Getting the Latest and Greatest from SAS® 9.4: Best Practices for Upgrades and Migrations

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ABSTRACT

SAS® 9.4 provides three ways to upgrade: upgrade in place, automated migration with the SAS® Migration Utility, and partial promotion. This paper focuses primarily on the different techniques and best practices for each. We also discuss the pros and cons of using the SAS Migration Utility and what is required for migrating users' content like projects, data, and code.

INTRODUCTION

Upgrading to the latest release of SAS might be a matter of applying a new maintenance release to an existing SAS deployment, or it could involve much more than simply installing new SAS software. In most cases, consideration must also be given to the migration of legacy content, which mainly includes metadata and physical files. Migration in this context refers to the process of copying this content over to the new environment, and in some cases, upgrading or reformatting it to run on SAS 9.4.

Metadata can be migrated in one of two ways:

1. Automated migration using the SAS Migration Utility
2. Partial promotion

Each of these options has its advantages and disadvantages, depending on the specific situation.

In addition to metadata content, physical files and project data often need to be migrated to the new SAS 9.4 environment. There are specific steps to follow for converting SAS data files and upgrading projects, depending on the differences between the legacy environment and the planned SAS 9.4 environment.

SAS 9.4 UPGRADE OPTIONS

UPGRADE IN PLACE

Upgrade in place refers to the deployment of a new SAS maintenance release on top of an existing SAS 9.4 instance, such as upgrading from SAS 9.4 M1 to SAS 9.4 M2. If you are upgrading in place, no migration of metadata or any other content is required, because only the SAS software gets updated. All metadata and physical files remain intact throughout the software upgrade process. Note that all SAS services must be stopped while the SAS software is being upgraded, so a planned outage should be scheduled when performing an upgrade in place.

When a new installation of SAS 9.4 software is required, the only options for migrating metadata are to use either the SAS Migration Utility or partial promotion. Migration of non-metadata content, such as physical files and projects, is also necessary when the new SAS 9.4 instance is installed on different hardware from the legacy system.

Terminology note: The term "migration" commonly refers to the use of the SAS Migration Utility to copy and upgrade metadata from an existing SAS environment to a newly installed SAS environment. The term "promotion" (also known as partial promotion) refers to the manual export and import of metadata from one environment to another.

SAS MIGRATION UTILITY OR PROMOTION?

SAS Migration Utility migrations are only possible in a like-to-like upgrade scenario, in which the legacy architecture, operating system, and software topology remain essentially unchanged in the new SAS 9.4

environment. The SAS Migration Utility is run to create a migration package on the legacy system, but the migration itself takes place during the configuration phase of the new SAS 9.4 software deployment. There are no options for excluding or reorganizing metadata objects, so the end result is essentially an exact replica of the legacy environment, running on the latest release of SAS.

The primary benefit of using the SAS Migration Utility is that it is an automated process, which potentially reduces the overall migration effort and lowers the risk of human error. However, a potential downside of the SAS Migration Utility is that it is an all-inclusive process, meaning that all legacy metadata is migrated to the new environment, including unwanted and orphan metadata.

The partial promotion approach is an option in practically every upgrade scenario, no matter what differences there might be between the legacy and target environments in terms of architecture, operating system or software topology. In many cases, promotion is the only option. This might be due to significant deviations from the legacy architecture or operating system, or might be due to timing, if the new SAS 9.4 platform has already been installed. In a promotion scenario, the SAS 9.4 software is installed and configured first, and then the metadata is manually exported from the legacy environment and imported into the new SAS 9.4 environment, as a post-installation exercise.

Although metadata promotion is a manual process, it does offer the inherent benefit of the user having complete control over which objects get promoted and where they get placed in the new environment. This selective capability provides the opportunity to "clean up" or reorganize the metadata as part of the promotion process. The interactive import/export wizards can be used to identify and exclude orphan metadata, duplicate objects, or objects with missing dependencies. And unlike the SAS Migration Utility, the import wizard provides the option to include or exclude access controls, which might be useful when implementing a new metadata security model as part of the upgrade to SAS 9.4.

Some of the primary differences between the SAS Migration Utility and promotion are shown in Table 1:

SAS Migration Utility	Partial Promotion
Pre-installation effort	Post-installation effort
Applicable in only certain upgrade scenarios	Applicable in almost every upgrade scenario
Automated	Manual
All-inclusive	Not all objects can be promoted
Non-selective	Selective
Command-line interface	Interactive GUI (wizard-based)
Requires download and configuration	Built-in to SAS® Management Console and SAS® Data Integration Studio
Pauses the metadata server; mid-tier server must be stopped	No downtime required of legacy environment
Rigid, inflexible	Fluid, flexible, dynamic, customizable

Table 1. SAS Migration Utility / Promotion Differences

SAS Migration Utility Decision Factors

Consider these factors in deciding whether to use the SAS Migration Utility or promotion:

1. Has the new SAS 9.4 software already been installed?
2. Does this upgrade scenario qualify for the SAS Migration Utility?
3. How much time would the SAS Migration Utility save over promotion?
   a. How many server tiers make up the legacy environment?
   b. How much metadata exists in the legacy environment?
   c. How much effort would be required to manually promote (or re-create) the metadata?

4. Are there any unwanted metadata objects in the legacy environment?
5. Is there a desire to reorganize the metadata folder content or alter the metadata security model?
6. How much tolerance is there for downtime?

Note that the SAS Migration Utility and promotion focus only on the migration of metadata and project metadata, not physical files. The file migration effort should not be a factor in choosing between SAS Migration Utility and promotion. The effort required to migrate physical files to the new server will be the same using either approach.

RUNNING THE SAS MIGRATION UTILITY

To help identify potential problem areas with the legacy environment, the SAS Migration Utility should be run in "analyze" mode as early as possible prior to the SAS 9.4 installation. Running the SAS Migration Utility in "analyze" mode is a good way to work through the configuration and testing of the SAS Migration Utility without interrupting active users on the legacy system.

The SAS Migration Utility executables and configuration files are included with the SAS 9.4 software depot, and can be found under the utilities directory, as shown in Display 1.

```
/sasshare/SAS_Software_Depot/utilities
-bash-4.1$ ls -l
total 20
drwxr-xr-x 2 sas sasg 4096 Sep 10  2015 depotchecker
drwxr-xr-x 3 sas sasg 4096 Sep 10  2015 depotcopier
drwxr-xr-x 2 sas sasg 4096 Sep 10  2015 smu92
drwxr-xr-x 2 sas sasg 4096 Sep 10  2015 smu93
drwxr-xr-x 2 sas sasg 4096 Sep 10  2015 smu94
-bash-4.1$
```
Display 2. SAS Migration Utility File Locations on Linux

The SAS Migration Utility command (smu92, smu93, or smu94) must match the release of the SAS software that is running on the legacy environment, as shown in Table 2:

SAS version (source environment)	Windows command	UNIX or Linux command
9.2	smu92_32.exe, smu92_x64.exe	smu92
9.3	smu93_32.exe, smu93_x64.exe	smu93
9.4	smu94_32.exe, smu94_x64.exe	smu94

Table 2. SAS Migration Utility Commands for Each SAS Version

Note: There is no direct migration path from a SAS 9.1.3 source environment to SAS 9.4. You must either re-create metadata in the new environment or follow a two-step process of migrating to a SAS 9.2 or 9.3 instance as an interim platform and then migrating to SAS 9.4.

The SAS Migration Utility command must be run on every legacy server where SAS is configured, and ideally the SAS Migration Utility output location should be accessible by all legacy servers. The standard procedure for running the SAS Migration Utility is as follows:

1. Download the SAS 9.4 software depot from the new software order.
2. Make the appropriate SAS Migration Utility files available to all servers in the legacy environment.
3. Create a SAS Migration Utility properties file for each legacy server.
4. Create a SAS Migration Utility output directory, to be shared across all legacy servers.
5. Run the SAS Migration Utility in "analyze" mode on every SAS server in the legacy system.
6. Run the SAS Migration Utility without the "analyze" option to create the migration package prior to the SAS 9.4 installation.

This is a sample SAS Migration Utility command for SAS 9.3, with the SAS® Metadata Server running on Linux:

```
> ./smu93 -- -analyze -properties /SASDepot/utilities/smu93/smu.properties.meta -replace
```

This is a sample SAS Migration Utility command for SAS 9.2 on Windows 64-bit compute tier:

```
> smu92_x64.exe -analyze -properties E:\\SASDepot\utilities\smu92\smu.properties.compute -replace
```

The "-replace" option is recommended so that the command can be run repeatedly during testing, if needed.

To create the migration package in preparation for the SAS 9.4 installation, remove the "-analyze" option from the SAS Migration Utility command. Running the SAS Migration Utility without the "analyze" option pauses the SAS Metadata Server during execution, which prevents users from logging on, so this step might need to be done during off-hours. Also, if a mid-tier server is part of the legacy architecture, the SAS Web Application Server must be brought down when running the SAS Migration Utility on the mid-tier server without the "analyze" option.

Post-Migration Tasks

As discussed earlier, not all content is migrated by the SAS Migration Utility. For example, physical files are excluded. In addition, for security reasons, passwords stored in metadata are not captured in the migration package. Therefore, a few manual post-migration tasks are necessary to complete a migration:

1. Enter database passwords stored in user or group logins (using the SAS Management Console User Manager plug-in)
2. Rebuild OLAP cube physical files (using SAS® OLAP Cube Studio)
3. Redeploy Data Integration jobs (using SAS Data Integration Studio)
4. Reschedule job flows (using the SAS Management Console Schedule Manager plug-in)
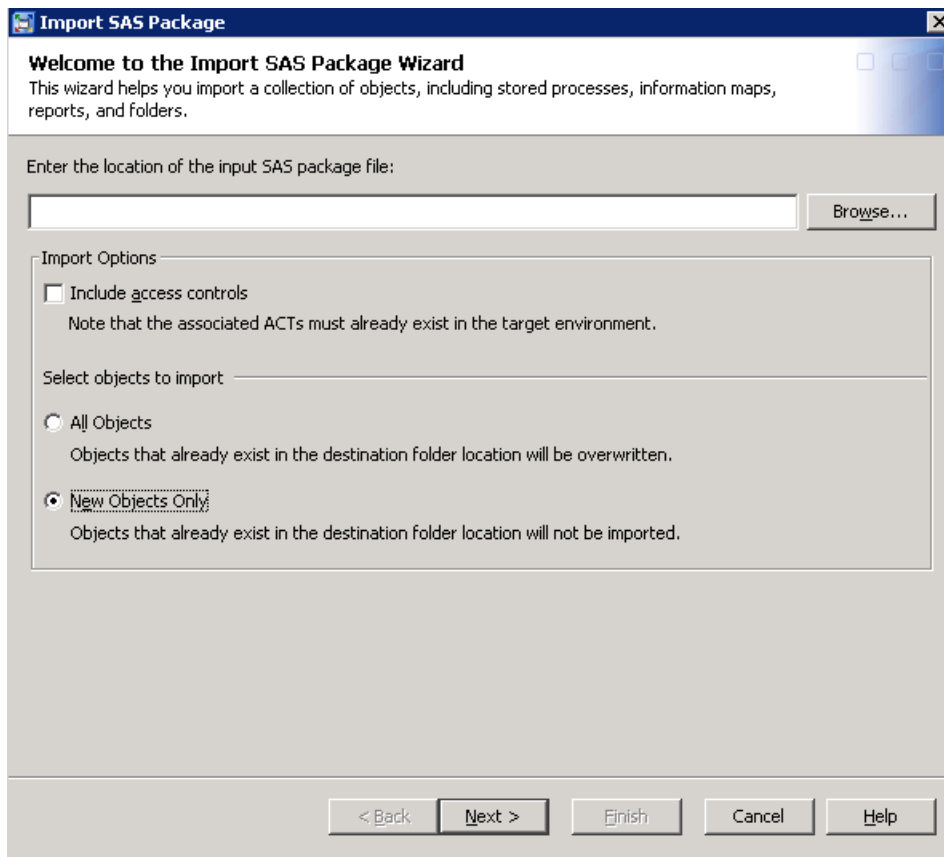
PARTIAL PROMOTION

The ability to promote metadata has been a feature of SAS Management Console since the release of SAS 9.1.3, and new capabilities have been added to the export and import wizards with each new release of SAS. With the release of SAS 9.4 all system and business metadata can be promoted using the export and import wizard in SAS Management Console, with the exception of SAS® Information Delivery Portal content. Portal metadata can be promoted, but only through the use of a command line utility.

Note that, as with the SAS Migration Utility, promotion of metadata directly from SAS 9.1.3 to SAS 9.4 is not supported.
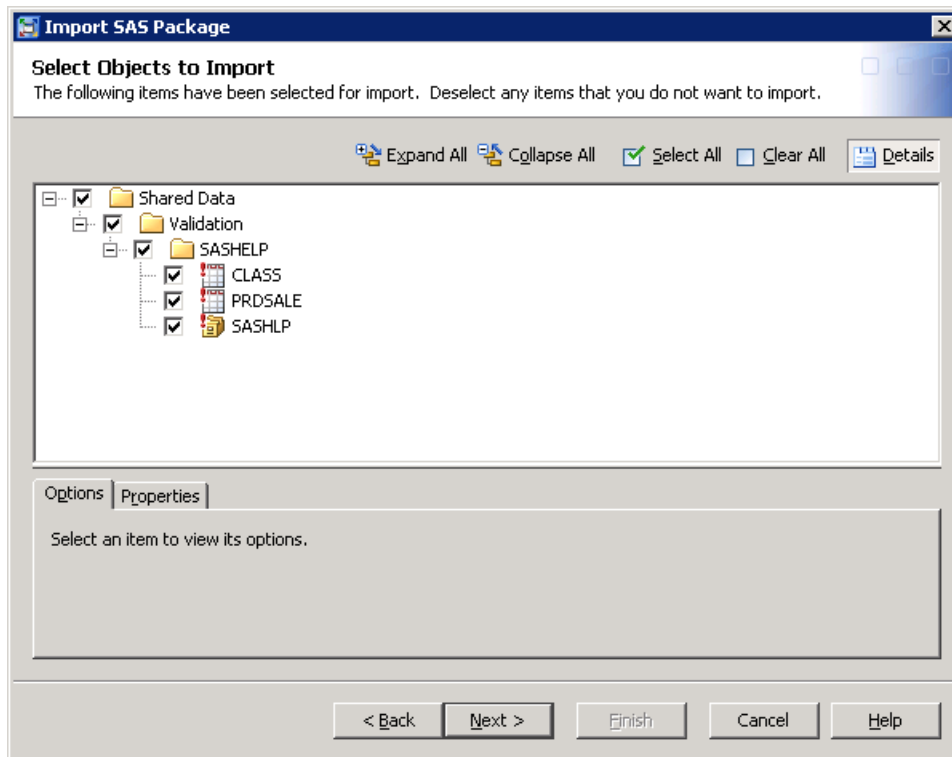
Promotion Techniques

When performing metadata exports and imports, it is imperative that the user log on to SAS Management Console as an Unrestricted user (typically the SAS Administrator). Doing this ensures that all metadata will be included in the export packages, and avoids any potential authorization issues during import.

The capability exists in the export and import wizards to include or exclude specific metadata objects. Objects that already exist in the new environment should not be promoted from the legacy environment, although it might be simpler to include all legacy metadata in the export packages, and then selectively import only those objects that are needed in the new environment. To facilitate the selective import process, the import wizard provides the New Objects Only radio button, which will automatically exclude objects that already exist in the target environment from being imported. See Display 2.

Display 2. Choose between All Objects and New Objects Only in the Import Wizard

When the All Objects radio button is selected during import, objects that will be overwritten in the target environment are marked with a red exclamation point, as shown in Display 3.

Display 3. Warnings about Objects That Will Be Overwritten by the Import Wizard

While metadata exports can be performed in any order, there is a specific sequence that should be followed when importing metadata, to ensure that dependencies among metadata objects are preserved. In general, system metadata should be promoted first, followed by business metadata, with any SAS Information Delivery Portal content promoted last, as described below:

System Metadata:
- Users, groups, roles (including authentication domains)
- Access control templates
- Database servers

Business Metadata:
- Libraries
- Tables
- OLAP cubes (including cube jobs)
- Jobs (including deployed jobs, custom transformations, and external files)*
- Scheduled flows
- Stored processes (including prompts)
- Information maps
- Web reports (including report components and images)
- BI dashboards (including indicators, indicator data, and ranges)
- Portal content

* recommend using SAS Data Integration Studio for export/import
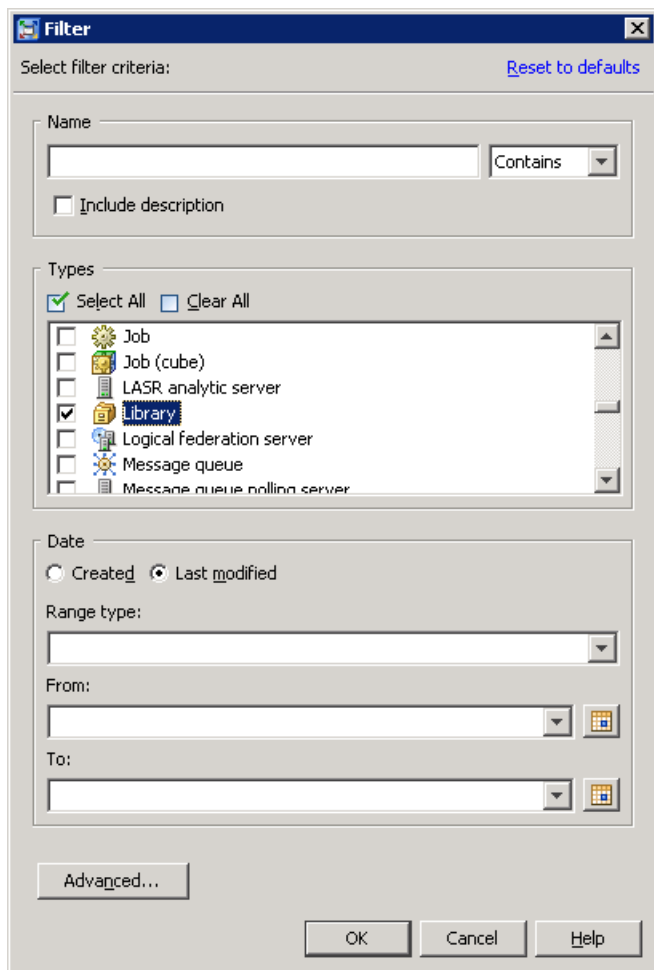
System Metadata Promotion

Beginning with SAS 9.3, users, groups, roles, and access control templates (ACTs) can be promoted from the /System/Security folder in SAS Management Console,. It is recommended to export the entire Security folder in one package, due to the interdependencies among these objects.

Beginning with SAS 9.4, database server connections can be exported from the /System/Servers folder in SAS Management Console. Note that authentication domains are not exportable, but are created as needed in the new environment during the import of user/group logins and database connections.

As with the SAS Migration Utility, passwords stored in the legacy metadata are not included in the system export packages, and therefore must be manually entered in the new environment as a post-promotion task.

Business Metadata Promotion

Unlike system metadata, business metadata can be reorganized into different metadata folders during the promotion process. To facilitate the reorganization of metadata, and to help ensure dependencies among objects, it is recommended to create separate export packages for each metadata object type. The Filter button in the export wizard provides an easy way to create separate export packages based on object type. For example, you can create one package for libraries, one package for tables, and so on. See Display 4:

Display 4. The Filter Option in the Export Wizard

Libraries should be promoted before any other business metadata, and should be followed by tables, because most other business metadata objects are dependent on these objects.

OLAP cubes and their associated cube jobs should be promoted together in the same export package. The physical files associated with OLAP cubes must be rebuilt in the new environment as a post-migration task. This applies to both SAS Migration Utility migrations and promotions.
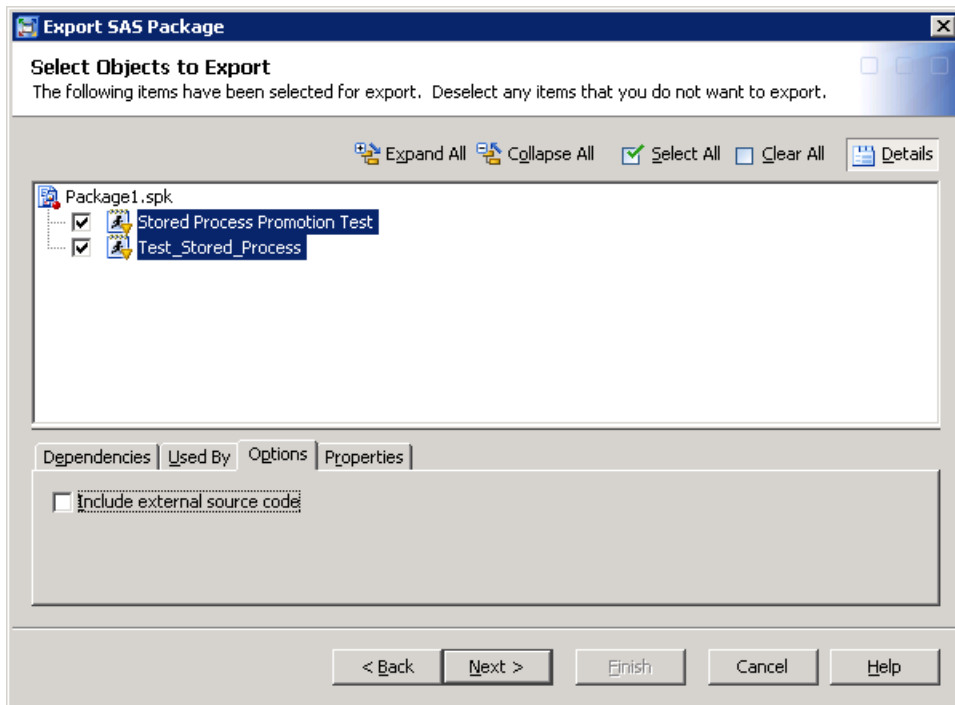
SAS Data Integration Studio jobs and deployed jobs, along with any supporting metadata objects such as custom transformations and external files, should be promoted using the export/import wizards in SAS Data Integration Studio. SAS DATA Step jobs and their respective deployed jobs can be promoted using the export/import wizards in SAS Management Console.

Deployment directories must be defined in the new metadata repository prior to importing deployed jobs, and SAS Data Integration Studio jobs should be redeployed after import. SAS DATA Step jobs do not need to be redeployed, although, as part of the file migration effort, the source code should be copied over to the new environment and modified appropriately.

Once the deployed jobs are in place, job flows can then be promoted using the export/import wizards in SAS Management Console. Job flows might need to be rescheduled in the new environment as a post-migration task.

Metadata for stored processes can be promoted using the export/import wizards in SAS Management Console. Source code should not be included in the export package, because these SAS programs are

typically copied over to the new environment as part of the file migration effort. To exclude the source code, uncheck the option, as shown in Display 5.

Display 5. Uncheck the Option to Include External Source Code in the Export Wizard

Information maps can be exported using SAS Management Console and should be imported after OLAP cubes and stored processes have been imported, since these objects can be used as data sources for some maps. Web reports are typically dependent on information maps, and therefore should be imported into the new environment following the maps, to preserve these dependencies.

Promotion of dashboard objects is only supported across certain releases of SAS® BI Dashboard. Dashboards cannot be promoted from a SAS 9.2 (SAS BI Dashboard 4.3) deployment to a SAS 9.4 (SAS BI Dashboard 4.4) deployment. The SAS Migration Utility can be used to migrate these objects from SAS 9.2, or they can be re-created in the new environment.

When promoting dashboards, it is recommended that you include all dependent dashboard components together in the same export package. These objects include the dashboard (*.dcx) and its indicators (*.idx), indicator data (*.imx), and ranges (*.rdx).

Note that for certain metadata objects, including web reports, dashboards, and SAS Enterprise Guide projects, much of this metadata is stored in the SAS Content Server. Therefore, the SAS Content Server must be functioning properly in both the legacy and target environments in order to promote these objects.

More information on promoting metadata objects can be found in the topic "Promotion Details for Specific Object Types" in *SAS 9.4 Intelligence Platform: System Administration Guide*.

Portal Metadata Promotion

The portal promotion process should be the last step of the metadata promotion sequence, after all the dependent metadata content has been successfully imported into the target environment.

The SAS Information Delivery Portal content can be promoted from the legacy environment through the use of the Portal Promotion Tool, which is included with the SAS 9.4 software on the mid-tier server. This command-line Java utility can be used to extract the entire portal application tree from the legacy environment, remove the default portal content from the new environment, and then import the legacy portal content into the new environment.

Documentation for promoting the entire portal application tree using the Portal Promotion Tool can be found in the topic "Promote the Entire Portal Application Tree" in *SAS 9.4 Intelligence Platform: Web Application Administration Guide*.

Post-Promotion Tasks

As with the SAS Migration Utility, several post-promotion tasks must be performed to complete the migration:

1. Adjust default ACT (using the SAS Management Console Authorization Manager plug-in)
2. Modify SAS Enterprise Guide Files location (using the SAS Management Console Workspace Server Properties window)
3. Enter database passwords stored in user or group logins (using the SAS Management Console User Manager plug-in)
4. Rebuild OLAP cube physical files (using SAS OLAP Cube Studio)
5. Redeploy Data Integration jobs (Data Integration Studio)
6. Reschedule job flows (using the SAS Management Console Schedule Manager plug-in)

FILE MIGRATION

Regardless of the metadata migration approach, migration of physical files is necessary whenever the new SAS 9.4 environment is deployed on different hardware from the legacy environment. These files typically include SAS data sets, catalogs, program files, project files, as well as files not associated with SAS, such as Microsoft Office files, text files, and so on. A comprehensive inventory of the file system should be conducted as a pre-migration task, to identify which directories and files should be migrated to the new SAS environment.

File migration typically consists of a series of repeatable steps, which can include:
- Transferring the files to the new server storage area (local, NFS, NAS, grid shared storage)
- Modifying SAS programs to account for differences in the new environment (LIBNAME statements, filename statements, X commands)
- Converting SAS data sets and catalogs to a different format due to a change in data representation or encoding
- Adjusting ownership and permissions on target directories and files.

Some (or all) of these steps might not be necessary, depending on the differences between the legacy and target environments. For example, transferring files might not be required if the current data storage can be directly mounted to the new server. Programs might not need to be modified if the directory structure and file locations remain unchanged. Conversion of SAS data sets is not required if the legacy and target operating systems are compatible. Also, there is no need to transfer and convert SAS data sets that can be regenerated on the new system.

Once the files have been transferred to the new server, PROC MIGRATE should be run to convert the data to the new operating system format. Other SAS procedures can be used for data conversion, such as PROC COPY and PROC CPORT/CIMPORT, but PROC MIGRATE is simpler to use than PROC CPORT, and unlike PROC COPY, it can migrate index files along with SAS data sets.

When run locally on the new environment, PROC MIGRATE only processes certain files types (such as *.sas7bdat and *.sas7bndx). It does not process SAS catalogs. However, PROC MIGRATE can be run in conjunction with SAS/CONNECT to convert SAS data sets and catalogs directly from the legacy system.

Without SAS/CONNECT, you must use PROC CPORT and CIMPORT to convert SAS catalogs to a new operating system format.

This is a sample of PROC MIGRATE code on Linux:

```
libname source "/tmp/staging/sasdata";
libname target "/sasshare/sasdata";

proc migrate in=source out=target;
run;
```

Note that PROC MIGRATE only processes a single directory at a time, and the target directory is expected to be empty prior to execution.

SAS configuration files and autoexec files (for example, sasv9.cfg, autoexec.sas) should also be examined as part of the file system inventory on the legacy environment. These files should not be copied over to the new environment. Instead, the settings contained within these files should be replicated in the new SAS 9.4 configuration files.

PROJECT MIGRATION

SAS® ENTERPRISE GUIDE® PROJECTS

SAS Enterprise Guide projects that have been saved in metadata folders can be promoted to the new environment using the export/import wizards in SAS Management Console. SAS Enterprise Guide projects stored on the file system can either remain where they are (often on users' desktops), or they can be copied over to the new server as part of the file migration effort.

All SAS Enterprise Guide projects, whether stored in metadata or on the file system, must be upgraded if the users will be moving to a newer version of SAS Enterprise Guide. SAS Enterprise Guide projects can be upgraded on a project-by-project basis, by opening each project in the new version of SAS Enterprise Guide and saving the project.

Alternatively, SAS Enterprise Guide projects can be upgraded by using the SAS Enterprise Guide Migration Wizard. This utility can be run to upgrade multiple projects at one time, and to update references to metadata objects and file locations. The SAS Enterprise Guide Migration Wizard is located in the same directory where SAS Enterprise Guide is installed, and is invoked by running the MigrationWizard.exe program. The Migration Wizard can also be used for upgrading SAS® Add-In for Microsoft Office projects.

More information on the Migration Wizard can be found in the topic "Migrate SAS Content with the Migration Wizard" in *SAS 9.4 Intelligence Platform: Desktop Application Administration Guide*.

SAS® ENTERPRISE MINER™ PROJECTS

SAS Enterprise Miner projects can be migrated across platforms on a project-by-project basis, by using the %EM_MigrateProject macro, which is available for download from the SAS Support site at https://support.sas.com/downloads/package.htm?pid=726

The primary steps to migrate a SAS Enterprise Miner project are:
1. Run the %EM_MigrateProject macro on the source environment to prepare the project.
2. Transfer the prepared SAS Enterprise Miner project directory to the target environment.
3. Run the %EM_MigrateProject macro on the target environment to restore the project.
4. Register the project in metadata (typically performed by the project owners via the SAS Enterprise Miner client).

SAS Enterprise Miner projects that will continue to run on a similar operating system do not require the %EM_MigrateProject macro. In these situations, the SAS Enterprise Miner project directories should be

copied to the target server as part of the file migration effort. As with migrated projects, users must still upgrade their projects and register them in metadata.

Instructions for registering migrated SAS Enterprise Miner projects in metadata can be found in the topic "Defining Migrated Projects in SAS Enterprise Miner" in *SAS Enterprise Miner 14.1: Administration and Configuration*.

SAS® FORECAST SERVER PROJECTS

When upgrading from a previous release of SAS Forecast Server, you can choose one of these three migration options:

1. SAS Migration Utility
2. Automatic registration
3. Archives

The SAS Migration Utility and automatic registration options should only be used when the migration destination path for the new SAS Forecast Server environment remains unchanged from the legacy environment, and when there is no change in operating system. To use automatic registration, the SAS Forecast Server project directories must be copied to the same location on the target server, and you can then use the SAS Forecast Server plug-in for SAS Management Console to register and upgrade the SAS Forecast Server projects in bulk.

The archive option is recommended when the location of the SAS Forecast Server projects will be different from the legacy location, or when you are migrating to a different operating system. Follow these steps to perform a migration using archives:

1. Export the SAS Forecast Server projects from the legacy environment using the %FSEXPORT or %FSEXPALL macros. The CPORT=YES parameter should be used when migrating to a new operating system.
2. Copy the resulting archive files (*.far) to the target server.
3. Import the SAS Forecast Server projects into the target environment using the %FSIMPORT or %FSIMPALL macros.
4. Update the SAS Forecast Server projects to the new version of SAS Forecast Server, using the SAS Forecast Server plug-in for SAS Management Console.

Beginning with SAS Forecast Server 3.1, the SAS Forecast Server plug-in for SAS Management Console can also be used to archive or unarchive individual projects.

CONCLUSION

It's always a good idea to consider all the options when upgrading to SAS 9.4. Performing an upgrade in place or using the SAS Migration Utility apply only in very narrow and specific situations, and might not always be feasible. Partial promotion of metadata is almost always a viable approach, although it can be tedious and time consuming. But it's not enough to focus only on the migration of metadata content. File migration is often the most time consuming part of a migration, depending on the volume of data and how many steps are involved to migrate the files. Likewise, project migration can also require several steps, especially when you are migrating SAS Enterprise Miner and SAS Forecast Server projects to a new platform. The steps outlined in this paper can help you understand the various migration options and what is involved with each approach.

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