

Paper 490-2013**SAS® Virtual Desktop Deployment at the US Bureau of the Census**

Stephen Moore, United States Census Bureau, Lori A. Guido, United States Census Bureau,

Michael Bretz, SAS Institute

ABSTRACT

The United States (US) Census Bureau supports a SAS user base of approximately 2600 users. In the past this required the deployment of many SAS client solutions on individual desktops. Using new deployment strategies, Census reduced service delivery time while increasing installation quality and standardization.

Census investigated implementation options of an enterprise-wide virtual desktop solution for use by the SAS user community. Client Virtualization is a technique for simplifying the configuration, deployment and support of the end-user computers needed by an organization. Client virtualization looks at changing the one end-user to one desktop computer paradigm for SAS software installation and finding ways of reducing the administrative complexities associated with the one end user desktop computer while gaining operational efficiencies and a more robust deployment model. This paper will focus on the following topics:

- Primary drivers for adopting this technology
- Census's SAS support model
- Client virtualization architecture
- Deployment best practices

INTRODUCTION

The US Census Bureau's mission is to serve as the leading source of quality data about the nation's people and economy. SAS is a key, critical tool in the processing, analysis, and visualization of data at the Census Bureau. Most Census business directorates are broken down into areas called divisions based on the data products they produce.

Most of these divisions use SAS to process and analyze census and survey data. Census divisions use SAS for decision support, data warehousing, data mining, and data visualization. Divisions use SAS® Foundation (i.e., BASE® SAS) to create many of their most important products including Economic Indicator data, the National Income and Poverty Measure Report, and Decennial reports.

IT Directorate in some ways is different from the other Census directorates:

- They are not responsible for reviewing or producing data products
- Their mission is to provide information technology solutions to advance Bureau strategic goals of customer service, high-quality data products, and market-competitive data collection and processing support
- The IT Directorate is divided into divisions based on the technologies and products that they support

The authors of this paper work in the Application Services Division (ASD) of the IT Directorate. The mission of the ASD is to be the definitive source for applications support at the Bureau. We support existing technologies and methodologies, and investigate and promote new technologies. We work closely with the staff in the other divisions of the IT Directorate that support the hardware, operating systems and networks on which Census runs SAS.

PRIMARY DRIVERS

Over the past four years, the number SAS tools and the security requirements for desktop tools have greatly increased, while the number of IT resources devoted to the support of those tools has decreased. This has led to the:

- Increased support demands and security risks for non-standard desktop installations
- Increased resources needed to do design, develop, test and deploy the installations
- Delays in deploying the latest versions of SAS to the business areas

Security Concerns

To standardize and strengthen agencies' security, the Office of Management and Budget (OMB), in collaboration with the National Institute of Standards and Technology (NIST), launched the Federal Desktop Core Configuration (FDCC) initiative in 2007. The goals of FDCC are to improve information security and reduce overall information technology operating costs across the federal government by providing a baseline level of security through the implementation of a set of standard configuration settings on government-owned desktop and laptop computers (i.e., workstations).

This mandate required us to standardize our deployment strategies.

Deployment Concerns

We used the Microsoft® System Center Configuration Manager (SCCM) tools to meet our standardization goals and automate the delivery of SAS to the desktop. Unfortunately, we encountered several problems as we utilized this approach:

- Due to the size and number of the SAS components (120), the lack of standardization in previous installs, and the security protocols we had to follow, the installations took up to 2 hours for each customer
- Each day we did an install, people from all areas of the IT Directorate would go into the business divisions' area to help the customers with issues generated from the install, thus burdening an already thinly stretched IT staff
- The installation took up business division staff time since they could not fully use their pc's while the installation was running
- The time it took to design, develop, test and then deploy using this installation model was unsustainable and resulted in delays in the deployment of new SAS versions

CENSUS SAS SUPPORT MODEL

The Census Bureau has approximately 2,600 customers that use SAS Foundation software, SAS Information Management, Analytics and BI that are available to them via our contract. They use SAS on PC's, windows servers and Red Hat Linux® servers. The Software Applications Development Branch (SADB) staff in ASD are responsible for the bulk of the day-to-day SAS support. We provide technical support for the Census Bureau's SAS products, distributes SAS software and licenses, and provide guidance on SAS usage to the customer community. In this role we:

- Manage multiple SAS related projects that cross division boundaries, such as actively working with the business divisions to set up and then test the use of new products
- Promoting and supporting the design, use, and implementation the SAS available through our contract,
- Design, oversee and administer security controls, configurations, shared services settings, system policies, and procedures needed to ensure all SAS instances inherit the baseline security controls used at Census
- Provide customer service to fulfill internal and external customer needs, providing, information, assistance, and/or training, resolving problems; explaining system and product functionality; and satisfying expectations.

Customer Needs

Every day is different for the SADB staff. On average, we get 84 service calls a month. We provide front line support for these calls and the tasks listed above with a staff of four (4) people, two of which are new to SAS. The calls can range from:

- Install issues that a customer or one of our IT peers has found on a PC or server,
- Feature issue where a customer is trying to find the best product for the business need, or they are having a problem using a particular feature of a product,
- Coding issues that a customer encounters while trying to develop or maintain one of their applications, and
- Performance issues that a customer or one of our IT peers has found on a PC or server. Sometimes these are just simple bad coding issues. Sometimes these are lengthy performance tuning activities. Those can involve coordination between SADB, the customer and the staff who maintain the hardware and operating system.

The SAS Products

Census has an enterprise license agreement for many of the Information Management, Analytics and Business Intelligence solutions. Due to the breadth of SAS products, we license and limited in-house resources, we rely on our customer community and the SAS Institute as resources to provide user support coverage. The following is a subset of SAS products from Census's enterprise license agreement where we provide the most user support.

- SAS® Foundation
- SAS® Enterprise BI Server
- SAS® Data Management
- SAS® Grid Manager
- SAS® Enterprise Miner / SAS® Text Miner
- SAS® DataFlux® Data Management Software

Our deployment of SAS in VDI includes SAS Foundation and all clients for many of the licensed solutions like SAS

Management Console etc. We look for support savings wherever and whenever possible due to the complexity of our environment, the number of SAS products we support, the number of platforms we support and the number of potential customers we have. We have already found that Census's virtual desktop infrastructure (VDI) cuts down on the time it takes us to design, develop, test and then deploy new versions of SAS compared to the SCCM deployment to the physical desktop as done in the past. It also cuts down on the number of PC service calls we receive concerning installation issues.

CLIENT VIRTUALIZATION ARCHITECTURE

Census's virtualization architecture implements an enterprise-wide virtual desktop solution via Citrix XenDesktop and Citrix XenApp. All Citrix infrastructure servers and desktops are virtualized. Remote users login using Active Directory and RSA token authentication when working remotely. Web interface servers provide a user access portal to the VDI environment which is configured for internal network user access while onsite. This architecture provides an alternative to a user's local SAS installation.

Census's virtual desktop infrastructure (VDI) for SAS consists of multiple server images running Microsoft Windows 2008 Server R2 x64. SAS is installed as part of the desktop virtual application package. A set of virtual servers are provisioned with SAS with users load balanced over these group of server images. As SAS user access and processing demands increase the virtual server images can be scaled out to meet resource capacity requirements. This scalability allows for increased performance for all SAS user processing.

Active directory controls the assignment of users to the set of virtual servers with SAS installed as part of the desktop virtual application package. These controls also assign what SAS client(s) a user has access to use in their session. This role-based access provides the following benefits:

- Separation of the SAS user community from non-SAS users using just desktop productivity applications
- Improved resource management of the SAS processing requirements for the SAS user community while reducing impacts to general desktop users
- Improved licensing management allow Census to manage contract license on limited use SAS components

Figure 1 illustrates an overview of the virtual architecture.

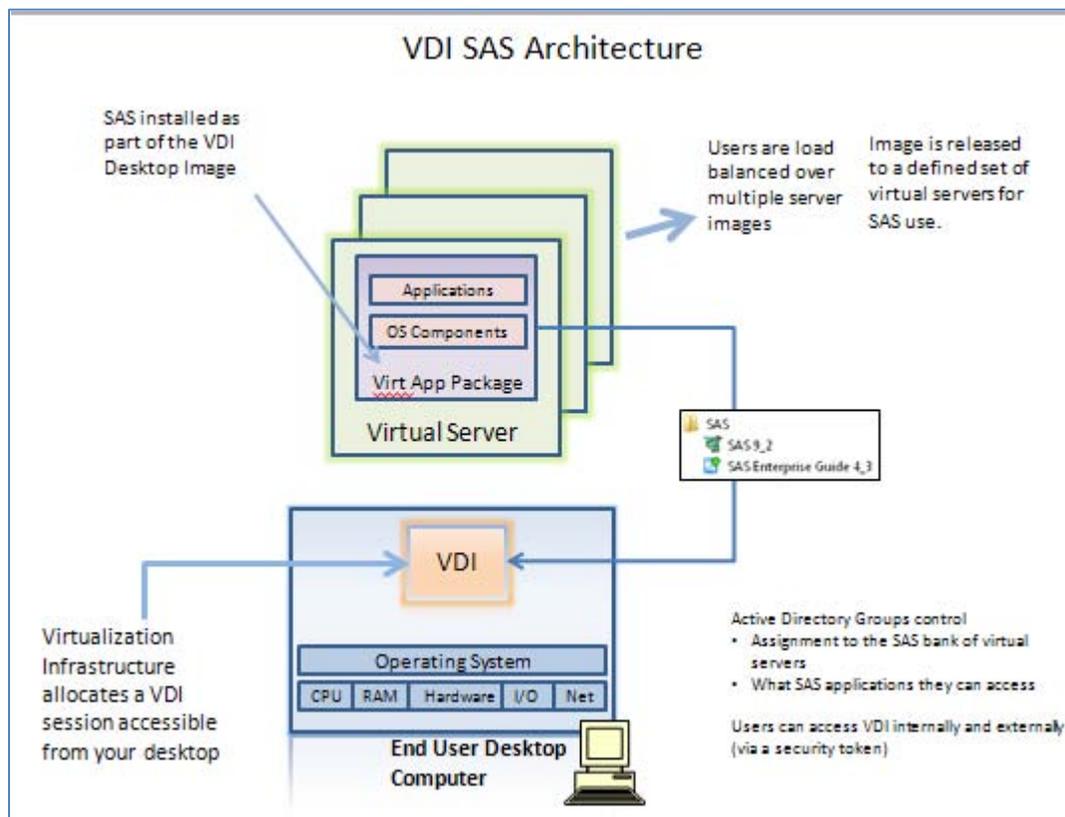


Figure 1: VDI SAS Environment

The SAS Deployment Wizard is used to install all SAS client software as permitted by Census's SAS license. This includes SAS Foundation and many SAS clients used with SAS solutions like SAS Enterprise Business Intelligence Server or SAS Data Integration Server software solutions. The following figure depicts the process used to deploy SAS within the Census VDI environment.

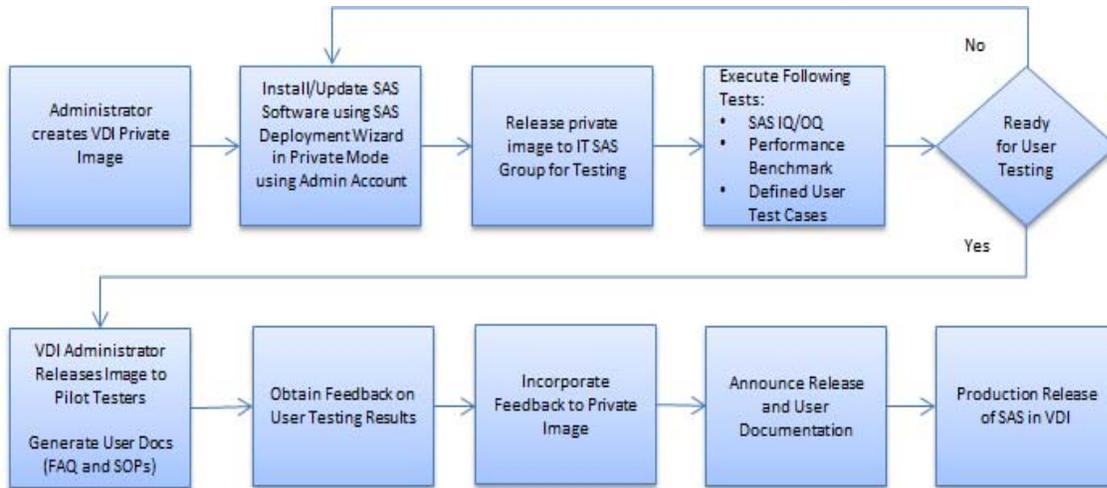


Figure 2: SAS Deployment Process

One SAS on-site consultant and one VDI administrator worked together in coordinating the installation and configuration of SAS software as outlined in this process. This release management strategy improves the quality of deployment process. The VDI environment allows rapid deployment of new images of SAS software with applied hotfixes or maintenance updates without impacts to the current user community. In addition, major release updates can be deployed as a pilot for user testing to allow the user community to assess migration efforts of current content to any new major release.

Below is a set of milestone timelines on Census's development of the VDI strategy and release of SAS to the user community.

- June 2012: Initial release of SAS products consisting of SAS Foundation 9.2 TS2M3, SAS Enterprise Guide 4.3 and the Universal File Viewer 1.1.
- September 2012: Deployment of all other SAS 9.2 clients (i.e., SAS Management Console) used with license SAS solutions
- November 2012: Deployment of SAS Foundation 9.3 (TS2M1) and all solution clients

Access and usage of SAS software within VDI is now scoped for use with Census Bureau employees approved for telework. Future infrastructure upgrades will continue to expand access and permit use by all SAS users at the agency and will mature into the SAS software desktop deployment model. There are no future plans to deploy SAS software on the user's desktop. All future releases of SAS software will be made available only through VDI.

CLIENT DEPLOYMENT BEST PRACTICES

The following sections outline best practices and lessons learned from the deployments of SAS 9.2 and SAS 9.3 to Census's virtual desktop infrastructure. An administrative account installs all SAS software using the SAS Deployment Wizard deploying to a private image. SAS Software documentation outlines co-existence information for the deployment of multiple versions of one or more clients on the same desktop. This information is also applicable installing SAS client components in VDI. Our team validates the software using the outlined deployment process.

SAS File Compatibility

As shown in Figure 3, the table summarizes when Cross-Environment Data Access (CEDA) processing is used pending the source and target SAS version and platform. The cells in gray represent the same operating system platform and SAS version and are not applicable.

		Target			
		9.2 XP	9.2 x64	9.3 XP	9.3 x64
Source	9.2 XP		Y	N	N
	9.2 x64	Y		N	N
	9.3 XP	N	Y		N
	9.3 x64	Y	N	N	

Figure 3: Source and Target Platform CEDA Processing Summary

SAS data sets and catalogs are forward and backward compatible between SAS 9.2 and SAS 9.3 from the same operating system. For example, users would be running SAS 9.2 or SAS 9.3 deployed in VDI and therefore no migration of files is necessary.

As an enhancement to SAS 9.3, CEDA processing is not invoked when the source Windows 32-bit (XP) data sets are processed in the target Windows 64-bit SAS 9.3 session. Likewise, CEDA processing is not invoked when source Windows 64-bit data files are processed in a Windows 32-bit (XP) SAS 9.3 session. Refer to the table where the cells are denoted with N (No).

If source Windows data sets in either 32-bit or 64-bit operating environments, you do not need to do anything to benefit from this functionality other than to use SAS 9.3 as represented by the right columns in Figure 3. At this time, use of SAS 9.2 on the desktop as well as SAS 9.2 and 9.3 in VDI is permitted by the user community. Note that in this deployment topology, there will be instances where CEDA processing is used and data sets must be converted to the target platform to perform any update to the SAS data set(s) as denoted in table with cell values of Y (Yes).

Catalogs are an exception. Catalogs are not compatible between 32-bit and 64-bit SAS for Windows. Care should be taken when using SAS catalogs. SAS catalogs created using SAS 9.2 and SAS 9.3 are forward and backward compatible since the files are used within the same OS platform. SAS 9.2 catalogs created on the desktop (WinXP) are in a 32bit format and will need to be migrated for use in VDI which is a Windows 64bit platform. The MIGRATE procedure or other utilities can be used to convert these files to the native target OS platform as outlined in SAS migration documentation.

Additional information about stored compiled macro catalogs can be found at the following SAS Support website as described in the following SAS Usage notes:

Usage note 46846: Compatibility of stored compiled macro catalogs across releases

<http://support.sas.com/kb/46/846.html>

Usage Note 43782: A stored compiled macro catalog created on a 32-bit machine is not compatible with a 64-bit machine

<http://support.sas.com/kb/43/782.html>

The following are additional SAS Usage notes outlining SAS running on 32-bit and 64-bit Windows environments:

Usage Note 38339: SAS file compatibility when upgrading from 32-bit to 64-bit Microsoft Windows

<http://support.sas.com/kb/38/339.html>

Usage Note 38379: In SAS®9.3, Base SAS data sets are interoperable between Microsoft Windows 64-bit and Microsoft Windows 32-bit operating systems

<http://support.sas.com/kb/38/379.html>

Customizing the SAS Foundation Session

Users adjust SAS options and session settings in the SASV9.cfg and autoexec.sas files for processing when running SAS installed on their desktop. This user requirement continued for use of SAS deployed to VDI with the following requirements:

- Use an autoexec.sas files as part of the SAS invocation
- Generate graphic output using SAS Output Delivery System (ODS)
- Redirect SAS work for larger processing job requirements

In order to meet these requirements the following changes were allocated to the SAS deployed image

- The SASINITIALFOLDER option was set to the users login profile folder ([Drive letter:]\) using a pre-defined Windows System environment variable
- The login profile drive was added to the PATH environment variable so that user defined autoexec.sas or sasv9.cfg placed on drive would be searched and referenced during invocation of the SAS session to override any system level SAS session settings
- -HELPBROWSER SAS is set to allow for viewing of ODS output in the SAS session under Windows x64. Without this option an error will occur when trying to view the content in the SAS session

The following figure is an example of the settings defined in the SASV9.cfg file to reference the ODS option and reference the users login profile or [Drive Letter]:\ drive.

```
/* set default locations
-fontsloc "!sasroot\core\resource"
-TRAINLOC ""
-SASInitialFolder "!HOMESHARE"
-HELPBROWSER SAS
```

Figure 4: SASV9.cfg

SAS Work Management

SAS Work by default will be defined to write SAS workspace to the C:\Users\

The system administrator allocates each virtual server image with SAS software installed this drive mapping for SAS Work with the following characteristics:

- 200 GB of space allocated to each virtual instance
- [Drive letter:]\TEMP is defined and assigned in the sasv9.cfg
- Cleanmgr utility is run on a routine basis to purge SAS work
- Users are not permitted to store any project work on SAS Work

The system administrator executes the Cleanmgr routine on a periodic basis to purge any allocated SAS work directories from SAS jobs that may have terminated abnormally.

As additional SAS releases are deployed within the image, the SAS Work location on [Drive letter:]\TEMP was partitioned into two subfolders to separate usage of SAS 9.2 and SAS 9.3 work files. This approach allowed for parallel operation of both software versions as users migrated and tested the new software version. The –work option in the sasv9.cfg was set for each version of software as shown.

```
-work [Drive letter:]\TEMP\saswrk1 <= SAS 9.2
```

```
-work [Drive letter:]\TEMP\saswrk2 <= SAS 9.3
```

A generic subfolder naming convention was used to allow the next version of SAS software to use the SAS Work slot of the oldest software release when the older version is deprecated for use. This minimized any administration setup of the physical directories on each server image using a hardcoded SAS version references in any directory path.

SAS and Excel Usage and Compatibility

SAS users at Census use the SAS/Access to PC File Formats heavily via the Import/Export Wizards and IMPORT and EXPORT procedures. Users have the expectation that the DBMS=EXCEL engine features and functionality behave the same when SAS is deployed on a Windows 64bit platform. Care should be taken to understand the user community requirements and uses of SAS and Excel. The DBMS=EXCEL option is not compatible for use on a Windows 64-bit platform.

In order to provide the similar user experience when referencing the DBMS= option the SAS 9.2 PC Files Server was installed and configured as part of the image for use by users. Note the SAS 9.3 PC Files Server cannot be installed to co-exist with a deployed SAS 9.2 PC Files Server configured as part of the image. This is a known issue and documented with SAS usage notes when installing and configuring PC Files Server.

SAS 9.3 allowed for use of the DBMS=XLSX engine which offered a workaround to installing the SAS 9.3 PC File

Server while also giving users a current DBMS engine to write out SAS data into Microsoft Excel 2010 format.

In addition, we promote the use of SAS Enterprise Guide to the SAS user community as it also provides its own engines to import or export various Excel file formats.

SAS/ACCESS® Software

All third party software requirements must also be included as part of the virtual image. A user requirement identified that data sources were stored in Oracle 11g DBMS. SAS/ACCESS to Oracle is installed and configured as part of the image. SAS requires the use of the Oracle 11g client to make the necessary connection to the Oracle DBMS.

Census's deployment of the Oracle client required setup of a TNSNAMES.ORA file to make the necessary DBMS connection to the data source. This file contains connection information providing the server and port connection information. An example TNSNAMES.ORA file is shown below. The <server> denotes the full name of the server, port and service.

```
ORA11R2 =
[DESCRIPTION =
  (ADDRESS = (PROTOCOL = TCP)(HOST = <server>)(PORT = 1522))
  (CONNECT_DATA =
    (SERVER = DEDICATED)
    (SERVICE_NAME = <server>)
  )
]
```

Figure 5: TNSNAMES.ORA File

A Windows system environment variable called TNS_ADMIN identifies the directory location of the TNSNAMES.ORA. This environment variable maps to the user's profile login drive as shown. This allows the user to setup their own DBMS connection to their data when the need arises.

TNS_ADMIN = [Drive Letter:]\tnsnames.ora

Referencing the Default SAS Version

The VDI infrastructure at Census also limited the user's ability to perform any administrative tasks typically enabled within a desktop session. In particular, users running applications in VDI are not permitted to perform any registry updates. Care should be taken for use with clients that will reference a local SAS session especially when multiple versions of SAS Foundation software are installed. One example, is SAS Enterprise Guide and its configuration to execute a local SAS session.

By default, SAS Enterprise Guide launches the most recent version of SAS installed. Users can assign the default version of SAS for use with SAS Enterprise Guide by using the `-regserver` option as part of a command run using `sas.exe`.

Running this option on your user desktop session would allow an SAS Enterprise Guide user to toggle between a SAS 9.2 and SAS 9.3 versions. However, implementation of this command is not permissible within our VDI environment. We configure SAS Enterprise Guide to reference the current release of SAS software deployed in VDI.

SAS Intelligence Platform Clients

The SAS Intelligence Platform consists of desktop applications like

- SAS® Add-In for Microsoft Office brings the power of SAS to Microsoft Excel, Word, and PowerPoint
- SAS Data Integration Studio enables enterprise data collection, analysis, reporting, and publishing using a graphical process designer and numerous data transformation templates.
- SAS Enterprise Guide provides a point-and-click interface for data querying, reporting, analysis, and SAS programming.
- SAS Enterprise Miner provides a point-and-click interface for creating predictive models that identify trends, opportunities, and threats based on the analysis of data from across your enterprise.
- SAS Information Map Studio provides a point-and-click interface for the creation and maintenance of

information maps. Information maps are metadata definitions of enterprise data that provide a basis for querying and reporting.

- SAS® Management Console provides the primary administrative interface for the SAS Intelligence Platform.
- SAS® OLAP Cube Studio provides a straightforward wizard interface for building, updating, and tuning SAS OLAP cubes

Census deploys these desktop applications as well as others as part of their enterprise license. Some SAS clients can run SAS 9.2 or 9.3 software versions. Census deploys these compatible SAS clients for use with SAS 9.2 and SAS 9.3. The following are some considerations when deploying these clients in a virtual desktop infrastructure.

The SAS Add-in to Microsoft Office installs a plug-in for use with common MS Office products like Excel, PowerPoint and Word. The Add-in Switcher Utility assigns what Add-in version to use when multiple versions are installed. Note that the Switcher Utility can no longer be used by users when deploying the Add-in to VDI.

The Switcher Utility requires execution via the Windows administrative account to update registry information and the utility can only be run in private mode to attempt to set the Add-in version. This configuration in a virtual desktop environment no longer gives the end user the choice of which plug-in version to run. Client virtualization forces all users to execute one version. In this usage scenario and requirement, the SAS Add-in to Microsoft Office 5.1 is set as the default version since it is compatible with both SAS 9.2 and 9.3 SAS BI and Enterprise BI Server solutions. This allows the users to migrate content from SAS 9.2 to 9.3 while gaining all new features and enhancements version 5.1 has to offer.

The SAS 9.3 Analytical clients include the following components:

- SAS® Forecast Studio 12.1 / SAS Forecast Project Manager 12.1
- SAS Enterprise Miner / Text Miner 12.1

SAS 9.3 introduces an architecture change requiring a pointer to an Environment URL to launch the client connection to a SAS 9.3 Server configured with a SAS Metadata Server / Mid-tier as part of the solution. The client will not launch without this information.

Users who invoke these clients will encounter the following error denoting the backend server requirements have not been configured.

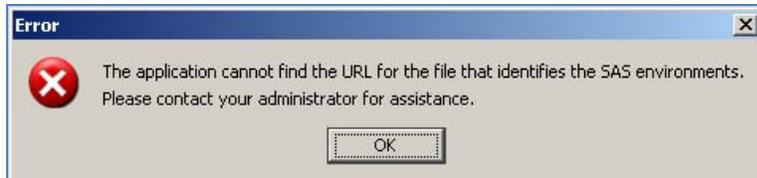


Figure 6: Environment URL Error

Census deploys these solutions not only to many business units but each business unit can have a dev/test and production environment of this solution. SAS 9.3 Architecture documentation outlines the use of an HTTP server to deploy the environment.url file when sites have multiple SAS analytical client deployments. Updates to the VDI architecture may be required to account for these deployment requirements. In the short-term, the VDI Deployment uses a file reference notation to point to this file on the H drive. Updates to this configuration approach will be refined as user community grows into using many of the SAS analytic product offerings.

CONCLUSION

The US Census Bureau supports a SAS user base of approximately 2600 users that used to require deployment of many SAS client solutions on individual desktops. The use of a VDI architecture provides the optimal deployment strategy for all new releases of SAS software. Application virtualization (streaming) for SAS 9.3 and SAS 9.4 will be investigated in the future to help improve the current SAS deployment model over installing all SAS versions and clients within the current desktop application package.

SAS Deployment Wizard silent installation processing issues are now minimized since the desktop hardware and software stack are now standardized with a controlled release management strategy. These benefits result in an improved delivery of software and keeping the user community current to the latest releases of SAS software.

This deployment model allows Census IT to keep up with new versions of SAS software and make them available to the Census SAS user community in a timely manner.

REFERENCES

SAS Institute Inc., "Peaceful Coexistence: Multiple SAS® Releases",
<http://support.sas.com/rnd/migration/papers/peaceful.html> (2012).

SAS Institute Inc. 2012. *SAS® Deployment Wizard and SAS Deployment Manager 9.3: User's Guide*. Cary, NC: SAS Institute Inc.

GAO report number GAO-10-202. 'Information Security: Agencies Need to Implement Federal Desktop Core Configuration Requirements'
<http://www.gao.gov/assets/310/301650.html> (4/2010)

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CONTACT INFORMATION

Your comments and questions are valued and encouraged. Contact the authors at:

Lori Guido
US Census Bureau
Work: 301.763.5852
E-mail: Lori.A.Guido@census.gov

Stephen Moore
US Census Bureau
Work: 301.763.4697
E-mail: Stephen.W.Moore@census.gov

Michael Bretz
SAS
Work: 301.763.5872
E-mail: Michael.Bretz@sas.com

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