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Taking Advantage of the SAS® System on the Windows® Platform

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ABSTRACT

The Windows operating system is a key environment for a majority of SAS users. Windows and related Microsoft products are undergoing significant changes and enhancements. The introduction of Windows 2000 Professional, Server, Advanced Server and Datacenter Server editions, 64-bit Windows, the upcoming "Whistler" release, the announcement of the Microsoft.NET framework, Digital Dashboards and improved performance for terminal services enables business and e-business applications to more fully utilize the Windows platform. Combined with new hardware systems from leading manufacturers including Unisys, Compaq, HP and Dell, Windows-based systems are now delivering previously unattainable levels of scalability and reliability. How do these new products benefit SAS users?

This paper presents a discussion of the state of the Windows platform and future direction, including operating system updates and new features and how the SAS system inter-operates with Windows. New SAS features that take advantage of new Intel hardware advances are also reviewed.

INTRODUCTION

In the past year, Microsoft has introduced a variety of new products and technologies that take the Windows operating system to new heights. With the introduction of Windows 2000 Server, Advanced Server and Datacenter Server, and the announcement of Microsoft.NET, Windows-based systems are now or will soon be capable of supporting many new uses. How does this affect SAS users today and in the future?

SAS is continuing to find new ways to take full advantage of new Microsoft server technologies and high-end Intel-based hardware capabilities. These exploitations center on the most effective use of the SAS System on large Windows 2000 server systems in applications such as data warehousing and decision support. In one sense, taking advantage of the SAS System on the Windows platform is easy because SAS has included much of the basic support in the software itself, ready for use. In another sense though, the task is more complex than before, because server-based features can be technically more difficult to understand as they relate to the operation of a specific use of SAS software.

This paper covers the current state of Windows operating system software, new Windows-based server products, and high-end server hardware likely to be applied to large-scale computational tasks and discusses how SAS is designed to take full-advantage of these new technologies. Some of this background will help the reader understand the quickly changing landscape of basic capabilities on PCs.

THE STATE OF WINDOWS

In the past year, Microsoft has introduced a staggering number of new products and technologies. There are now four versions of Windows 2000 (Professional, Server, Advanced Server and Datacenter Server). Windows Millenium Edition (Me) –the last product in the Windows 9x product line- was introduced. Perhaps most important, Microsoft introduced .NET - Microsoft's vision of the future of computing. Today, .NET is little more than a statement of vision – there aren't really any products available and .NET won't be fully implemented until at least 2003 – but the impacts of the .NET vision have the potential to affect all users of PC-based systems and applications. Microsoft also launched a series of new server products that set the stage for .NET and provide a new and rich set of capabilities.

In addition, systems based on new processors like Intel's Pentium 4 and the 64-bit Intel Itanium processors will dramatically impact the benefits and costs of PC-based computing.

The Windows 2000 Family

During 2000, Microsoft launched Windows 2000, the follow-on to Windows NT 4.0. Windows 2000 includes four products:

- Windows 2000 Professional: a desktop/workstation oriented operating system.
- Windows 2000 Server: provides support for up to four CPUs, targeted for use as an application and file/print server.
- Windows 2000 Advanced Server: provides support for up to eight CPUs and two-node

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fail-over clustering and is targeted as an application and database server.

- Windows 2000 Datacenter Server: introduced in September, Datacenter Server offers mainframe-level capabilities with support for up to 32 CPUs, four-node fail-over clustering and improved reliability (99.9% uptime and beyond) for large-scale line-of-business and enterprise and ".com" back-end usage. Supports server consolidation and enhanced scalability.

Together, these servers provide a broad and comprehensive line of products for most all business use. With Datacenter Server, Microsoft for the first time is offering a product that competes with high-end UNIX and mainframe systems. In addition to feature differences, Datacenter Server is available only through computer vendors as part of a certified package. (Reference table 1)

Microsoft also introduced the follow-on to Windows 98: Windows Millennium Edition (Windows Me). Windows Me is the final product in the Windows 9x product line and is targeted specifically to home/consumer use. It is not designed or priced for business use.

Table 1. Comparison of Windows 2000 capabilities

Edition	Pro	Server	Advanced Server	Data-center Server
# CPU limit	2	4	8	32
Physical Memory Supported	4GB	4GB	8 GB (PAE)	64 GB (PAE)
Concurrent Client Network connections	10	Unlimited	Unlimited	Unlimited
Clustering (failover)	N/A	N/A	Two-node	Four-node
Other Features	N/A	N/A	N/A	Process Control Manager tool
Additional Layered Services	N/A	Server domain controller Active Directory service Software-based RAID DHCP server DNS server DFS server Certificate Services Remote install and Terminal Services		

One of the greatest challenges facing an enterprise administrator is the management of computer networks as they become larger and more complex. For many corporations the migration from a Windows NT 4 domain structure to the Windows 2000 peer domain structure was and is a major infrastructure change, often requiring several months to a year for implementation and training. A major reason for this change was the addition of Active Directory. Active Directory, based on the standard of Lightweight Directory Access Protocol (LDAP), is one biggest features of the Windows 2000 server platforms. Active Directory provides location, policy, and organizational information on the enterprise-wide level. Information regarding using SAS with Active Directory is available from the authors.

In order for Microsoft platforms to more effectively support the enterprise, some management infrastructure and management tools were needed. Other complementary additions to Windows 2000 include the Microsoft Management Console (MMC) and Windows Scripting Host (WSH). The Microsoft Management Console is the presentation framework for writing management applications. Windows Scripting Host allows administrators to automate complex tasks via a script language.

A Look Ahead at Whistler

In 2001, Microsoft will introduce the next major version of Windows, code named "Whistler". While Whistler will include some new functionality, one of the major changes is the consolidation of the Windows operating system source trees into one common code-base. With the introduction of Whistler, Microsoft will cease all development of Windows Me (and the Windows 9x code-base). Another important feature of Whistler will be the support for 64- bit Intel processors. With the exception of the upcoming Whistler Consumer Edition, all Whistler-based operating systems will be offered in 32-bit and 64-bit editions. With the addition of 64-bit support, Whistler will be able to utilize larger amounts of memory and provide increased performance for users. The SAS System will fully support the Whistler 64-bit operating systems.

Whistler will not include many significant new server-oriented features. Most major new server features will be deferred to the following release of Windows code-named "Blackcomb". (Reference Table 2: Windows Roadmap)

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Table 2: Windows Roadmap

Edition	2000	2001	2002
Consumer	Window 98/Me	Whistler Consumer	Blackcomb
Work-station	Win2000 Professional	Whistler Professional	
Servers	Win2000 Server	32-bit Whistler Server	Blackcomb
		64-bit Whistler Server	Blackcomb
	Win2000 Advanced Server	32-bit Whistler Server	Blackcomb
		64-bit Whistler Server	Blackcomb
	Win2000 Datacenter Server	32-bit Whistler Datacenter Server	Blackcomb
		64-bit Whistler Datacenter Server	Blackcomb

For SAS users, this means that, if you're using Windows 95, Windows 98 or Windows Me, now is the time to start planning your migration to Windows 2000 Professional. Microsoft has a support policy of "n-1". This means that they will provide "quick fix engineering support" (QFE) for the current release of an operating system and the one previous version only. As an example, when Windows Me was released, Microsoft stopped QFE support for Windows 95 since it became the n-1 operating system. When Whistler is released, Microsoft is expected to stop QFE support of Windows 98 and so on.

Expected Whistler Features

As Windows 2000 introduced some new base features and infrastructure into the operating system, Whistler improves many of these initial features on both the workstation and server platforms along with adding improved performance and manageability. Some of these features include:

- 64-bit support
- Manageability: completely scriptable, command line access to all of Windows functions via Windows Management Instrumentation (WMI)
- Terminal Services everywhere
- Headless Server Support
- Improved Clustering Support
- Side-by-side install (SxS)
- Group Policy
- MSMQ Support
- PC Health – system restore
- Storage via snapshot backup

- Security – common UI for authorization
- Improved reliability with fewer crashes or other service interruptions.
- Improved Plug and Play support
- Improved performance

Windows Management Instrumentation (WMI)

WMI is one of several recent Microsoft technologies built on industry standards to further support the management of systems in an enterprise. The Web Based Enterprise Management (WBEM) initiative is the precursor of what Microsoft has dubbed WMI. The goal of the WBEM initiative was to develop standards for managing enterprise systems and devices. WMI is the technology that enables remote management of Windows-based systems and applications. WMI allows IT administrators to use a simple, consistent mechanism to query for information or configure settings on computers across an enterprise. A large amount of information now becomes available to application developers and administrators. Hardware settings, performance information, event log information, driver information, BIOS information and application settings are a few of the areas of the system that can now be queried a via simple, industry-standard management object model. The power of this technology makes it unnecessary to for administrators and developers to learn the specifics of every Windows API set provided by Windows.

Headless Server Support

Headless Server Support is a technology that is new to the Windows platform that has been added to Whistler. A headless server is a server that allows complete remote administration from power-on to disaster recovery and never requires access to the hardware except for physical maintenance. This technology can be thought of as a "server in a closet" or "server behind a glass wall" where an administrator cannot physically touch a console with a keyboard and mouse that is attached directly to that server. Headless support will only be offered in 32-bit editions of Whistler server platforms and will not be a part of Whistler Professional. There will not be headless support for Windows Whistler 64-bit editions initially.

For remote administration of headless servers and problematic clients, Whistler includes a Remote Desktop feature based on Windows 2000 Terminal Services. Remote Desktop lets

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administrators access systems on the network directly, without physically visiting the machine.

Whistler server platforms will add support for headless hardware via the Headless Emergency System Management (HESM). HESM does not require a keyboard, mouse, or monitor to be connected to the system. The system can be accessed via a serial port via a simple, text-based, well-understood interface called Secure Administrative Console (SAC). This technology allows for administrators to return the system to a working state at which time the other Windows-based management tools can be used.

Improved Clustering Support

Whistler features enhanced failover clustering support. Two node failover clusters will be increased to support four node failover clusters in Advanced Servers. This four-node cluster support will lower the cost of excess capacity and increase management flexibility. The addition of heterogeneous cluster support allows for "mix and match" certification rules, lower cost and effort to certify configurations, and more choices in mixing servers within clusters. Mount points will be supported on cluster volumes, which permits the volume containing the mount point and volume to which it points to be cluster volumes. This improvement will conserve drive letters to support more volumes. The check for duplicate network names on a failover has been eliminated allowing for faster failover of IP addresses by several seconds. Other expected capabilities and benefits include: Cluster Installation Simplification via improved setup (from one system), programmability–resource scripting, WMI instance and event providers, and WMI Tracing. The expected differences for Windows 2000 Datacenter include broader availability and broader hardware support due to the lower hardware requirements of Advanced Server.

Terminal Services Integration

Terminal Services allows multiple users to share a single Windows Server, using their own GUI and normal applications that have been installed on the server. The Windows 2000 line of server platforms (Server, Advanced Server and Datacenter versions) incorporate Terminal Services in the base operating system, which is a change from Windows NT where Terminal services were offered as a separate version. Windows 2000 Terminal Services now offers two install modes: application serving and remote

administration. Terminal Services were first added into Windows 2000 Server platforms to better facilitate its use for larger numbers of users.

Terminal Services are now further integrated in the "business editions" of Whistler, including Whistler Professional edition. The Terminal server client is now built-in and "always on" in all of the Whistler platforms allowing for control of a remote desktop for single users in Whistler Professional edition. The benefit of this technology allows a user to login directly to their workstation allowing access to exactly the same desktop and applications as if they were physically at that machine. As part of this new functionality, the console is redirected to allow for one user to be using a workstation machine at a time, either remotely or directly. Additionally, remote control of a console session, which allows for support organizations to better assist end users, has also been added. Other Terminal Server client improvements include: file system redirection, port redirection, network printer redirection, audio redirection, and increased color & resolution support for a more seamless experience. Microsoft has also developed a COM client component that provides the functionality of the terminal server client now hosted on a web page. This component shipped in July 2000 and can be found on the Windows 2000 SP1 CD in the valueadd subdirectory.

Enterprises considering SAS application deployment for large numbers of users should consider Terminal Server as a deployment option. Enterprise support for Terminal Services has also been addressed in Whistler server platforms. Terminal Services now support load balancing for both servers and session-based applications. Load balancing support includes both Network Load Balancing (NLB) and IP-request balancing that is available in Microsoft's Application Center 2000.

MICROSOFT.NET AND .NET SERVERS

The biggest change introduced in the past year is Microsoft.NET ("dot NET"). As previously mentioned, .NET is Microsoft's vision for the future of computing incorporating three main goals:

- Enabling information access that addresses the wide variety of computing devices via connectivity to the Internet, providing access to information any time, any place from any device.

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- Providing a platform for creating applications that work in the .NET environment.
- Delivering the ability to support application-hosting to deliver services over the Internet.

Microsoft's .NET (which takes its beginnings from Microsoft's DNA (Distributed Network Architecture) strategy and was previously known as "Next Generation Windows Services") extends the concept of collaborative, on-line computing across the entire Microsoft product line. . NET heavily leverages XML and SOAP (Simple Object Access Protocol) to "component-ize" computing so that it takes full advantage of the web and can be easily adapted for use by Application Service Providers (ASPs). .NET redefines software *as a service.* With the .NET model, customers (both consumers and business) will (generally) no longer buy software but pay for it on a per user/per CPU/per transaction and per month basis. Microsoft intends to extend this "leasing" model to *all* software solutions, regardless of vendor.

All Microsoft products are now being ".NET enabled" - though products with real .NET designs and capabilities won't begin to hit the market until later this year (Whistler includes some basic .NET frameworks) and will culminate with the *Blackcomb* release of Windows in late 2002 or 2003. In the meantime, Microsoft will be heavily promoting the *vision* of .NET to the marketplace. The first tool in the .NET family -Visual Studio.NET- was distributed in beta form to developers in July 2000.

Visual Studio.NET

Visual Studio.NET delivers an interactive development environment (IDE) that provides a rich set of features and productivity tools that allow developers to rapidly create enterprise-scale applications for the Web Services Platform. Visual Basic, C++ ,and a new language, C# (pronounced "C sharp") are all supported via the same IDE and can now be used interchangeably. C# provides many of the same benefits of Java such as memory management and garbage collection along with the power of compatibility with C++ and Visual Basic.

The focus of Visual Studio.NET is to empower developers with the tools to continue to develop with their existing sets of skills (i.e. Win32, MFC, and COM) along with web-enabled technologies such as SOAP, XML, and web services. As the web is evolving and technologies for universal data exchange such as XML are beginning to proliferate, a new development paradigm has emerged where software is seen as a collection of readily available web services that can be distributed and accessed via standard Internet protocols. Web Services provide middle-tier business functionality exposed via standard Web protocols. XML is used to invoke and return data from these Web Services and allows programs written in any language, using any component object model, and running on any operating system to access this functionality. In Visual Studio.NET any function can be exposed as a web service and as an added benefit, Visual Studio.NET will automatically generate an XML file that describes the function and, when it is called, the function will automatically send and receive XML packets. Visual Studio.NET provides the tools for support service delivery, service integration, and long running operations.

.NET Servers

Microsoft has introduced a series of .NET server products. These servers sit on top of Windows 2000 and each provides specific features and benefits. When assembled together, the .NET servers can provide a complete business solution. While these products do not yet actually include .NET features, Microsoft chose to label them as .NET for marketing reasons – to get customers to start thinking about .NET. Here's a brief description of the .NET family of servers.

- **Exchange 2000**

Exchange 2000, along with Windows 2000 and SQL Server 2000, makes up the core of the .NET enabled platform by providing messaging, collaboration and infrastructure. It includes a Web Storage System for building business applications and support for data, audio and video conferencing services. SAS supports Exchange services and can run in Exchange environments.

- **SQL Server 2000**

SQL Server 2000 is the follow-on release to SQL Server 7.0 offering improved performance and very basic business intelligence tools. SAS supports SQL Server as a data repository.

- **Application Center 2000**

Application Center 2000 provides centralized management of web server clusters and IP load

balancing from a single desktop by providing deployment, management and diagnostic tools.

- **Host Integration Server 2000**

Previously known as SNA Server, HIS 2000 provides access to mainframe-based DB2 and other data on mainframes, AS/400 and UNIX systems. It is targeted at customers who are moving from these environments to Windows environments or those that want to integrate with these environments.

- **Commerce Server 2000**

The follow-on product to Microsoft Site Server, it is a comprehensive system for building and deploying consumer, retail and supply-side B2B solutions.

- **BizTalk 2000**

Provides a gateway for exchanging XML documents between different organizations for e-business (B2B, B2C).

- **ISA Server 2000**

Formerly known as Proxy Server, it adds new functionality for web caching, proxy and security for networked and Internet-oriented computing.

IMPACT OF .NET

It is too soon to determine the impact of the .NET strategy in the marketplace. However, Microsoft will attempt use .NET to redefine the basic computing model. This may prove beneficial to SAS users as there are some well-conceived ideas in the .NET strategy.

SAS is ideally suited to work with many of these servers in that SAS is an excellent solution for analyzing data generated in e-commerce or web-based business and SAS also utilizes SQL Server as a data repository.

STATE OF THE ART: 32-BIT AND 64-BIT PROCESSORS

This past year saw continued improvements in processor speed, with current processor speeds at 1.5 GHz as of this writing, nearly twice as fast as a year ago. Other improvements in RAM technology and bus speed have produced

commensurate throughput improvements. In addition, the capacity of disk drives continues to grow steadily as does their basic performance.

For the Intel-based IA-32 family of processors, the Pentium 4 processor became available in November 2000 and 1.5 GHz versions of the Pentium III are now available. The Pentium III processor continues to provide the highest throughput levels in a PC-class server. Xeon processors include a memory-addressing mode that allows use of more than 4GB of memory, which is the typical limit for 32-bit computers. This mode, which actually uses 36-bits of addressability instead of the otherwise standard 32-bits, raises total memory availability from 4GB (2^{32}) to 64GB (2^{36}). Version 8 of the SAS System takes advantage of this capability though its support for ESMA (Extended Server Memory Architecture). This architecture allows an application to utilize more memory than the Windows NT operating system is capable of accessing via an Intel-supplied driver program.

Windows 2000 Advanced Server and Datacenter Server platforms also take advantage of this capability natively using Intel's Physical Addressing Extensions (PAE), which is similar to ESMA but much more integrated into normal operating system operation. PAE is a 32-bit only feature since it is tied to Intel 32-bit CPUs. Intel 64-bit CPUs don't have this same limitation since they have larger registers. PAE memory allows applications to utilize memory beyond the 4GB address space currently available to most Windows 2000 based programs. Windows 2000 Advanced Server is limited to 8GB, and Windows 2000 Datacenter server is limited to 64 GB. Even with PAE enabled, the underlying architecture of the system is still based on 32-bit linear addresses. This effectively retains the 2 GB of application space and 2 GB of kernel mode space because only 4 GB of addresses are available. However, multiple processes can immediately benefit from the increased RAM since they are less likely to encounter physical memory restrictions and begin paging. Additionally, applications can be modified to use the AWE API to allocate memory outside of the applications process space, bypassing the 2 GB limit for applications.

Version 8.2 of the SAS System also takes advantage of other features of the Pentium III processor line, which are called Streaming SIMD instructions. These new processor capabilities facilitate faster completion of some types of operations such as data retrieval and data

throughput as well as improved floating point calculation performance.

The SAS System utilizes new instructions that ask the processor to prefetch data before it is actually needed for calculations. In this way, the processing of data can continue to proceed nearly as quickly as the processor can run instead of having to stop frequently to ask for and then receive data from slower main memory areas.

Intel's IA-32 family looks to continue to improve in terms of processor speed; initial releases of the Pentium 4 showed potential for powerful growth for visualization applications. And, the Pentium III architecture still offers the potential of faster and faster clock speeds.

This year, Intel will begin volume shipments of the new 64-bit Itanium processors. However, the introduction of the IA-64 bit architecture (with Itanium) doesn't mean that Intel is any less focused on the IA-32 architecture. In fact, some impressive new designs are expected in the near future including the "Foster" release.

SAS will continue to support IA-32 compatible processors from AMD.

Itanium: 64-bit Personal Computer Processors

Intel is expected to begin volume shipments of the new Itanium 64-bit processor in the second quarter of 2001.

SAS views the 64-bit IA-64 family of Intel processors (of which Itanium is the first implementation) as very significant because of the vastly increased scalability it will allow for truly high-end applications. SAS plans to support the Itanium processor with SAS version 9 in 2001. While ESMA and EMA provide some scalability improvement on 32-bit platforms, 64-bit processors and operating systems can provide dramatic performance improvements. With 64-bit addressing, memory can be addressed up to 2^{64} (or 18,446,744,073,709,551,616) bytes, opening the door to more sophisticated algorithms that can benefit from the vast memory space. Not only can you run more sophisticated algorithms but you can also load more data into memory delivering on the ability to support "in memory databases" for significantly faster analytics.

Itanium also includes hardware compatibility with IA-32 software and new throughput enhancements. These enhancements include:

- the ability to execute multiple instruction sequences concurrently, which is called Instruction Level Parallelism, effectively multiplying throughput by the parallelism factor.

- Larger set of processor registers allowing higher degrees of algorithm optimization.

- Instruction predication to facilitate a more consistently busy processor. Using predication, multiple code sequences can execute in "what-if" scenarios whose outcome only later becomes known.

- Improved floating point performance to speed typical mathematical operations, of which SAS applications are typically comprised.

- Speculative data loading to request data early and execute programs as if the data were retrieved in a timely fashion. Again, this is another form of "what-if" processing that allows the processor to remain busy and ready for multiple eventualities.

SAS began working with Intel on IA-64 platforms several years ago by running SAS on IA-64 simulators. In early 2000, SAS demonstrated the SAS System running on early versions of Itanium on a variety of 64-bit operating systems, including Windows. In fact, SAS was one of the first applications publicly demonstrated on Windows on Itanium. SAS is continuing our close working relationship with both Intel and Microsoft to ensure complete optimization of SAS on the Windows/Itanium platform.

AMD will introduce an x86-64 processor for 64-bit computing that uses a different architecture design that is not compatible with the Intel IA-64 design. SAS has not announced any plans to test SAS or support SAS on this AMD x86-64 architecture.

Choosing 32-bit or 64-bit Systems

While there can be significant benefits provided by 64-bit computing, many users of SAS software will likely continue to utilize 32-bit computing platforms for a variety of reasons:

- Some applications won't need the vastly improved memory scalability to perform their basic tasks.

- Performance of 64-bit Itanium systems might not be significantly different from then-current

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32-bit processors for applications in which scalability isn't a concern.

- 32-bit systems will continue to evolve and remain attractive due to performance and feature improvements.
- Although SAS products will 64-bit with version 9, other companies' software packages may remain 32-bit. The premium price of a 64-bit PC may not be easily justified, even if that PC can run 32-bit applications well.

- Later generations of the IA-64 family (code named McKinley, Madison, and Deerfield, listed here in the expected delivery order) should demonstrate large improvements over Itanium. In some cases, initial Itanium performance many not be significantly different from IA-32 processors for many applications.

Intel is committed to continuing development of both 32-bit and 64-bit systems. This will lead to a wider range of choices for SAS software users and improved price/performance on Intel-based systems.

SAS is committed to taking full advantage of Intel's design features in both the IA-32 and IA-64 product lines. Intel and SAS recently announced a joint development laboratory at SAS' Cary headquarters. This new lab is specifically focused on evaluating the very latest Intel technology so that new Intel product features are designed with SAS in mind for maximum performance and functionality.

Microsoft's current plans are to support Itanium with the Whistler release. Initial support is expected to be for desktop versions of Whistler in late 1H01 with support for server systems in 2H01.

NEW SYSTEM PRODUCTS

The advent of these new operating system and microprocessor technologies marks a turning point in computer system design as Windows-based Intel systems can now deliver mainframe-class performance, scalability and reliability. Several system vendors including Unisys, HP, IBM, Compaq, Dell and others have announced landmark new computer systems that attempt to exploit these new processor and operating system features.

Most of these systems utilize Windows 2000 Datacenter Server Edition. As previously discussed, Datacenter Server expands Windows

support to 32 processors, four node failover clustering and 64 GB of memory. Equally important however is Microsoft's "Windows Datacenter Server Program".

This program requires *all* hardware configurations and some software applications to be certified by the hardware OEM and ISV before they may be sold to the end user. Datacenter 2000 is available *only* through certified OEMs who are members of the Program. A certified OEM must meet several requirements in order to participate in the Program and be able to sell and support systems with Datacenter 2000. These requirements are:

1. Establish and manage a 24x7 technical support center with guaranteed four-hour response time and an option for on-site support.
2. Guarantee to provide customers with 99.9% minimum uptime.
3. Receive certification for fully populated hardware configurations along with any kernel invasive applications by an independent testing lab (Veritest). Re-certification is required for any software or hardware changes.
4. Certify any cluster offerings in a 4-node configuration.

The SAS System does *not* require certification under this program.

Currently 12 OEMs have qualified for the program and only a handful of system configurations and applications have been certified but additional OEMs and configurations will be announced in the near term. Certified OEMs are (November 28, 2000): Amdahl, Bull, Compaq, Dell, Fujitsu, Fujitsu-Siemens, Hitachi, HP, IBM, ICL, Unisys, Stratus.

Some of the new systems incorporate very advanced designs and technology. For example, Unisys has announced its ES7000, which incorporates its CMP (Cellular Multi-Processing) technology. These systems (OEM'd by Compaq, HP, Dell, Hitachi and ICL) offer a variety of features new to the Windows user community.

- Mainframe-oriented crossbar system bus architecture.
- Support for up to 96 PCI channels.
- Supports up to 64GB of segmentable memory.
- Support for up to 32 CPUs (initially IA-32 but will support IA-64).

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- Third-level cache and cache coherency algorithms.

- Hard partitioning support: can be partitioned as single SMP system of up to 32 processors, two sixteen-processor systems, four eight-processor systems or eight four-processor systems.

- No single point of failure and use of service processors for system monitoring and management.

This example is cited for the purpose of demonstrating that mainframe-class technologies are now available in Intel-based Windows systems. These types of systems offer the opportunity, over time to get mainframe class performance at PC market driven prices.

PLATFORM FEATURES

Beyond taking advantage of basic operating system and processor capabilities, the personal computer platform has evolved towards a complete system on which to run mission-critical applications. SAS System support for these capabilities is covered in this section.

Interoperability

The SAS System takes advantage of interoperability with other applications available on the Windows platform.

Communication to applications such as Lotus Notes Mail, Microsoft Exchange, and other SMTP-based systems is supported through MAPI and SMTP. This SMTP support is in Version 8.2 of the SAS System, which supports SMTP mail directly (as compared with earlier versions that depended on MAPI mail clients to perform this function). SAS System output can be formatted in HTML to allow sharing and collaboration with many applications.

Beyond HTML, Version 8.2 has a new portable engine, named XML, that generates XML tagged output from a SAS data set.

Security

The SAS System takes full advantage of security services provided by the operating system. This includes the improved security services present in Windows 2000 such as Kerberos support.
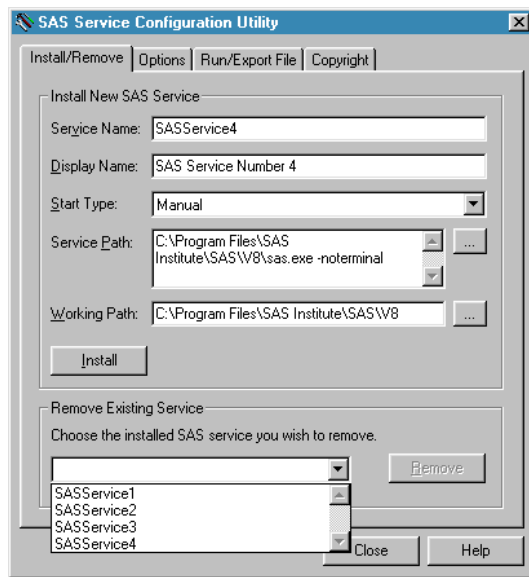
File Systems

NTFS remains the file system of choice for complex applications. NTFS 5, newly available on Windows 2000 adds basic functionality to the overall NTFS picture, of which maximum reliability is the key benefit. NTFS support for journalled recovery, dynamic resizing, fault tolerance, off-line (Intellimirror) support, hierarchical storage management, and built-in compression or encryption make it a high-performance and safe location for critical data storage. NTFS also remains the only Windows file system capable of storing individual files that exceed 2GB in size. Although FAT32 supports overall partitions larger than this size, it limits individual file size to a 2 GB limit. As a result, SAS System applications that require access to files larger than this limit should use NTFS.

A frequently forgotten aspect of file system performance is fragmentation. As larger and larger disk drives are used, the potential for high degrees of fragmentation rises dramatically. In addition, with single drives past 36GB in size, some systems will operate with a smaller number of "spindles" or individual disks in use. The heavy use of very large volumes can exacerbate the effects of high fragmentation. A high-quality defragmentation package (and schedule for its use) is a must for mission-critical applications.
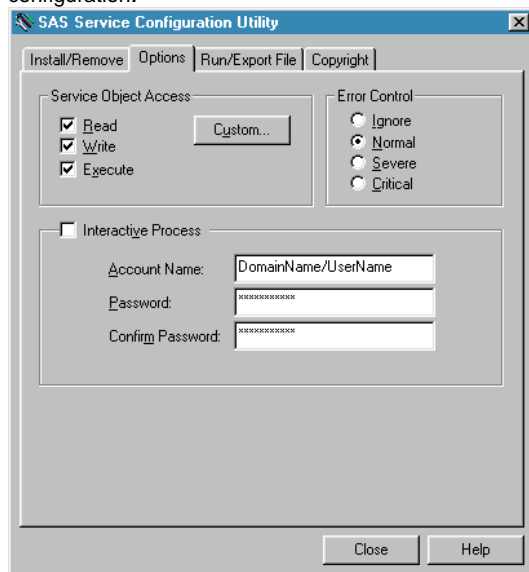
Operation as a Windows NT/2000 Service

Version 8.2 of the SAS System continues to support the capability of running a SAS session as a service, which can be started in unattended mode, and which can be remotely administered using the Windows NT/2000 Service Control Manager. The SAS Service Configuration Utility allows ease of installation for administrators via a GUI-based interface, command line interface via a data file. This utility can be used to specify various service parameters and also to perform various maintenance activities on the running service.

Figure 3. Version 8.1 SAS Service Configuration Utility for installation and removal of SAS services.

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Options related to service operation are highly configurable through the GUI interface and all of this information can be saved to a data file that can be re-used to configure a collection of servers to run similar services.

Figure 4. Account and interactivity settings for service configuration.

Performance Improvements

Every release of the SAS System since 6.12 has been performance tuned by SAS, with the assistance of Intel Corporation. SAS uses tools that help pinpoint potential performance issues in the application code so they can be addressed. In addition, SAS utilizes any reasonable capability of the operating system or machine hardware that

results in more optimal performance on the Windows platform. This includes application code as well as the internal compiler used to build the system.   Recent improvements capitalize on exploitations of processor optimizations, memory utilization, and parallelization.

CONCLUSION

The introduction Windows 2000 Server, Advanced Server and Datacenter Server, coupled with recent advancements in Intel 32-bit processors and the availability of new IA-64 Itanium-based systems can provide previously unreachable levels of performance, reliability and scalability on Windows platforms.   New features in SAS version 8.2 and the upcoming SAS version 9 will take full advantage of many of these new features. SAS is increasingly investing in our relationships with Intel and Microsoft to provide a highly optimized solution.

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