Database Servers

In this report:

File Servers ..... -102
Database Server Advantages ..... -102
SQL Links ..... -103
What SQL Database Servers Are Available ..... -103
SQL Server Differences ..... -104

Editor's Note

A database server allows a user application (client) running on a computer to access the database management (server) services maintained on another computer. This report contrasts database servers with file servers, discusses SQL links, and describes what SQL database servers are now available. For information on a related topic, see Report 713-101, "Client/Server Computing."

Report Highlights

During the 1990s, organizations great and small will be adopting cooperative computing—an information processing environment where both the applications and associated data are distributed among local-to-global networks of desktop-to-centralized computers. Database servers, based on a client/server network architecture, will be pivotal elements in multilevel, multiplatform cooperative computing. They will provide, much like today's minicomputers and mainframes, the database services necessary to support user applications on networks of interconnected PCs, workstations, and host computer systems.

This report was developed exclusively for Datapro by Bernard J. David, president of General Information Services, Inc., Wilmington, DE, a firm specializing in computer connectivity, consulting, evaluation, and product provision. Mr. David is also a lecturer in entrepreneurship at the Wharton School, University of Pennsylvania.

Database Servers

In general, a database server (a.k.a. client/server database) allows a user application or "client" running on one computer to access the database management or "server" services maintained on another. Current emphasis is on providing SQL (Structured Query Languages, pronounced "sequel") accessed, relational database support to PC or workstation applications running over local area networks (LANs), though such support was initially delegated to larger mini/mainframe system platforms.

SQL-type database work is apportioned between front-end client and back-end server software. The front-end portion, used with or residing within the client application, structures the SQL query needed to find specific data required by the application and forwards the query over the network to the server. The back-end portion, residing on the server, receives and interprets the query, finds and logs out the appropriate data, and then returns it to the client for further processing.

File Servers

File servers are now used for most multiuser database work on PC LANs. File server LAN versions of dBASE IV, Paradox, R:Base, Q & A, FoxBase, DataEase, and other popular PC database managers are being marketed today.

Though loosely conforming to a client/server model, the file server functions primarily as a big disk storage subsystem for shifting or downloading the database among a number of "client" user workstations on the network. The database management program and the files it maintains can reside on the file server, but most of the actual work must be performed at the user's PC or workstation.

A user-phrased request for database function is first executed in a DOS prompt-command-like fashion at the user's PC or workstation. The command is forwarded over the network to the file server, which returns a complete copy of the database program and loads it onto the PC. Once loaded, further prompt-command requests for specific data can be made to the file server from the user's PC, which, in turn, locates, logs out, and returns to the user the entire file containing the requested data.

Database Server Advantages

File servers, therefore, provide somewhat simple and passive back-end support. They store and distribute complete files across the network but assume no other active role in the running or management of client database work.

By contrast, database servers provide powerful and interactive back-end support. They also store complete files but distribute only the specific data required by the client application, thereby relieving the client of all database management tasks. Database servers offer a number of major advantages.

Less Traffic, Faster Access, and Secure Networks

Database servers are result oriented in that they process queries and return answers. This greatly reduces traffic overhead, providing better response times and reducing transmission errors and unauthorized access, because only the data needed to answer a client query is transferred over the network.

File servers burden network facilities with heavy traffic loads, have slower response times, and increase the chances of experiencing data errors or eavesdropping, because they must shift the entire database to/from user workstations.

Multiple Client/User Database Access

Result-orientation also allows multiple users or client applications to access the same database simultaneously. A query for specific data is answered specifically by the database server, so at any given time only certain portions of a database file will be logged out and unavailable to others. Multiple client applications or users are therefore able to query the database server for the remaining, unaccessed, or unused portions of the same database.

File servers answer a data query by transferring the entire database to the user's workstation. This prohibits access by all other users, who must wait until the first user finishes processing and returns the database to the file server.

Power at a Server versus Power at the Stations

Powerful PCs or mini/mainframe-like computers, with high-speed processors, buses, and high-capacity disk subsystems, are specifically configured as database server platforms. These dedicated servers can handle large and complex databases constructed with the aid of very refined management and control software. Since the database server manages all database operations, even a low-power, low-cost PC (i.e., an 8088-based XT) or workstation can access data from such a robust database and then process it in a client application.

Databases residing on file servers must run on a user's workstation. Thus, the database can only be as hardy as the workstation itself. Any large or complex database called up from a file server requires the services of a powerful (and pricey) client workstation.

Other Database Server Advantages

Separating application front-end tasks from database back-end tasks provides other advantages unique to database servers. The front-end software can be changed while the back-end database remains the same, allowing the user or the front-end software developer to customize or enhance the client application and still have access to the same back-end database support. One caveat is that the

query links joining clients with servers remain unchanged. Another, more serious caveat is that major changes in, or revisions of, the back-end software might entail similar changes to all of the front-end client applications that access the database.

The relational nature of database servers also allows for distributing processing over and between system networks. Applications can be assigned to idle or underutilized workstations on the network or to "compute" server workstations configured to handle complex or process-intensive tasks. When multitasking operating systems such as OS/2 become common on PCs, such off-loading could possibly lead to parallel processing networks where PCs on the LAN run other work in a background mode.

Relational database servers can also be used in a distributed database environment. Here, one database server may act as a client or network gateway to a network of other servers containing additional data files or a larger "master" database. A client workstation accessing a network of distributed databases would have its query forwarded to the server (or host computer) managing the database that contains an answer.

SQL Links

Not all database servers are relational, and not all relational database servers are SQL. But as an IBM invention and under its patronage, SQL has become the interface language of choice for interacting with relational databases.

SQL is part of IBM's Systems Application Architecture (SAA) grand strategy for integrating all of its proprietary system platforms. It is available in four versions: DB2 for MVS systems, SQL/DS for VM, SQL/400 for OS/400, and the Database Manager component of OS/2 EE. Other host system databases structured on SQL principles include Tandem Computers Nonstop SQL, and Bull (Honeywell) PDQ and RDBC.

The query language has also been employed with the minicomputer databases and database servers marketed by Oracle, Ingres (Relational Technology), Sybase, Informix, and others. Similar firms such as Gupta and XDB Systems also offer SQL-based servers and development tools for standalone to multiuser PC environments.

ANSI and ISO have embraced SQL as an interface language "standard." But with many versions of SQL, differences have already arisen in the special SQL dialects being built on the standard by these database or database server vendors.

SQL is an interface language for interacting with relational databases and not a fully functioned program development language like Pascal, Fortran, or C. SQL, covered in the ANSI/OSI standard, concentrates primarily on syntax, which, in turn, covers only the basic command sets needed to query, manipulate, and configure the relational database.

All of SQL's different dialects are designed around and compatible with this standard. But most of the database developers have also tweaked the standard by adding their own unique extensions in hopes of making their SQL a much more flexible database interface language.

These vendor variations on a standard SQL theme tend to enhance overall performance at the expense of interoperability and portability. Two vendor consortiums have recently joined forces with hopes of resolving compatibility issues by redefining the standard—the SQL Access Group and X/Open.

The SQL Access Group and X/Open plan to build upon each other's definitions and then introduce a new SQL specification that will ensure interoperability. Recommendations on SQL interfaces and formats, and on related networking protocols, were due out of committee by spring 1990. Until such an enhanced standard emerges and is widely accepted by the vendors, complete interface compatibility between any client application and any database server cannot be assured.

What SQL Database Servers Are Available

Markets, however, rarely wait for finished standards. With hopes of gaining an early lead in what is soon to become a hot SQL seller's market, several vendors are already delivering or developing their own brand of database server based on extensions to the interface. Table 1 lists the SQL database servers known to us that are currently available or are nearly ready for delivery.

The independent software developers are likewise already deciding which of the present SQL

Table 1. Database Servers

Vendor Database Server	Server Operating System	Client Operating System	Network Protocol*	Other Features and Extensions
Apple CL/1 Server**	VMS, MVS, & VM	Mac	AppleTalk-2	depends on server database**
Fox Software Fox Server	NetWare 386	DOS	SPX-IPX	—
Gupta Technologies SQL Base	DOS & OS/2	DOS, DOS-Windows & OS/2	NETBIOS	Stored Procedures & DB2 Interface
IBM OS/2 EE Database Manager	OS/2 EE	DOS & OS/2 EE	NetBIOS & APPC	—
Ingres Ingres	DOS, OS/2, & UNIX	OS/2, UNIX, VMS & MVS	Async, NetBIOS, TCP/IP, & SPX-IX	Data Encryption, Triggers & Stored Procedures
Informix Informix-Net & Online	UNIX-NetWare 386	DOS & UNIX	TCP/IP & SPX-IX	—
Microrim Atlas	OS/2, UNIX, VMS, MVS, & VM	DOS, DOS-Windows, OS/2, Mac, UNIX, & VMS	—	—
mdbs MDBS IV	DOS, OS/2, UNIX, & VMS	DOS, OS/2, UNIX & VMS		Data Encryption
Microsoft-Sybase SQL Server	OS/2	DOS, DOS-Windows & OS/2	Named Pipes	Triggers & Stored Procedures
Neuron Data Nexpert Object	OS/2, UNIX, VMS, & MVS	DOS, OS/2, Mac, UNIX & VMS	—	—
Novell NetWare SQL	NetWare-DOS & NetWare-OS/2	DOS, OS/2, Mac, UNIX, others	SPX-IPX	Data Encryption
Oracle Oracle Server	OS/2, UNIX, NetWare, & VINES	DOS, OS/2, Mac & UNIX	NetBIOS, Named Pipes, APPC, TCP/IP, & SPX-IX	—
Progress Software LAN Progress	DOS & UNIX	DOS & UNIX	NetBIOS	Data Encryption & Stored Procedures
Ratliff Software Emerald Bay***	DOS	DOS	NetBIOS & SPX-IX	Data Encryption
Via Information Systems VIA/DRE	DOS, OS/2 & UNIX	DOS, OS/2 & UNIX	NetBIOS	Triggers & Stored Procedures
XDB Systems XDB Server	DOS, OS/2, & NetWare 386	DOS & OS/2	NetBIOS, APPC, Named Pipes, & TCP/IP	Data Encryption, Triggers, & Stored Procedures

**Protocols depend on the specific client-server operating systems and networks employed.*

***Employs CL/1 versions of Oracle, Ingress, Informix, Sybase, DB2, SQL/DS, or Rdb databases.*

****Emerald Bay is a nonrelational database with optional SQL links.*

dialects and servers will most likely meet with market success. They are busy building front-end SQL versions of some of their more popular PC applications and program development tools, in association with or independent of the server vendors. Conversely, some of the server vendors are offering their own SQL interfaces that attach to some of the more popular PC applications (Lotus 1-2-3, Microsoft Excel, etc.). Table 2 presents a partial listing of such front-end client wares available now or due out later in 1990.

SQL Server Differences

Besides the diverse SQL dialects, each database server (including model-series configurations offered by the same vendor) has a number of other differences.

Operating Systems

The most basic difference among servers concerns the operating system under which the server platform runs. DOS-based servers are single tasking

and must be multithreaded to support multiple users or clients. Processor cycles are thus divided among users requesting service. OS/2, UNIX, and the proprietary operating systems used on other servers are multitasking and multithreaded.

Though not a hard-and-fast rule, servers based on a multitasking operating system tend to have better performance attributes. They are capable of supporting higher traffic loads and larger, more complex databases. Some client applications, however, may still run better under DOS. DOS servers are also a degree less costly than their multitasking counterparts.

What the client PC or workstation runs under is much less critical and depends primarily on the desktop applications with which the user wishes to work. Indeed, some servers will support a variety of client platforms running under different operating systems. The proviso is that the client supports the same SQL and transport interfaces and the same peer-to-peer protocol used by the network and the server.

Peer-to-Peer Protocols

Database servers also use a variety of peer-to-peer protocols for interprocess communications between clients and the server. The following paragraphs describe the most common protocols.

NETBIOS: IBM's older PC-LAN protocol, which is also used on a wide variety of third-party, PC-type LANs.

SPX-IPX: the protocol used by Novell's NetWare. Novell's dominance of the LAN market makes NetWare SPX-IPX a de facto standard for PC networking.

APPC: IBM's new, proprietary solution for building peer-to-peer applications links between micro-to-mainframe systems under its SAA umbrella.

Named Pipes: a network extension to OS/2, as well as Microsoft's answer for interprocess communications on DOS or OS/2 PC LANs.

TCP/IP: a protocol standard developed by the Department of Defense (DOD) and widely used to internetwork LANs.

Data Transaction Controls

Database servers and/or the client applications they support must provide a number of transaction controls to manage the flow of data into and out of the database.

Servers impose an *exclusive lock* on data (ranging from a "page" of one or more rows of records to an entire data table) that has been accessed and is being changed by a client. This prevents access to the data by other clients during an insert, update, or delete operation. But it also may give rise to a *deadlock.*

Two clients having locks on separate data each might desire access to the other's data to complete their transactions. For example, Client A is waiting for Client B to unlock data, but Client B will not release the lock until Client A's data is available. Both clients are therefore deadlocked, and neither can continue until one of them is forced to abort. Most database servers can detect deadlock and then forward an abort message to one of the contending clients.

Some database servers may also impose a *read-only lock* (a.k.a. browse or shared lock) on data. The read-only lock gives any number of clients read and copy rights to the data. This prevents a client spreadsheet user, who might spend hours massaging the data, from preventing others access to that data.

However, a read-only lock on some servers might also prohibit any access rights to change the data. In this instance, a client seeking an exclusive lock on the data encounters a *livelock* condition and must wait until all locks are released.

A few database servers avoid this condition, imposing no locks at all on data that is being read. They can also allow access to previous editions of data that is in the process of being changed and then flag the client when the change has been committed.

Data Recovery

Database servers also provide facilities for data recovery when a client transaction must be aborted or when the server, workstation, or network fails.

A *transaction log* monitors all in-process changes being made to the database and stores copies of both the original and the revised data. If during processing the client has not finally committed the change, the transaction can be aborted and the

Table 2. Front-End Client Applications and Development Tools

Client Software Vendor Application Program or Development Tool	Microsoft SQL Server	Oracle Oracle Server	Novell NetWare SQL	Gupta SQL Base	Other Database Servers
ABM Computer Systems *Platinum*	—	—	X	—	—
Alpha Software *Alpha 4*	—	—	X	—	—
Ashton-Tate *dBASE & Framework*	X	—	—	—	OS/2 EE
Blyth Software *Omnis Quartz*	X	—	—	—	—
Borland *Paradox*	X	X	X	—	OS/2 EE; Fox Server
Channel Computing *Forest & Trees*	X	X	—	X	—
Clarion Software *Professional*	—	X	—	—	—
Communication Horizons *RaSQL*	—	—	X	—	—
Computer Associates *SuperCalc*	X	—	—	—	—
Concentric Data Systems *R&R*	—	X	—	—	XDB Server
Datalex *Entrypoint 90*	—	X	—	—	—
Datawiz *Capture & WP*	X	—	—	—	—
DB/Access *Access/Starr*	X	—	—	—	—
Digital Composition Systems *DB Publisher*	—	X	—	—	—
Digital Equipment *Rdb/VMS*	—	—	—	—	CL/1
Enable Software *Enable OA*	—	X	—	—	—
FormMaker Software *FormMaker II & Horizon*	—	X	—	—	—
Fox Software *FoxBase*	—	—	X	—	Fox Server
Gupta Technologies *SQL Windows*	X	X	—	X	Fox Server; Nexpert Object
Information Builders *PC/Focus*	X	—	—	—	—
Information Research *Syzgy*	—	X	—	—	—
Informix Software *Informix SQL & Wingz*	—	—	—	—	Informix-Net
Informix Software *Informix CL/1 & Wingz*	—	—	—	—	CL/1
Ingres *Ingres*	—	—	—	—	CL/1; Ingres Server
Jyacc *Jam*	X	X	—	X	—
Lotus *1-2-3*	X	X	X	X	Atlas; Emerald Bay; VIA/DRE
Marc Software *WordMarc Composer*	—	X	—	—	—
MegaHaus *Form System*	—	X	—	—	—

data restored to its original state. Almost every database server on the market maintains a *roll back* transaction log to provide such error recovery capability.

Recovery of in-process or completed transactions after catastrophic server, workstation, or network failure is provided by a *roll forward* transaction log. Here the log is read, and all of the transactions stored are reexecuted.

Data Validity and Integrity

Database servers also contain controls to validate data transactions and ensure data integrity.

Table 2. Front-End Client Applications and Development Tools (Continued)

Client Software Vendor Application Program or Development Tool	Microsoft SQL Server	Oracle Oracle Server	Novell NetWare SQL	Gupta SQL Base	Other Database Servers
Micro Data Base Systems (mdbs) *Guru, Object/1, & Knowledgeman/2*	X	—	—	—	MDBS V
Microrim *R:Base*	—	—	—	—	Atlas
Microrim *Atlas GUI/PM*	—	—	—	—	Atlas
Microsoft *Excel*	X	—	—	X	Nexpert Object; VIA/DRE
Must Software *PC Nomad*	X	—	—	X	—
Nantucket *Clipper*	X	—	—	X	VIA/DRE
Neuron Data *Nexpert Object*	—	X	—	—	CL/1; Nexpert Object
Novell NetWare SQL	—	—	X	—	—
Odesta *Double Helex III*	—	—	—	—	CL/1
Oracle *Oracle*	—	X	—	—	—
Oracle *CL/1*	—	—	—	—	CL/1
Paperback Software *VP-Expert*	—	—	—	X	—
Pictureware *Picturepower*	—	X	—	—	—
Pioneer Software *Q+E*	X	X	—	—	—
Progress Software *Progress*	—	X	—	—	LAN Progress
Ratliff Software *Vulcan*	—	—	—	—	Emerald Bay
Revelation Technologies *Advanced Revelation*	X	X	X	—	Fox Server; OS/2 EE; VIA/DRE
Saros *Fileshare*	X	—	—	—	—
Software Solutions *Dataease*	X	X	—	—	OS/2 EE; VIA/DRE
SourceMate Information Systems *Accountmate*	—	X	—	—	—
SPSS *SPSS for OS/2*	—	X	—	—	—
SQ Software *SQR*	—	—	—	—	XDB Server
Sybase *Sybase*	X	—	—	—	CL/1
Symantec *Q&A*	—	X	—	—	—
System 5 *SQL Builder*	—	X	—	—	—
Tactics *FastMap*	—	—	—	—	CL/1
Vinzant *SQL File*	X	—	—	—	CL/1
WordTech Systems *DBXL & Quicksilver*	—	X	X	X	—
XDB Systems *XDB-SQL*	X	—	—	—	XDB Server
Zanthe Information *Zim*	—	—	X	X	Fox Server

Rules: ensure that the data being entered or changed conform to certain preset parameters (i.e., have a specific value or fall within a certain range of values; match a particular alphanumeric pattern; etc.).

Triggers: are automatically-invoked SQL action statements that execute as data is inserted, updated, or deleted to control data consistency and legality. For example, a trigger can be used to ensure that an insert, update, or delete made to one data record triggers a related change in another.

Stored Procedures: allow frequently executed commands or repetitive procedures to be stored at the server. This reduces interactive client/server traffic and improves server response time.

Other Differences

Some database servers may employ *caching* to improve performance by making an educated guess of what the client will want next. For example, a server answering a client request for a customer invoice record might move other customer records out of disk and cache them in memory in anticipation of similar client requests.

Finally, SQL is a flexible language that allows users much latitude in how a query can be phrased. This is a blessing for the user or front-end program writer, but a curse for the server. Different wordings for data can adversely effect how fast the query is answered.

Therefore, servers use various *optimizer* routines to analyze a client's SQL request and reorganize it so that it can be executed in the speediest way possible. Some optimizers can reword the query into a more efficient statement. Others take a more complex route, keying in on special aspects of the query based on the past history of the database tables and indexes.

Vendors

Listed here, for your convenience, are the addresses and telephone numbers of the vendors whose products are listed in Tables 1 and 2.

ABM Computer Systems
3 Whatney Drive
Irvine, CA 92718 (714) 859-6531

Alpha Software Corp.
1 North Avenue
Burlington, MA 01803 (617) 229-2924

Apple Computer, Inc.
20525 Mariani Avenue
Cupertino, CA 95014 (408) 996-1010

Ashton-Tate
20101 Hamilton Avenue
Torrance, CA 90502 (213) 329-8000

Blyth Software, Inc.
2929 Campus Drive, 429
San Mateo, CA 94403 (415) 571-0222

Borland International Inc.
1700 Green Hill Road
Scotts Valley, CA 95066 (408) 438-8400

Channel Computing, Inc.
53 Main Street
Newmarket, NH 03857 (603) 659-2832

Clarion Software
150 E. Sample Road
Pompano Beach FL 33064 (305) 785-4555

Communication Horizons
701 Seventh Street, Suite 900
New York, NY 10036 (212) 840-1555

Computer Associates International, Inc.
1 Tech Drive
Andover, MA 01810 (617) 685-1400

Concentric Data Systems
18 Lyman Street
Westboro, MA 01581 (508) 366-1122

Datalex, Inc.
100 Pine Street, Suite 2400
San Francisco, CA 94111 (415) 362-4466

Datawiz International
1290 E. Hillsdale Boulevard, Suite 210
Foster City, CA 94404 (415) 571-1300

DB/Access, Inc.
20111 Stevens Creek Boulevard, Suite 200
Cupertino, CA 95014 (408) 255-2920

Digital Composition Systems, Inc.
1715 W. Northern Avenue, Suite 201
Phoenix, AZ 85021 (602) 870-7666

Digital Equipment Corp. (DEC)
146 Main Street
Maynard, MA 01754-2571 (508) 493-5111

Enable Software
Northway Ten, Executive Park
Ballston Lake, NY 12019 (518) 877-8600

FormMaker Software, Inc.
57 S. Schillinger Road
Mobile, AL 36608 (205) 633-3676

Fox Software
118 W. S. Boundary
Perrysburg, OH 43551 (419) 874-0162

Gupta Technologies, Inc.
1020 Marsh Road, Suite 210
Menlo Park, CA 94025 (415) 321-9500

Information Builders, Inc.
1250 Broadway
New York, NY 10001 (212) 736-4433

Information Research Corp.
6486 S. Quebec Street
Englewood, CO 80111 (303) 694-9180

Informix Software, Inc.
4100 Bohannon Drive
Menlo Park, CA 94025 (415) 322-4100

Ingres Corp. (formerly Relational Technology)
1080 Marina Village Parkway
Alameda, CA 94501 (415) 769-1400

International Business Machines Corp. (IBM)
Old Orchard Road
Armonk, NY 10504
Contact your local IBM representative.

Jyacc, Inc.
116 John Street
New York, NY 10038 (212) 267-7722

Lotus Development Corp.
55 Cambridge Parkway
Cambridge, MA 02142 (617) 577-8500

Marc Software International, Inc.
260 Sheridan Avenue
Palo Alto, CA 94306 (415) 326-1971

MegaHaus Corp.
6215 Ferris Square
San Diego, CA 92121 (619) 450-1230

Micro Data Base Systems, Inc. (mdbs)
P.O. Box 248, Two Executive Drive
Lafayette, IN 47902 (317) 463-2581

Microrim, Inc.
3925 159th Avenue NE
Redmond, WA 98052 (206) 885-2000

Microsoft Corp.
16011 NE 36th Way, Box 97017
Redmond, WA 98073 (206) 882-8080

Must Software International
101 Merrit 7, 4th Floor
Norwalk, CT 06856 (203) 845-5000

Nantucket Corp.
12555 W. Jefferson Boulevard, Suite 300
Los Angeles, CA 90066 (213) 390-7923

Neuron Data, Inc.
444 High Street
Palo Alto, CA 94301 (415) 321-4488

Novell, Inc.
122 E. 1700 S.
Provo, UT 84601 (801) 379-5900

Odesta Corp.
4084 Commercial Avenue
Northbrook, IL 60062 (312) 498-5615

Oracle Inc.
20 Davis Drive
Belmont, CA 94002 (415) 598-8000

Paperback Software International
2830 9th Street
Berkeley, CA 94710 (415) 644-2116

Pictureware, Inc.
111 N. Presidential Boulevard
Bala Cynwyd, PA 19004 (215) 667-0880

Pioneer Software
5540 Centerview Drive, Suite 324
Raleigh, NC 27606 (919) 859-2220

Progress Software Corp.
5 Oak Park
Bedford, MA 01730 (617) 275-4500

Ratliff Software
2155 Verdungo Boulevard, Suite 20
Montrose, CA 91020 (818) 546-3850

Revelation Technologies, Inc.
3633 136th Place SE
Bellevue, WA 98006 (206) 643-9898

Saros Corp.
10900 NE 8th Street, Suite 205
Bellevue, WA 98004 (206) 646-1066

Software Solutions Unlimited, Inc.
5600 Wyoming Boulevard NE, Suite 10
Albuquerque, NM 87109 (505) 828-9000

SourceMate Information Systems, Inc.
20 Sunnyside Avenue
Mill Valley, CA 94941 (415) 381-1011

SPSS, Inc.
444 N. Michigan Avenue
Chicago, IL 60611 (312) 329-2400

SQ Software
2000 Lee Road, Suite 120
Cleveland, OH 44118 (216) 397-0551

Sybase, Inc.
6475 Christie Avenue
Emeryville, CA 94608 (415) 596-3500

Symantec Corp.
10201 Torre Avenue
Cupertino, CA 95014 (408) 253-9600

System 5—Construction Computer Corp.
615 E. Michigan Street
Milwaukee, WI 53202 (414) 278-0500

Tactics International Ltd.
16 Haverhill Street
Andover, MA 01810 (508) 475-4475

Via Information Systems
101 Carnegie Center, Suite 209
Princeton, NJ 08540 (609) 243-0433

Vinzant, Inc.
4 Skyline Drive
Portage, IN 46368 (219) 763-3881

WordTech Systems, Inc.
21 Altarinda Road
Orinda, CA 94563 (415) 254-0900

XDB Systems
7309 Baltimore Avenue, Suite 220
College Park, MD 20740 (301) 779-5486

Zanthe Information, Inc.
1200-38 Antares Drive
Nepean, ON, Canada K2E 7V2 (613) 727-6940 ■