Integrating the SAS® System for Personal Computers into Your Enterprise
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Abstract
To utilize the full potential of SAS System software on the personal computer, your PC should be fully integrated into your enterprise. SAS System products for the PC provide many client/server architectures that Information System designers can use to access, update, and analyze the entire spectrum of enterprise data. SAS System client/server products are introduced in different PC-based scenarios and several PC, network and SAS System configuration suggestions are presented to help you get better returns from your hardware and software investment.

Introduction
Organizations are extending the effective reach of their centralized systems by interfacing workstations to large PC, mainframe, and UNIX server systems. Many of these organizations are planning on using Windows, Windows NT, Windows 95, and UNIX platforms for the development of new applications.

Version 6.11 of the SAS System, codenamed the Orlando release, delivers a synchronized release of advanced features to all of these workstation platforms. This release provides a seamless computing environment on these platforms, allowing UNIX and Windows NT server based servers to be used with Windows 95, Windows NT, and WinSAS client machines.

One way to integrate these platforms is through client/server computing, which is described below. Data warehousing is a common implementation, and one for which the SAS System is uniquely qualified. In addition, PC-based systems have a wide range of networking configurations which can help meet information sharing needs.

Other important enterprise considerations include performance optimization and software installation/maintenance issues.

SAS System Client/Server Support
The SAS System for Personal Computers provides a window to your enterprise data and offers cooperative processing configurations that can access the diverse and scattered data formats while making optimal use of the wide range of enterprise hardware. The following SAS System features and products form the basis for these client/server computing solutions.

MultiVendor Architecture
Version 6 of the SAS System is available for many types of computer hardware and operating system combinations including: MVS, VMS, VSE, OpenVMS VAX, OpenVMS AXP, UNIX, OS/2®, Windows NT, Windows 95, Windows NT, Windows 95 and Macintosh. The compatibility in terms of SAS programs, user interface, and data transportability make inter-system use of the SAS System on various platforms an attractive foundation for enterprise architecture. Your SAS applications can communicate with each other to exchange data no matter where they are located. You can develop and test applications in one environment and move them to another with minimal modifications. And you can cooperatively run applications across multiple platforms.

Multiple Engine Architecture
The central technology in the SAS System’s data access strategy is the Multiple Engine Architecture modular design. This architecture allows the SAS System to transparently access all data, regardless of vendor, format or location, through loadable engines. Engines provide the framework for translating read, write and search calls to native SAS, OS file formats or external database management systems. Engines can surface data sets as views or actual data files.

A view is a SAS data set that describes how to logically access other data rather than physically containing it. Views contain information about the data such as data attributes and location. There are three types of SAS data set views:

- SAS DATA step views, which run a predefined DATA step at the time the data view is accessed and dynamically derive the data as it is requested.
- SAS/ACCESS views, that enable you to access DBMS data from other vendors.
- PROC SQL views, that can describe local or remote SAS data. SAS/ACCESS views or can use SQL Pass-Through to allow the user the ability to take advantage of DBMS features such as table joins, Stored Procedures and Triggers if supported by the DBMS.

The 6.11 SAS System provides support for many different engine types that allow access to formats including current and older versions of SAS native data sets, system file formats like DIF and VSAM, Excel and Lotus spreadsheets, hierarchical DBMS formats such as IMS and relational DBMS systems such as DB2, SYBASE, dBase, SQL Server and Oracle. Engines are supplied by the base SAS System and by the SAS System add-on products SAS/ACCESS®, SAS/SHARE® and SAS/CONNECT®.

ODBC Support
Microsoft Corporation’s Open Database Connectivity (ODBC) standard, part of the Microsoft Windows Open System Architecture (WOSA) umbrella, is used as a call level API to numerous DBMS formats from the Windows operating system. ODBC has significant DBMS market penetration and ISV support and is being ported by various vendors to OS/2, UNIX and the Macintosh.

SAS System client/server products extend the advantage of SAS Multiple Engine Architecture design to third party applications that support the Microsoft ODBC database standard. The SAS ODBC Driver allows ODBC applications to connect to a local SAS ODBC server and to remote SAS/SHARE servers. SAS/ACCESS to ODBC allows the SAS System for Windows to access third party DBMS data sources.

Implementing a Data Warehouse
Customers are moving from the mainframe batch and OLTP environments down to client/server and desktop analysis. SAS Institute Marketing has estimated that 95% of IT budgets are allocated to collecting data and only 5% to analyzing the data. Data warehousing empowers end users and gets the IT center out of the business of providing custom reports as well as getting and users...
off the mainframe. Offloading provides better on-line transaction processing performance where response time is crucial.

A data warehouse contains data physically separated from an organization's day to day operational data. The data warehouse includes decision support data that has been collected, cleaned and summarized from isolated departmental data across the enterprise in order to provide more meaningful, accessible information for modeling, forecasting and analysis by the organization decision makers. The data warehouse is designed to be read from and not written to because the end users are making decisions on existing data not entering data. The three most critical elements of a data warehouse are: easily accessing the data, transforming and managing the data and analyzing the data in a friendly manner.

Using the SAS System for Data Warehousing
The SAS System has strengths in all areas of data warehousing and various SAS components can be interfaced with other vendor products that are already a part of the enterprise. One of the primary activities of the IT center should be time spent transforming OLTP data into sensible and meaningful formats. The SAS System provides many tools for data collection, transformation, reduction, modeling and visualization.

SAS/ACCESS and its various engines can be used to extract data from the different OLTP and archive structures and computing environments which include SQL accessible relational databases as well as many non-relational legacy systems where it is estimated near 70% of corporate data still resides. SAS/ACCESS can take advantage of Stored Procedures to process and subset data at the OLTP server to help minimize network traffic. Popular base SAS routines can be used to clean, summarize and otherwise transform data into more user friendly formats used to stock the data warehouse locations after collecting transaction level data from diverse data sources.

SAS/CONNECT remote submit offers application partitioning which can be used to remotely process queries against the warehouse and can keep users from flooding the network with data. SAS/CONNECT can be used to transfer data to more localized servers or local SAS data sets from different architecture repositories. This allows better decision making when large numbers of users around the enterprise want ad hoc query access to the same information. SAS/CONNECT can be driven from the desktop or from the central location when transferring the data. The SAS ODBC Driver can be used to give other third party desktop analysis tools access to the SAS data on the local or server platform. SAS/SHARE servers can be positioned at strategic points in the enterprise and can provide SAS and ODBC clients shared read/write access to SAS data.

The SAS Domain Server can bridge protocol domains and simplify and reduce costs for configuring and administering PC clients.

SAS/AF® and other SAS System analysis products can be used to build custom front ends and user interfaces to the data warehouse and which present the data using the latest object oriented analysis techniques.

Using Windows NT for Data Warehousing

Release 6.1 of the SAS System operating under Windows NT can be a good server platform for a data warehouse application. This platform is not inhibited by a two gigabyte file size (and therefore data set) limitation. Instead, maximum data set size is limited only by the available disk space on the Windows NT machine.

Since Windows NT also supports software disk striping, multiple hard drives (currently available in sizes up to nine gigabytes) can be configured into a very large, parallel access disk array, usually limited only by the number of drives that can be accommodated in the PC cabinet. Using nine gigabyte drives, a system with seven available full-height drive bays could be used as a 60 gigabyte data store.

In addition to NT's ability to handle very large files, it also supports symmetric multiprocessing (SMP) to provide an additional performance boost. A system with four CPU's can support nearly four times the computing load as a comparable single CPU system. This can be helpful in configurations in which SAS/SHARE servers and Remote Computing services are used.

PC-based Data Sharing
PC networks support various ways to allow access to SAS data stored in remote locations. Keep in mind that most of these options allow multiple read-only sessions or a single read/write session when accessing a centrally stored catalog or data set of the SAS System. A SAS/SHARE server is always needed in order to provide access for shared read/write sessions to native SAS data for multiple clients whether on the same or different machines.

In all the scenarios described in this section, it would never be recommended to have a second level of data indirection by having a SAS/SHARE server use a remote file server for the shared data sets. That is, any machine running a SAS/SHARE server should have sufficient local storage for the SAS data sets, otherwise excessive network traffic (and therefore slower performance) would be generated. Any external DBMS data access provided by the server via SAS/ACCESS engine can access local or remote data as appropriate.

Defining indexes on SAS data sets can significantly improve data access performance and is especially recommended for large files maintained on file servers and for SAS data sets accessed via Remote Library Services. When used in conjunction with SAS WHERE clause processing, the SAS System can use an index to directly locate the requested records greatly reducing CPU time, disk I/O and network traffic from file or application servers. Indexes are not needed for data sets always accessed sequentially. Various portions of the computing network can provide services for desktop personal computer client systems running OS/2 or Windows and the SAS System. Although a wide range of configurations are possible, some do not make efficient use of computing and network hardware. A number of references have been added to the end of this paper and can be further consulted for more detailed information on SAS System client/server architectures.

Operation of SAS System products in some typical enterprise scenarios including certain advantages and disadvantages follow.

PC File Server Access

Running the SAS System from the local hard drive and accessing only local data sets is the simplest computing model. A local configuration normally allows for the best performance of the SAS System but requires the most disk space on each workstation. Usually, SAS System data is processed locally in conjunction with data sets stored remotely or downloaded from or uploaded to other data sources in the enterprise. The simplest client/server scenario is desktop PC using a PC-based file server to store SAS data sets. It is also reasonable to access the SAS System itself as well as SAS data sets from network file servers rather than from the local hard drive when local hard drive resources are small or when shared read-only access is desired for easy installation and maintenance.

Since file servers are normally dedicated to the task of providing access to data, this approach can support a large number of client PCs. Among the most popular are NCR's LAN Server and Windows NT Server, which can allow a single server to handle hundreds of simultaneous client connections. A benefit of Windows NT Server
over Novell Netware is NT Server's ability to act as both a file server as well as an applications server. Applications for the SAS System for Windows can be run on a Windows NT server while it is also acting as a file server.

Besides Novell Netware and Windows NT Server, the SAS System supports operation across a wide range of network operating systems. A basic rule of thumb is that if a network is supported under a PC-based operating system, the SAS System running under that operating system will function well on that network.

There are various options concerning the actual distribution of programs and data between the local machine and the remote server. The SAS System Companion manuals for OS/2 and Windows contain configuration suggestions for installing onto a file server. Some of these configurations include:

- Running the SAS System from the local hard drive and accessing data sets from a network file server. For large amounts of data, this can be an attractive solution as long as the SAS data is indexed. However, if you make multiple random passes of non-indexed data residing on a file server you will flood the network and degrade everyone's network performance.

- Also common is installing from or running the SAS System from a network file server and accessing data sets from the local hard drive. If quick access to data is required, this may work best. Since the SAS System is a large application, accessing it entirely from a file server saves local disk space but can be time consuming if SAS System sessions are frequently started as would be the case for a large scripted SAS batch programs.

- Running both the SAS System and accessing SAS data sets from a network file server minimizes the desktop disk space requirement, but can place a high load on the PC network.

- A hybrid approach may be the best solution. The SAS System allows monitoring of all SAS System components including SAS data sets and catalogs that are accessed. You can determine which files are accessed during an often executed SAS session by using the RTRACE and TRACEDLOC system options and the COPYSAS autocal macro as documented in the OS/2 or the Windows versions of the Release 6.10 "Changes and Enhancements to the SAS System". Using this information, the network administrator can determine a subset of the SAS System most often accessed and can design an efficient hybrid installation that places the most often used load modules, utility files, read-only data sets and user and work areas of the SAS System on the local disk for optimal performance. Performance is increased but usage of local disk space is still minimized by not having all the SAS products installed locally.

- Available beginning with Release 6.11 of the SAS System is a network install that allows client machines to access SAS Software already installed on the network. Network setup adds OLE and SAS file type registrations to the client PC's registry, and folder and icon additions are made to the desktop. Any information from RTRACE logs supplied by a SAS system administrator can be used to select System System components to install to the local disk for better performance. This type of install is also useful to run from a CD or a previously installed local image when running other Windows OS systems on the same machine. At the Institute, we often run Windows 3.1/Windos, Windows NT and Windows 95 on the same machine.

Using Another Desktop PC as File Server

Peer-to-peer networking packages, such as OS/2 WARP CONNECT, Windows for Workgroups, Windows NT and Windows 95 enable any PC to act as a file server to other PCs which become clients to that PC. While an extremely cost-effective solution for data sharing, this approach does not handle a large number of client PCs. Since the PC acting as a file server is typically an ordinary desktop PC, even a small number of clients can significantly degrade the performance of the desktop PC acting as the file server.

UNIX and Mainframe NFS File Servers

The file server concept can also be extended beyond the PC local area network environment using the TCP/IP based Network File System supported by most UNIX and some mainframe OS systems. Various vendor products are available to add NFS client support to the PC which allow the desktop PC to access files stored on the remote system as if they were stored on any other local or file server disk. One benefit could be better managed backup and archiving on these centrally managed servers.

SAS System Support for Client/Server Applications

Various products and features of the SAS System enable the development of distributed applications. These are described below.

SAS Application Servers

SAS/CONNECT and SAS/SHARE software further extend the file server model and allow an ODBC or SAS System client on one PC remote access to another SAS System running on a different OS/2 or Windows PC, or on a UNIX or mainframe computer. Remote computers acting as SAS application servers are normally more powerful than PC based systems or have unique and desired hardware or software capabilities. The SAS System client/server components communicate using communications protocols that we refer to as SAS Communication Access Methods or just SAS Access Methods. Appendix A lists the protocol to peer SAS Access Methods supported by each SAS System product.

Remote Library Services

The Remote Library Services (RLS) Remote engine provided by SAS/CONNECT or SAS/SHARE software allows SAS System client applications on one hardware/OS platform access to remote SAS data libraries on any other hardware/OS platform even when the machines use different internal data representations. RLS can also provide gateway access to external DBMS systems that the server can access using SAS/ACCESS engines. You can also use RLS with all three types of SAS data views.

Remote Library Services allows you to assign a SAS LIBNAME statement in your local SAS session for data which resides on a remote system. The local SAS System is then able to transparently access any remote data set including views as if they were on the local system. This transparent access makes RLS one of the most powerful client/server technologies of the SAS System when used for small, frequently updated or randomly accessed data sets. An example use of these services is that the SAS System for Windows can directly access and update SAS data stored on mainframe and UNIX workstations.

Remote Library Services can be used by the client SAS System to access a single user SAS/CONNECT server for shared read or exclusive write access to remote SAS data or can be used to access a multi-user SAS/SHARE server for shared read/write access to remote SAS data. RLS does not make a physical copy of the remote data but rather enables users to work against the current version of the data.

When using RLS, one way to reduce the amount of data that moves over the network is to use the WHERE clause on your local data steps and procedures. Another is to use an index on variables that
are likely to be used in WHERE clauses to help the data set engine
directly locate data.

Some types of operations are not well suited to use with Remote
Library Services. If you have large amounts of data that must be
processed sequentially, it may be more efficient to use
SAS/CONNECT Compute Services to do remote processing at the
data source. Also, if your application makes several sequential
passes over the data, such as PROCs SORT and PLOT, it may be
more efficient to make a local copy of the data using RLS and
PROC COPY or to use SAS/CONNECT Data Transfer Services.

This is not to say that Remote Library Services are slower than other
client/server approaches but rather that in any environment you do
not want to pass all your data over the network; especially not
multiple times. Remote Library Services are better suited for use
with PROCs like FSBROWSE or FSEDIT, which interactively
access records one at a time either sequentially or based on a
WHERE clause.

A SAS System application for data entry or retrieval that allows PCs
to access or update data stored on a central computer system works
well if relatively small amounts of data are accessed or updated
infrrequently. An application that accesses a large portion of the data
multiple times would generate a large amount of network traffic that
would slow completion of the task. Excessive or unneeded network
traffic also slows the operation of other network users.
SAS/CONNECT Data Transfer Services or Compute Services
would make better use of computing and network resources when
processing large amounts of data or making multiple passes of the
data.

One important restriction to note is that Remote Library Services
supports only SAS data sets and not catalogs when the client and
server are on different hardware/OS platforms. SAS Institute plans
to remove this restriction in future versions of their client/server
products. Another, restriction is that the SAS/ACCESS engines and
the SQL engine, when used on the server to access external DBMS
systems, only allow update access for the SAS/CONNECT single
user server. The local SAS ODBC server and the SAS/SHARE
multi-user server are restricted to shared read/only access.

Either the SAS/SHARE or SAS/CONNECT product will supply the
Remote engine on the SAS System client machine to enable access
to a single user SAS/CONNECT server or to a multi-user
SAS/SHARE server.

SAS/SHARE

The SAS/SHARE product originated the Remote Library Services
technology used by ODBC and SAS clients to communicate to the
SAS/SHARE, local ODBC and SAS/CONNECT single user
servers.

The SAS/SHARE product includes the client side Remote engine as
well as a multi-user server that can be accessed from any SAS
System client running the Remote engine. Multiple SAS RLS clients
can access a SAS/SHARE server which manages libraries of SAS
data sets and catalogs in shared read/write mode. The
SAS/SHARE server can provide read/only access to external DBMS
systems that are accessed using SAS/ACCESS engines. A multi-
user SAS/SHARE server allows you to develop basic on-line
transaction processing systems.

A separate SAS process running PROC OPERATE on the same1 or
another machine is used to control a SAS/SHARE server including
user access to the SAS/SHARE server libraries. ODBC and SAS
clients on the same machine as a SAS/SHARE server can still
access the server though not actually remote.

Both client and server sides of SAS/SHARE software are available
for all computers supported by the Release 6.11 SAS System.

SAS/CONNECT

SAS/CONNECT software provides several client/server features.
These include the single user server, the RLS Remote engine, Data
Transfer Services and Compute Services. All features of SAS/CONNECT can be used concurrently to one or
more remote platforms. Both client and server sides of
SAS/CONNECT software are available for all computers supported
by the SAS System. The single user server is not available for
Windows 3.1/Win32s or for the Macintosh due to OS restrictions.

SAS/CONNECT Single User Server

The SAS/CONNECT product provides a single user server that can
be accessed from any SAS System client running the Remote
engine. Each single user server provides one SAS RLS client with
shared read/only or exclusive read/write access to SAS data on the
server platform.

The SAS/CONNECT single user server can provide read/write
access to external DBMS systems that are accessed using
SAS/ACCESS engines. Multiple SAS/CONNECT single user
servers can be run on all SAS platforms except Windows
3.1/Win32s where only a single instance of SAS is allowed to run.

SAS/CONNECT Data Transfer Services

If batch mode processing is to be performed on a remote data set, or
if data will be accessed multiple times, the data can be downloaded
to the remote server to the client machine for local processing to
minimize redundant network usage. SAS data sets, catalogs,
graphics and system files can be transported in either direction
between any SAS System platform using commands available in the
SAS/CONNECT product. Data Transfer Services are very useful for
centralized, off hours, distribution, collection and backup of data and
applications to or from multiple client machines. SAS/CONNECT
takes care of all data set and catalog translation between platforms.
Data can be selected and subsampled during transfer using WHERE
clauses. These transfers are performed through PROC UPLOAD
and PROC DOWNLOAD. The Query Window component of
SAS/ASSIST® provides an interactive graphical interface for moving
SAS files using Data Transfer Services.

By moving entire data sets or subsets of data to PC workstations, Data
Transfer Services offloads processing from the remote
platforms. This approach can be useful if the remote machine is
overloaded relative to the local machine or excessive network traffic
is a concern. Data analysis, application development and report
writing that involves multiple passes of the data, can be performed
on the less expensive desktop computer. Data Transfer Services
also reduces your dependence upon the network and server
resources and allows you to continue to work during temporary or
planned outages.

You can also address access to large amounts of data using various
data warehousing techniques. For example, SAS/CONNECT could
download local summarized copies of the data to individual
machines or network servers nightly from a mainframe for next day
processing by local SAS Systems. It would be inefficient, however, if
the actual use was on a small subset of the overall data transferred.
The time required to transfer the entire data set would be large
relative to the amount of useful data really transferred. In order to
minimize the amount of network traffic generated by large transfers,
you may want to download a subset of the data for processing using
WHERE clauses or summarizing the data prior to downloading. If
the data needed to be later updated to the central location, a
combination of SAS/CONNECT Compute and Data Transfer
Services can be used to upload and merge the subset data. Or you

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1 The Windows 3.1/Win32s platform can run only one copy of the
SAS System due to operating system restrictions.
could directly merge the changes back into the original data set with Remote Library Services.

**SAS/CONNECT Compute Services**

SAS statements and programs can be forwarded to a SAS System running on another computer using SAS/CONNECT software. As remote processing progresses, the program listing and any graphical output are presented on the local system as if the program had executed locally. This allows compute or data intensive processing to occur on the most capable computing resource or at the location where large volumes of data reside. The remote computer may have unique hardware such as multiple or vector processors or graphics peripherals or software that only runs on the server platform that users need access to. Unique features make remote computers attractive or necessary for certain applications.

In addition to unique software and hardware capabilities, the remote platform may have SAS Software that is not licensed for the local PC that the user wants to utilize. Applications can be prototyped and tested in a desktop environment against subsets or samples of production data and then partitioned for execution in a distributed environment. Unlike SQL Stored Procedures which is tied to a specific RDBMS and so are not portable, SAS programs can be relocated to a wide variety of server platforms due to the MultiVendor Architecture design.

Important factors to consider are the amount and location of the data that must be analyzed. Compute Services are especially useful where large amounts or frequently updated data reside on the remote server. In these cases it would not be practical to download that data or to remotely analyze it via Remote Library Services due to the tremendous network traffic that would be required to get data records to the local client machine.

Compute Services are ideal for computationally complex activities which require multiple passes of very large data files. Moving the application logic to the server would make more sense than flooding the network with traffic, especially if central computing resources are plentiful or unique and desktop resources limited. Exploiting the server’s computing resources rather than moving data also helps maintain centralized security and data administration.

**SAS/ACCESS**

SAS/ACCESS provides a view technology called view descriptors that can be used from SAS DATA steps and procedures or from SQL Pass-Through views. The SAS/ACCESS views provide both read and write access to the underlying database. View descriptors are easy to use compared to PROC SQL views but PROC SQL views can pass table joins to the DBMS whereas they would be done much more efficiently than retrieving all the data and doing the join back on the client application.

The SAS/ASSIST Query Window provides a point and click interface for generating SQL requests against SAS data sets as well as native SQL for supported DBMS systems.

SAS/ACCESS engines provide the ability to access many different DBMS and system file formats including text, VSAM, Access, dBase, DB2, SYBASE, SQL Server and ORACLE. In addition, when SAS/CONNECT single user engines or a SAS/SHARE multi-user server, the ODBC and SAS clients on one platform can use the server as a gateway to access external database systems. The database systems can be local or remote to the SAS application or SAS server that is using the SAS/ACCESS engine.

SAS/ACCESS engines and the SQL engine only allow update access to external databases for the SAS/CONNECT single user server. The local SAS ODBC server and the SAS/SHARE multi-user server are restricted to read-only access.

SAS/ACCESS provides the middleware for SQL Pass-Through connectivity to remote RDBMS systems which can process a SQL request and return result sets back to the SAS System. This architecture is best for activities which return a relatively small amount of data such as running SQL summaries or Stored Procedures that subset the data to be returned. If large amounts of data are requested, too much data is passed over the network impacting network performance as well as moving processing to the workstation impacting its performance.

It may not always be appropriate for end users to access the RDBMS data directly in order to avoid ill-formed or ill-framed queries. If so, you can run nightly batch jobs that create SAS data sets that provide a virtual database or data warehouse to keep the users out of trouble and keep resources available.

**SAS/ACCESS to ODBC**

SAS/ACCESS to ODBC bears special mention since it allows the SAS System on Windows open access to numerous DBMS formats from a wide range of vendors. For example, the SQL Pass-Through facility and the ODBC engine allow SQL queries and other transactions to be executed on databases such as dBase, Paradox, Access, Excel, ORACLE and SYBASE.

The SAS/ASSIST Query window facility has a new access type for ODBC and allows the user to easily navigate to the desired tables and columns through a friendly user interface so it is not necessary to know the ODBC SQL language dialect. SAS/ACCESS to ODBC can also take advantage of Stored Procedures and Triggers if supported by the ODBC data sources. SAS/ACCESS to ODBC only requires CORE level APIs to be supported in a driver for SQL Pass-Through to work. Two additional level 1 APIs, SQLDriverConnect and SQLTables must be supported for the Query Window to operate.

**SAS ODBC Driver**

The SAS ODBC Driver for the SAS System allows third party ODBC compliant Windows applications, such as Microsoft’s Excel or Visual Basic, open access to SAS data sets. The SAS ODBC Driver is a multi-tiered driver meaning that it does not directly access SAS data sets but rather communicates with either a local SAS ODBC server or a remote SAS/SHARE server. The SAS ODBC Driver does not connect to a SAS/CONNECT single user server.

SAS System servers transparently handle all cross architecture issues such as floating point data translation between different hardware/OS platforms. The same SAS ODBC Driver comes included with either the base SAS System or with SAS/SHARE®NET software. The local SAS ODBC server also comes with the base SAS System and allows access to local SAS data. To access SAS data remote from the local machine, you use the SAS ODBC Driver to connect to a SAS/SHARE® server that has the SAS/SHARE®NET software installed.

When used in conjunction with SAS/ACCESS software on the local or remote server machines, the SAS ODBC Driver serves as a read-only gateway to the wide variety of DBMS data supported by the various SAS/ACCESS engines. The SAS ODBC Driver supports both local and network DDE and TCP/IP for connection to local ODBC or remote SAS/SHARE servers. SAS Institute will expand the available access methods for the SAS ODBC Driver in the future.

Both the local SAS ODBC server and the SAS/SHARE server support multiple ODBC client connections. The SAS ODBC Driver provides level 1 API conformance and minimum SQL grammar conformance and does not support cursors.

**SAS/SHARE®NET**

SAS/SHARE®NET software is added to a SAS/SHARE server to allow third party ODBC compliant Windows applications, such as...
Microsoft's Excel or Visual Basic, open access to remote SAS System data sets in shared read/write mode. When used in conjunction with SAS/ACCESS software on the server machine, the SAS/SHARE server becomes a read-only gateway for the ODBC client applications to access the wide variety of data supported by the various SAS/ACCESS engines.

The SAS/SHARE*NET software provides the same SAS ODBC Driver software that comes with the base SAS System in addition to server side licensing that enables SAS/SHARE servers to support ODBC clients.

SAS Domain Server
The SAS Domain Server protocol gateway service allows message exchange between SAS sessions that run in different network environments and use different SAS access methods. An enterprise network can be made up of one or more logical domains. A logical domain maps a topological area according to the communications protocol, or access method it supports. A SAS session can communicate with any other SAS session running in the same logical domain because they all use the same access method.

In addition, a SAS session can be part of more than one logical domain if the machine on which the session runs supports multiple communication protocols. The SAS Domain Server provides the necessary gateway to enable message exchange between SAS sessions executing in different logical domains. The goal of this technology is to deliver full, enterprise-wide, protocol independent messaging between all of the SAS client/server products.

The SAS Domain Server can currently be used by either SAS/SHARE or SAS/CONNECT clients to send requests from a network serviced by one protocol to a remote SAS/SHARE or SAS/CONNECT server running on a platform serviced by a different protocol. From a user's perspective, the operation of the SAS Domain server is nearly transparent and is accomplished by setting some configuration variables.

A primary reason that the Institute developed the SAS Domain Server was that the TCP/IP protocol is more popular within the PC and UNIX worlds and APPC/APPN is more popular in the IBM mainframe environments. An example of using the SAS Domain Server would be a Windows SAS/CONNECT client using the TCP/IP protocol to access a SAS/SHARE server on MVS using the APPC protocol. The SAS Domain Server allows the Windows machines that already have the TCP/IP protocol installed to use Remote Library Services on the MVS server without licensing or maintaining APPC for each client machine. A cost-savings advantage can be realized with this configuration because it eliminates the requirement to license, configure, and support both TCP/IP and APPC protocol stacks for each Windows desktop in the enterprise.

SAS System OLE Interoperability
The 6.11 release of the SAS System for Windows fully exploits Microsoft OLE 2.0 functionality which is actually a very sophisticated form of client/server computing. The SAS System for Windows supports the following OLE 2.0 features:

- drag and drop. Lets you drag OLE objects from a Windows application to a FRAME entry. The default action performed when you drag and drop is determined by the type of OLE object and the target window. If multiple actions can be associated with the object, you can select another action by applying a keyboard modifier (like the Ctrl key) or using the right mouse button for nondefault drag and drop.

- visual editing, that lets you activate objects inside your FRAME entry without switching to another application window. All of the menus and tools that the object's application (its OLE server) provides automatically become available to you from within the SAS System through its menus and toolbars.

- OLE automation, which lets you use SCL to drive another OLE application. An example use of automation is to use SAS to open an Excel spreadsheet, enter data into the spreadsheet, and generate a graph.

- OLE custom controls. These let you use OLE custom controls (OCXs) in your SAS/AF applications. You can use SCL code to communicate with these objects as you would with any SAS/AF object. Controls differ from other insertable objects in that they generate events upon which the SAS System can act. Release 6.11 under Windows provides two OLE controls: a text entry control and a combo box. Other 32-bit controls are available from third party vendors.

- automation server. This allows an external automation controller (like Visual Basic) to start a SAS System session. Once started, you can send commands to the SAS session from the controller, as if commands were being typed on the command line.

- OLE server. Current OLE server research involves prototyping PROC Insight as an OLE object. This would allow, for example, embedding a rotating insight plot into a Microsoft Word document and being able to modify the graph in place within Word.

For a more complete discussion of the OLE support available in the SAS System, please refer to the paper, "OLE and the SAS System for Windows Release 6.11," also in these proceedings.

Other SAS System Interoperability Support
Several new methods are available in Release 6.11 of the SAS System to allow enhanced inter-program operation and data sharing.

The SAS System's support Lotus Notes enables users to populate Notes with SAS output including attachments such as data sets, graphs, and reports.

Electronic mail can be sent from within the SAS System either by using the Send Mail dialog (available from the main SAS System File pull-down menu), or by using the EMAIL access method from a DATA step or SCL code.

Three new access methods available in Release 6.11 provide increased cross-platform data interoperability. The communications protocols can replace normal external file processing, so they can be used anywhere an external file would be accessed from the SAS System. The FILENAME statement can be used to indicate that you want to use an alternate external data source access method. These access methods include:

- The FTP access method can be used to read and write remote data files using the industry-standard FTP (file transfer protocol). Options can be used to specify remote host name, record format, username and password information, change directory commands, and directory listing commands. FTP commands like get and put can be used, but this method transfers files to and from your SAS session without first storing them on your system. This method can be used to access directory listings, access anonymous FTP sites, retrieving and running SAS programs from a remote system, as well as transport SAS data libraries.

- The TCP/IP socket access method can be used to establish peer-to-peer connections with remote applications. Options can be used to provide remote host name and port information, record format, and connection limit information. A SAS application can act as a SOCKET client (and attach to a remote application acting as a server and waiting for a connection) or as a SOCKET server, in a wait state waiting for a remote
application to connect to it. The server will accept only one connection at a time, so sessions must disconnect to allow new sessions to be initiated.

- An experimental URL access method allows a SAS application to access remote files using a URL (universal resource locator) and a WWW (world wide web) server. An option is used to specify the URL when the FILENAME statement is entered. Flat files or transport data sets can be easily accessed across the web by using the URL access method.

SAS System integration with the Windows 95 Explorer allows Windows 95 to understand different types of SAS System files (including SAS data sets, catalogs, and SAS System source code), which are represented by unique icons. Each file type is also associated with default actions that can be accessed through the Explorer's pop-up menus.

The SAS System also supports long filenames, which are supported by many other applications under Windows 95, Windows NT, and OS/2 with HPFS support. These filenames, which can be up to 256 characters long, can include embedded space and separator characters, make file system interaction more intuitive and inter-application data sharing transparent.

Finally, Release 6.11's ability to access external dynamic link libraries (DLLs) from within the SAS System can extend your processing power. Functions contained in custom DLLs developed in-house, or system or third-party DLLs can be called from within the SAS System by experienced programmers. The external DLL can be loaded, routines invoked, and the DLL unloaded upon completion.

For a more complete discussion of the new features available in the SAS System, please refer to the paper, "Introducing Release 6.11 of the SAS System for Personal Computers," also in these proceedings.

Enterprise Performance Suggestions

When you select new machines, there are certain features that can have a major impact on both desktop and server machine performance. Some of these are briefly described below:

Bus Architecture makes a big difference. Most new PC's are equipped with a PCI (Personal computer interconnect) bus. This type of bus provides a very fast backbone for data transfer between major system components such as hard drive, network, CPU, and display adapter. The PCI bus is far faster than older bus systems (such as ISA) which are common on older machines.

CPU type and speed are very important as well. The SAS System is optimized for Pentium (and later) processors, so a performance gain can be realized when using these processors. Keep in mind that internal chip optimizations can make a "newer" CPU faster than an older CPU with the same speed rating. A 100MHz Pentium system should outperform a 486DX4 system, and P6 or Pentium Pro systems should easily outperform a comparable Pentium system. Of course, you should always have enough cache memory to keep your CPU running as quickly as possible.

Video Adapter technology can make a great difference in apparent CPU performance due to video accelerator chips and 32 bit PCI bus throughput. Some of this performance gain may be offset, however, by the use of very high display resolution (such as 1600x1200 displays) and pixel depth (such as True-Color, which requires at least 24-bits of data for each pixel displayed on the screen). High-resolution true-color configurations may degrade video output, especially for highly graphical displays or heavily scrolling output.

Disk Adapters should be 32 bit PCI bus compatible SCSI or Enhanced IDE to offer the best throughput on new machines. In addition, disk systems that use fast and wide SCSI can realize additional performance gains due to increased throughput. Hardware or software approaches to parallelizing disk access (such as data stripping and spanning available under Windows NT) can also enhance server disk performance by decreasing effective disk wait periods.

Network Adapters are important in heavily networked configurations. Fast network cards can help speed network-based applications along. As the number of heavy network users increases, the need for 100M/sec Fast Ethernet or FDDI network will become apparent.

Protocol Stack can also affect network performance. Newer 32-bit operating systems using 32-bit driver software should be tuned for the type of network fileserver configuration in use.

Operating System versions are a factor for determining compatibility, capability and performance. IBM OS/2 WARP CONNECT and Microsoft Windows 95 and Windows NT 3.51 offer much improved integrated client support in conjunction with 32 bit system performance with their 16-bit predecessors.

Installation Issues

The SAS System SETUP program, available with version 6.11 of the SAS System for Windows and for OS/2 adds features that facilitate enterprise use of the SAS System. In addition, enhancements to the SAS System for Windows, Release 6.11, require that the SETUP program be used for full functionality of the SAS System on your PC. The new SETUP program has a new user interface to make it easier to use and more reliable in large-scale enterprise use.

Typical and Compact Installation

Easily-selectable default installation types are now available to facilitate easy use of the SAS System SETUP program for typical users. A Typical configuration will install the most commonly-used parts of all products for which you are licensed, and a Compact configuration will install commonly-used parts of only the Base SAS System. The commonly-used parts refer to all SAS System product files except sample programs and sample data sets, multimedia samples, SAS/GRAPH Map data sets, and installation text streams. Omitting these files from the typically used installation types saves local PC disk space, and can be separately selected for installation using the Selective Custom installation type described below.

Client Installation

A new capability of the installation program for the SAS System beginning at Release 6.11 is called a client installation. This capability allows a PC to become a client of SAS System software located on either a CD-ROM or a network drive. In this mode of operation, no SAS System files need to reside on the PC's hard drive or in a user's network directory. Instead, all SAS System files are accessed from the remote file server or the SAS System CD-ROM. Only files and data generated by the user need to be stored on their own disk space. While the performance of this type of configuration might not be as good as a normal installation, a client installation has the following benefits:

- All SAS software resides on the file server or on the original CD-ROM. This makes software maintenance and distribution easier for network administrators, since only one copy of the SAS System software is actually used.

- Disk space use is minimized. Since the SAS System software is accessed from a single location (in the case of a networked image) or from the SAS System CD-ROM, only SAS programs and data sets created by the user need to be stored in a modifiable location.
Partial Client Installation

In addition to the "full client" installation described above, the 6.11 SETUP program also supports what is called a partial client. This allows the user to select which SAS System products or product components will be physically copied to modifiable user disk space. Any licensed products that are not selected will automatically be accessed from the filesys file server or CD-ROM location. In this way, a knowledgeable user or administrator can select products or components based on their available disk space and their knowledge of which products will be used most frequently and therefore need the best performance. The benefits of a partial client installation include:

- increased performance as compared to a full client installation since commonly-used products can be loaded on the local PC hard drive.
- a smaller network load than a full client installation since the SAS System will first look to the local PC hard drive for SAS System components. Products that have not been installed to the local PC hard drive will still need to be accessed from the remote network location, however.

Selective Custom Installation

The 6.11 SETUP program also supports a normal standalone selective installation mode. The user can select products and components to copy to their user disk space based on descriptions of the products and components. This is different from a client installation in that only the selected (and copied) products or components can be run by the user; no products on the distribution CD-ROM or a networked location can be accessed in this configuration. This configuration should provide superior performance to a client installation, but will require more local hard disk space to be used.

CD35 Media and floppy diskette generation

A new distribution media available starting in Version 6.11 is called CD35, which is a CD-ROM containing diskette images of 3.5" floppy diskettes. While this CD-ROM doesn't support client installation mode, it does provide the new functionality of being able to generate floppy diskettes from the SAS System CD-ROM. An administrator with CD35 media can select a list of products and generate SAS System product floppy diskettes identical to those shipped by SAS Institute. These floppy's can then be used for intra-site distribution.

Uninstall under Windows 95

Available in the Spring 1996 release of the SAS System for Windows is full uninstallation of the SAS System software utilizing Windows 95's uninstallation support. This will allow uninstallation of all SAS System files installed as well as system modifications made by the SETUP program at installation time. These system modifications include updated drivers that may be placed in the Windows system directory, updates to the Windows registry database related to SAS System operation, and the SAS System files installed into user disk space. The uninstallation will not modify any user-generated files or data.

Improved problem detection and logging

The SETUP program attempts to detect many common system limitations during the installation process. Issues such as WIN32S version, floating point processor status, and operating system revision levels are checked, and any problems noted are reported to the user of the SETUP program. Any potential problems, as well as a chronology of the installation process are stored in a log file that can be later reviewed to reproduce configurations or aid in problem resolution. In addition, supplementary installations, such as Microsoft WIN32S, the SAS ODBC driver, the Intel indextm driver, and operating system font registration for full SAS/GRAPH availability are all encompassed in the main SAS System SETUP program to streamline the installation process for network administrators.

Conclusion

Various approaches to SAS System PC client/server computing and data access are possible and have been explored. Each can be useful in certain configurations and situations. The flexibility of the SAS System allows Information System designers to design an enterprise computing system that utilizes data and resources efficiently. There is a wide range of variables in areas such as application design, remote data access, remote computing access, and desktop PC speed and disk size. No single approach is best for all configurations. Application needs, data quantity and data locations will direct how a system should be organized. Factors to consider include:

- The location of SAS System software. Network installations are possible to save disk space but can affect performance in some cases. If the SAS System is run from a file server, hybrid local and network installations are suggested to minimize local disk space requirements while keeping network delays small.
- The processing power and configuration of the desktop and server computers are of critical importance and PCI bus machines with 32 bit video and disk adapters should be selected. Increasing remote server performance and availability is an easy way to increase performance for users. Plan for eventual migration to the new OS/2 and Windows platforms with integrated client support.
- Offloading jobs to PC platforms from overloaded central resources can get the job done quicker in many cases and will usually lower costs compared to using central resources.
- If you must process all records of a large data set multiple times, use SAS/CONNECT Compute Services to process the data at the server or Data Transfer Services to download the data set for local processing. Either approach will help reduce network traffic.
- Use WHERE clauses on your procedures and data steps and indexes on SAS data set variables that are likely to be used to subset your data by the WHERE clause. These two features will significantly increase data access performance and reduce network traffic.
- Rely on central services when they are plentiful and when data is centrally located. Mainframe and other centralized computing resources typically have access to unique hardware and software products as well as high quality system support and backup facilities that may be required in many cases. SAS/CONNECT and SAS/SHARE software allow critical data to remain in the safest location and be analyzed on the most capable platform.
- Take advantage of interoperability with other applications. Third party ODBC access to SAS data, OLE interoperability, and SAS/ACCESS connections or flat file access to external sources add flexibility for system designers. This means that data can be accessed or processed in the most efficient manner by the most appropriate software tool set.
- Lotus Notes and e-mail access through the SAS System can help meet organizational needs. You can also extend the power of the SAS System through external DLL access and full integration with operating systems like Windows 95.
- Use the SAS Domain Server gateway if you do not want to bear the cost and maintenance of multiple protocol stacks when you must contact diverse protocol domains.
Systems Architecture

- Network administrators and system designers as well as power users should determine the optimal uses of the enterprise hardware and software which will lead to more optimal use of personnel time.
- A properly configured installation can help performance as well as the maintainability of the installed software.

In summary, the SAS System provides a wide range of computing and data access options that meet just about any system requirement from desktop analysis to data warehousing. The desktop PC running the SAS System can play an important role in your enterprise computing strategy and will increase both your productivity and your capability.

**Trademarks**

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**References**


**Appendix A - 611 SAS Access Methods**

The following peer to peer access methods are available in the Version 6.11 of the SAS System.

**SAS ODBC Driver for Windows**
TCP/IP (Winsock)
Local and Network DDE

**SAS/SHARE for Windows**
TCP/IP (Winsock)
NetBIOS
SPX
WOSA APPC and CPIC
Local and Network DDE
DECnet

**SAS/SHARE for OS/2**
TCP/IP
NetBIOS
SPX
APPC

**SAS/CONNECT for Windows**
TCP/IP (Winsock)
NetBIOS
SPX
WOSA APPC and CPIC
DECnet
EHLAPI
TELNET

**SAS/CONNECT for OS/2**
TCP/IP
NetBIOS
SPX
APPC
ASYNC
EHLAPI
TELNET

**SAS Domain Server for OS/2 and Windows NT**
TCP/IP (Winsock)
NetBIOS
SPX
APPC (OS/2) and APPC and CPIC (Windows NT)

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