on other computers that have access to the central data base
- Server houses DBMS, does data base processing; client manipulates results independently of the server
- A centralized bank of information that can be segmented and processed in smaller chunks on an individual workstation
- A LAN-based system whereby a workstation acts as a front-end processor to the data base; the workstation handles all the I/O and all read/write calls
- Splitting an application into two parts, each part assigned to a resource best suited to handle it
- Workstation makes requests of a server, server responds to request
- Workstation performs a task and shares data which resides on a master server
- Any time you have one machine requesting services of another machine
- Anything that's providing information to anything else

Two user-designed client/server examples are described below. The first example typifies the second type of client/server architecture portrayed in Exhibit III-1, where little or no application code is ever resident at the client. The second example typifies the third type of client/server architecture portrayed in Exhibit III-1, where some application code is always resident at the client.

- *Strong server functionality* —A user-developed example of a client/server architecture with strong server functionality and little processing done on the client is a *data visualization* application in use at a large research institute. The server is a Silicon Graphics workstation that houses the applications software and does most of the data processing.

  The clients are PCs and Macs. In this example the client does very little processing, but provides the user with a display of the required information. Data is requested from the server for additional processing, but this is secondary to the graphical representation function.

- *Strong client functionality* —An example of a client/server implementation with strong client functionality is a *semiconductor test process* application implemented by a large aircraft manufacturer. The objective of this client/server implementation is to store all project data in one central location for easy access by all program personnel. In addition, because engineers solve problems iteratively, they don't want to have to rely on other people for data querying or report production.

  In this example the server, a RISC workstation using Ultrix, runs the data base. The data base is a repository for a large portion of the project data, quality information, work-in-process information, functional and parametric test results, semiconductor process information related to building of the devices, cost information and assembly information. The server sends specific information about a semiconductor test process, costing information or customer information to the client upon request.

  The server is accessed by 15 clients. The clients are MicroVAX and Sun workstations, and Macs and PCs that conduct functionality and operability tests as well as run the day-to-day operations of the test lab.

  Internally developed semiconductor test applications software resides on the clients, as well as several different query tools, spreadsheets, data visualization tools and electronic publishing software. Raw data also resides on the client, is reduced by applications software that resides on the client, and then is sent to the data base on the server.

E

Conclusions About Client/Server Definitions

Client/server, in its broadest sense, encompasses anything from a nonintelligent terminal accessing a host computer to an intelligent workstation accessing a nonintelligent file server. However, the newness of the client/server concept is not in these two extremes, but in the functionality alternatives that lie in between—*where the application processing is shared between client and server.*

This wide variation in the perception of the client/server concept is responsible for much of the inconsistency in client/server application and product definition to date because:

- It allows vendors to be able to use the term in a self-serving way. By describing their products as client/server they are able to advantageously position them, thereby enhancing their salability.

- It confuses users who are less interested in the fact that any given solution embodies client/server attributes and more interested in the implementation that makes the most sense from an economic and functional point of view.

In the remainder of this report, INPUT will focus on the narrower and newer definition of client/server, where application processing is shared. INPUT has selected this focus because it believes that shared processing is what will leverage the newer computer equipment technology and bring expanded functionality and price/performance benefits. Shared processing is also what will cause the most change in both the user and vendor environments.

User Experiences and Expectations

This chapter presents findings and an analysis of interviews with companies that have at least one client/server implementation under way or planned for the near future.

INPUT elected to identify client/server architecture implementors as firms that have or plan to have client/server applications where the application processing is shared between a client and a server. Implementations fitting this description were difficult to identify. Even among the nine identified client/server users in this survey, INPUT questions, in a number of cases, whether or not the processing is actually shared in the way described in Chapter III.

Although many respondents indicated that they had client/server implementations, when they were queried further it became clear that they did not have client/server applications as INPUT has elected to define client/server. These firms had downsized an application, implemented a PC LAN-based application, and/or replaced their nonintelligent terminals with personal computers and added a GUI, none of which by itself is client/server.

Identifying client/server implementations was not the only challenge INPUT encountered in its user research. Other challenges were:

- Only one-third of those respondents with client/server implementations had an idea of how much had been spent or will be spent on such implementations.

- Three out of every four of those with client/server implementations indicated that their organizations did not have client/server strategies, did not have one person or organization spearheading its implementation, and did not know what applications were most likely to be migrated to client/server next. Only two companies were in the process of thinking about a strategic client/server direction.

- There was nothing inherently different about the decision to implement a client/server implementation than any other application solution decision.

- Vendors were not selected because they provided a client/server architecture, but because they had the best solution.

- A pattern of kinds of companies that implement client/server—either by type of industry sector, or by company revenue size, could not be identified.

- A pattern of kinds of companies implementing client/server architectures based on centralized or decentralized IS functions was not apparent.

INPUT therefore concludes that a distinct market for client/server software products and services probably does not exist. As is true with all new technologies, client/server architectures are likely to be implemented first by companies that are "early adopters" or by companies that are undergoing change that prompts corresponding change in the supporting technology infrastructures. Client/server architectures are also likely to be implemented by companies that are in a difficult competitive environment and that have fully depreciated solutions.

The rest of this chapter is organized as follows:

- Section A describes the characteristics of companies implementing client/server architectures that were interviewed by INPUT.

- Section B presents and analyzes reasons respondents gave for implementing or not implementing client/server architectures.

- Section C presents and analyzes the benefits and drawbacks, according to the respondents, of implementing client/server architectures.

- Section D analyzes responses about future plans for implementing client/server architectures.

- Section E presents INPUT's conclusions regarding user experiences and expectations.

Vendor comments about client/server users are also included in this chapter. Their comments are noted so as to keep them distinct from findings of INPUT's user survey.

A
User Characteristics

1. Types of Companies and Applications

Respondents' company types and client/server applications are listed in Exhibit IV-1.

EXHIBIT IV-1

Respondents' Company Type and Client/Server Application

Type of Company	Application
Food processor	Warehouse automation
Freight shipper	Financial system
Aircraft manufacturer	Semiconductor test process
Research	Data visualization
Banking	Financial instruments
School district admin.	Student system
Engineering services	Quality control, CAD/CAM
Utility	Work management system

- Industry sectors represented are process and discrete manufacturing, transportation services, research services, engineering services, education, and utilities.

- Companies range from having a highly centralized primary computing environment (as is the case with the freight shipper) to a highly decentralized primary computing environment (as is the case with the bank).

These responses suggest very little about the types of companies implementing client/server solutions. However, additional survey data suggests that companies implementing client/server are likely to have these characteristics:

- Information technology is considered a key to future company success.

- The company is willing to forge new directions. A food processor, for example, recently hired a new IS director to "take them into the next decade." And the freight shipper hired a new systems planning director to "help the firm get into client/server computing."

In each case, the client/server application is a production-level system used by professionals.

According to vendors interviewed by INPUT, client/server architectures are likely to be implemented first by the banking and finance, insurance, and manufacturing industries. Also, according to vendors, client/server solutions are likely to be used by highly paid professionals for the purpose of expediting customer response. INPUT survey results neither confirm nor disprove these vendor comments.

2. Description of Client/Server Implementations

Exhibit IV-2 presents descriptions of respondents' client/server implementations showing server and client hardware platform and function.

- Most of the applications software products were purchased. The ones that were developed internally most closely fit the definition of client/server architecture where the application logic and processing is divided.
- An equal number of UNIX workstations and personal computers function as server platforms. Client platforms are predominantly 286-based PCs. UNIX workstations and Macs are also clients. In two instances, mainframes are the server.
- The server function is data base maintenance and management; clients process part or all of the application.

3. Size of Implementations and Expenditure Levels

Within the companies identified by INPUT as client/server implementors, the number of current client/server installations ranged from 2 to 22, and the number of users, or clients, per installation ranged from 40 to 200 (see Exhibit IV-3). The average number of users was 120.

According to respondents who had plans for future client/server implementations, the size of their efforts were expected to double within the next two to three years. Thus, these respondents have, or are expecting, positive results and will continue with client/server architectures.

EXHIBIT IV-2

Respondents' Client/Server Implementations

Application	Server Platform	Server Function	Client Platform	Client Function
Warehouse Automation (Purchased)	• 486 DOS	DBMS and network Functions (DBase3, Novell)	• 286 PCs • Windows • Hand-held radio devices	• Inventory Transaction Processing
Financial System (Developed)	• RISC 6000 AIX • Mainframe as server to RISC 6000	DBMS Functions (Oracle)	• 286 PCs, OS/2	General Ledger, Accounts Payable, Accounts Receivable transactions
Quality Control (Purchased)	• Various UNIX workstations	• BOM Explosion • Data base maintenance (Oracle, Sybase, Ingres) • Interfaces to Purchasing	• PCs • Macs • UNIX Workstations	• MRP Application • Scheduling/ Rescheduling
Semiconductor Test Process (Purchased)	• DEC RISC • Workstations	• Data base maintenance (Oracle)	• 286 PCs • MicroVAXes • UNIX • Workstations	• Functionality and operability tests
CAD/CAM (Purchased)	• VAX • PCs (OS/2)	• Parts data base • Spec. sheets • All that supports CAD system (RDB, Dbase)	• Various PCs • VAX workstations	• XWindows • Design & manufacturing specs.
Data Visualization (Purchased)	• Silicon Graphics • Workstations • UNIX	• Modeling software • All users' data files	• PCs and Macs	• Graphical representation, simulation, run codes, code development
Financial Instruments (Developed)	• PC (OS/2)	• Various RDBMSs, Excel, Word process., Lotus Notes	• PCs	• Build and track financial instruments
Student System	• PCs (OS/2)	• Student data base	• 286 PC	• Student record transactions
Work Management (Developed)	• IBM mainframe (MVS)	• Data base maintenance	• PCs, OS/2	• Plans, schedules

EXHIBIT IV-3

Respondents' Current and Future Client/Server Implementation Size

Type of Company	Current		Within Next 2-3 Years	
	Number of Installations	Number of Users	Number of Installations	Number of Users
Food Processor	4	40	No specific plans	
Freight Shipper	0	0	10-20	Several 100s
Aircraft Manufacturer	2	130	No specific plans	
Bank	6	200	9	300
School District Admin.	22	100	70	200-300
Engineering Services	6	50	6	100
Utility	1	200	3	500

Of the respondents implementing client/server applications, only one-third were able to answer questions about current and future expenditure levels. They indicated that:

- The expenditures on client/server implementations would increase from 0-10% of total IS expenditures in 1992 to 15%-90% within the next 2-3 years. The large range of the share of total expenditures suggests that some user organizations are progressing slowly, whereas other organizations view client/server architectures as so beneficial that they are migrating practically all applications to that environment.

- Computer equipment expenditures accounted for between 50% and 75% of the total client/server expenditures, and applications software products accounted for between 18% and 25%. The rest of expenditures were unspecified.

B

Reasons for Implementing or Not Implementing Client/Server

1. Reasons To Implement Client/Server

Respondents were asked why they selected their (client/server) application as opposed to any other applications software product. Their responses are listed below:

- One-third of the respondents indicated that the solution was the best response to an RFP.
- Another third favored more local control over data and applications.
- Two respondents indicated that the computer platform led to the selected applications software product. One respondent purchased the applications software product because it ran on smaller hardware platforms and therefore reduced costs. Another respondent purchased the application because it was replacing nonintelligent terminals connected with intelligent PCs to be connected to a server.
- One respondent simply cited reduced costs.

These responses suggest that the software products were selected because they met the need and were competitively priced. The fact that they used client/server architecture really had nothing to do with the decision process. They just happened to be client/server.

INPUT believes that client/server applications are not being actively sought out; a number of different solutions could have provided reduced costs, for example, or easier data access. Client/server is a grouping of technologies (GUIs, data bases, LANs, applications software and customization tools) any one of which could have provided a solution.

In fact, only one company knew prior to implementation that it wanted a client/server product. In all other cases—as one respondent put it—client/server "just sort of evolved."

2. Reasons Not To Implement Client/Server

Of all those interviewed, the 64% who were not implementing—and had no plans to implement—client/server architectures were queried about their lack of interest in that capability. Responses are summarized in Exhibit IV-4.

EXHIBIT IV-4

Respondents' Reasons for Not Implementing Client/Server Architectures

Concern	Those Not Implementing Client/Server (Percent)
Lack of experience	44
Don't know how to support	19
Too large an undertaking	13

- The most frequently cited reason for not implementing client/server architectures is lack of experience with its component parts, including GUIs and RDBMSs. Specific responses relating to lack of experience include:

  - Client/server architectures are complex, involving a "mix and match" approach to systems design, using products and technologies from a wide range of vendors.

  - Issues such as data integrity, distribution of new software releases, and management of a multivendor network are too difficult to deal with.

- The second most frequently cited reason for not implementing client/server architectures is that respondents do not know how to support client/server technology, nor do they believe users are prepared to take on systems management responsibility themselves.

- The third most often cited reason for not implementing client/server architectures is that it is too large an undertaking. INPUT interprets this response to mean that it is simply too large a task technologically, in which case it could be combined with the first reason—lack of experience. Another consideration is that it may require too large a hardware and software investment.

Other reasons given for not implementing client/server architectures were that there were concerns about data security; there was a bias toward IBM mainframes; LANs are considered inappropriate for the environment (oil rigs); and that client/server has never been given any thought.

Several respondents indicated that client/server was risky, in that the expected benefits may not materialize and that it is not supported by their organizations.

All of these responses indicate a need for information, education and client/server support services.

C
Benefits and Drawbacks

1. Anticipated Benefits

Even though client/server architectures are not being actively pursued as solutions because they are client/server, once they are installed respondents expect the benefits listed in Exhibit IV-5.

EXHIBIT IV-5

Respondents' Expected Gain from Implementing Client/Server Architectures*

	Those Who Have Client/Server Installation (Percent)
Lower costs	89
Better/faster application development	56
Easier systems management	45
Faster data access	45
Other	43

* Multiple responses per respondent

- The most frequently mentioned anticipated benefit is cost reduction.
  - In cases of downsizing, computer equipment cost savings come not from having to purchase a larger central computer, but rather from moving applications software to several smaller platforms.
  - In the case of replacing standalone desktop computers with a LAN and client/server-based solution (upsizing), cost savings can be attained through reduced systems administration costs.

  The extent to which these cost savings are being realized, however, is unclear. For example, the research services firm that downsized to a client/server data visualization application indicated that support costs have increased dramatically. Support for client/server will become more cost effective as standards evolve.
- The second most frequently mentioned anticipated benefit is better/faster application development. For example, a utility company is using CASE technology to develop client/server applications. The CASE tool does not specifically have the capabilities to assist with division of application logic between two platforms. However, it does assist with development of an application that will take advantage of OS/2. It will also reduce maintenance efforts and costs.

INPUT believes respondents are not using client/server-architected application development tools, nor are they referring to tools that are specifically for the development of client/server applications software where the application logic is divided. Thus the responses merely reflect that the

benefits of a new breed of application development tools, including CASE—which typically resides on workstations or PCs rather than mainframes—are gaining recognition. Users perceive these to be "client/server" tools.

- Four respondents, who are migrating from standalone PCs to a networked environment, indicated that ease of systems management was an anticipated client/server architecture benefit. As would be expected, respondents who are implementing client/server architectures through downsizing did not mention ease of systems management as a benefit.

- Four of the respondents expected faster data access by end-user organizations.

Other benefits respondents expected to gain through implementing client/server architectures were:

- Ability to keep up with the state of the art
- Increased availability of the application
- Easier-to-use interface
- Replacement of old computer equipment

These other anticipated client/server benefits may in fact have little to do with client/server architectures where the application logic is divided. For example, adding a GUI to a desktop computer, downsizing (without necessarily implementing client/server), deploying better development tools (that may or may not be for client/server applications), or merely purchasing a more powerful desktop may also provide the benefits sought.

As with the responses given for *not* implementing client/server architectures, INPUT believes that responses about anticipated client/server architecture benefits are indicative of a user community that not only doesn't have a clear understanding of what client/server architecture is, but also does not clearly understand what its benefits are.

Regardless of the confusion surrounding client/server architectures, respondents are satisfied with the results of their implementations. On a scale of 1 to 5, where 1 is very dissatisfied with the results of client/server and 5 is very satisfied, client/server averaged a score of 3.9. This rating implies that the benefits of reduced costs, better/faster application development, ease of systems management and ease of data access are in large part being met.

2. Client/Server Drawbacks

Client/server drawbacks, or obstacles incurred while implementing client/server, are listed in Exhibit IV-6.

EXHIBIT IV-6

Client/Server Inadequacies

	Those Who Have Client/Server Installation (Percent)*
Lack of systems management tools	78
Increase in support requirements (UNIX)	75
Increase in user training requirements	45
Client not powerful enough	44
Lack of application environment	22
Other	67

* Multiple responses per respondent

- The most important client/server drawbacks are the increase in support requirements and lack of systems management tools. Even respondents that anticipated the benefit of ease of systems management indicated these were key drawbacks. One respondent indicated that management did not take client/server architecture seriously enough and did not anticipate the need for additional (decentralized) support.

- Four respondents found the client hardware platforms inadequate in that they lacked capacity to operate a GUI, and the application processing exceeded what they had expected.

- Among other responses, a freight shipping firm indicated that expected benefits might not materialize.

3. IS Organization Restructuring

In general, respondents do not want to restructure their IS organizations. Although they are not planning to reorganize, half of the survey respondents do acknowledge that client/server implementation will be accompanied by change. Anticipated changes include:

- The requirement for new knowledge about networking, UNIX and application development on the part of IS organizations
- End-user organizations will need to learn how to use the new applications, e.g., Windows, as well as how to support their systems.
- New ways of doing business will evolve (re-engineering).

The capital markets group of a large bank has hired an industrial engineering firm to assist in the transition to—and promotion of—client/server. This group is preparing to become more responsible for its own applications development and technology transfer to the end user.

D
Future Plans

In research separate from this project, INPUT queried IS management and vendors about the timing of significant client/server implementations, the extent to which major applications would be deployed using client/server, and when client/server would be the predominant architecture. (Note that the definition of client/server used in this research included all four possible implementations, thus examining a larger population than the two implementations considered for this study.) The results are summarized below. The full research project results are in INPUT's report, *Putting Downsizing in Perspective*, published in February 1992.

Exhibit IV-7 plots the years in which significant client/server applications will be installed. Considering the variety of definitions on the part of vendors and users, the nearly unanimous results are not surprising.

However, the fact that over 50% of IS managers and vendors specifically state that this will occur by 1993 is significant. Then, by 1995, there is a strong conviction that client/server architecture will have become an important part of the information systems infrastructure.

EXHIBIT IV-7

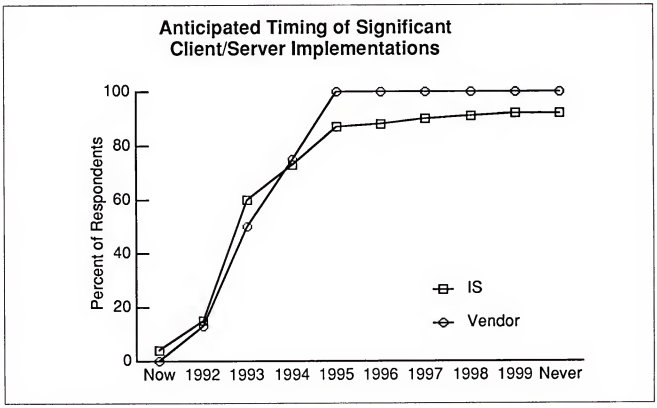


Exhibit IV-8 shows that approximately 25% of IS management feels that at least some major business applications will be converted to client/server architectures by 1993. Vendors are unanimous in their belief that this will occur by 1995.

Exhibit IV-9 shows that the majority of IS management feels that client/server will become the predominant architecture for new applications in the same timeframe in which major business applications are converted to that architecture.

The percentage of IS and vendor managers who feel that client/server will be the predominant architecture for new applications is practically identical through 1994, when slightly over 70% of both respondent sets agree with the statement. By 1995 and beyond, all vendors—and more than 90% of the IS managers—believe that client/server architecture will dominate new implementations.

Thus, by 1995, approximately two-thirds of all new systems development will be done using a client/server architecture. This represents a substantial architectural shift that obviously must be supported with appropriate computer equipment and systems software.

EXHIBIT IV-8

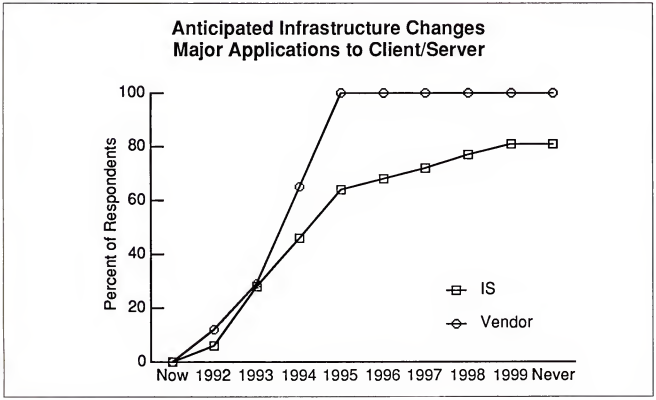
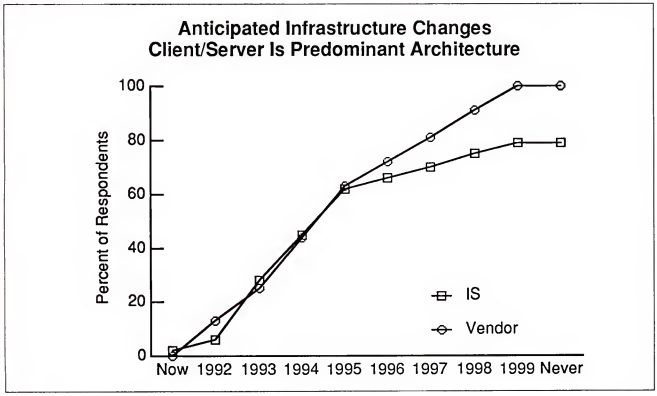


EXHIBIT IV-9



E
User Conclusions

A pattern of types of companies and types of applications does not appear to exist for client/server architectures. Client/server architectures are being implemented by varying end-user and IS organizations within a diverse range of companies. These companies are diverse not only in the industry sectors they represent, but also in the kinds of client/server architectures they are implementing.

In all implementation cases except one, a client/server solution *per se* was not sought out; it "just sort of evolved"—the impetus for it coming from user organizations that had a need to share information or IS organizations that did not want to spend money on a larger hardware platform.

Both downsizing and integration of workstations/PCs (upsizing) are driving the movement to client/server. In cases of downsizing, the primary motivation is to reduce computer equipment costs.

In cases of upsizing, the major anticipated benefit is not computer equipment and software cost savings. In fact, implementors are skeptical about these potential cost savings. The benefits will come from centralizing—that is, support and maintenance will become more efficient. However, upsizing can only go so far until, again, systems and network management issues loom as distributed processing begins to unfold.

Of concern to both implementors and non-implementors are the increased support requirements and end-user training needs necessitated by a decentralized environment. Decentralized support is implicit in client/server architectures, and adequate systems and network management tools are not yet available for this task.

Vendor Perspective

Many leading vendors claim to have client/server products and strategies. Examples are provided in Exhibit V-1. The extent to which these products or services are in fact client/server—in the newer sense of the architecture—is ambiguous.

EXHIBIT V-1

Examples of Leading Vendor Involvement in Client/Server Architectures

Vendor Level of Involvement	
Software Products	
Lotus	New business model built around network computing (Notes and cc:Mail)
Microsoft	Windows and Windows NT
Dun & Bradstreet	Strategy shift to client/server where application logic is divided. Products will ship by year end.
Computer Associates	Strong shift to Windows-based products
Oracle, Ingres, Sybase, Gupta	RDBMS is dominant server engine
Computer Equipment	
IBM	Placing more emphasis on high-powered PCs
Hewlett-Packard	Emphasis on corporate-wide data access
Professional Services/ Systems Integration	
Andersen Consulting	Most proposals contain at least some element of client/server computing
SHL/Systemhouse	Client/server is an attribute of 50% of projects

A
Vendor Strategies

1. Software Vendors

a. Applications Software Products Vendors

The majority of applications software products vendors claim to have client/server products available or under development, but many of these products may simply be modified versions of existing software to which a GUI front end has been added. These are not client/server products in the narrower, newer sense where the application logic is divided. Vendors are just beginning to provide the latter types of applications software products.

Regardless of what definition of client/server is applied, applications software products vendors' so-called client/server strategies have several elements in common. All strategies, for example, include broad market appeal through portability across multiple vendors' hardware platforms and operating systems, and multiple RDBMSs.

Another strategic element of client/server applications software product sales is the offering of a development tool set for use on a client platform. The tool set is used for customization as well as development of additional applications.

As is the case with UNIX, initially smaller vendors are quicker to develop client/server-architected products, and their market reach will be limited because of their limited resources. As technology solutions become increasingly complex and as corporations move toward enterprise-wide computing, it will continue to become more difficult for small systems and applications software companies to succeed by themselves.

The following three companies have product offerings fitting the narrower definition of client/server-architected applications software products, where the processing is shared.

- PeopleSoft Inc.—PeopleSoft's first product, PS/HRMS (1988), was designed in a 4GL environment and complies with IBM's SAA. A fully integrated line of financial accounting applications is due out this year.

  In PeopleSoft's client/server framework, most of the business rules are on the client; the server does data base storage and retrieval. PeopleSoft servers include Gupta Technologies Inc.'s SQLBase for OS/2, IBM's DB2 for MVS, Microsoft's SQL Server on OS/2, Oracle Corp.'s ORACLE Server on the HP 9000 running HP/UX, Digital's RdB on the

VAX VMS platform (future), and Hewlett-Packard's Allbase/SQL server on MPE/XL (future). Clients can also access IBM's DB2 running under MVS using a Gupta-supplied connectivity product. PeopleSoft will continue to broaden its server base.

Although PeopleSoft's products have been client/server since inception, the company is positioning its products based on features and functionality, rather than client/server specifically. Strategy elements also include its strong application development tool set, PeopleTools.

- Dun & Bradstreet Software Services—DBSS announced its client/server strategy last year. Products will begin to appear by year-end 1992. DBSS will incrementally deliver a single client/server product line for ease of migration for current customers. Components of the client/server strategy include relational SQL-based technology, graphical user interfaces—initially using Microsoft Windows 3.0—and groupware-enabled functionality.

  DBSS' intention is to provide client/server applications that are high-performance, high-quality transaction processing applications.

  Dun & Bradstreet's approach to client/server technology is the distributed function model, in which most of the business rules are on the server. Where there are large numbers of users accessing a single server, this approach keeps network traffic to a minimum. It also allows for server-enforced integrity, which uses triggers and stored procedures to guarantee that business rules are followed no matter how the table change is initiated. This approach to client/server computing makes sense for a company like Dun & Bradstreet, whose customers are mainframe-based Fortune 500 companies.

  DBSS will use Powersoft's PowerBuilder tools to build its next generation of client/server applications software products. Under a pact with Powersoft Corp., DBSS has licensed PowerBuilder and will sell and support the tools. In exchange, Powersoft, which is also a Microsoft Corp. SQL Server partner, will receive royalties.

  A challenge for Dun & Bradstreet, and all other software companies that are rewriting their products, is minimizing application development time without compromising product integrity; while new products are under development, would-be customers are likely to wait on the sidelines and not buy anything from their current vendors, or switch to other vendors.

- Fourth Shift Corporation—This company was one of the first companies to bring client/server applications to market; Fourth Shift has had a client/server manufacturing series of applications software products since 1985. It is DOS-based and will soon be running on HP's UNIX environment as well. In Fourth Shift's client/server model, the process-

ing function is divided between a back end and a front end. Much like PeopleSoft's product, the back end is an intelligent data base server that controls all data access and updates. The front end is the user's intelligent workstation, which performs calculations and creates screen displays. All of the application logic runs on the desktop.

b. RDBMS Vendors

Even among RDBMS vendors variety exists as to the purity of client/server offerings and the approach taken.

- ASK/Ingres—Ingres was the first RDBMS company to develop client/server capabilities; its Ingres/Net was delivered in 1983 to provide client/server connectivity. The Ingres strategy is to maximize the intelligence of the data base as opposed to placing integrity rules on the client. Ingres Intelligent Database, the foundation of the INGRES product family, allows businesses to model their operations in the data base by managing knowledge (business policies and procedures) and objects as well as conventional data.

  The company's strategy is also to move toward enterprise-wide applications, where data bases are distributed throughout an organization and can be used for individual areas that can be linked together, when a corporation is ready for distributed processing.

  Ingres/Windows 4GL and Ingres/Vision are GUI- and character-based development kits that allow users to implement client/server applications across a number of heterogeneous platforms using the same tool. Ingres/Windows 4GL is available on UNIX, VAX and Windows. And Ingres/Vision runs on UNIX and DOS. Ingres/Windows 4GL supports multiple Windows managers, including Motif and Microsoft Windows.

  Ingres has partnerships with EDS (EDS has a 20% investment in The ASK Companies), with multiple hardware vendors, and with tool vendors, including Information Builders and Verity.

  Although Ingres is currently the most active ASK company in the client/server arena, ASK Computer Systems is completely rewriting its MRP software to run within a client/server architecture; its direction is "Enterprise Resource Planning," which will be an enterprise-wide information system.

RDBMS companies must continue to aggressively recruit independent software vendors to deploy applications for their data base platforms. They will also have to continue to forge partnerships with hardware vendors for wide-scale availability across a broad range of hardware

platforms. The extent to which RDBMS companies are successful in these endeavors will have a great deal of impact on the growth of client/server architectures. Of course, hardware vendors will want to do the same to assure usability of their platforms.

c. Applications Development Tool Vendors

Due to the lack of applications software products on the market, development tools are playing an increasingly important role in selling the client/server concept. Tools play a leading role in RDBMS sales in particular.

At least a dozen tools exist for developing software components within a client/server architecture. Lack of tools is not a growth inhibitor for client/server use; nonetheless, users lack familiarity with these products and the know-how to use them in combination with one another.

- Powersoft—This company was founded in 1974 as a custom software development organization (originally known as C Computer Solutions, Inc.). It develops and markets two software product families: GrowthPower, an integrated set of manufacturing and financial applications, and PowerBuilder, which is its programming environment.

  Powersoft introduced PowerBuilder last year. It is a Windows 3.0-based SQL front-end development environment that's designed to be used by teams of programmers. The product allows programmers to choose between using a traditional procedural language or an object-oriented, event-driven approach to building client/server applications. Dun & Bradstreet Software Services has bought part of the company.

d. Systems Software Products Vendors

A software battle will rage between operating systems—including Windows NT, UNIX, and IBM's OS/2—that will vie for leadership position as the server operating system of choice. Microsoft Windows NT will play a leading role and will initially be positioned as an OS/2-like server running on Intel and also on the ACE consortium chip.

Systems software vendors have yet to develop and introduce systems management and network management products for decentralized solutions. However, LEGENT, and perhaps Candle, show signs of moving in that direction. For example, LEGENT's LANspy, introduced in early 1992, gathers performance statistics about various clients on a LAN, as well as the server and the compatible micro/mainframe gateway, and sends it to NetSpy on the central mainframe. In this example, the mainframe still obviously plays an important role.

2. Services Vendors

Services vendors can assist corporations in determining the relative timing and magnitude of benefits derived from client/server processing and selecting the migration path that captures high value-added applications first.

The majority of the current market need to integrate existing software with new client/server software is met by smaller regional professional services firms and systems integrators who specialize in a narrow band of products. Other than the hardware and software vendors themselves, it's the smaller services vendors who are largely responsible for client/server consulting and training at this point. Andersen and SHL Systemhouse are the most active large services firms in client/server matters.

- Andersen Consulting, through its New Age Systems organization and Network Solutions group, provides client/server systems integration and professional services. Client/server activities primarily involve work with corporations that are re-engineering their business processes and that need assistance in defining their needs.

  Fundamental to Andersen's client/server capabilities is its repository-based Foundation for Cooperative Processing (FCP), a full CASE environment for client/server application development. Foundation supports OS/2, DOS Windows, VAX, Motif and UNIX as the client, and OS/2, MVS, UNIX and VAX VMS as server platforms. Client and server applications on different platforms are linked via FCP's Distribution Services.

  Distribution Services support several standard networking protocols and operating systems, including LU6.2, Novell, LAN Manager and LAN Server, and TCP/IP and DECnet. The future of FCP includes support for additional client platforms, server platforms and communications protocols.

  Andersen indicates that all proposals contain at least some element of client/server computing.

- SHL/Systemhouse—This company works as the prime systems integrator in client/server projects, with responsibility for the application and technical architecture and delivery of the solution. This usually involves the integration of existing products with custom-developed components.

  Specific services provided include user interface design, existing application integration, production selection, functional decomposition, and remote LAN management. Systemhouse is also typically responsible for developing standards for individual users and developers of the applications.

In about 50% of the company's new applications work, at least some client/server technology is being implemented.

3. Computer Equipment Vendors

The parallel trends of downsizing from mainframes and upsizing from standalone PCs meet head on in what INPUT identifies as a "technological battle zone." This technological battle zone is where minicomputers, RISC workstations, and PCs are waging war to become the servers of choice in the new IS infrastructure. It will be a fierce battle replete with major issues, any of which could be the subject of additional major research efforts.

The combination of downsizing from mainframes and upsizing from relatively independent intelligent desktop computers to more complex network architectures means that the role of midrange computers should become more, not less, important during the 1990s. Hardware price/performance (MIPS) is the primary weapon being used to wage this war, and there have already been many casualties as computer processing power becomes a commodity.

- IBM—IBM's client/server products are a mix of OS/2 and AIX with the intention that the mainframe will be the enterprise data base server and enterprise communications gateway, and potentially the security server (RACF gateway). Other servers are AS/400 and RS/6000. Nonetheless, INPUT believes that IBM is inhibiting the adoption of client/server architectures because of its centralized mainframe and nonintelligent terminal orientation and because the company continues to be slow to change product strategies.

- Digital—DEC is in a good position to capitalize on client/server technology. NAS (Network Application Support) is Digital's strategy for delivery of a unified software environment that can be deployed across a wide range of systems. DEC VAX and RISC-based systems are positioned as servers. Standard SQL interfaces access data bases on IBM mainframes and distributed relational data bases in VMS and ULTRIX systems.

- AT&T/NCR—NCR's architectural framework is open (with adherence to standards) cooperative computing. Cooperative computing generally refers to two different processes that coordinate and cooperate to complete a business task. Within this framework, client/server is a structured form of cooperative processing.

  NCR promotes "rightsizing"—moving the processing power away from mainframes and toward the user. The company is in a group that has submitted a proposal for an object-oriented request broker to the Object-Oriented Standards Committee. NCR also supports OSF's distributed computing environment.

- Hewlett-Packard—HP's Cooperative Computing Systems Operation group is spearheading the company's client/server product and marketing strategy. HP uses the term client/server broadly to mean an evolving technology that allows users on any workstation to use and gather resources throughout a company-wide information network.

  Initially this group had responsibility for an integrated office system, NewWave Office. NewWave Office lets a system running UNIX, OS/2 or HP's own MPE operating system act as a server for clients that may include UNIX, DOS, OS/2 and Macintosh microcomputers. Its charter, however, has been expanded to encompass enterprise-wide solutions rather than just office solutions.

  Within HP's use of the term client/server, NewWave Office components include a worldwide E-mail system, an information access component through the use of Windows, access to an enterprise-wide document management system, a concept-based retrieval system, and a mail-enabled, object-oriented workflow system.

Unlike the traditional or mainstream software and hardware industry, a new breed of computer equipment vendors—at least new to the commercial arena—will play a pivotal role as market drivers and as a distribution channel for client/server technology and UNIX software. These companies provide computers that incorporate advanced microprocessor technologies, and include Compaq Computer Systems and Sun Microsystems. Some of their products, such as Compaq's SystemPro, are PC-compatible, yet have multiple CPUs, run UNIX, support gigabytes of storage, and support many users.

- Sun Microsystems—Sun has been involved in client/server technology since the company's inception ten years ago, and has done much to popularize UNIX and workstations in the commercial arena. It has strong hardware and networking capabilities and a solid operating system. Although still over 50% of its workstations are sold for engineering and scientific applications, it has a growing presence in financial services.

  Solaris, a SunSoft product, will compete against other versions of UNIX, Windows NT, and OS/2 as a server operating system. Sun was recently asked by IBM and Apple to join its joint venture, Taligent, but Sun has so far declined.

B
Vendor Conclusions

Demands that will be placed on vendors over the next several years—especially as they relate to open systems, downsizing and client/server—will be staggering. Vendors are undergoing fundamental changes in management perspective, company functions and structure as well as products.

In the meantime, lack of client/server applications and systems software products, and ambiguous client/server strategies on the part of many vendors leave plenty of room for entirely new vendors to enter the U.S. market. Therefore, the probable winners are not as obvious as in the past. For example, client/server—along with UNIX and downsizing—adds new issues to pricing schemes for software products, and it remains to be seen how pricing strategies will evolve.

Client/server is one of those pivotal technologies for an enduring market presence for systems and software vendors: a vendor's long-term viability may in fact hinge on how effectively it makes the transition to client/server architectures. Success will also depend upon strong alliances.

Computer equipment (the availability of powerful desktop computers and workstations) is one of the major driving forces in the move to client/server architectures, and software is increasingly driving the computer equipment purchase decision. It is therefore obvious that vendors of computer equipment and software need to work closely together.

It is also obvious that services are needed in order to effectively apply a new (complex) processing method. Thus client/server computing will encourage even further the formation of IS industry alliances between all three types of vendors.

VI

Market Analysis and Forecast

INPUT set out to define client/server products and to forecast the market. However, as we progressed, we recognized that the term client/server, as commonly used, really refers to an architecture rather than a specific product or set of products. It is a loosely defined concept which is used to describe the distribution of applications and data between multiple hardware platforms. Thus vendors and users invoke the term to describe any distribution of functions, from option 1 to option 4 in INPUT's Client/Server Application Functionality Continuum, provided in Chapter III and repeated here as Exhibit VI-1.

EXHIBIT VI-1

Client/Server Application Functionality Continuum

Option	Client Functionality	Client	Server	Server Functionality
1	Less	• No application code resident at terminal	• All application code at server	More
2		• No application code normally resident at terminal - Require load modules	• All application code at server, but some designed to be downloaded to client	
3		• Some application code *always* resident at terminal - Require code	• Some application code resident at the server, most resident at client	
4	More	• All application code resident at terminal	• No application code at server	Less

The use of the architectures described in options 1 and 4 at least promulgates experimentation by vendors and users to divide application logic between two separate computer platforms. In addition, some implementation of this form of client/server architecture is also taking place. INPUT believes that most of what is being implemented today that is termed client/server encompasses options 1 and 4.

This chapter nonetheless presents forecasts of the markets for software products and computer equipment used in the options 2 and 3 client/server architectures. Because education and support services are important aspects of successful client/server implementations, INPUT also provides a forecast for client/server-related systems integration and professional services.

To reiterate, INPUT has selected this focus because we believe shared processing will bring about the greatest change and benefit in terms of leveraging information technology.

The forecasts are derived from:

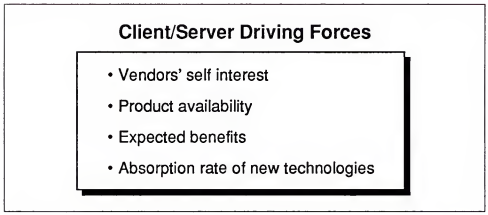
- Knowledge of overall industry-wide current and forecasted expenditure patterns for software products, computer equipment and services
- An analysis of qualitative and quantitative information obtained from interviews with users and vendors
- Internal INPUT analysis by senior staff members

A
Driving Forces

Exhibit VI-2 summarizes factors that INPUT believes will drive the adoption of client/server architectures (options 2 and 3) over the next five years.

Vendors' self interest—As indicated previously, vendors' self interest is promoting the adoption of client/server architectures in a broad sense. Self interest, however, is also an inhibiting factor.

EXHIBIT VI-2



- Vendors are capitalizing on the term client/server as a means of broadening the appeal of their current product offerings. For example, a GUI application development product vendor could consider itself a client/server vendor although there is nothing inherently "client/server" about its product offering. Or a CASE product can design and generate code for client/server-architected applications but, again, not treat the development process any differently from traditionally architected solutions.

  At the very least, use of these so-called client/server products are a first step to an architecture where the application logic is divided between a client and a server. However, nothing about them is necessarily "client/server."

- Vendors' self interest can also inhibit adoption of client/server architectures. Vendors must protect their installed base of products and existing revenue stream, and at the same time develop and begin to introduce new products. Mainframe vendors and mainframe-based software products vendors have the most to lose.

Product availability—Client and server hardware platforms are widely available and, now, affordable. So too, are LANs, operating systems and GUIs, and RDBMSs.

- However, options 2 and 3—client/server-architected applications software products—are just beginning to appear. As explained in Chapter V, INPUT could identify very few vendors with applications software products in which the application logic is divided.

- Systems and network management products that support decentralized environments and, implicitly, client/server architectures are not yet available. And as more systems management and network software vendors enter the market, the more complex data management becomes. A single source of support for all of these multivendor environments is not available now, nor is one likely to be available in the near future.

- Additional systems control, and systems and network management tools will be forthcoming, but not until the last half of the forecast period. Many elements, such as software distribution, asset management, help desk support and performance monitoring, are missing. All these functions must be performed remotely because most sites cannot justify local technical support. In the meantime, users are creating their own makeshift systems software solutions.

Expected benefits—As discussed in Chapter IV, the market is not demanding client/server architectures. The technology behind the solution is secondary. The market does, however, want lower costs and more data access.

- Reduced information technology costs—When INPUT asked respondents to evaluate expected benefits from implementing client/server architectures, lower costs was the most frequently cited benefit. However, the realization of lower costs is driven by the specific circumstances of the implementor.

  - Reduced computer equipment costs depend on whether an organization is downsizing or migrating from standalone PCs to a PC LAN environment. In the former case, lower computer equipment costs are expected through lessened use of the mainframe. Lessened use of a central computer is especially noticeable with option 3 client/server architectures. In either case, costs of a central computer can only be eliminated if all applications and data are downsized.

    In cases where users are migrating from a standalone PC environment to PC LANs, more expensive server platforms must be purchased. In both cases, it is likely that all clients will eventually need to be upgraded and this will therefore be an added expense.

  - It is unclear that the software component of client/server architectures is less expensive than more traditional software products. Because the software is more complex, it is more expensive to develop.

  - Reducing costs through easier systems management is the perspective a company or department takes if it is migrating to a networked environment. The systems management function would be centralized and therefore easier to manage. On the other hand, for companies that are downsizing, systems management becomes more difficult; end users must be trained in maintenance and care of their systems.

  - Another implicit cost reducer is savings through use of more efficient applications development. However, use of new application development tools requires extensive retraining of the development team, which is an added expense.

- The need for, and therefore the cost of, computer equipment services will potentially increase. More dependence on LANs, servers and clients, and the increase in complexity of a client/server architecture will require well-thought-out spare parts and service plans.

The extent to which vendors and users can show that client/server architectures support the goal of reduced costs will determine, to some degree, the momentum of the movement to client/server architectures.

- Local control over data and applications—End-user departments hope to gain increased applications software availability and ease of data access by implementing client/server architectures. Insofar as end-user departments are involved in purchase decisions, this driving force is significant. However, IS organizations may resist giving up their control, not only of applications and data, but also of computer equipment.

Absorption rate of new technology—Simple resistance to change and investment in existing systems are other key growth inhibitors for client/server architectures.

- Respondents acknowledge that client/server architectures will require fundamental changes in the way IS organizations will ultimately function and think, including the way applications are developed and systems are managed. Any kind of change is difficult, but especially changes of such magnitude.

- Client/server architectures may be generating awareness of the possibilities of re-engineering business functions. Re-engineering triggers changes of many kinds, not just of the business process itself. Job designs, organizational structures and management systems must be refashioned in an integrated way. Such change may be resisted.

- The strength of the existing portfolio of software and the platforms they run on is dependent not only on how long ago they were purchased (the longer ago they were purchased the more replaceable they are), but also how strongly large systems vendors, such as IBM, endorse client/server architectures. IBM presents a confused client/server front and is slow to respond to anything that threatens its mainframe business.

- Users lack not only understanding about what client/server architecture is, but also lack experience with the component technologies such as networking and integrating networks, using RDBMSs and GUIs. The component products of a client/server architecture will undergo a great deal of change, which causes further confusion, which causes potential customers to adopt a "wait and see" attitude.

- Another potential inhibitor is the challenge inherent in effectively integrating new technologies with existing systems. Insofar as client/server implementations are driven by user departments rather than IS organizations, and without regard to an overall strategy, there is the possibility of increasing the "islands of technology" dilemma. In this scenario, over time, resulting integration problems will further inhibit growth.

In summary, vendors' self interest, product availability and expected benefits are all growth promoters, but they can act as growth inhibitors as well. The fourth driving force and perhaps the strongest, absorption rate of new technology, will act as a growth inhibitor.

B
Forecast

INPUT's forecasts of client/server expenditures are presented in Exhibit VI-3. The 1992 and the "low" 1997 forecast is for option 3 client/server software products, computer equipment and services; the "high" 1997 forecast is broader in scope and encompasses both options 2 and 3 definitions of client/server architecture.

- Software products forecasts include both applications and systems software products.

- Services expenditures refer to that portion of systems integration and professional services used to assist with the development and implementation of client/server architectures.

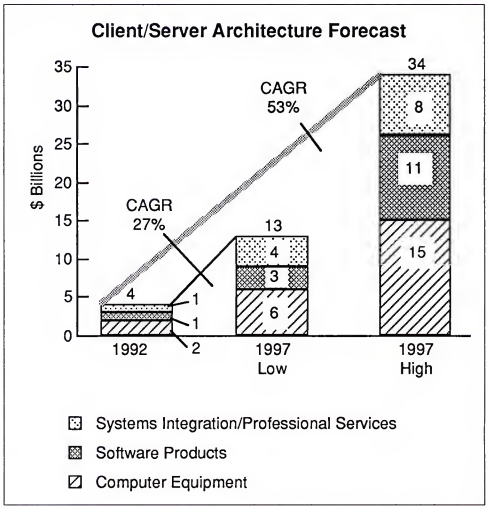
- Expenditures on computer equipment include only new products purchased explicitly for the implementation of client/server architectures.

Expenditure assumptions for 1992 are:

- Software products—The majority of expenditures are for operating systems, GUIs, and RDBMS products. Most applications are currently developed internally, because few applications software products are available.

- Services—Large systems integration and professional services firms, notably Andersen Consulting and SHL Systemhouse, are beginning to provide client/server support.

EXHIBIT VI-3



- Computer equipment—INPUT assumes that the largest portion of expenditures is for new client and server computer equipment. User interviews indicate that an estimated 60% of all client/server expenditures are for computer equipment; vendor interviews suggest that less than 5% of total computer expenditures are for client/server architectures as defined by INPUT.

  Even so, it is unclear how much is being spent on computer equipment that will be incorporated into a client/server architecture now, versus how much is being purchased with the intent, some time in the future, to implement client/server architectures.

1. "Low" Forecast

The 1997 "low" forecast assumptions are:

- The proportions of the three components—software products, services and computer equipment—will remain the same as for 1992, with the largest portion being spent on computer equipment.

- Software products—Additional client/server-architected applications software products will be available for purchase. New systems management and network administration products for distributed computing will also be available for use in client/server architectures.

- Services—As the move toward client/server architectures gains momentum, additional systems integration and professional services vendors will gain expertise; their services will be eagerly sought. INPUT believes that services vendors will be heavily called upon because internal staffs are more familiar with traditional methods of implementation.

- Computer equipment—The market will be far from saturated by 1997, and the movement toward decentralized computing will continue.

2. "High" Forecast

Following are the 1997 "high" forecast assumptions:

- Because less needs to be added to an existing architecture or environment in order to make it an option 2 compared to an option 3 client/server architecture, option 2 products will be less expensive, more readily available, and more readily absorbed by the marketplace.

- INPUT's "high" forecast assumes that expenditures on products within option 2 client/server architectures will be almost double what will be spent on option 3 client/server products, resulting in a market that is almost three times the size of the "low" forecast scenario.

- The proportions of the three components—software products, services and computer equipment—will normalize; in other words, they will parallel the expenditure patterns for the overall information technology industry.

- Software products—Option 2 applications software products will be more readily available and more readily accepted by the market compared to option 3 products. The market will not suffer as much from lack of systems management and network management products for decentralized environments because most of the application and the data will still reside on a central computer.

- Services—Option 2 client/server architectures are easier to develop and implement. Services for option 2 architectures will be more readily available.

- Computer equipment—Fewer additional resources will be required for the client. Thus, less will need to be spent on additional computer equipment, which means less resistance to purchase.

Given the forecasts above, client/server expenditures are an estimated 2% of overall expenditures now, and are forecast to grow to an estimated 8% to 20% of total expenditures on software products, services and computer equipment by 1997.

EXHIBIT VI-4

Client/Server Architecture As Percent of Total Expenditures on Software Products, Services and Computer Equipment

	1992 (Percent)	1997 (Percent)	
		Low	High
Software	<1	4	10
Services*	<1	8	15
Computer Equipment	2	6	15
Total	2	8	20

* Professional services, systems integration

INPUT estimates that another $1 billion will be spent in 1992 by user corporations on people, data communications, equipment services, other information services, facilities and overhead related to client/server architectures. Thus total expenditures on client/server architectures in 1992 are less than 1% of overall information technology spending.

By 1997, INPUT estimates, total expenditures on client/server architectures could be between $40 billion and $90 billion, or between 8% and 14% of total IT spending.

In other words, even in five years, total spending on client/server architectures—where the application logic is divided between a client and a server—will be a small portion of all expenditures. Vendor development and user adoption of client/server architectures will be a slow evolutionary process.

Conclusions and Recommendations

Client/server is a loosely defined concept that refers to an architecture that divides application logic and processing across multiple computer equipment platforms for the purposes of improving performance, increasing accessibility, reducing costs and leveraging IT investments.

The confusion surrounding the term client/server is not unlike other generalized IT concepts, such as open systems, downsizing and re-engineering. Vendors use the term in a self-serving way to refer to their existing products, regardless of what they are. Users reflect what vendors tell them, plus offer their own unique interpretation of what "client/server" means.

INPUT believes that by the end of the forecast period, the definition of client/server will either become understandable and widely accepted or that highly distributed processing will be the norm and the term will become meaningless. Either way, it is clear that an evolution to highly distributed and integrated applications environments, with elements of individual applications spread across a network, will continue.

Given this situation, INPUT concludes that a distinct client/server market does not exist. To substantiate this conclusion, companies that INPUT interviewed that are implementing client/server architectures are from diverse industry sectors, are implementing diverse applications, and expect diverse benefits depending on whether they are downsizing or integrating.

INPUT estimates current expenditures on client/server architectures, where the application logic is divided between a client and a server, to be about $4 billion. By 1997, expenditures will be between $13 billion and $34 billion, depending on how one defines client/server. (The higher forecast encompasses a broader range of possible ways to divide application logic.) By 1997, given the high forecast scenario, expenditures on client/server software products, services and computer equipment could represent 20% of total expenditures for these three categories.

The factors driving client/server architecture implementation are as complex as the issues that face users and vendors. For example, the major driving force is reduced computer equipment costs. However, computer equipment costs are not *always* reduced. Nor are costs of software products and services necessarily reduced.

INPUT's recommendation to users is to seek out those applications that are likely to be easily cost justified first. Additionally, cost reduction should not be the only goal. Another, more important goal is to leverage information technology investments. Additionally, improving the efficiency of employees and of the corporation itself should obviously be a goal.

The second INPUT recommendation for users is to begin to implement client/server architectures with an overall blueprint or IS strategy in mind. Otherwise, client/server architectures will potentially increase the so-called "islands of technology" challenge. Individual pockets of client/server architectures, implemented with little regard for the whole, could result in an eventual systems integration nightmare.

Client/server architecture is inevitable—whether it is called client/server in the future or not—because both user needs *and* technological advances point to such an environment. Therefore, vendors need to develop client/server products, services and strategies. On the other hand, they do not necessarily have to call it *client/server*. Client/server is a term that can be used to a vendor's advantage without regard for customer need or perception, and it means different things to different vendors. Over time, the term will probably become meaningless.

Vendors need to understand what empowerment at the desktop means and what it implies. A massive educational process and migration has to take place through the 1990s for client/server architectures to succeed. All types of vendors—not just services vendors—will need to educate users about the new technology and how to make the transition.

Users indicate that they need more understanding of the alternatives to and implications of client/server architectures. Systems and software products vendors are not yet providing adequate education and training, and services firms are just beginning to enter this arena.

An easy-to-follow migration strategy, as well as integration services, are required. As enterprise-wide computing gains momentum, standards will also become critical.