

Migrating a SAS Programming Environment to a Virtual Linux Server

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ABSTRACT

Following the decision to replace the well established HP-UX platform for SAS programming by a novel open source system, Accovion successfully migrated its SAS programming environment from SAS version 9.1 on a proprietary HP-UX system to version 9.2 on a virtual Linux server.

At the beginning of the project, a migration plan was developed to minimize interruption of ongoing programming work. The virtual Linux server was installed, SAS version 9.2 was implemented and the programming environment was transferred to the virtual server in accordance with the software development lifecycle and current guidelines for computerized systems in the pharmaceutical industry. User manuals were developed and users were trained before the system went into operation. Almost 50 active projects comprising more than 200 studies were migrated to the new SAS programming environment without interruption of day-to-day operations.

Despite early concerns, no major problems were observed during the migration process. Only the differing behavior of SAS version 9.2 compared to version 9.1 caused minor problems. The new programming platform has been in operation since the beginning of 2010 and is now stable; users are very satisfied with the new platform.

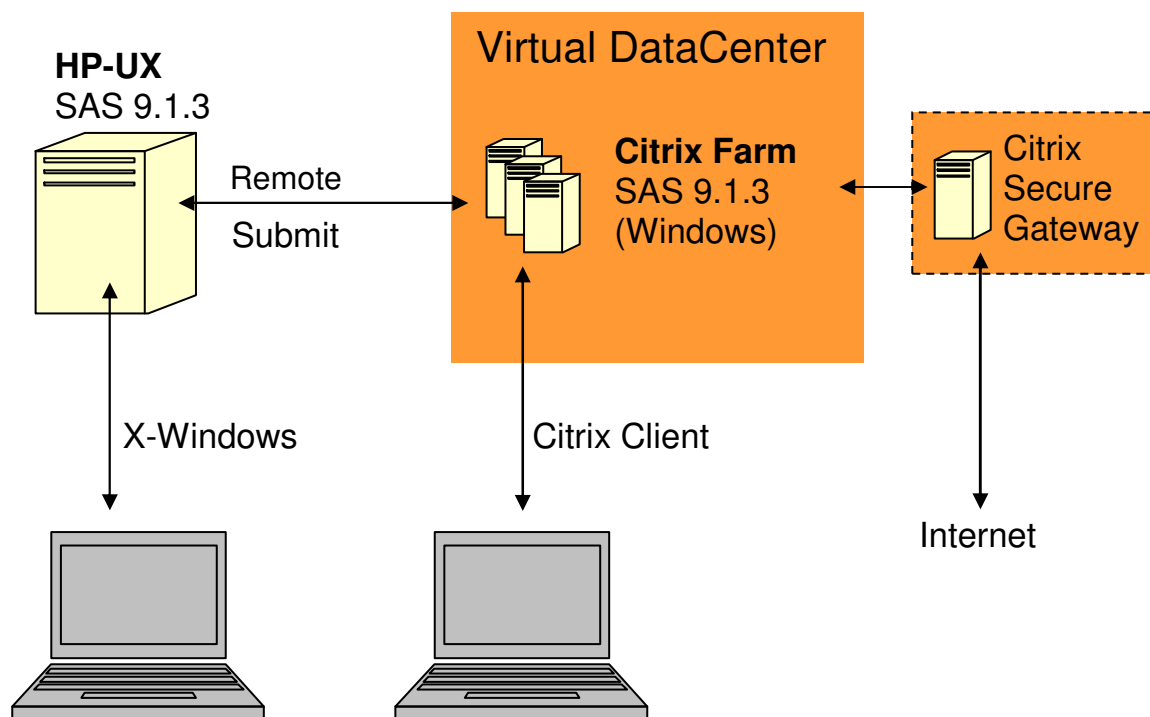


Figure 1: Programming environment before migration

INTRODUCTION

As a clinical research organization Accovion uses SAS software for data preparation and analysis of clinical data. Before migrating to Linux, Accovion's programming environment, including standard SAS macros, was installed on a HP-UX RP5470 server (Figure 1). Because of its user rights management the HP-UX machine was also used for data storage. The system had been in use for a long time and was fairly reliable. However, hardware maintenance costs increased over the years because of the system's age and resulted in the decision to retire the HP-UX RP5470 and migrate to a new system.

Accovion's server environment has changed in the last decade to a modern and lean server farm using virtual servers. Virtualization is not possible with a HP-UX server and to continue with a HP-UX based programming environment would not have really been compatible with Accovion's IT strategy. Therefore Accovion's management decided to evaluate alternative solutions.

DECIDING ON A PLATFORM

SAS programmers at Accovion can choose between working with SAS software on UNIX directly via X-Windows and developing programs with SAS for Windows, which requires the submission of programs to the UNIX server for remote processing. The possibility of migrating the programming environment completely to Windows was discarded very early on, although the Citrix server has already been available as a virtual machine. The migration effort in this scenario was considered too high and customer compatibility was not considered ideal because Unix is used widely in the pharmaceutical industry. However, it was also clear that the Windows platform would still be needed in future.

For the decision phase a small core team from programming and IT was established. It was the core team's task to identify possible platforms to host Accovion's programming environment. During the testing of the new system this core team was supported by up to 20 colleagues from multiple departments. In a first step, to gain the stakeholder's support and to ensure that all business needs for a new system are taken into account, all functions using SAS software within Accovion were interviewed for their specific needs.

In each scenario a huge increase in performance was expected. Furthermore it was assumed that all current Accovion processes needed to be implemented on the new system. The two most important aspects of this migration project became clear:

- Customer compatibility
- Costs

Customer compatibility

Most pharmaceutical companies use SAS software on Windows or SAS software on a UNIX platform. Therefore other platforms were dropped from consideration at a very early stage. To match the processes of our customers as much as possible it seemed necessary to keep both Windows and a UNIX system. The two UNIX platforms, HP-UX

PhUSE 2010 TS01

as a well-established system and Linux as modern and low-cost software, remained on the shortlist.

Although there is a general trend towards open source software, Linux is currently rarely used in the pharmaceutical industry.

Costs

Regarding costs, both non-recurrent expenses and recurrent costs were taken into account.

As most systems at Accovion had already been implemented within a virtual server environment, only low expenses would be incurred for hardware if SAS software was implemented on a virtual server. However, SAS software could only be installed on a virtual server under Linux and not HP-UX. Upgrading the HP-UX system would have required the acquisition of dedicated new HP hardware.

HP-UX and Linux are very similar but not identical. Therefore the duration of the migration to Linux was estimated to be slightly higher than the migration to a newer version of HP-UX on a new server.

No significant difference was expected for server administration costs between HP-UX and Linux. But the virtualization of the SAS server increases the scalability and the reliability of the system. Furthermore Linux is an open source operating system which is widely spread and with a large number of available free and open-source software.

Testing

The migration team decided to perform a test of the Linux system in order to get a complete picture of possible risks associated with a migration to Linux. A separate test of an updated HP-UX was not considered necessary because of Accovion's extensive experience with the HP-UX system.

To ensure all of Accovion's processes could be performed under Linux, Red Hat Linux Enterprise Release 5 was installed as a virtual test server including Accovion's standard programming environment and standard macros. The standard processes were tested in the new environment and a test study was implemented under Linux. Data preparation and analysis of the test study was repeated on the Linux server and output was compared to the one created under HP-UX. Everything ran even better than expected; only minor problems occurred that could be solved with little effort. The performance of the test system was excellent.

Final Decision

After testing and evaluation of the pros and cons there was no clear advantage for one UNIX system over another. No short term tangible benefit from migrating to Linux in comparison to staying with the established HP-UX environment was seen. However, migrating to Linux offered the opportunity to be at the forefront of technology and would establish a modern system providing flexibility in the future. Taking all points into consideration, Linux as main system with SAS on Windows as the alternative system seemed to be the best solution for Accovion. The risk associated with the migration to Linux seemed very low.

To avoid having to migrate to a higher SAS version within a short time frame, the latest available SAS version was to be used. As a result, not only would the platform change from HP-UX to Linux but also the SAS version would change from SAS 9.1.3 to SAS 9.2. Installing the new SAS version in the new environment in one go would be beneficial. On the other hand, additional problems resulting from the version update had to be expected.

DEVELOPING A MIGRATION PLAN

In the SAS programming environment the clinical data and programs were structured as one directory per project with subdirectories for all related studies within a project. An inventory of all projects and studies with timelines for active studies was created. For each project one responsible person was named to determine the migration status, i.e. whether migration was necessary or archiving could be done. Where migration was necessary, the best time point per project had to be defined in order to avoid conflicts with important timelines. Some flexibility was needed because of changing timelines and last minute requests by the project teams.

To reduce the migration effort, non-active projects (no active studies within a project) were archived before the start of the actual migration. After archiving was completed, approximately 50 active projects with over 200 studies remained for migration. As programs and data could be shared within one project across different studies and to reduce the complexity of a migration plan, it was decided to move projects en bloc and not single studies within a project separately.

The down time for projects was to be minimized to keep the migration costs as low as possible. To accommodate project needs and to ensure minimal interruption of the working process it was planned to migrate project by project instead of all projects at the same time. Due to this stepwise migration of projects, two productive systems were in place for a short time and the migration team set itself the goal of 4 weeks for the actual migration to reduce this time window.

The components that had to be moved to Linux were divided into two parts:

- General programs (including applications), generic macros and shell scripts
- Study dependent programs and data

Migration of general programs had to be performed first, directly after the system setup and before the first study was moved. For these general programs a second migration plan was created where all programs and scripts were listed.

IMPLEMENTING THE SYSTEM AND MIGRATION

The virtual Linux server was set up on a VMware ESX Server (Figure 2). The programming environment including SAS and Accovion's standard macros was then transferred to the Linux server following the software development lifecycle. Some of the UNIX scripts and tools programmers use for their daily work were modified and re-created under Linux. User accounts were transferred to the Linux system before the actual migration of the projects started and daily file backup routines were implemented.

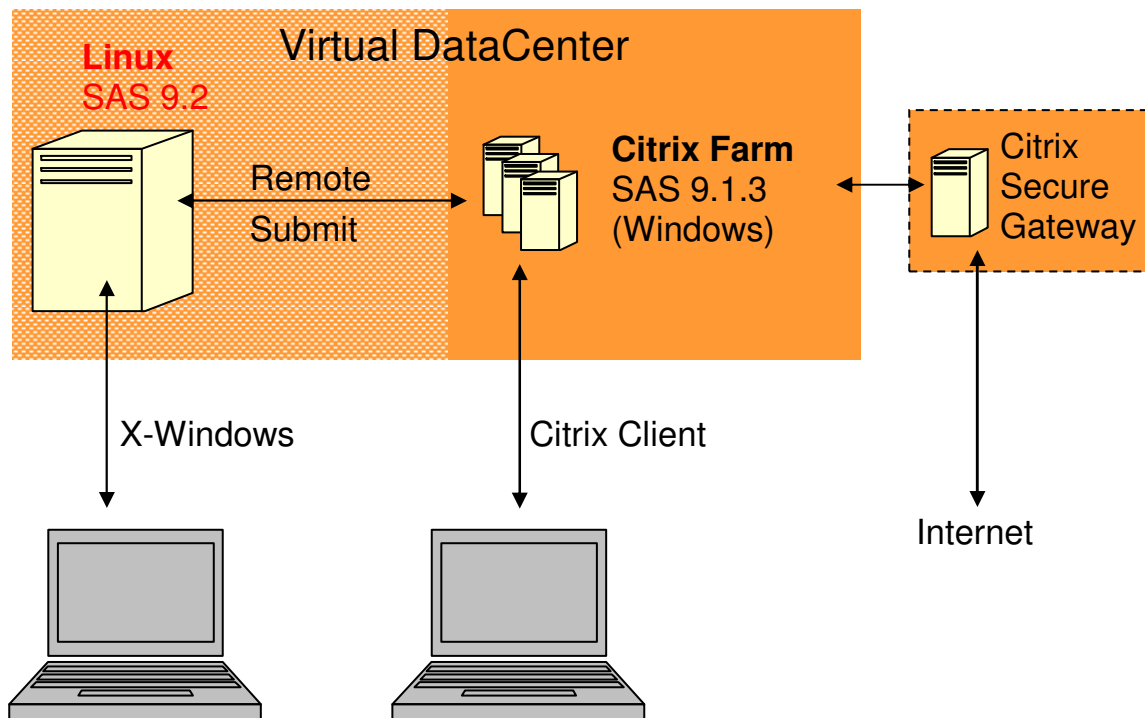


Figure 2: Programming environment after migration

Software development lifecycle

The installation of SAS 9.2 on Linux was tested according to the software development lifecycle with all required documents:

Document	Short description
System registration	• Inventory of software, software components • GAMP level • Business criticality
Validation plan	• Documentation of validation steps • Decisions on validation steps not performed but required according to GAMP level
User requirements	• Any user requirements for the software
Installation qualification	• Documentation of the verification of the SAS installation with the SAS IQ tool
Risk analysis	• Documentation of risk analysis of impact on the business
Traceability matrix	• Link between user requirements, the risk assessment, and the test procedures

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Document	Short description
Acceptance test	• Documentation of test cases and results
Documentation about 21 CRF Part 11 compliance	• Check-list for compliance and gap assessment
System release	• Documentation of system release to production

Update and re-validation of macro library

As soon as the SAS software was available and validated under Linux, preparation of the macro library on the Linux system was started. In most cases generic Accovion macros had been written completely platform independent and did not have to be changed. For some macros minor modifications had to be performed resulting from either the change of platform or the new SAS software version. User manuals were updated if necessary and all standard macros were re-validated in the new Linux programming environment. Migration and validation were documented using change control forms.

Furthermore UNIX scripts were adapted to the new system. Because Linux and HP-UX are very similar, few changes were necessary

MIGRATION OF PROJECTS

Preparation

The IT department developed and validated a script for copying the clinical studies from the old programming environment to the Linux environment. This script not only copied the files but also applied checks, e.g. the comparison of number of files. In addition the script removed access to the project in the old environment to avoid inconsistencies. Groups and access rights were transferred from HP-UX to Linux.

For each study a checklist was prepared in advance to ensure that all necessary changes were made to the study specific programs, e.g. update of the current version of Accovion's standard macros.

An issue log was implemented to trace all findings that emerged during the migration process along with the resolutions.

Migration

The migration of ongoing projects to the new Linux environment was a critical part of the migration. Interruptions to daily work needed to be minimized and time critical programming projects needed special attention. Based on the migration plan, which had been developed in close cooperation with users, the migration of clinical projects was performed over a period of two months. At the start of the actual migration phase only one clinical project was migrated over two days, to leave enough time to refine the process and to solve potential problems. Later in the process up to 3 projects were

migrated on a single day.

An announcement was sent to the respective key users at least 2 days before a clinical project was to be migrated. Any programming work on the respective project had to be stopped during the actual migration. The IT department then used their script to copy all files from all studies within a project to the new programming environment and removed access rights on the old system.

For active studies all datasets were recreated under Linux and compared to the datasets created under HP-UX. If necessary, system dependent macros and version numbers of Accovion's standard macros used in active studies were updated. After all checks and updates were made the project, including all respective studies, was released for production. The programming team for a study decided whether a comparison of SAS output between the two systems was necessary based on the validation status of the respective SAS programs. All migration steps for each study were documented on a checklist.

Migration took about half a working day per project, depending on the number of active studies within a project.

TRAINING USERS AND GOING LIVE

After the decision to develop a new platform was reached, all SAS software users within Accovion were informed about the planned system change, the timelines and the migration plan.

All SAS users were trained with a basic Linux training with special attention to the differences between Linux and HP-UX directly before the actual migration started. All users received a Linux user manual with all scripts and commands necessary for Accovion processes. "Cheat sheets" with the most important Linux and programming environment commands were distributed. Accovion's Linux "cheat sheet" is a well structured double sided and laminated A4 page with the migration mascot printed on top and it became very popular.

During and after the migration process colleagues from the migration core team were always available to find solutions in case users encountered problems with the new programming environment. All such cases, as well as their resolution, were tracked and communicated to the affected users. The change from SAS version 9.1 to 9.2 was responsible for the majority of problems reported.

Testing of the Linux environment showed very early on that the change would only marginally impact on daily programming routines. However, because this fact was so obvious to the core migration team, the team missed the opportunity to communicate this directly to the users. This resulted in some unnecessary anxiety regarding the new system in the user community. Once the migration team recognized this communication gap it started Q&A sessions with users and this issue was quickly remedied. However, one important lesson the migration team learnt from this was:

Don't forget to communicate the obvious.

TECHNICAL SPECIFICATIONS

The virtual Linux server is hosted on a VMware ESX server-based cluster and is assigned 2 virtual CPUs and 4GB of memory. SAS version 9.2 was installed on the virtual Linux server under Red Hat Linux Enterprise Release 5, currently the only Linux distribution supported by SAS. SAS version 9.1.3 was installed on the Citrix Presentation Server 4.5 a, which is also installed as a virtual server on the ESX cluster.

CONCLUSION

Thorough planning and tight management of the migration process paid off as the migration was performed within a short time frame and without slowing down project-related programming activities for too long. However, it was important to be flexible enough to accommodate the project team's needs, e.g. react to last minute changes in timelines. It was very important to inform all affected users and management at an early stage in the process. To prevent unnecessary anxiety regarding the new technology we found that it was important to keep all stakeholders informed of progress even if there was no immediate action required or impact.

As users were already trained when the new system was up and running, project work could be resumed seamlessly on the new system in nearly all cases. The few problems that occurred were resolved directly but continued support after roll-out of the new system was needed. In our case the upgrade of the SAS version 9.1 to 9.2 caused more trouble than the platform change from HP-UX to Linux.

As expected, working on the new Linux server is much faster than working on the outdated HP-UX server. Overall the system has been in operation for more than 9 months and we have observed a very stable and reliable system performance.

In the short term we did not see a financial benefit resulting from the migration to Linux. However, we expect a long term benefit resulting from reduced hardware costs, the openness of the Linux system, the increased reliability and scalability of the system.

REFERENCES

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