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SAS® Enterprise Application Consolidation

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In enterprise organizations today, SAS applications are used across a broad spectrum of business lines. In the past, these applications were typically built with different SAS components, with various interfaces to the users, varying underlying operating systems and different operational procedures.

Some of these applications were developed based on technologies that would be called legacy today. Even though old technology is often still playing a vital role in the daily business processes of an enterprise, the trend towards IT consolidation of SAS applications is growing.

The enterprise application consolidation process meets the needs and challenges of providing a sustainable and secure future infrastructure that gives the opportunity to re-create and protect business value. This paper provides insights on the technical and IT governance challenges during such an enterprise application consolidation process.

Contents

INTRODUCTION

Worldwide, CIOs and IT executives face an ever-increasing range of challenges. Topics such as: getting a clear view on the data that is running within the enterprise, managing security and privacy of their systems and data, and driving the digital transformation. To keep track of all those challenges an enterprise can only be successful if it adapts quickly enough to those changes.[1] As the volume of data is growing in an enterprise and digitalization has a high priority on the agenda of the business within the enterprise the move towards a centralized environment can be achieved by making use of the application consolidation methodology approach.

Application consolidation is the process of merging applications running on independent systems into centralized systems. Generally, there are two flavors of consolidation. The merger of instances of the same system and the merger of different systems, maybe even from different vendors with similar functionalities, into one system.

Governance is a key element during the enterprise consolidation application process in order to meet future demands of the enterprise and its business. Successful governance during the merger of instances to one centralized system is critical and comprises effective decision making, including the mitigation of risks. Therefore the responsibilities of all the stakeholders involved in the process on strategic, executive management and operational IT and business level must be clearly articulated and understood.

Getting a clear view on the data that is running within the enterprise brings us to the essence of our paper. Since 1976 SAS has provided a programming language that is used in business processes to manage data. The challenge is that besides developers doing SAS programming, analytical and business users were also designing their own solutions on various SAS technologies that are now running on deprecated operating systems and on SAS versions that were often not upgraded. The retirement from the workplace of these developers and the various distributions of installations and users as shown in Figure 1 causes major issues in managing maintenance and operations within the enterprise. Read on if you want to find out how you can make your enterprise future proof by optimizing and consolidating your SAS enterprise application infrastructure in order to provide the existing solutions a modern runtime environment and to get a hold on the massive data within your enterprise.

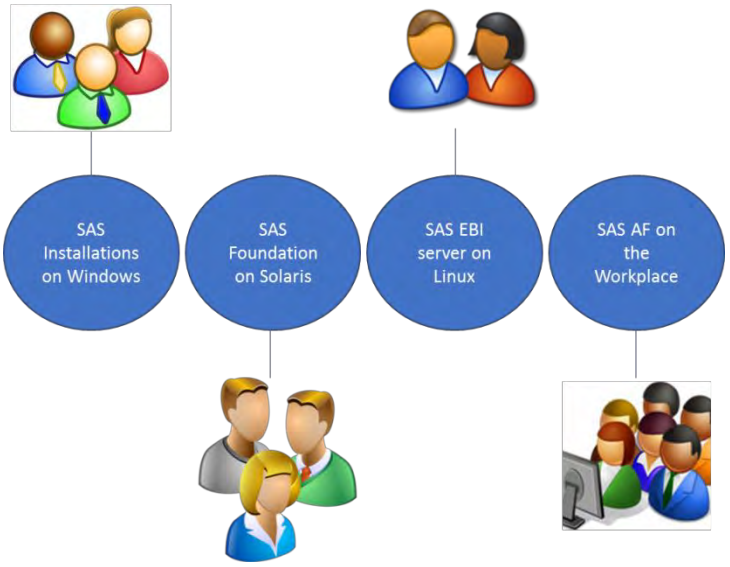

Figure 1: AS-IS situation: distributed installation vs users

[1] http://www.mrc-productivity.com/blog/2016/11/5-big-challenges-facing-cios-and-it-leaders-in-2017/

WHY APPLICATION CONSOLIDATION

Application consolidation is one of the main priorities for IT executives. Enterprises are dealing with a large number of applications that they would like to reduce for several reasons.

Main list of drivers for application consolidation:

- Reduction of costs (by replacing legacy applications and operations effort)
- Optimization of business process functionality by protecting business value
- Infrastructure reached end of the lifecycle
- Reducing architectural complexity within the enterprise
- Change in organizational structure (retirement of employees)
- Resolving years of technical debt within the enterprise
- Usage of advanced technology and a secured platform
- Performance and capability improvement through version upgrade
- Consolidation of software licenses to be cost efficient

Maintaining business as usual and transforming business operations to survive and compete in the future goes hand in hand during a consolidation process. To take advantage of those benefits the enterprise has to move from their distributed systems towards a central, scalable and consolidated platform as shown in Figure 2. How entities could move towards a centralized environment can be read in the upcoming chapters.

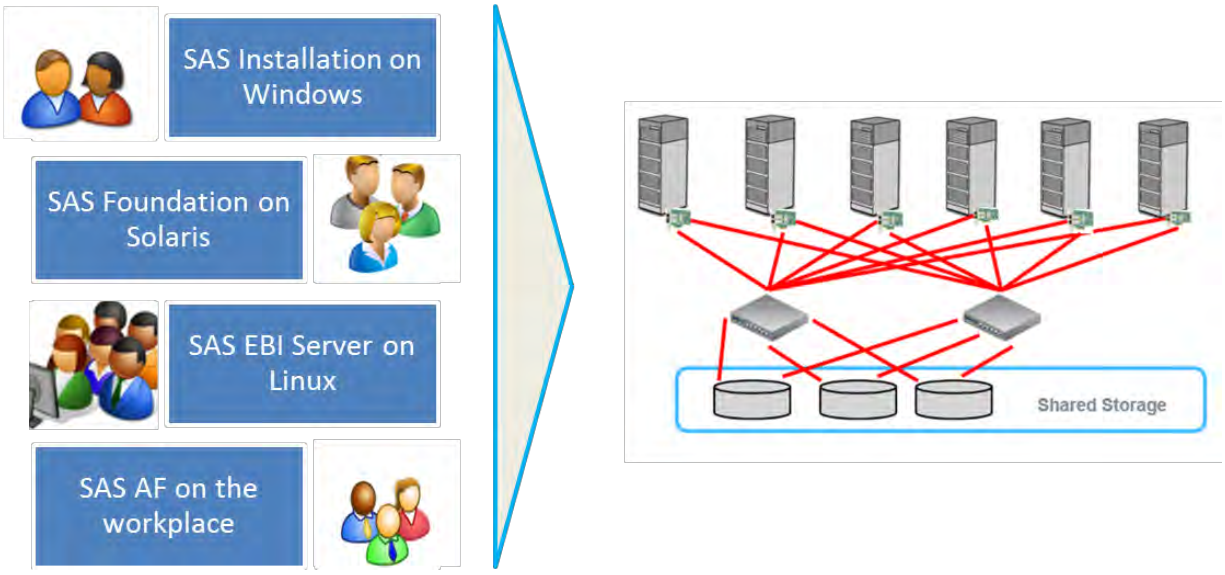

Figure 2: Movement towards a centralized platform

FOUNDATION OF APPLICATION INFRASTRUCTURE CONSOLIDATION

A solitary application infrastructure foundation is required for this approach. The selected architecture has to support the various needs of users within the enterprise:

1. Support the analytical capabilities to get value out of data
2. Scalability; to allow different SAS configurations for different use cases
3. Data movement (ETL); analytical tasks such as forecasting and reporting
4. Protecting customer data
5. Interfaces for using analytical capabilities in other business processes

INFRASTRUCTURE FOR APPLICATION CONSOLIDATION

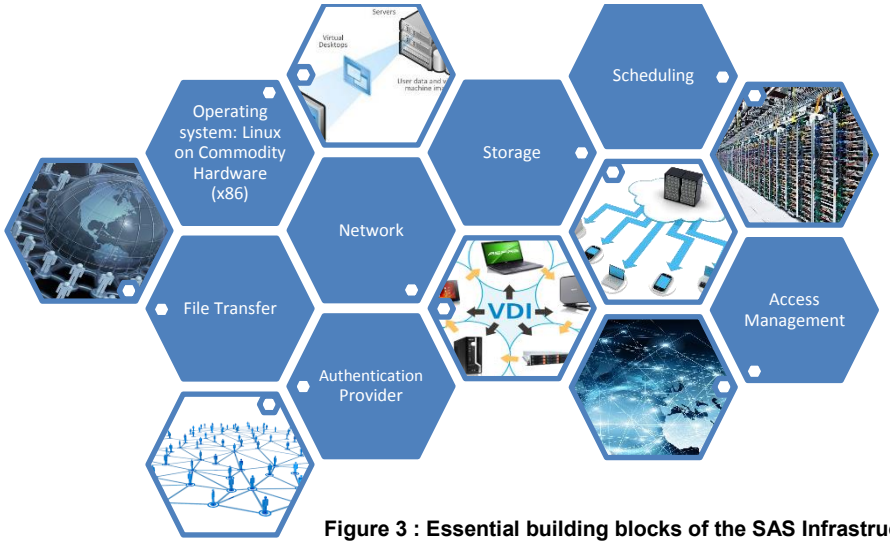

Figure 3 : Essential building blocks of the SAS Infrastructure

Figure 3 identifies the essential elements for building the foundation of an application consolidated platform. Availability of hardware and cost effectiveness are the main drivers for the selection process of the underlying hardware and software. In general Commodity hardware (x86) is an option for an enterprise with Linux as the operating system. This is often already the foundation for cloud-based applications characterized by fast delivery and the benefit of economies of scale on the operational side of the enterprise.

On top of those building blocks, SAS® GRID Manager technology composed with the SAS® Enterprise BI Server will provide the enterprise with the foundation to create the application infrastructure. SAS® Grid Manager technology provides the option to grow, based on user demand, when required. In this approach computing tasks are distributed among multiple computers on a network.

SAS® GRID Manager technology comprise a scheduling component. As an alternative, an existing enterprise scheduler can be integrated into the process to allow the integration with existing process flows.[2] File transfer allows the exchange of data when a connection via a SAS/Access® interface is not feasible.

[2] https://support.sas.com/rnd/scalability/grid/InterfaceEnterpriseScheduler.pdf

In an application consolidated environment with heterogeneous workplaces, leveraging virtual desktops or published applications could provide the needed infrastructure to deliver the SAS clients such as Enterprise Guide® and Data Integration Studio. The selected approach should support the synchronous update of the client and backend infrastructure. Centrally provided workplaces have the advantage of efficiently steering the client updates. Virtual desktops support the minimization of data transfer out of the data center towards the workstations of the users and improving the user experience.

REQUIREMENTS FOR THE SAS CONFIGURATION

Requirements for the consolidation platform:

- Provide the customer with guaranteed capacity for data processing
- Separate the individual customer groups
- Minimize the impact of outages
- Allow different backup and restart windows

For an efficient use of the infrastructure with **'grow based on demand'** and **'multi tenancy approach'** strategies, the essential foundation is to share the infrastructure between several applications. The multi tenancy approach permits the sharing of resources. [3] [4] [5] Therefore resource management between the different applications is required to guarantee each customer the agreed computation capacities of processing their individual workload. Within SAS® Grid Manager, IBM® Platform™ LSF® is included to manage workloads.[6] LSF queue and host options together with operating system capabilities like CGROUPS can be applied to manage the resource demand of different applications and customer groups.[7] [8]

A multi-tenancy design approach inside one SAS Metadata server will introduce drawbacks towards the customers. With one Metadata server, all hosted applications experience the same change windows and outages in the metadata server or in web applications. Ultimately, this means that all customers on the same platform will be impacted. An option to mitigate the risk of an outage that impacts hosted applications is to group the applications in several independent metadata servers. Those independent metadata servers can share the compute environment and allow the efficient use of SAS licenses and compute resources. For each metadata server, a dedicated configuration directory must be formed on the computation servers. Therefore, the metadata server can be placed on a dedicated server outside the compute cluster. In addition, the SAS web application server and the SAS Web Infrastructure Platform Database server (WIP) could be hosted on this server as well as shown in Figure 4.

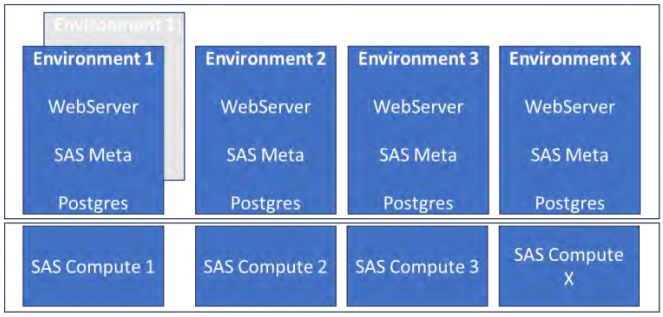

Figure 4: Consolidation Platform

[3] http://support.sas.com/resources/papers/proceedings16/11562-2016.pdf
[4] http://support.sas.com/resources/papers/proceedings13/494-2013.pdf
[5] http://support.sas.com/resources/papers/proceedings16/11684-2016.pdf
[6] http://support.sas.com/rnd/scalability/platform/PSS9.1/lsf9.1.3_admin.pdf
[7] http://support.sas.com/resources/papers/proceedings16/11562-2016.pdf
[8] http://support.sas.com/resources/papers/proceedings14/SAS289-2014.pdf

Within this configuration all servers can use similar configurations. For the SAS application server contexts, each instance requires a dedicated port to avoid conflict between different metadata servers.

Depending on the desired capacity of concurrent users in the web layer a vertical or horizontal cluster can be arranged. [9] The introduction of a cluster allows the rolling restart of a web application without service interruption.

A shared filesystem as shown in Figure 5 allows the execution of SAS workload on every compute server in a distributed system. The performance of the consolidated platform relies on the performance of the chosen shared filesystem and storage subsystem.[10] Careful evaluation is required to forecast the estimated workload and the desired capacity. By choosing a number of smaller servers, the bandwidth to the storage is spread over more connections and scales better in comparison to large, monolithic servers with a huge demand for bandwidth.

Figure 5 explains the network and storage architecture and the importance of considering the available network bandwidth. 100-150 Mbyte per core is a reasonable assumption for calculating the capacity demand. [11] When using 8 cores, the theoretical limit of a 10 GBit network connection is almost reached without considering the needed additional capacity for connections to external databases. Dedicated servers with higher core counts have an even higher demand and can often not be fully utilized due to constraints within the network connections to the storage provider.

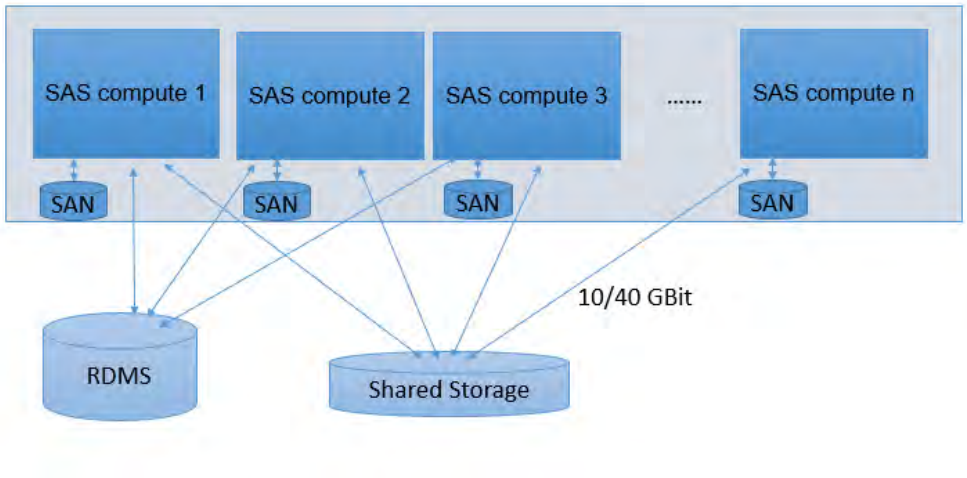

Figure 5: Grid Shared Storage: connection with 10GBit/40GBit

In this example, SAN Storage is used for local filesystems on each node to store the operating system, SAS binaries and configuration information related to this server. On each node, the content and configuration of SAS is stored in the shared file system whereby each node is using the same configuration from the shared storage to access the Database (RDBMS) systems. Through this approach, the execution of the customer workload can be processed independently on the used server inside the grid.

SECURITY CONFIGURATION

In a shared environment, security requirements are mandated by the application with the strictest requirement. Encryption is mandatory for all the communication channels between the components. Figure 6 shows that TLS is used for web (HTTPS) components and SAS/Secure™ to protect IOM

[9] http://support.sas.com/documentation/cdl/en/bimtag/69826/PDF/default/bimtag.pdf
[10] http://support.sas.com/rnd/scalability/papers/SurveyofSharedFilepaper_20131010.pdf
[11] https://support.sas.com/resources/papers/proceedings15/SAS1501-2015.pdf

communication. For data stored in SAS Libraries, SAS Metadata-bound secure libraries provide the capabilities to encrypt the data at the filesystem level.

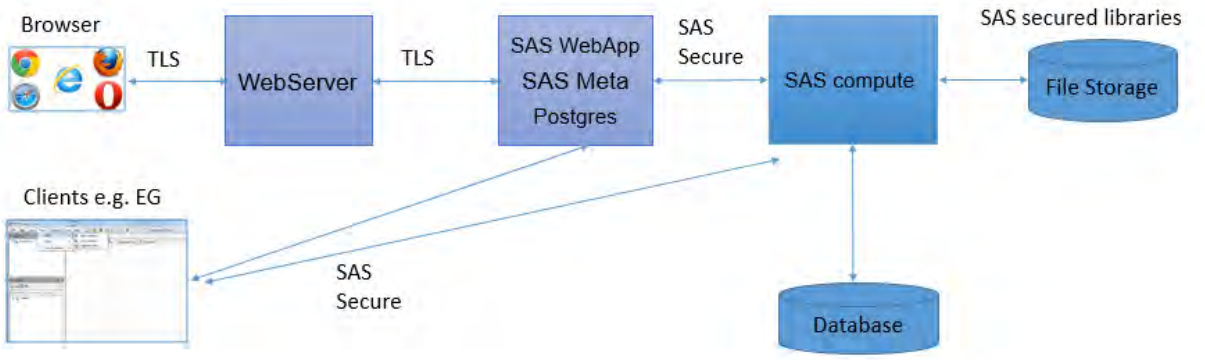

Figure 6: Security configuration and the encryption of communication

Deployment of the application infrastructure in a shared environment with multiple configurations for different customers is a challenging task. The configuration process must create reproducible results and should meet the customer expectations of cloud based architecture within short delivery times. The usage of a highly automated approach to installation and configuration of the SAS applications addresses these requirements[12].

In addition to the security configuration and the encryption of communication, SAS in a multitenant configuration requires separation of different customers within the environment. This requires changes within the metadata folder structure and within the directory layout of a filesystem. All applications in scope of the migration must adjust and conform to this common structure. Root directories can be provided in SAS macro variables to allow all customers the creation of their own sub structures independent to the root directory structure:

Sample of variables:

```
/* Filesystem folder */
%let TENANT_DIR = /tenants/tenant1;

/* SAS Folders in the Metadata */
%let TENANT_FOLDER_SHARED_DATA = /Shared Data/tenant1;
%let TENANT_FOLDER_REPORTS = /Reports/tenant1;
%let TENANT_FOLDER_STP = /Stored Processes/tenant1;
%let TENANT_FOLDER_ETL = /ETL/tenant1;
%let TENANT_NAME = tenant1;
```

To allow the code to run in a grid enabled environment all dedicated server dependencies need to be removed and replaced with grid enabled calls. One example is the usage of MP Connect and the adjustment with the grdsvc_enable call.[13]

A great challenge for the migration to a centralized SAS installation is the legacy use of DDE[14] on SAS Windows installations. SAS applications on Windows can use DDE to update cells in an excel spreadsheet. DDE works only between Windows processes on the same machine. This method was introduced in the late 80's of the last century. Today DDE is outmoded and it is unknown how long this will be supported in the Windows world. Possible alternatives to replace DDE in a SAS Grid environment are the use of the SAS Add in to Microsoft Office or ODS Excel tagset functionality[15].

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[12] http://support.sas.com/resources/papers/proceedings17/0814-2017.pdf
[13] http://support.sas.com/documentation/cdl/en/gridref/67371/PDF/default/gridref.pdf
[14] https://en.wikipedia.org/wiki/Dynamic_Data_Exchange
[15] http://blogs.sas.com/content/sasdummy/2014/10/14/dde-is-doa/

IMPLEMENTATION OF THE MIGRATION

MANAGEMENT OF THE MIGRATION TO APPLICATION CONSOLIDATION

Consolidation implies 'change' of the existing enterprise structure and processes. To lead and manage the 'change' of the enterprise application consolidation, the enterprise has to generate a temporary organization. The scope of the temporary organization will depend on the number of applications and organizational units involved in the consolidation. If the enterprise has to coordinate, direct, and oversee the implementation of multiple consolidations to the shared platform, multiple related projects may be established for a program set-up. If the enterprise has to deliver a single consolidation of migrations, a single project will be sufficient.[16] A program will usually include a program manager and a program office support to facilitate the sharing and exchange of resources, knowledge, and management activities across the projects within the program. The benefit of a program in this case is the collaboration and knowledge sharing across different projects.

Carefully consider the following basic elements during the start-up phase of your project/program:

I. Governance sign-off by the highest authority possible forms the trigger to start
II. Appoint the sponsor and executives of the project
III. Capture previous lessons from other projects in your enterprise before starting the project
IV. Appoint the project manager and the team members with the required expertise
V. Prepare an outlined business case and align formal costs within the enterprise upfront
VI. Select the project approach based on the specialties and uniqueness of the migration case
VII. Plan the application consolidation migration within the enterprise in detail
VIII. Initiate a communication plan to streamline and align communication during all project phases

GOVERNANCE OF THE PROJECT

During the application consolidation process, three layers within the enterprise should be activated as shown in Figure 7. In all layers, the three basic elements of structure, process and relational mechanisms play an essential role during the entire lifecycle of the project.

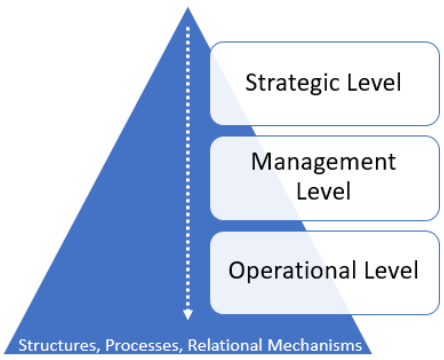

Figure 7: Layers of involvement

Starting at the top with the strategic layer, the strategy and the direction of the program will be defined with the involvement of board members. Integration of the business strategy versus the IT strategy will be adjusted. The program or project manager has to ensure that the project is a regular agenda item in the IT strategy committees. On this level, project values, risks and the assured activities have to be transparent.[17]

On a management level, active participation from executives on the IT and business side is required to streamline actions and decisions within the project.

[16] The Stationery Office, 2009. "Managing Successful Projects with Prince2", 308-309.
[17] Van Grembergen, W. and S. de Haes. 2008. "Enterprise Governance of Information Technology: Achieving Strategic Alignment and Value" 21–29.

Regular IT steering committees within the enterprise during the project are essential. The Chief Information Officer (CIO) who is reporting to the CEO must be involved in the decision-making process and plays a crucial role when it comes to: stakeholder management, commitment of resources and crucial investment decisions. At an operational level business and IT are involved to plan and execute the application consolidation project.

ESSENTIAL ROLES IN MIGRATION PROJECTS AT OPERATIONAL LEVEL

For the execution of the migration, the enterprise must ensure that the resources involved in the project contain a diverse and broad skillset. Project business domain knowledge, technical knowledge, communication skills, action oriented skills, and a personal network within the enterprise are essential elements.

At the operational level, four 'must-have' IT roles for a successful project are required:

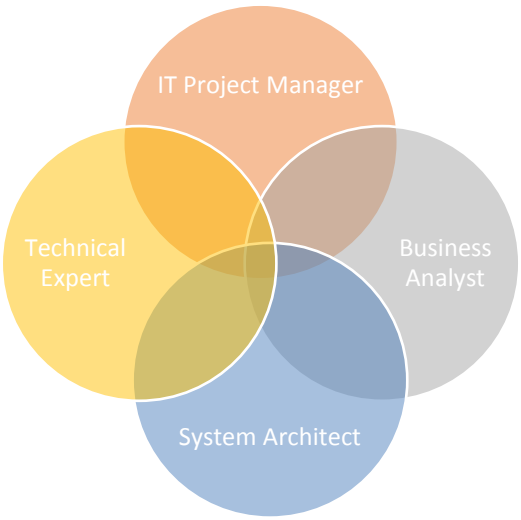

Figure 8: Essential roles on operational level

The **IT Project Manager** is responsible for planning the migration and defining the scope of the project. Maintaining the budget, planning the resources and making sure there is actual tracking on all activities during the project are all seen as daily tasks. Communication between all stakeholders and the different layers within the enterprise is required to make sure that the project will be delivered on time. The support on the change management process within the enterprise, managing the risks during the project and establishing the escalation process if required are additional tasks that have to be covered by this role.

The **Technical Expert** must have in in-depth SAS and IT knowledge to execute and support the migration team where necessary during the process. This person has deep knowledge of the integration techniques and the connection points of other applications to the SAS environment. This role should champion the change process: the usage of a shared SAS environment and advocate the adoption of the development and deployment processes within the enterprise. After one successful migration, a migration guideline, could be developed for future purposes.

The **System Architect** brings in knowledge of the overall application landscape and technologies that are required to enable the integration of the new application infrastructure with the existing data flows and business processes. This person has to manage the technical dependencies such as job scheduling, network connectivity and security requirements. As all implemented configurations should be validated for vulnerabilities through penetration testing, the Systems Architect will play a pivotal role in topic by providing expertise during the analysis and remedying of results.

Finally, the **Business Analyst** within the project is representing the business interests and is the bridge between the business and the IT department. IT requirements should be gathered by this person and changes in the technical infrastructure and processes should be aligned upfront.

Between the different layers and roles of involvement, regular steering committees within the enterprise should be organized. Close collaboration and face to face interaction through established communication channels with all involved parties is the key to success. Sharing of knowhow and best practices across projects must take place to help optimize the overall migration approach.

PROJECT METHODOLOGY: TRANSITION AND MIGRATION APPROACH

The lifecycle of a project comprises seven phases where the inventory of the required infrastructure has to be defined as a starting point. As a second step the deployment of the platform, the installation of the hardware, and the configuration of the services as described within the chapter 'foundation of application consolidation' have to be in place. There is a high probability that a special task-force should be in place during the build-up of the platform. This task-force should be able to deal with daily infrastructure topics within the enterprise.

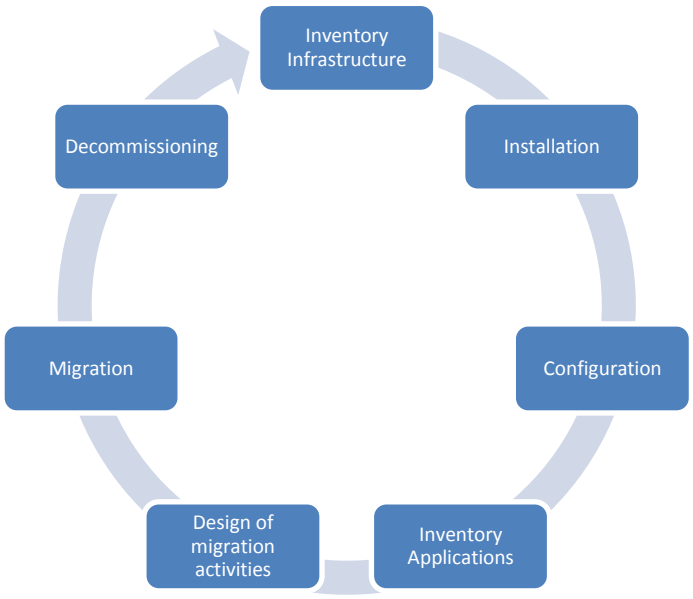

Figure 9: 7 essential phases during the project

Phase 4 entails an inventory of the infrastructure landscape of the enterprise. A fit-gap analysis will incorporate:

1. Scope of the enterprise: number of applications
2. Application details: features, criticality, volume of the data
3. Business areas and users that that will be affected
4. Interfaces to other systems
5. Requirements of the business

As a subsequent step the migration strategy can be defined by the enterprise and mostly embraces a phased approach of software testing and deployment. Providing a playground for the enterprise for testing purposes to get familiar with the changes could be beneficial. A sign-off from all relevant customers is required before heading towards the migration phase. If more projects are planned, the suggestion is to start with a pilot where the results can be used as the starting point for the migration approach.

As a first step within the migration phase the SAS applications will be migrated to the development system in the new environment. This includes setting up the metadata structure, security model, the interfaces to other systems such as database connectors, SAS program code, data (usually test data), executing tests and creating the deployment processes and packages. As a second step the SAS applications are deployed to a system integration environment. There the deployment process (movement of content between environments) is thoroughly tested. Users may or may not access the test environment for verification. Then, the application is deployed to the production environment where business users perform end-to-end tests to verify the front-end client application and backend processes. In this time the old and the new environment are running in parallel and the data is synchronous between two environments. Once the business users accept the new environment, the application is rolled out to the entire user population. From that moment on all users within the enterprise could make use of the new deployed applications.

After the validation and cutover to the new infrastructure and achieving the milestone to replace former infrastructure with the migrated application, the project manager could start the decommissioning phase of the former servers. Before shutting down the application, the enterprise should decide the duration to retain the archive specific data if required. As soon as the decommissioning process is triggered, the server can be shut down and workplace applications related to the old environment can be deactivated. From that moment on the application has been fully migrated to the target platform and managed from there, mostly by the daily operations team within the enterprise.

PREREQUISITES FOR APPLICATION CONSOLIDATION

TECHNICAL APPROACH

In each migration, several different types of components have to be migrated, each potentially requiring different migration methodologies. Based on the component the optimum migration approach should be considered.

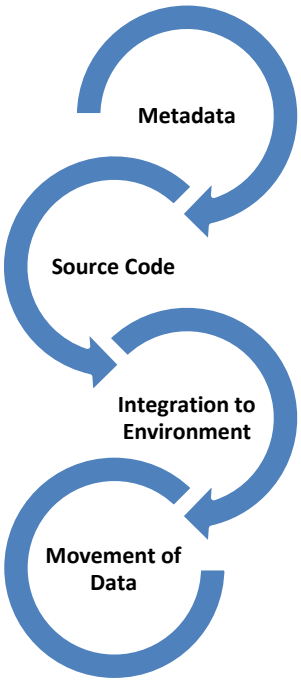

Figure 10: Components for migration

The first methodology is to move the SAS **metadata** component that leverages the partial promotion technique and includes an export from the source system and an import to the target environment. Regular tasks can be automated with the SAS Platform object framework available in SAS Foundation[18].

Guidance for developers on how to **migrate the source code** is helpful. A migration guideline with samples snippets can reduce the complexity to migrate major code items. The code must be adjusted to the grid environment by changing any single server calls to grid enabled calls. Find and replace functions of specific strings could help to automate frequent required changes in source files. Similar to the movement of the data for SAS catalogues and code, different migration methods are needed if the operating systems are different: SAS/Connect® or cport/cimport can support this task. For equal systems rsync can be used to copy the source files to the new environment.

The source and destination systems have to be **connected to the new environment.** Database connections to databases like Oracle, DB2 or file transfer methods to the target or destination system must be enabled. With the introduction of the new environment newer versions of client tools like SAS® Enterprise

[18] http://documentation.sas.com/api/docsets/bisag/9.4/content/bisag.pdf

Guide®, DI Studio are supplied and have to be installed and configured to allow the access to the new installation. Access management rights have to ordered for the users to access the target environment. Job scheduling is recommended to automate the data management and orchestrate tasks like ETL, Reporting and Analytical tasks on the central installation.

The last component, the **movement of data** is dependent on the initial situation of the environment of the enterprise. When working with different operating systems between source and target – for example Linux and Windows, cport/cimport[19] or copy via SAS/Connect®[20] is highly recommend for data movement. If the operating systems versions are equal, build in commands like rsync could be used for the migration. The data synchronization jobs are the enablement for validating the data. The validation itself can be executed with the proc compare function.

Best practices on how to orchestrate the technical approach

I. Learnings from the first migration phase could be fed back into later migration phase(s)
II. Enable migration tasks to run 24 hours, supported by automation[21]
III. Place a subject matter expert on the highest value tasks
IV. Breakdown the 'content in scope of the migration' into small individual migration subsets to allow parallel migration activities
V. Migration must run in a controlled and repeatable way
VI. Lessons learned from a playground environment (to get early contact to the application infrastructure) could decrease migration times
VII. Feedback loops on high valued tasks to automate routine(s).

MAJOR RISKS DURING THE PROJECT

The project manager has to mitigate the following risks during the project:

I. Lack of commitment from the different stakeholders
II. Lack of commitment from the business if they don't see additional value
III. Lack of knowledge within the enterprise to support the migration
IV. No budget foreseen within the different lines of the enterprise for the transformation
V. Employee unwillingness to support the change
VI. Technical dependencies that were unforeseen
VII. On time delivery and availability of suppliers
VIII. No homogenous workplace environment to provide the environment to the users.

Different techniques can be used to mitigate those risks:

I. Engage people at all levels within the enterprise. Collaboration is the key to success
II. Make sure to change the people's mind-set and let the employees be part of the change
III. The technical expert should speak the language of the organization and can lead by example
IV. Set-up of a temporary migration area 'playground' for the enterprise in order to get used to a new way of working.
V. Fail fast; test critical components upfront
VI. Plan (UAT) Test migrations and sign offs within the enterprise
VII. Create an information stream between different stakeholders with clear escalation paths
VIII. Establish a new way of working for the employee within the enterprise as some of the tasks that were formally locally executed will be centrally executed.

[19] http://documentation.sas.com/api/docsets/proc/9.4/content/proc.pdf
[20] http://documentation.sas.com/api/docsets/connref/9.4/content/connref.pdf
[21] https://support.sas.com/resources/papers/proceedings15/SAS1857-2015.pdf

CONCLUSION

The trend towards IT consolidation of SAS applications is growing. Merging applications running on independent systems into centralized systems to get hold on the data within the enterprise is essential. The application consolidation approach meets the needs and challenges of providing a sustainable and secure future infrastructure that gives the enterprise the opportunity to re-create and protect business value in existing solutions within the enterprise.

Reducing costs, optimizing business functionality by reducing complexity and increasing both performance and security are main reasons for creating the solitary application infrastructure foundation. Analytical capabilities, scalability, data movement and protection of customer data will make the enterprise future proof.

The essential building blocks for the foundation of such a platform is the availability of hardware and software with the option of using Linux as the operating system. Therefore, elements such as file transfer, network, storage, scheduling and access management have to be integrated. Requirements for building up the infrastructure and SAS configuration is based on two strategies. The infrastructure grows based on the demand of the customer and the multi tenancy approach: sharing the infrastructure between several applications for efficient use of the infrastructure.

To lead and manage the ‘change’ of the enterprise application consolidation, the enterprise has to create a project or program organization depending on the number of applications to migrate. During the application consolidation process, three layers within the enterprise should be activated: the strategic, management and operational layer. While executing the migration, the enterprise must ensure that resources involved in the project contain a diverse and broad skillset. At an IT operational level four must-have IT roles for a successful outcome of the project or program are required.

The lifecycle of the application consolidation comprises seven phases where the inventory of the required infrastructure has to be defined as a starting point. The next steps contain the deployment of the platform, the installation of the hardware, and the configuration of all the components that are essential. The next phase entails an inventory of the infrastructure landscape of the enterprise followed by the design of the migration phase. In the migration phase SAS applications will be migrated to the new environment. After the validation and cutover to the new infrastructure and achieving the milestone to replace former infrastructure with the migrated application, the project manager could start the decommissioning phase of the former servers within the enterprise.

To orchestrate the technical approach the enterprise has to adopt learnings from their first migration phase as they will feed back into later migration phases within the process. Allow parallel migration activities by breaking down the migration into small individual subsets and by placing a subject matter expert on valuable tasks. A new way of working within the enterprise has to be established as some of the tasks that were formally executed locally will from now on be centrally executed.

Engaging people at all levels within the enterprise is a must, as collaboration will be the key to success in the transformation process.

CONTACT INFORMATION

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