

## Paper 214-25

**Deploying the SAS® System using Windows NT® Server 4.0, Terminal Server Edition**

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**ABSTRACT**

Deploying the SAS System to a large number of Windows® clients can be time consuming and costly, and often results in a system that is difficult to maintain. However, by deploying the SAS System using Windows NT Server 4.0, Terminal Server Edition, it is possible to install and configure the SAS System only once, and to have it immediately available to all clients on the network. The installation of maintenance releases and service packs are also performed only once, further reducing the costs of deployment.

In addition, Terminal Server can provide all SAS users on your network with access to the latest release of the SAS System running on a fast and reliable Windows NT system, even if the clients themselves are still running older operating systems such as Windows 95 or Windows for Workgroups.

This paper will describe the process of deploying the SAS System under the Windows NT Server 4.0, Terminal Server Edition operating system, including sizing and configuration of the server, installation and configuration of the SAS System, and performance tuning.

**INTRODUCTION**

Windows NT 4.0, Terminal Server Edition is a multi-user version of Windows NT. Terminal Server provides a virtual Windows NT Workstation 4.0 desktop to remote Windows clients. Users working at the client workstations run applications using the CPU, memory and disks of the Terminal Server system. The users' keystrokes and mouse movements are transmitted across the network from the client to the Terminal Server, and screen updates are transmitted back to the client systems. Client operating systems currently supported by Terminal Server include Windows for Workgroups, Windows 95, Windows 98, and Windows NT.

The Terminal Server Edition of Windows NT 4.0 was released in 1998. It is based on technology from Citrix®, which markets a similar product named WinFrame® that is based on Windows NT 3.51. Citrix also markets a product called MetaFrame™ that adds many useful extensions to the Terminal Server product.

In the future, Terminal Server will be available as an installable service on all Intel® versions of Windows 2000 Server.

**BACKGROUND**

The Department of Biostatistics and Research Epidemiology (BRE) at Henry Ford Health System has used the SAS System as its primary data analysis tool for over 10 years. During that period, nearly all of our SAS processing was performed on Sun® Microsystems servers running the SunOS™ version of the UNIX® operating system. MS-DOS®, Windows and Sun workstations connected to our Sun servers and executed SAS using either telnet or an X Windows client. Configuring the client systems so that function keys worked consistently on each platform was a nagging problem, especially since it seemed that one or more keys changed with every release of the SAS System.

Although UNIX provides a very fast and reliable system for SAS processing, UNIX has several drawbacks, among them high

hardware and maintenance costs, complexity, and a notoriously unfriendly user interface.

In 1997, it became necessary to replace our existing Sun server because it was no longer eligible for onsite maintenance from the manufacturer. At that time, Microsoft had just announced the pending release of the Terminal Server Edition of Windows NT Server 4.0. We obtained a beta version of the product as soon as it was available and began running benchmark tests on a 200MHz Pentium® system. The benchmark tests showed that Terminal Server would deliver better performance than the Sun server we were using at the time (admittedly, the Sun system was 5 years old, so the comparison was somewhat unfair). Given that we had nearly two years of experience running a Windows NT file server with outstanding results, we decided to replace the Sun server with an Intel-based system running Terminal Server.

It was our belief that a Terminal Server system would deliver better performance than our existing UNIX system, that the system would be easier to administer and maintain, and that the system would be much easier to use. Our experience has shown all of these beliefs to be true.

**THE BRE NETWORK ENVIRONMENT**

At this time, the local area network (LAN) at BRE consists of three Windows NT servers and eighty PC workstations. One server is configured as a Web server, one as a file and print server, and one runs the Terminal Server version of Windows NT Server 4.0. The workstations are a mixture of Windows 95 and Windows NT Workstation systems. The typical Windows 95 system has a 75MHz Pentium processor, 32MB of RAM and a 540MB hard disk, while the typical Windows NT system has a 233MHz Pentium processor, 32MB of RAM, and a 3.2GB hard disk. The physical network is 10BASE-T (10Mb/s) Ethernet.

The staff at BRE consists of biostatisticians, epidemiologists, computer programmers, data managers, abstractors, interviewers, and secretaries. There are roughly 80 employees total, and of that number about 20 are moderate to heavy users of SAS and 20 more are occasional users of SAS.

We are currently using version 6.12 of the SAS System. The modules that we use in addition to Base SAS are SAS/STAT®, SAS/GRAPH®, SAS/IML®, and SAS/FSP®.

We have several incentives for using a centralized method of deploying and running the SAS System:

- Purchasing a SAS license for every workstation that needs one would be extremely expensive. While a server license for the SAS System is expensive, it is still considerably less than the cost of 40 individual SAS licenses. Even when one includes the cost of the Terminal Server operating system and its associated client licenses, it is still cheaper to run SAS on the server.
- Installing, maintaining, and upgrading the SAS System on 40 workstations would be time consuming. Although the SAS System can be installed on a LAN with most of the System residing on a central file server (where all upgrades and maintenance could presumably be applied), we have found that the SAS System performs very slowly in that configuration, at least when running on a 10Mb/s Ethernet. The bandwidth issue would, in fact, be worsened by having all SAS users accessing both the SAS System and their

data files over the LAN. A Terminal Server system requires less bandwidth since only screen updates, keystrokes, and mouse movements travel across the LAN, and all data is (ideally) stored locally on the Terminal Server system.

- Many of our workstations are old and poorly equipped to run the SAS System, and due to current financial pressures in the health care industry, this situation may continue for some time. Installing the SAS System on a Terminal Server system means that every SAS user on our LAN has access to a quad-processor Pentium system with 1 gigabyte of RAM and a very fast SCSI disk array.

## SELECTING AND SIZING THE SERVER

Selecting a server that would meet our needs was not easy since the operating system was brand new, there was little information available, and we did not know anyone who was using the system to run SAS. We wanted a system that would support roughly two dozen simultaneous SAS users, and we wanted the system to be able to support future releases of Windows NT and the SAS System as they became available.

We eventually found a handful of performance white papers on the Citrix, Hewlett Packard®, and Compaq® web sites that suggested that a quad-processor Pentium system with 1 gigabyte of RAM would support up to 45 power users. Since we consider any SAS user a power user, we chose this baseline for the system we purchased.

We chose a Dell PowerEdge™ 6300 server based on our experience with Dell servers and desktops. The system was configured with four 400MHz Pentium II Xeon™ processors with 512 kilobytes of cache, 1 gigabyte of RAM, and four 9 gigabyte SCSI drives configured in a RAID 5 array.

## CONFIGURING THE SERVER

The server hardware and the operating system need to be configured properly before the installation of the SAS System.

### INSTALLING AND CONFIGURING THE OPERATING SYSTEM

The Terminal Server installation process is nearly identical to that of Windows NT Server 4.0. The following suggestions may make your Terminal Server implementation a little smoother:

- Your Terminal Server system should be configured as a Member Server in your Windows NT domain, not as a Primary or Backup Domain Controller. The reason for this is that you want all of the processing power on your Terminal Server to be available for running applications on behalf of your clients.
- For the same reason, you should also avoid installing the server-based portion of client/server applications such as Internet Information Server™ or SQL Server™ on your Terminal Server system.
- Format all of the drives on your server using the NTFS filesystem, not the FAT filesystem. Since all of your Terminal Server users will actually be logging on to your Terminal Server to run their applications, the extra security provided by NTFS is extremely important.
- After the installation completes, set the amount of virtual memory on your Terminal Server system to two times the amount of installed RAM. *Be sure to consider this when planning the layout of your drives and partitions. If you have a gigabyte of RAM installed on your server, you will need to reserve two gigabytes of disk space for virtual memory. If you configure your server to write a memory dump to disk in the case of a system crash, you will need yet*

*another gigabyte of disk space to hold the dump file!*

- Note that service packs for Windows NT Server, Terminal Server Edition are different from the service packs for Windows NT Workstation and Windows NT Server. If you plan to install any service packs on your Terminal Server system, be sure to obtain the correct versions. Service packs for Terminal Server are typically released a few months after the service packs for Windows NT Workstation and Windows NT Server.

### CONFIGURING THE HARDWARE

The four disk drives on the server were configured as a single 27-gigabyte RAID 5 drive. The resulting RAID drive is partitioned into three logical drives:

- Drive C, which holds the Terminal Server operating system, one half of the system swap file, and all user profiles, is 4 gigabytes.
- Drive D, which holds the SAS WORK area and the other half of the system swap file, is also 4 gigabytes.
- Drive M, which holds both the SAS System and user data, uses the remaining 19 gigabytes.

### SECURING THE SERVER

Securing the Terminal Server operating system presents some challenges. You must keep in mind that your users will actually be running their applications on the Terminal Server itself, not on their own desktop systems. In a typical NT Server environment, your users will see only the filesystems that you have chosen to share over the network. On a Terminal Server system, your users can see and access your entire server, including the contents of the C drive.

The most important step in securing your Terminal Server system is to download and install the Terminal Server Zero Administration Kit (ZAK) from Microsoft. The Zero Administration Kit includes scripts to secure the system files on your server as well as policy templates for use by the System Policy Editor.

*Please note: The Terminal Server Zero Administration Kit is packaged as an executable file. If you click on this executable file in the Windows Explorer, ZAK will install the ZAK System Policy Editor templates, then proceed to secure all of the files on your C drive. You may not want all of the file permissions on your C drive to be changed, since this may make some of your applications unavailable to your users. To avoid this, use WinZip® or a similar product to unpack the contents of the ZAK archive. That way you will be able to examine (and modify) the scripts used to secure the system files before running them.*

The policy templates supplied with ZAK are very useful. They can be used to tightly lock down your Terminal Server users' desktops and limit their access to the system. For example, we have implemented the following policies using ZAK:

- The Run, Find, and Shutdown commands have been removed from our user's Start menus.
- All items on the desktop, such as My Computer and Network Neighborhood, are hidden.
- Users cannot run any registry editing tools.
- Users have no access to the Control Panel.

Another security application included with Terminal Server is the Application Security tool. The Application Security tool is used to create a list of applications on the Terminal Server system that you

users are allowed to execute. Any application not listed in the Application Security tool cannot be used, except by the Administrator. The Application Security tool can be difficult to employ since many applications, such as SAS, have dozens of executable DLL files associated with them, and all of them must be individually listed in the Application Security tool for your applications to run properly. For this reason, we do not use the Application Security tool.

## MANAGING THE SERVER

Terminal Server includes several tools specifically designed for administering the system. The Terminal Server Administration tool can be used to display a list of all connections to the Terminal Server system. This list shows how long the connection has been active, as well as its current state (Active or Disconnected). The Terminal Server Administration tool also shows a list of all processes running on the system. This list includes the Process ID (PID) of every process, which is of interest since this will uniquely identify the WORK directory associated with each SAS session running on your server. This information can be used to find and erase SAS WORK directories that are no longer needed.

The Task Manager included with Terminal Server is also a very useful tool. Using Task Manager, you can get a very detailed list of all processes running on your server. This list can be sorted in several ways:

- If the list is sorted by user, you can see all of the applications each user is running.
- If the list is sorted by CPU, you can see which users/applications are using the most CPU cycles.
- If the list is sorted by Mem Usage, you can see which users/applications are using the most memory.

The Task Manager also includes a Performance tab which shows current CPU and memory usage.

## CONFIGURING THE USER ENVIRONMENT

It is important to take the time to configure the initial Terminal Server user environment. If this is done properly, your users will be immediately comfortable (and productive) using the Terminal Server system.

### CONFIGURING THE DEFAULT USER ENVIRONMENT

There are three steps to configuring the initial user environment:

- 1) Create a user account that will be used to create a template user profile for all other users.
- 2) Log on as the template user and configure the desktop and all end-user applications, including SAS. You can also create icons on the template user's Start menu that start up SAS in either interactive or batch mode.
- 3) Copy the template user's user profile to the Default User profile.

This will ensure that all users who log on to your Terminal Server get the same initial settings.

### THE TERMINAL SERVER LOGON SCRIPT

The Terminal Server logon script is named USRLOGON.CMD and it is located in the WTSRV\SYSTEM32 directory. This logon script runs only when the user logs on to your Terminal Server system. The Terminal Server logon script is used to configure the user

environment each time a user logs on.

The most important function of this logon script is to map each user's Terminal Server home directory to a drive letter using the Windows NT SUBST command. For example, on our system, each user's Terminal Server home directory is mapped to drive W via the logon script. This is useful in cases where your applications expect their configuration files to be in a specific location. By telling those applications to look for their configuration files on drive W, each user ends up with their own personal copies of those configuration files in their home directory. That way each users' settings remain separate.

We have configured SAS, via the CONFIG.SAS file, to store each user's SAS profiles in W:\SASUSER. Since drive W is mapped to each user's home directory when they log in, each user ends up with their own personal copy of the SAS configuration files.

### SETTING UP PRINTERS

The Terminal Server Administrator should install and configure all of the printers that his or her users might use before the first user logs on. These printers will then be available to every user on the system. Note that the three fonts that SAS installs on your Terminal Server system (SASMONO.TTF, SASMONOB.TTF, and SAS1252.FON) should also be installed on all of your client systems and any remote print servers that will print SAS output. If you don't, you may occasionally find that the output you have printed from SAS has been printed using the wrong font. This behavior is caused by a bug in Windows NT.

If new printers are added after users have logged in for the first time, they will need to be installed for each user one at a time, which is a lot of work. The Printers folder from the Control Panel can be added to the Start menu so that users can add printers themselves, if necessary.

If your users want to be able to print to printers that are attached directly to their desktop systems, it is a bit more involved. Those printers need to be shared via the network, then mapped to the user's Terminal Server session via the Terminal Server logon script. This process can be completely automated by using either the Citrix MetaFrame or Network Computing Devices® ThinPATH Plus® add-on packages for Terminal Server.

## CONFIGURING THE CLIENTS

One of the most remarkable features of Terminal Server is the ease with which the client systems are configured. If you have ever configured the SAS System to run under a telnet or X Windows client, you will appreciate the ease of installing and configuring the Terminal Server client – there are no keys to map, and no Xresource files to edit!

The Terminal Server Client software requires only 1 megabyte of disk storage and, when running, uses only 2 or 3 megabytes of RAM. The only settings that must be configured on the client are the name of the server to connect to, and the desired video resolution.

A few other items that you can take care of while you are at the client system:

- Install the SAS fonts described above in the section on printing.
- Change the Terminal Server Client registry settings to make the mouse more responsive in remote sessions. Refer to Microsoft Knowledge Base article Q196460 for details.
- Share any printers that your clients will want to use for SAS output.

## INSTALLING SAS ON THE SERVER

Although installing the SAS System on a Terminal Server system is essentially the same as installing SAS on any other Windows system, there is one very important difference. The System must be installed for simultaneous use by multiple users, rather than just for one single user. This is achieved by installing the application via the Add/Remove Programs applet in the Terminal Server Control Panel. When an application is installed using the Add/Remove Programs applet on Terminal Server, the application can be installed either for one user (the installer) or for All Users.

If you choose to install the application for All Users, Terminal Server monitors the entire installation routine and makes a record of all registry keys that are added or modified and any INI files that are installed by the application. These registry settings are then added to each user's registry when the application is executed, thereby providing each user with their own individual copy of these settings. Any INI files installed by the application are handled in a similar manner by copying them to the user's personal Windows directory, located in the user's Terminal Server home directory (in our case, drive W).

## CONFIGURING SAS ON THE SERVER

SAS for Windows NT Server needs to be customized to run smoothly in the Terminal Server environment.

### THE CONFIG.SAS FILE

The default CONFIG.SAS file installed by the SAS System needs to be modified slightly to work properly in the Terminal Server environment. The changes we made include the following:

- The `-NOSPLASH` option was enabled to prevent the SAS System from displaying its initial splash screen. The SAS System starts faster with this option disabled, and transmitting the splash screen across the network to each SAS user's terminal wastes precious network bandwidth.
- The `-SORTSIZE` option was set to 250m. This limits the amount of RAM available to each SAS session for sorting to 250 megabytes. Limiting the amount of RAM used by any individual user makes more available for other users of the SAS System. This is one of the trade-offs required when running SAS on a multi-user operating system. It may also be desirable to limit the total amount of memory available to a SAS session by setting the `-MEMSIZE` option, however, we have not found it necessary to do so at this time.
- The `-SASUSER` option was set to point to W:\SASUSER. Remember that W is actually an alias for the user's Terminal Server home directory. By pointing the `-SASUSER` option to W:\SASUSER, each user's SAS profiles are kept separate from the others.
- The `-WORK` option was set to point to D:\SASWORK. The SAS System automatically creates (and later destroys) a WORK directory for each SAS session in the D:\SASWORK area. Each SAS session has its own unique WORK directory name. The name is based on the Windows NT Process ID of the SAS session.

### MODIFYING THE REGISTRY

The registry on the Terminal Server system must be modified to change the default behavior of the Terminal Server system when SAS is run in batch mode, in the background, or when disconnected from the Terminal Server.

By default, any application that uses a lot of processing power while running in the background on a Terminal Server system is considered to be misbehaving. The Terminal Server system automatically lowers the priority of such applications. This behavior

is by design, and it is intended to keep misbehaving applications from using more than their fair share of processing power. However, this lowers the priority of any SAS session that you may be running in the background while working in another application, and this is not generally desirable.

This behavior can be modified by applying the registry changes described in Microsoft Knowledge Base Article Q198060. *Be sure to make a backup copy of the registry before making any changes to the registry.*

### CONFIGURING THE DEFAULT SAS ENVIRONMENT

There are four steps involved in creating the default SAS environment for your users:

- 1) Log on as the template user created in step 1 of Configuring the Default User Environment, above.
- 2) Start a SAS session and configure the size and shape of the SAS PROGRAM, LOG, and OUTPUT windows, key settings, fonts, and any other settings that you would like to define for your users. Save your settings and exit from SAS when you are done.
- 3) Copy all of the files in the template user's SASUSER directory to a central location.
- 4) Modify the USRLOGON.CMD script to copy the template user's SASUSER files to a directory called W:\SASUSER, if they do not already exist.

This will ensure that all users who log on to your Terminal Server get the same initial SAS settings.

## RUNNING SAS FROM THE CLIENT

Running SAS for Windows on a Terminal Server system is just like running SAS for Windows on your own desktop. The main difference is that you must first connect to the Terminal Server system using the Terminal Server client. Here are a few tips regarding the Terminal Server client:

- When you first log on to a Terminal Server system from the client, the Terminal Server screen will overlay your local desktop. If you want to be able to see both your Terminal Server session and your local desktop, the `<Control><Alt><Break>` key combination will turn your Terminal Server session into a window on the local desktop. Press `<Control><Alt><Break>` again to restore the Terminal Server session to full screen.

*On some of our PCs, the `<Control><Alt><Break>` key combination does not seem to work reliably, but we have found that `<Control><Alt><Scroll Lock>` does.*

- When your Terminal Server session occupies the full screen, you can bring local applications to the foreground using the `<Alt><Tab>` key combination.
- There are two ways to exit from a Terminal Server session. From the Start menu, you can select either Disconnect or Logoff. If you select Disconnect, all of the applications that you are running on the Terminal Server will continue to run after you disconnect. You can later log on to the Terminal Server and resume that same session. If you select Logoff, all of your applications are closed and the Terminal Server session is terminated.

## MAINTAINING YOUR SAS INSTALLATION

Once the SAS System has been properly installed and configured

on your server, maintenance is minimal. Since our system was installed, we have applied two maintenance releases of the SAS System - TSO 55 and TSO 60. Each of these maintenance releases took only a few minutes to install. We normally install maintenance releases immediately after a full backup so that we can restore the system if we run into problems. Note that maintenance releases of the SAS System should be installed using the Add/Remove programs applet in the Terminal Server control panel, and they should be installed for All Users. This also applies to Microsoft's Terminal Server service packs and hot fixes.

The directory that SAS uses to store WORK files needs to be pruned on a regular basis to get rid of files left behind when SAS terminates improperly. We use a script that is run every 12 hours via the Windows NT Scheduler service to look for, and erase, SAS WORK directories that do not have an active SAS session associated with them.

## PERFORMANCE

Our Terminal Server system has met or exceeded all of our expectations in the area of performance. Our Terminal Server system is 3 to 6 times faster than the Sun system that it replaced, and for tasks that require a lot of memory, such as the GLM procedure, the system is as much as 20 times faster. Interactive performance is excellent, even when the Terminal Server system is heavily loaded.

## LIMITATIONS

Although Terminal Server proved to be an excellent fit in our environment, it has a number of limitations that may make it less desirable in your own environment.

### NETWORK PROTOCOL SUPPORT

*Terminal Server currently supports only the TCP/IP network protocol for remote desktop connections.*

Given the current popularity of the TCP/IP protocol, this is not a serious limitation in most LAN environments. However, if you need to access a Terminal Server system using other network protocols, Citrix MetaFrame provides support for the IPX and NetBEUI network protocols.

*Note that Terminal Server supports TCP/IP, IPX, and NetBEUI for file access.*

### CLIENT PRINTER SUPPORT

*Terminal Server does not provide support for automatically mounting client printers at login time.*

If your users need to print to locally attached printers, there are currently three ways to do this:

- Share the client printers over the network and mount them on the Terminal Server via the user's Terminal Server logon script. This must be configured manually for each user and each printer.
- Install NCD's ThinPATH Plus client software, which provides for automatic mounting of client printers at login time. At the time of this writing, ThinPATH Plus could be downloaded from NCD's website at no charge.
- Install Citrix MetaFrame, which also provides for automatic mounting of client printers at login time.

### CUT AND PASTE BETWEEN SERVER AND CLIENT

*Terminal Server does not support cut and paste between applications running on the server and those running on the local desktop.*

This can be an annoyance when you want to include a piece of SAS code or output in a Word document that you have open on your local PC. This capability is available in the Citrix MetaFrame product.

## PROBLEMS

So far, we have experienced only a few problems with our Terminal Server. The system is not as reliable as we would wish, with a crash occurring on average every two months since the system was installed. In all cases but one, the system immediately rebooted itself and was up and running again in just a few minutes. Given that this is a brand new operating system, the number of crashes does not seem unreasonable. We expect the number of crashes to be significantly reduced by the installation of the Terminal Server version of Windows NT service pack 5, which appears to address the causes of several of our system crashes. The total *unscheduled* downtime for the nine months that the system has been running is approximately 90 minutes.

There have been a few problems with the system that we have been unable to resolve, and we are unsure whether they are caused by the Terminal Server operating system, the SAS System, or an interaction between the two. One recurrent problem results in an interactive SAS session that switches rapidly back and forth between the Output window and the Log window. There appears to be no way to break out of this loop, and the only resolution for this is to have the Windows NT Administrator terminate the user's Terminal Server session.

All in all, we have been very satisfied with the performance and reliability of the system. The occasional crash is an annoyance but it is not fatal in our environment.

## CONCLUSION

Windows NT Server 4.0, Terminal Server Edition, is an excellent way to deploy the SAS System to a large number of Windows clients. Although configuring the SAS System to run properly on a Terminal Server is more complex than simply installing SAS on a file server and distributing it via a LAN, this is more than made up by reduced support and maintenance costs. Patches and maintenance releases are installed only once, on the Terminal Server, saving you a trip to each individual client system. Terminal Server is fast and reliable and it has a user interface that your users will be very comfortable with.

## REFERENCES

Harwood, Ted. *Windows NT Terminal Server and Citrix MetaFrame*. Indianapolis: New Riders, 1999.

## ACKNOWLEDGMENTS

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