Systems Architecture

Comparing the SAS® System Release 6.11 for Microsoft® Windows® 95 and Windows NT™
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ABSTRACT

The SAS System for Windows Release 6.11 is a Win32® application. This means that a single binary image of the SAS System executes on Microsoft Windows 3.1 (or Windows for Workgroups 3.11) using Win32s® technology, Windows 95, and Windows NT. Windows 95 is one of the most significant and influential operating system releases for workstations in the history of personal computing and has made a significant impact in both the home and corporate software market. Windows NT Release 3.51 and later releases, represents the continuing incremental improvement in this operating system, and many corporations are beginning to adopt Windows NT for both client and server applications. While Windows 95 is optimized for client computing, Windows NT is also now being widely accepted as one of the most robust and powerful client platforms. This paper presents an overview of both operating systems Windows 95 and Windows NT, with respect to the SAS System. The SAS System for Windows executes on both operating systems, but there are some differences in capabilities of the operating system that SAS System is optimized for. On Windows 95, the SAS System is optimized for end user computing centered around the graphical user interface. Windows 95 introduces a collection of new capabilities such as the Explorer, the first step in presenting an object based user interface. Windows NT has inherited the same Windows 95 user interface but has also consistently pursued the server market by providing interfaces to support powerful file and compute server applications. This paper will help to explain the Institute's commitment to both Windows 95 and Windows NT, and explain which operating system is preferred for the SAS System in different scenarios.

INTRODUCTION

This paper describes the main two members of the Microsoft Windows family and the releases of the SAS System that support them. These two members, Windows 95 and Windows NT, share many product features, but also deviate with specialization in different areas. This paper attempts to discuss Windows 95 and Windows NT, with respect to the SAS System releases available on these platforms, and provides guidelines as to which operating system is best suited for a given scenario. The paper begins by reviewing the SAS System releases provided on the Windows platforms, and then discusses the main characteristics of the operating systems. A small discussion is reserved for comparing Windows NT Workstation to Windows NT Server. Finally, four business scenarios are presented in order to help clarify which Windows operating system is best suited for each scenario.

Note: Throughout the paper, unless otherwise specified, the term Windows NT generally refers to the code base and feature set that is represented in both product offerings, Windows NT Workstation and Windows NT Server. The paper assumes that the current release of Windows 95 is the retail version available in August 1995, and the version of Windows NT Workstation and Windows NT Server is 3.51. When referring to Windows 3.1, the product Windows for Workgroups 3.11 is also implied.

Review of SAS System Releases for Windows

The following table provides an overview of the history of the SAS System releases provided for Windows:
<table>
<thead>
<tr>
<th>Windows Release</th>
<th>SAS System Release</th>
<th>Architecture Windows/SAS</th>
<th>Date released</th>
<th>Major SAS Exploitation for the specific Windows release</th>
</tr>
</thead>
<tbody>
<tr>
<td>Windows 3.1</td>
<td>6.08</td>
<td>16-bit / 16-bit</td>
<td>Sept 92</td>
<td>Windows GUI, OLE 1.0 support</td>
</tr>
<tr>
<td>Windows NT 3.1</td>
<td>6.09</td>
<td>32-bit / 32-bit</td>
<td>Nov 93</td>
<td>32-bit processing, OLE 1.0 support</td>
</tr>
<tr>
<td>Windows 3.1 using Win32s</td>
<td>6.10</td>
<td>16-bit / 32-bit</td>
<td>Dec 94</td>
<td>32-bit processing, OLE 1.0 support, improvements in the GUI and printing, Microsoft ODBC clients supported</td>
</tr>
<tr>
<td>Windows 3.1 using Win32s, Windows 95, Windows NT</td>
<td>6.11 Orlando</td>
<td>16-bit / 32-bit</td>
<td>Nov 95</td>
<td>Improvements in GUI, OLE 2.0 support, Email support, Pre-production support for Windows NT, Experimental Support for Windows 95, SAS ODBC Server support</td>
</tr>
<tr>
<td>Windows 3.1 using Win32s, Windows 95, Windows NT</td>
<td>6.11 Wave 2</td>
<td>16-bit / 32-bit</td>
<td>1H96</td>
<td>OLE 2.0 support including SAS OLE automation server, Production support for Windows 95 and Windows NT Workstation and Server, Large file support on Windows NT</td>
</tr>
</tbody>
</table>

The SAS System support for Microsoft Windows has been consistent and timely across the last few years. With each release of Windows, the SAS System has delivered strategic extensions of the SAS System to exploit the capabilities provided by Windows. The most current releases that are in production include Release 6.11 Orlando and the Wave 2 of Release 6.11 (as of SUGI 21 - March 1996). (Note: Wave 2 is the internal code name for this release.) The Orlando release supports Windows 3.1 using Win32s technology (explained below), Windows NT Workstation as a pre-production release, and Windows 95 as an experimental release. The same binary image runs unmodified across all these Windows platforms. SAS 6.11 Orlando exploits the OLE 2.0 technology including OLE container support, visual editing, OLE automation controller, and drag and drop.

SAS 6.11 Wave 2 provides for production support and full exploitation for Windows 95. This release is built explicitly to support the major features of a Windows 95 application which includes:

- Support for Win32 API
- Ability for the same binary image to run properly on Windows NT
- Support for the common dialogs in Windows 95 such as Open, Save, Save As, Fonts, Print, and Print Setup
- Support of the user interface guidelines in The Windows Interface Guidelines for Software Design
- Support of the Windows 95 registry; avoidance of using system or application .INI files
- Integration with the Windows 95 Explorer
- Support for OLE 2.0 including OLE container support, visual editing, drag and drop, and OLE automation
- Support for a properly configured Setup program for installing and de-installing the SAS System

In addition, the support for Windows NT Workstation and Windows NT Server was upgraded to production status, being fully tested and qualified by the SAS Institute Quality Assurance Department. The licensing arrangements for the Windows releases have been updated to include two licenses:

1. The SAS System for Windows Workstation - a license for the SAS System to execute on Windows 3.1 using Win32s, Windows 95, and Windows NT Workstation.
The SAS System for Windows NT only supports the Intel architecture. Please contact the author or your SAS account manager if you are interested in SAS on other RISC platforms.

For Windows NT, the major features supported include:

1. Support of 64-bit file I/O using the NTFS file system. This provides for the ability of SAS data sets to be larger than 2 Gigabytes. For example, a 10 Gigabyte SAS data set could be read or written. Windows NT is the only PC operating system that can support large files.

2. Support of a SAS/CONNECT spawner that runs as a NT Service. This allows a Windows NT machine to service SAS/CONNECT remote requests without:

   1. requiring the user to first log onto the Windows NT PC and execute the spawner program, and
   2. the spawner honors the access rights of the Windows NT registry with respect to the requesting user id.

3. All features supported on Windows 95 are also supported.

Comparing members of the Windows family

Three members make up the Windows family of operating systems: Windows 3.1 using Win32s technology, Windows 95, and Windows NT. All of these members are developed around an Application Programming Interface (API) named Win32. This is the standard Windows programming interfaces for Windows 32-bit development. Win32s technology used only on Windows 3.1 and derivatives, was Microsoft's stopgap measure to help transition software vendors toward developing 32-bit Windows applications on the lucrative Windows 3.1 platform, before the market for Windows NT or Windows 95 was profitable. Win32s technology provides a subset of the Win32 API hosted on top of the 16-bit Windows 3.1 run time executables. The result allows an application to be developed in 32-bit code calling the Win32 APIs provided by Win32a, and then the Win32s calls would be "thunked" or translated down to the 16-bit Windows 3.1 interfaces. This allows a Windows application to be developed in 32-bit code regardless of the processor mode used by underlying operating system code. SAS Institute chose to support Win32a in the SAS Release 6.10 and 6.11, in order to allow the SAS System to be optimized on a 32-bit platform. This decision was based purely on performance and reliability of the software. By developing for Win32a, the SAS System was able to execute in pure 32-bit environment thus eliminating inefficient 16-bit coding techniques, and also allowed for optimizing on the assumption that a floating point processor (either an Intel 387 math coprocessor or an Intel 387 floating point unit) was present. Assuming the presence of a floating point processor afforded tremendous performance gains in the SAS System for numerical analysis. After the release of Windows 95 and thus the creation of a new profitable Windows 32-bit software market, Win32s is no longer enhanced for future Windows releases.

Nearly everyone, on the face of the earth, knows about Windows 95, as the result of Microsoft's massive marketing campaign. Windows 95 is a non-portable implementation of the Win32 API, that was designed to run on entry level, and existing PCs, with little or minimal upgrading necessary. Windows 95 also introduced a new user interface, based on years of user interface testing. Windows 95 also presents the developer with a full 32-bit programming interface, but under the interfaces, still a great deal of Windows 95 internal code runs in 16-bit mode. This fact is responsible for the poor performance of Windows 95 on the Intel Pentium Pro processor, which is tuned for 32-bit computations, and is initially lacking in 16-bit performance. Windows 95 is targeted towards the entry level business user as well as the home consumer and home and small office users.

Windows NT is now in its full 2nd generation, with the Windows NT Workstation 3.51 and Windows NT Server 3.51 release. NT Workstation and NT Server share the same microkernel, and is portable to several RISC platforms, including MIPS, DEC Alpha AXP™, and the PowerPC™ Prep Platforms. Windows NT provides C2 security, large file access (files greater than 2 Gigabytes), and a very robust architecture for mission critical applications. Windows NT also supports the Win32 API but also provides additional APIs that allow NT to optimize in the high end desktop and server arenas. Windows NT Server provided along with Microsoft BackOffice provide the product offerings to provide services for electronic mail and messaging, SNA services, Internet publishing and services, inventory management, and data base services.

Microsoft's strategy is to have a family of Windows offering from the low end Windows 3.1, to the entry level business environment Windows 95, through the high end power user and server platforms with Windows NT. Applications should be able to run across all of these environments unmodified. Now, this strategy is narrowed to Windows 95 and
Windows NT Workstation and Windows NT Server, with the demise of Win32.

The next sections compare the various attributes of the operating systems Windows 95 and Windows NT.

Multitasking and Memory Management

Both Windows 95 and Windows NT provide for preemptive multitasking. Applications execute within their own address space and are prevented from corrupting other applications. Memory is addressed linearly up to a limit of 2 Gigabytes of address space per process. Memory management APIs are provided for a rich set of interfaces including memory mapped files, named shared memory, and dynamic loading and unloading of code libraries. Under both Windows 95 and Windows NT, applications execute in a robust tasking environment and the memory management architecture virtually removes the out-of-memory constraints of previous Windows 3.1 releases. This includes the removal of the 64 kilobyte limitations of the USER and GDI segments.

Both Windows 95 and Windows NT provide for the ability to execute multiple concurrent SAS sessions.

Symmetric Multiprocessing Support

Only Windows NT supports symmetric multiprocessing (SMP). Out of the box, up to four processors are supported in which any thread of execution could execute on any processor, at any time. Up to 32 processors can be supported but requires that the customer purchase a software component named a HAL (Hardware Abstraction Layer) directly from the PC hardware vendor, that would provide the support for the additional processors. Windows 95 does not, and will not ever support SMP. Incidentally, Windows NT provides better support for SMP with more throughput and saturation of the available processors than does IBM's OS/2 Warp SMP². This is because in Windows NT, even the microkernel is multithreaded. Therefore, units of computational work can take advantage of SMP processors even while executing in the kernel.

Performance Considerations

Benchmarking tends to be more of an art than a science. Developers can generally prove whatever point needed with an appropriate benchmark. Here are the facts concerning the SAS System performance on the Windows platforms. The SAS System for Windows only supports Intel platforms, at Release 6.11. The mechanics for building the SAS System include using an SAS Institute developed C compiler and compiling the 7 million lines of C source code, just once. The compiled code is bound into executable files (.exes) and load modules (.dlls). For a given executable or load module, for a given SAS procedure or executable, the binary image is byte for byte the same, across all Windows platforms. Therefore, if provided a standard hardware configuration of exactly the same hardware running on Windows NT and Windows 95, the image of the SAS System is exactly the same. What then, are the factors involved that are responsible for performance differences between Windows 95 and Windows NT? These factors can be broken down into 3 categories:

- Difference in the SAS System execution path, dependent on the operating system
- Differences in the implementation of the Win32 API across Windows platforms
- Differences in the operating system architecture of the Windows platforms

Even though the SAS System executable code is exactly the same across all Windows platforms, there are runtime differences. Throughout the SAS System code, there are runtime checks for Windows 95 and Windows NT. Typically, in the Explorer related GUI code, checks are made to determine if the SAS System is executing on Windows 95, in order to exploit a certain GUI feature only available on Windows 95. Conversely, in areas such as file i/o, runtime checks are made for Windows NT for example, in order to use the 64-bit file i/o APIs only available on Windows NT. These runtime checks have been made with great care, and it is believed that any performance difference attributed to these runtime checks is negligible.

Although the Win32 API is provided across all Windows platforms, which provides scalability and portability, the implementation of the Win32 API across the platforms may not be the exact same code. Therefore, the same API call, when executed across different Win32 platforms may take proportionately different times for execution. Still, it is very difficult to measure or make any general statements regarding these differences.

Clearly though, the architecture of the Windows platforms deviate greatly, and this is the major reason for performance advantages across Windows 95. Windows 95 represents a simpler architecture, but much of the underlying code for the GUI is still in 16-bit Windows code.
The best performance of the SAS System on Windows 95 would generally be on Windows 95, running computational oriented processing, with 16 to 20 Megabytes of memory. Computational processing would avoid excessive Win32 API calls that would tend to slow down performance because the thinking to 16-bit Windows code would be generated. Typically, on a Pentium based PC, performance on Windows NT would be expected to be a bit slower than on Windows 95. This is because of the overhead associated with Windows NT. Although Windows NT is superior in design and architecture, the C2 level of security alone, as well as the coding costs incurred to maintain a portable microkernel, would tend to make Windows NT execute slower with more overhead, than Windows 95.

C2 Level of Security

Only Windows NT provides the level of security designated as C2 by the standards of the U.S. Department of Defense. Some of the most important requirements of C2-level of security include:

- The owner of a resource (such as a file, directory, printer) must be able to control access to the resource.

- Audit trails of security related events must be provided for system administrators.

- The operating system must protect data stored in memory for one process so that it is not reused by other processes, or cannot be read by other processes. For example, memory to be freed will be cleared at memory free time, to prevent another process from seeing the memory contents.

- Each user must have a unique way of identifying themselves. Windows NT achieves this by providing a unique logon name and password before being allowed to access the system. This logon id is used to track the activities of the user in audit trails.

There are no plans for Windows 95 to pursue C2 security. Windows 95 is not considered to be a secure operating system.

Portability

Portability can be measured in two ways: 1) portability of the Win32 applications, and 2) portability of the Windows operating system to be provided on a new and different processor and architecture. First, applications developed to the Win32 API are completely portable not only across Windows Win32 platforms but also across Windows processor platforms. The Win32 API is completely supported across all Windows Win32 operating systems including Win32a, Windows 95, and Windows NT. If the application is to be used across Intel platforms (Intel 486, Intel Pentium, Intel Pentium Pro platforms), the Win32 application can be compiled once, and the single binary will execute across all Win32 platforms. If the application is to be used across differing hardware platforms (example: Intel, MIPS, Alpha, and PowerPC), then the source image of the code using the Win32 API would need to be recompiled for each of the different hardware platforms. However, the source code itself would entirely be portable.

Windows NT itself is portable across differing hardware platforms, including Intel, DEC Alpha, MIPS, and the PowerPC Prep specification. Portability was one of the design goals of Windows NT, and provides customers with hardware independence. This is accomplished with the use of a portable microkernel built on top of modules named HALs for Hardware Abstraction Layers.

Windows 95 is not portable and is not intended to port to any other processor or architecture. Windows 95 is built directly for the Intel x86 architecture, and contains non-portable assembler code, and non-portable architectural constraints.

Microsoft has publicly indicated the desire to merge the source code and kernel of Windows 95 and Windows NT in several years. For now, this is only a plan.

Graphical User Interface and OLE 2.0

Windows 95 brought forth a new GUI, the Explorer shell. This user interface was designed after many man years of GUI design studies. The Explorer interface was meant to address the main user interface issues that created confusion for customers while using Windows 3.1 Program and File manager. This user interface is similar to OS/2 Warp Workplace Shell, and the Apple MacIntosh. Although Windows NT 3.51 uses the Windows 3.1 user interface for compatibility, the Windows 95 Explorer interface is also available on Windows NT. The SAS System for Windows Release 6.11 exploits the Explorer interface for both Windows 95 and Windows NT.

OLE 2.0 is supported equally well on both Windows 95 and Windows NT. All OLE support in the SAS System works equally well on both platforms. This includes support for OLE containers, visual editing,
drag and drop support, and OLE automation controllers and servers.

File Systems

The file systems for Windows 95 and Windows NT are similar and compatible with each other, with a few caveats. Windows 95 supports the FAT, VFAT, and the CDROM file system. With the VFAT, long filenames up to 250 characters including blanks, and upper and lower case names are supported. This feature is quite popular and useful in Windows 95. Filenames can be meaningful and not limited to the DOS 8.3 convention. On Windows NT, the file systems supported include FAT, HPFS, CDROM, and NTFS. The FAT file system is provided for compatibility with MS-DOS, while the High Performance File System (HPFS) provides compatibility with OS/2. The NT File System provides for a secure file system that provides for 64-bit byte addressing, supporting large files greater than 2 Gigabytes. Release 6.11 of the SAS System properly supports NTFS allowing SAS data sets to be accessed that are larger than 2 Gigabytes. Data sets around the size of 8 to 10 Gigabytes are common in this scenario. Windows NT also supports long filenames.

Both Windows 95 and Windows NT Workstation can provide disk sharing services to peer connections. Also, within the same network, Windows 95 and Windows NT clients can seamlessly coexist. For large scale file server capability, Windows NT Server provides for a powerful and secure file server capability that will support more than just a small workgroup. See Comparing Windows NT Server to NT Workstation, Release 3.51

File compression is provided on both Windows 95 and Windows NT. However, Windows NT provides for a per file or per directory file compression on the NTFS file system, where as Windows 95 supports only per volume compression.

Network Connectivity

Windows NT and Windows 95 provide for a large collection of network connectivity options. Out of the box, both operating systems support TCP/IP including PPP and SLIP, NetBEUI, DLC, and IPX/SPX. Both provide for remote access services to allow remote dial-in to the system. Currently, only Windows 95 provides support for the Microsoft Network (MSN) and for a universal inbox supporting email and fax. Both of these are planned for a future Windows NT release.

MS-DOS and Windows 16-bit Compatibility

Windows 95 will run almost all Windows 16-bit applications, and MS-DOS® applications. However, these applications will not run with preemptive multitasking. DOS applications that write directly to the hardware and thus violate the system integrity will not execute. Windows NT supports Multiple Virtual DOS Machines (MVDM) which allows preemptive multitasking of 16-bit applications for Windows and DOS with full memory protection. Each application runs in its own address space resulting in increased application responsiveness and maximum data and program protection. Full OLE and DDE support is provided between separate VDMs.

Setup

Windows 95 provides a control panel applet that is responsible for installing and de-installing applications. Applications should be installed in the Program Files folder, and should keep a log of the changes made (including folders created, files copied, registry changes made). Later, the de-install applet for the application, can remove cleanly the entire application. Setup programs should not update or maintain .INI style files but instead update the system registry. For Windows NT, a system registry is also used. In the future, Windows NT is expected to support and embrace the same guidelines for installation programs.

Plug and Play Support

Plug and Play support is provided for PCMCIA peripheral cards on Windows 95. From a software perspective, this requires application software to recognize the changing status of hardware devices such as modems, external CD-ROM drives, and network connections. The major benefit of Plug and Play is for system administrators. Plug and Play eliminates most of the time consuming hassles involved with adding peripheral cards to a PC.

Preliminary support for plug and play for PCMCIA devices is provided in Windows NT, and incremental support is planned for future releases. Plug and Play support is vitally important to the PC industry and can be assumed to be pursued across all major PC operating systems.
Window Open System Architecture (WOSA) services are APIs that Microsoft identifies to address specific industry problems and attempts to create broad industry support. Examples of successful WOSA services include Windows Sockets (WinSock) for TCP/IP communications, Open Data Base Connectivity (ODBC) for accessing SQL-based databases, OLE COM for object-based programming, and Messaging API (MAPI) for electronic mail and forms messaging. In addition, there are many other WOSA services. Microsoft targets both Windows 95 and Windows NT for all WOSA services, and has proven to be consistent in providing adequate development support for the WOSA services across both platforms. Once again, there is substantial proof to indicate Microsoft's commitment to a family of operating systems.

The SAS System for Windows supports ODBC both client and server applications, WinSock, SNA Server and SNA services, electronic mail using MAPI, and OLE, equally well on Windows 95 and Windows NT.

What's new in Windows NT Release 3.51

Windows NT Release 3.51 was synchronized with the release of Windows 95 in August 1995. Some of the new features provided in the upgrade release of Windows NT include:

- Support of the Power PC platform using the Prep specification
- Improved PCMCIA support for very high end notebooks and laptop computers
- Support of Windows 95 common controls and dialogs, to provide a common user experience between Windows 95 and Windows NT
- Support for the popular Delrina 16-bit fax applications WinFax Pro 4.0 and WinFax Lite
- Per file and per directory compression on NTFS file system volumes; this provides transparent file compression
- Customizable Windows NT logon screens and sequences

Some of the major improvements provided in Windows NT release 3.5, that were upgraded from the original Windows NT Release 3.1 include:

- Multiple Virtual Dos Machine support that allows 16-bit Windows and DOS applications to support preemptive multitasking, and run in separate address spaces
- Integrated Netware support
- Improved TCP/IP support providing over 100% performance improvement
- A dump facility to record the state of a system crash, and the ability to auto-reboot

Windows NT Server Release 3.51 provided three new features as outlined below:

- Licensing and License Manager
- Remote Access Service Data Compression for faster communication across modems
- Network client administration for Windows 95

Comparing NT Server to NT Workstation, Release 3.51

There are two distinct products for Windows NT including Windows NT Workstation and Windows NT Server. Both of these products are built on top of the portable microkernel of Windows NT and have the same underlying base code. Both of the products provide 32-bit computing, preemptive multitasking, advanced security (C2-level) and reliability, built-in networking, and complete scalability including SMP support across hardware platforms. Both products provide built file compression with the NTFS file system at the per file or per directory level. Both products support the Win32 API including OLE. The SAS System supports both products equally well.

Windows NT Workstation is meant to address the client side workstation tasks for high end users, especially in the scientific, engineering, and business industries. With built-in networking including support for TCP/IP, Novell Netware, Banyan VINES, DEC Pathworks, and NFS, the system is easily integrated into a heterogeneous environment. Additionally, Windows NT Workstation supports an unlimited number of outbound connections to servers on a network, and up to 10 peer-to-peer inbound network server connections. Windows NT Workstation will serve three major types of customers:

- Corporate Desktops which require robustness, security, large capacity and maximum stability.
• Developers using Windows development tools as well as the SAS System development tools such as SAS/AF and SAS/EIS. Applications developed on Windows NT are immediately portable to other Win32 platforms. In fact, the development of the SAS System for Windows is developed on Windows NT because it is the most stable and robust Windows platform.

• Technical users including engineers, scientific users, and statisticians will find the performance required by powerful analysis to be best suited for Windows NT. The industry trend indicates a shift of scientific computing from the traditional UNIX platforms to Windows NT. Given that Windows NT is portable and can be ported to RISC platforms, this trend is expected to continue, and Windows NT provides hardware independence to allow scientists to move to the most powerful platform available.

Windows NT Server is built upon the same base code of Windows NT Workstation. This includes 32-bit processing, Win32 API, Symmetric Multiprocessing, and a flat linear memory model. Windows NT Server is targeted to high end server applications. Typically, (but not always), Windows NT Server is run on a very high end machine with at least 32 - 64 Megabytes of memory and at least 8 - 10 Gigabytes of disk area. Windows NT Server is the platform that hosts the Microsoft BackOffice server products such as SQL Server, Internet Server, SNA Server, Exchange Messaging Server, and Systems Management Server. Often an enterprise application combines the SAS System with SQL Server to manage a large corporate data base. In such a case, the SAS System should be run on the Windows NT Server with SQL Server to avoid unnecessary network traffic between the SAS System and SQL Server.

**Hardware Configurations**

The following table describes the suggested Windows platform for the SAS System given the hardware configurations.

<table>
<thead>
<tr>
<th>Processor</th>
<th>Memory</th>
<th>Application</th>
<th>Windows Platform Suggested</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intel 386</td>
<td>16 Meg or more</td>
<td>End User application</td>
<td>Windows 95</td>
</tr>
<tr>
<td>Intel 486</td>
<td>16 Meg or more</td>
<td>Data analysis - low end</td>
<td>Windows 95</td>
</tr>
<tr>
<td></td>
<td></td>
<td>SAS development - low end</td>
<td>Windows 95</td>
</tr>
<tr>
<td>Intel Pentium 100 Mhz or less</td>
<td>16 Meg or more</td>
<td>End User application</td>
<td>Windows 95</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Data analysis - mid range</td>
<td>Windows 95</td>
</tr>
<tr>
<td></td>
<td></td>
<td>SAS development - mid range</td>
<td>Windows 95</td>
</tr>
<tr>
<td>Intel Pentium greater than 100 Mhz</td>
<td>At least 16 Meg, 20 Meg or more is recommended</td>
<td>Data analysis - high end</td>
<td>Windows NT Workstation</td>
</tr>
<tr>
<td></td>
<td></td>
<td>SAS development - high end</td>
<td>Windows NT Workstation</td>
</tr>
<tr>
<td>Intel Pentium Pro</td>
<td>32 Meg or more</td>
<td>SAS Server application</td>
<td>Windows NT Server</td>
</tr>
</tbody>
</table>

In general, Windows NT Workstation is the preferred environment for SAS data analysis and end user application development. NT provides the ability to multitask applications more efficiently and provides for a more stable and robust environment. However, Windows 95 is nearly equally as well suited for the SAS System if ample memory (16 Megabytes or more) is provided, on a Pentium 120Mhz or higher processor.

It is highly recommended for advanced development with the SAS System, to have at least 16 Megabytes of memory available. The SAS System will run with less memory for Windows 95, but at least 12 Megabytes of memory should be provided, and the application will appear to run slower at times.

Care should be taken reviewing the hardware requirements for Windows NT. Windows NT is not supported across all Intel based PCs. The Windows NT Hardware Compatibility Guide should be consulted to determine compatibility with existing hardware. Windows 95, on the otherhand, will almost always run on existing hardware.

**WHEN TO USE WINDOWS 95 OR WINDOWS NT?**

The choice between using Windows 95 or Windows NT, can be decided by considering the environment and type of computing that will be performed. Below, four scenarios are presented to help describe which operating system is best suited for each of the business cases.
Scenario 1: Business Desktop
The business desktop scenario describes an environment in which end user applications are run and data analysis is performed. The end user application is typically a SAS/AF or SAS/EIS application, or possibly a Data step application. The data analysis could be Data step and procedural programming, with a large degree of numerical and statistical analysis.

Windows 95 - Choose Windows 95 if the application is a SAS/AF application providing a nice GUI. SAS/AF generally does not overtax the system, especially in runtime mode. The Windows 95 Explorer user interface is comfortable for end users, and the support for OLE is complete and robust. Applications availability from other software vendors is plentiful. The deciding factor of choosing Windows 95 for data analysis is the size of the data set. The SAS System on Windows 95 can comfortably process SAS data sets up to 1 Gigabyte. Recommended system memory for this scenario is 16 Megabytes.

Windows NT Workstation - Choose NT workstation in the case that SAS/EIS is being used. SAS/EIS uses many more SAS products and system resources. Although it could run fine on Window 95, it would tend to push Windows 95 to its maximum limits. Windows NT would provide a far more robust environment for an EIS system. If large SAS data sets are needed to be accessed, greater than 1.5 Gigabytes, the preferred environment would be Windows NT Workstation. The reason 1.5 Gigabytes is considered a boundary point, is that temporary data sets are created during procedural executions, and typically the temporary work data sets can grow larger than the original data set, thus precariously approaching the 2 Gigabyte file limit of Windows 95.

Scenario 2: Developers - End User Apps
This development scenario entails the SAS developer creating SAS Data step and SCL programs. Typically, the display manager, SAS/AF Build mode, and SAS/EIS would be used. Also, application development with other third party software tools would be used.

Windows 95 - A high end PC running Windows 95 could be used for SAS development. The number of programs being multitasked should be limited to no more than 5 applications in order to allow good response from SAS.

Windows NT Workstation - The best environment for SAS development and Windows development is Windows NT workstation. The more effective and robust underlying memory and task management provides a more robust and responsive development environment. A larger number of development applications could be multitasked concurrently, as is common in a development environment.

Scenario 3: Mobile Users
This development scenario entails the SAS user working in the field or in a home office using a laptop or notebook computer. The other possibility would be a user that uses a laptop computer with a docking station at work, and with dialin access when away from the docking station.

Windows 95 - Clearly, Windows 95 is the clear winner in this category. The support for dial up networking, TCP/IP, SLIP and PPP, provides more than adequate services to support mobile computing. The SAS System works well on the laptop, as long as 16 Megabytes of system memory is provided. There are options within the SAS System to help identify the minimum footprint of executables to allow a smaller customized installation of the SAS System to be used.

Windows NT Workstation - There are users that have been successful with running Windows NT on a hi-end powerful laptop. This is not recommended. In most cases, the memory and disk space available is just not enough to allow Windows NT to perform with optimization.

Scenario 4: SAS Server applications
In the client server computing world, Windows NT Server is gaining substantial momentum as a server. Combined with SAS/Share, the SAS ODBC driver, and Microsoft BackOffice products such as SQL Server and the Internet Server, Windows NT Server provides a high capacity, scalable, high throughput server at a relatively low cost when compared to most UNIX server systems. Typically, this scenario involves data base access to a SQL based data base, using the SAS System as the data analysis and data repository tool.

Windows 95 - is not recommended. Windows 95 does not support high throughput file i/o. It simply is not designed for server applications.

Windows NT Server - provides for high capacity file services through the support of the NTFS file system. Combined with support for ODBC, SNA Server, the
Internet Server, and SQL Server, a powerful server application can be built around the SAS System on this environment. The hardware for this scenario is typically at the upper end, with at least 6 Gigabytes of disk storage and 32-64 Megabytes of memory. SMP machines support from 4 - 8 matched Intel processors are also common.

CONCLUSION

The SAS System Release 6.11 provides for a single binary image that will run across Windows 3.1 using Win32s technology, Windows 95 and Windows NT Workstation and Windows NT Server. Windows 95 is now considered the standard Windows client as Win32s technology is slowly phased out by Microsoft. The SAS Systems runs equally well on Windows 95 and Windows NT, with Release 6.11 Wave 2 being optimized for the Windows 95 Explorer user interface. Both Windows environments work best with the SAS System if at least 16 Megabytes of memory is available. The Windows NT Server platform is also supported in Release 6.11, providing a very high end server environment for large scale data processing applications. SAS Institute is committed to the Windows family of operating systems and can be expected to invest heavily in future development.

REFERENCES


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