

Paper 475-2013

Grand Designs: Why It Pays to Think About Technical Architecture Design Before You Act

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ABSTRACT

The sustainability of a business is built not on short term objectives, but on effective planning and considered thinking. The same principle of sustainability applies for IT systems, including those leveraging technologies from SAS. Getting the best out of SAS® technology is easy once all the IT and business requirements and constraints are clearly defined, understood, and agreed upon as being testable. This paper describes the effective thinking and systematic approach that can be applied to creating a sustainable SAS® solution. The paper also outlines the advantages to this approach and describes a simple checklist that can be advantageous when designing a new SAS environment.

INTRODUCTION

The purpose of this paper is to bring into focus the crucial planning, design, and execution activities of implementing a SAS® solution within an organization. Remember, such solutions are designed to bring a level of business transformation, which leads to a more successful organization. The paper does not dive deeply into the technical aspects of SAS solutions, but instead raises the reader's awareness of key design, planning, and implementation concepts and their implications. This, in turn, provides an opportunity to facilitate dialog within the organization and between external consultants specializing in the delivery of SAS solutions.

The paper was written for a diverse audience of potential stakeholders at organizations including department managers, IT professionals, technical architects, and consultants. All such stakeholders are likely to be involved in building multi-user SAS solutions within their organizations. The information reflects practices developed at SAS, concepts discussed within frameworks such as ITIL®, TOGAF®, and the Zachman Framework™, and general technical implementation architecture practices.

In this paper, we will provide a short overview of SAS solution components, followed by a focus on technical architecture design concepts, delivering the technical architecture design, and the installation activities. (See Figure 1.) Operational management activities for the SAS solution(s) are not discussed in this paper but can be found in other SAS sponsored literature. We conclude with key points from the paper and a simple checklist to support implementing some of the concepts discussed in the paper.

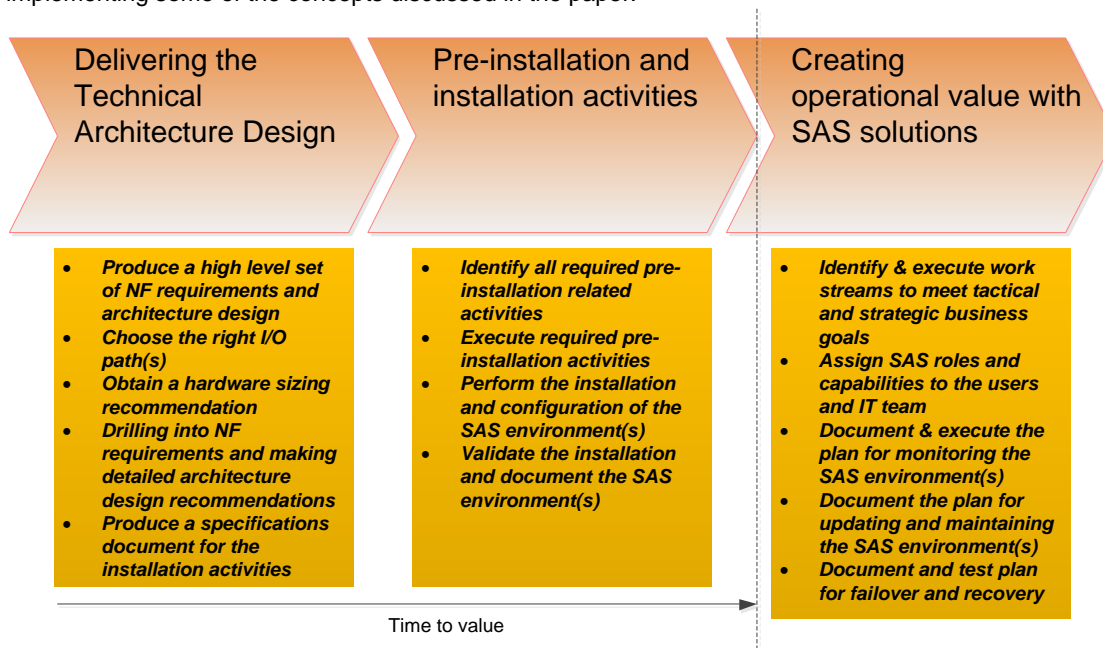


Figure 1

The key takeaways from the paper are as follows:

- Organizations that exercise effective planning and considered thinking can provide speedy time to value while also ensuring year-on-year value from their SAS solutions.
- Delivering an effective SAS solution requires SMART (Specific, Measurable, Attainable, Relevant, and Timely) non-functional (NF) requirements and constraints to be gathered and clearly stated.
- When executing SAS solution implementation projects, organizations should look to leverage specialists in the area of SAS technical architecture design and installation activities.

A BRIEF INTRODUCTION TO THE SAS® INTELLIGENCE PLATFORM AND SOLUTIONS

The SAS Intelligence Platform is a comprehensive, end-to-end infrastructure for creating, managing, and distributing enterprise intelligence. SAS offers solutions for industries such as financial services, life sciences, education, government, health care, retail, manufacturing, and utilities as well as line-of-business solutions in areas such as customer management, enterprise risk management, and financial management. In essence, the SAS Intelligence Platform and the solutions that are built on top of it provide the means by which organizations identify and target positive outcomes (such as increased sales and profit), identify statistically significant effective medicines, forecast demand for products, and target fraudulent activities.

For the remainder of this paper, any reference to SAS solutions will also infer a reference to the SAS Intelligence Platform. In addition, this paper will refer to the servers that make up the SAS Application Server as SAS compute servers to reflect the processing that takes place on those servers.

The SAS Intelligence Platform is a highly software offering whose components can be placed in a distributed manner across an organization's computing infrastructure. In recent years, SAS has added a High-Performance Analytics tier to provide enhanced velocity for organizations.

Reviewing the roles of the components of the SAS Intelligence Platform from a high-level viewpoint provides insight into your design options as you build out your computing infrastructure.

SAS® METADATA SERVER TIER

The SAS Metadata Server tier controls access to a central repository of metadata that is shared by all of the SAS applications in the deployment. The SAS Metadata Server enables centralized control so that all users access consistent and accurate data.

Features of interest include the following:

- The SAS Metadata Server provides connection and execution details that enable SAS client applications to access the processing capabilities of SAS and third-party servers.
- The SAS Metadata Server is managed through SAS® Management Console, which is the primary interface to the server and the underlying metadata repository.
- Consider implementing redundancy options as your requirements for high availability increase. Under SAS® 9.3 and previous versions, a deployment can have only a single instance of the SAS Metadata Server. (SAS® 9.4 will provide an option to install a cluster of metadata servers for a given SAS solution environment.)

SAS APPLICATION/COMPUTE SERVER TIER

SAS compute servers deliver most of the computational processing to SAS solutions. Whether it is performing ETL processing, reporting, or advanced analytics, the compute tier is where data processing takes place. For SAS solutions that incorporate the SAS® High-Performance Analytics tier, the SAS compute servers provides a pivotal role in communicating with the server and, in certain use cases, passing data to the SAS High-Performance Analytics tier.

Features of interest include the following:

- The SAS compute tier consists of four main classes of server processes to service the different types of processing requests that it receives: workspace server, OLAP server, stored process server, and pooled workspace server.
- The compute server is used to access data from RDBMS source systems. To do this, SAS components leverage RDBMS client software that will have been installed on the compute server host.

- The compute server is highly scalable, with the ability to have "N" hosts to provide load balancing capability.

SAS HIGH-PERFORMANCE ANALYTICS ENVIRONMENT

SAS High-Performance Analytics takes advantages of both software and hardware architectures to process big data using a mixture of scalability and parallelization techniques. Currently, the three main types of SAS High-Performance Analytics are SAS@ In-memory Analytics, SAS@ In-Database, and SAS@ Grid Computing. Nearly all implementations of SAS High-Performance Analytics environments contain the following SAS tiers: a metadata server, a compute server, a middle tier, and clients.

Features of interest include the following:

- The in-memory environments can leverage both commodity hardware and appliances from relational database vendors.
- SAS In-Database technologies use optimized routines to leverage the functionality within database architectures for fast execution and minimize data transfers between SAS hosts and the database.
- SAS Grid Computing lets you quickly create a managed, shared environment for processing large volumes of data and analytic programs using dynamic, resource-based load balancing and leveraging multiple symmetric multiprocessing (SMP) machines using shared physical storage.

SAS MIDDLE TIER

The middle tier of the SAS Intelligence Platform provides an environment in which the business intelligence web applications, such as SAS@ Web Report Studio and the SAS@ Information Delivery Portal, can execute. These products run in a web application server and communicate with the user by sending data to and receiving data from the user's web browser.

Features of interest include the following:

- A key element of the middle tier is SAS Remote Services. In SAS 9.3 and earlier versions of SAS solutions, SAS Remote Services runs outside of the web application server. In SAS 9.4, the functionality of SAS Remote Services will be absorbed into the web application(s).
- A number of the web-based SAS solutions provide scalability by taking advantage of clustering (both horizontal and vertical).
- Enhancements that are planned for SAS 9.4 include a new SAS Web Application Server, which will provide greater consistency for integrating solution components.

SAS CLIENT APPLICATIONS

The clients in the SAS Intelligence Platform include web-based and desktop interfaces. Using the SAS client software, end users can perform tasks ranging from accessing content to submitting queries and generating reports. A suite of client applications delivers the business intelligence functionality for information creators and consumers in an organization. Some of the desktop interfaces are native Windows applications and others are Java applications.

Key features include the following:

- Most SAS solution client applications require users' identities to be registered in the metadata server.
- Some of the SAS Java desktop interfaces rely on accessing the SAS Metadata Server via the SAS middle tier to begin the logon process.
- Many of the native Windows applications support Integrated Windows Authentication, which allows users to connect to SAS solutions without being prompted for a user name and password.

FOCUSING ON TECHNICAL ARCHITECTURE DESIGN CONCEPTS

This paper uses the following key terms in relation to implementing SAS solutions:

- *Non-functional (NF) capabilities*: This term refers to requirements and constraints describing the qualities of overall system behavior that are necessary for the effective use of the system. A portion of NF requirements are defined by one or more organizational policies or by external governance specifications.

- *Technical architecture*: This term refers to the practice of systematically addressing the NF requirements and constraints of a proposed SAS solution through a detailed understanding of SAS and third-party technologies and subsequently producing a detailed design of the system for stakeholders.

The term *stakeholders* is commonly used in business analysis to refer to “anyone who has an interest in, or may be affected by, the issue under consideration” (Paul, Yeates, and Cadle 2010).

A robust technical architecture design contributes significantly to the successful implementation of a SAS solution. This is reflected by a productive user community and an IT department that is comfortable in managing the environments over time.

Figure 2 illustrates one way to consider the technical architecture of a SAS solution. Recognition of the many pieces of the jigsaw will assist organizations in developing a robust design that helps the SAS solution deliver continuous, year-on-year value. Each of the jigsaw pieces represents a category of NF requirements and constraints that should be addressed by the technical architecture design.

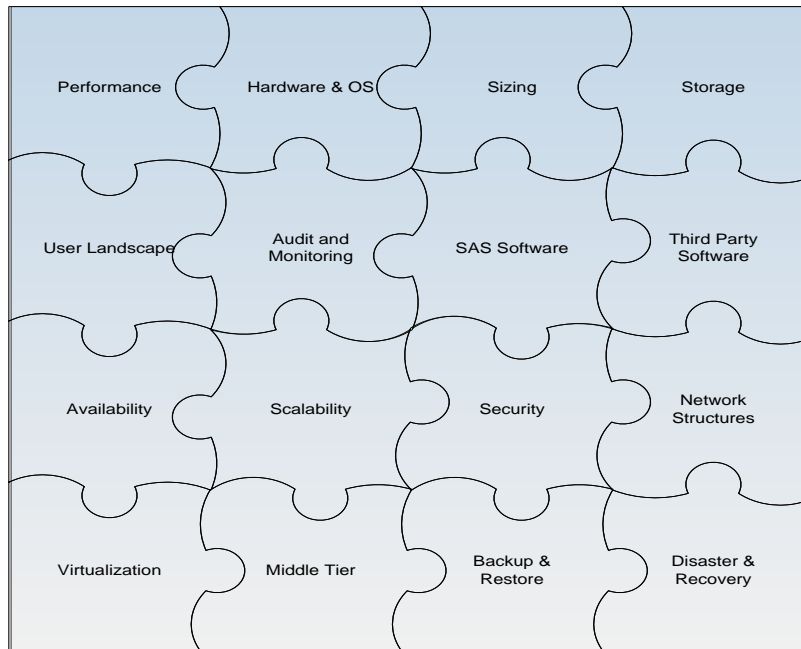


Figure 2

Here is a brief description of each of the NF requirements categories:

- *Performance*: These requirements address the need to have a responsive system for a given set of workloads. It is important to think about performance across the whole of the system and not just for the processing of data (for example, I/O characteristics, and the responsiveness of SAS web-based client applications).
- *SAS[®] software*: This category details the different components of the SAS solution and defines the specific requirements, the utility, and the supported hardware and OS platforms for each component.
- *Security*: This is a critical and broad subject covering a diverse set of factors such as authenticating users, securing metadata, securing data, and securing communications across the system.
- *Hardware and OS*: SAS software is supported on a large combination of hardware platforms and operating systems. Understanding the nuances of the relationships among them all assists in identifying optimum implementations.
- *Availability*: These requirements address the factors that provide a system-wide level of availability including both software and hardware elements. These include components that can be clustered and single points of failure. Availability is a factor in determining and agreeing on support service level agreements for the organization.

- *Sizing*: Understanding the proposed workloads provides the opportunity to size hardware resources (memory, CPUs, host, and network components of the I/O path) to ensure fit for purpose. For details, contact your SAS account manager to find out more about the SAS Enterprise Excellence Center.
- *Storage*: These requirements typically look at the type of storage that will be required. Considerations include the size of data, how fast it can be accessed, how fast data can be updated, and how reliable it is. Requirements for storage, performance, and networking tend to overlap. Where they do, it is important to consider the whole I/O path.
- *Scalability*: As the number of users and the volume of data increase over time, and key events during the business year require more processing power for activities such as producing end-of-year reports, having a scalable system to meet increased demands is critical.
- *User landscape*: These requirements describe the groups of users from a number of different viewpoints and how they map to one another (for example, business value provided, activities and tasks undertaken, SAS application usage, and geographical and time zones).
- *Audit and monitoring*: These requirements address the practical aspects of auditing usage of SAS solution(s) and monitoring SAS processes that are key to the health of the system. For more information, go to http://support.sas.com/rnd/emi/APM_main/index.html.
- *Third-party software*: These requirements provides details of the integration points between SAS and third-party software. For example, they describe how SAS leverages RDBMS client software to access data.
- *Network structures*: Network structure requirements typically define how computers can communicate with one another, how fast data is transferred, the flexibility with which users can access the system, and what failover mechanisms exist.
- *Virtualization*: A range of virtualization technologies are available. As with the requirements for hardware and OS, it is important to understand the nuances for each virtualization technology to gain an optimum configuration for the system.
- *Middle tier*: This category refers to the configuration of SAS web-based applications to meet a given number of different users' requests. Integrating with web application servers and modifying the web application properties to provide a level of required customization are typically covered in this category. Elements of performance, scalability, security, and availability contribute to this category.
- *Backup and restore*: This category refers to the backing up of key content (for example, data, metadata, and configuration files) across the distributed components of the SAS Intelligence Platform. Synchronized backup and restore methods enable systems to be restored in a timely manner.
- *Disaster and recovery*: Organizations that have business-critical systems are often required to plan for exceptional outages as part of their Continuity of Business plans. These types of requirements seek to understand what mechanisms can support the SAS Intelligence Platform being returned to a normal status in a potentially new infrastructure environment.

As you consider and document the design options for each of the jigsaw pieces, the detail is revealed and the requirements and considerations become tangible. Figure 3 provides some sample requirements and questions linked to four pieces of the jigsaw. The reader is encouraged, as a short exercise, to draw up a small number of sample requirements and questions for the other jigsaw pieces in Figure 2. The number of requirements and constraints can increase as the scale and breadth of the business needs and dependencies increase.

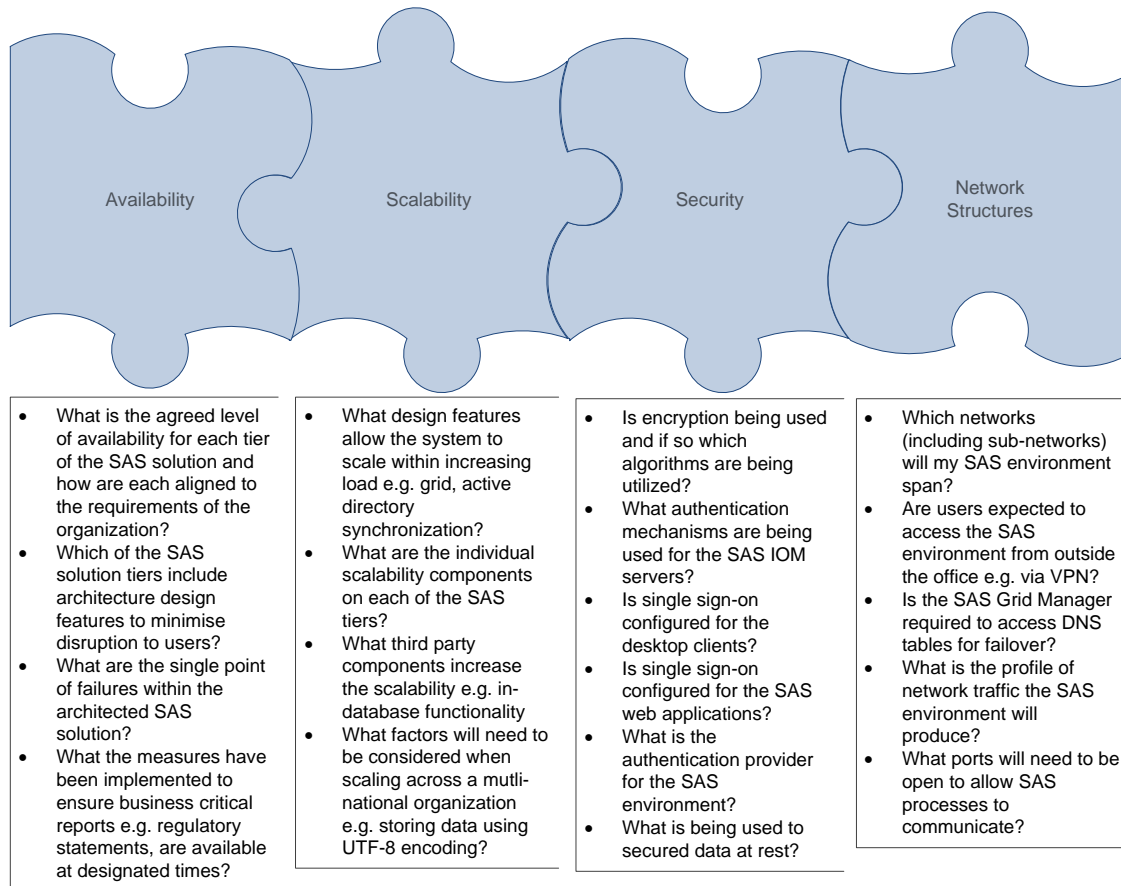


Figure 3

DELIVERING THE TECHNICAL ARCHITECTURE DESIGN

In this section, we will briefly discuss the following:

- requirements gathering
- producing a high level set of NF requirements and architecture design
- choosing the right I/O path(s)
- hardware sizing
- drilling into NF requirements and making detailed architecture design recommendations
- the installation specification document

REQUIREMENTS GATHERING

Requirements gathering is a two-way process. First, business analysts work with the organization's stakeholders to elicit requirements and constraints for both business functions and IT functions. Once the NF requirements have been validated, the technical architecture team can begin the process of designing and delivering a technical architecture design. Second, the technical architecture team puts forward an initial technical architecture design in response to the NF requirements from stakeholders. The technical architecture design will necessitate passing some NF requirements back to the stakeholders to be considered (for example, making provisions for multicast communications for the SAS solution web applications). Effectively managing the requirements from the stakeholders and the technical architecture team is critical to keeping time to value at a minimum.

Tables 1a and 1b show examples of relatively well-formed requirements ("Relatively SMART") and some ambiguous requirements ("Not-So-SMART"), respectively.

Table 1a. Relatively SMART Requirements

Relatively SMART Business Requirements		Relatively SMART IT Requirements
The system will provide 3 users with concurrent access to the source data "Gold" (CSV file) containing between 3 and 5 million records, in order to perform a frequency calculation of the categorical variable "job type" within a 2 minute real-time interval.		The server-side processes of the system will be compatible with running on the Red Hat Enterprise Linux 6.2 operating system.
The ability of staff to access reports from the system should be defined by staff membership at the departmental level.		The owners of server processes running on the system should be identifiable from their network user IDs.
The user should be able to store and retrieve data within the system using UTF-8 encoding.		User credentials being passed over the network should be encrypted using at least a 128-bit key.

Table 1b. Not-So-SMART Requirements

Not-So-SMART Business Requirements		Not-So-SMART IT Requirements
The users shall be able to delete data.		The server-side processes must be able to access the data.
All users shall be able to access all reports.		The system should be highly available.
Users should be able to access the system remotely.		The system should perform well.

HIGH-LEVEL REQUIREMENTS AND HIGH-LEVEL ARCHITECTURE DESIGN

Completing high-level architecture designs followed by more detailed architecture designs is a commonly accepted approach. It allows project teams to build up key information and share it with stakeholders. Any areas of concern can also be quickly flagged when a major requirement cannot be met.

High-level requirements and constraints and the associated high-level architecture design provide stakeholders with a glimpse of what the SAS solution will look like. The level of detail of such designs can vary, but typically they will include details of the purpose and business benefits of the solution, the SAS software being used, third-party software such as operating systems (UNIX, Z/OS, Linux, Windows) and web application servers, a reference to any source data systems, the different types of users, and some key statements concerning security, performance, scalability, and availability. The high-level designs do not usually provide a great amount detail concerning the final solution and how to implement each element of the solution.

Here are some examples of high-level requirements:

- The system should be supported on Windows platforms.
- The web-based reporting application is required to meet the demands of no more than 50 users.
- The system should provide single sign-on mechanisms for client applications.
- The system should provide Read and Write access to "X" RDBMS.

CHOOSE THE RIGHT I/O PATH(S)

An inherent strength of the SAS solution technology is the ability to process very large data effectively, and this capability has continued to grow over time. Even before the term "big data" was coined, SAS had been relied upon to crunch wide and deep data, such as financial transactions and census data. Fast processing of the data requires the following:

- an understanding the I/O paths to identify areas of strengths and potential bottlenecks

- an understanding of the SAS workloads that will leverage the I/O paths

Understanding the I/O path hardware and software components is crucial to obtaining the throughput required. The organization's storage and network subject matter experts will be able to play a key role in articulating the potential performance behavior of the I/O path. The following table lists the major hardware components along the I/O path (Farley 2004).

Table 2. The I/O Path

Host server system hardware components	Processors, memory, memory bus, I/O bus, network interface
Storage subsystem hardware components	Network interface, storage controller, cache memory, subsystem bus/network, storage device, storage media
Network hardware components	Network hardware components: Network media, port hardware, buffer system, switch core

SAS has produced a number of papers detailing how best to leverage the I/O path for a given set of workloads. The very insightful paper "Best Practices for Configuring your IO Subsystem for SAS®9 Applications," which is available at <http://support.sas.com/rnd/papers/sgf07/sgf2007-iosubsystem.pdf>, describes workload examples and SAS I/O characteristics and identifies improvements at both a software and hardware level (Crevar and Brown 2011). Readers are encouraged to access the paper and to visit <http://support.sas.com/rnd/scalability/index.html>.

The following are examples of key topics that are covered in the IO Subsystem paper:

- the major types of SAS workloads
- how SAS processes leverage the I/O path
- the benefits of specifying different file systems
- local versus shared file systems
- correcting performance issues

HARDWARE SIZING

At some point during the high-level and/or the detailed architecture design, the hardware sizing activities will take place. The hardware sizing activity is a crucial contributor to the success of the implementation of the SAS software. It gives recommendations of hardware configurations based on a number of key parameters such as the type of SAS processing activities, the size of data, the numbers of users, the number of concurrent users across different parts of the SAS solution, and the organization's preferred operating systems. The greater the level of detail provided during the hardware sizing activity, the firmer the information on which the recommendations can be made. Since any sizing activity should reflect the need for the system to remain robust over a period of "x" years, the final sizing recommendation reflects rates of growth for key parameters such as the number of concurrent users and the size of data. For more details about obtaining sizing recommendations from SAS, please contact your SAS account manager and ask for information about the SAS Enterprise Excellence Center.

DRILLING INTO NF REQUIREMENTS AND MAKING DETAILED ARCHITECTURE DESIGN RECOMMENDATIONS

Having a high-level set of requirements and design to work from, it is then possible to begin the work of collecting the detailed NF requirements and constraints in order to complete the final and detailed architecture design.

Collecting the detailed requirements requires individuals who have strong skill sets in the areas of business analysis, technical architecture (focused around SAS solutions), source data systems, third-party software, and physical infrastructure such as servers, storage, and networking. Using collaborative workshops as a method to elicit the NF requirements is a tried and tested approach to quickly obtain information and validate the information..

Here are some examples of detailed NF requirements:

- The system should be supported on Windows 2008 Enterprise R2 x64.
- SAS Web Report Studio is required to scale in a horizontal cluster in order to load balance the expected concurrent user demand of 75 users.
- The system is required to authenticate all users via Microsoft® Active Directory™.

The detailed NF requirements and constraints can then be mapped to the NF categories and the affected SAS tiers. This mapping allows the stakeholders to quickly determine if there are gaps or overlaps. The following table provides a simplified example of detailed requirements, a design recommendation, and the scope of the recommendation.

Table 3. Example of Mapping Requirements to Technical Architecture Design Considerations

			SAS Solution and Third-Party Tiers					
			Key: MS = Metadata Server, CS = Compute Server, MT = Middle Tier, RDBMS = Relational Database, SD = Storage Device, C = Clients					
Requirement or Constraint	Non-Functional Categories	Design Recommendation(s)	MS	CS	MT	RDBMS	SD	C
All server host machines will use the Intel X64 processor architecture.	Hardware and Operating System	The SAS software order will reflect the 64-bit processor architecture.	✓	✓	✓	N/A	N/A	N/A
The operating system for each host must be based on the Microsoft® Server 64-bit operating system.	Hardware and Operating System	Use the Microsoft® Windows® 2008 Enterprise R2 x64 operating system, as this is supported by SAS on all tiers of this SAS solution. Referenced from: http://support.sas.com/documentation/installcenter/en/ikbientsrvofrsr/64739/HTML/default/index.html	✓	✓	✓	N/A	N/A	N/A
The WebDAV content will be required to service 1000+ SAS Web Report Studio users across the business.	Scalability, Third-Party Software, Middle Tier, Availability	<ul style="list-style-type: none"> The SAS® Content Server will store content within a scalable repository such as the existing RDBMS "X," which also provides inherent availability benefits. The SAS Content Server will be clustered across 2 different server host machines. A jdbc connection will be used to connect the SAS Content Server to the RDBMS "X." 	N/A	N/A	✓	✓	N/A	N/A
The temporary SAS files will not be shared by other processes/users.	Performance, User Landscape, Storage	The SASWORK directories will be placed on a non-shared file system to maximize performance.	N/A	✓	N/A	N/A	✓	N/A

			SAS Solution and Third-Party Tiers					
			Key: MS = Metadata Server, CS = Compute Server, MT = Middle Tier, RDBMS = Relational Database, SD = Storage Device, C = Clients					
Requirement or Constraint	Non-Functional Categories	Design Recommendation(s)	MS	CS	MT	RDBMS	SD	C
The middle tier environment will be distributed across multiple physical server host machines to maximize performance and availability.	Middle Tier, Performance, Availability, Scalability, Networking,	<ul style="list-style-type: none"> The SAS web applications will be distributed across 5 server host machines. SAS Remote Services will be placed on a dedicated server host machine. The TTL value for the multicast setting will be set to 1. 	N/A	N/A	✓	N/A	N/A	N/A

Once a list of detailed design recommendations has been provided, it is possible to create a detailed architecture design document.

The detailed architecture design document will contain the following:

- a link to (or references to) the detailed requirements document
- the detailed design recommendations
- a collection of stakeholder views that reflect in a concise manner (for example, through a graphical representation) the detailed design recommendations grouped by the NF categories

As previously defined, a stakeholder is “anyone who has an interest in, or may be affected by, the issue under consideration” (Paul, Yeates, and Cadle 2010). In the context of this paper, stakeholder views are documents that describe in words and/or pictures one or more elements of the SAS solution, such as the software, user community, IT integration points, and I/O path(s). The use of stakeholder views provides the following benefits:

- The stakeholder is able to make and support decisions based on clear and unambiguous information.
- The stakeholder views provide value from the technical architecture design phase through the providing of support for the SAS solution when it has entered into service.

Figures 4 and 5 are examples of stakeholder views used for SAS® Visual Analytics.

SAS Visual Analytics 6.1 HDFS, SAS Enterprise BI Server and SAS DI Server

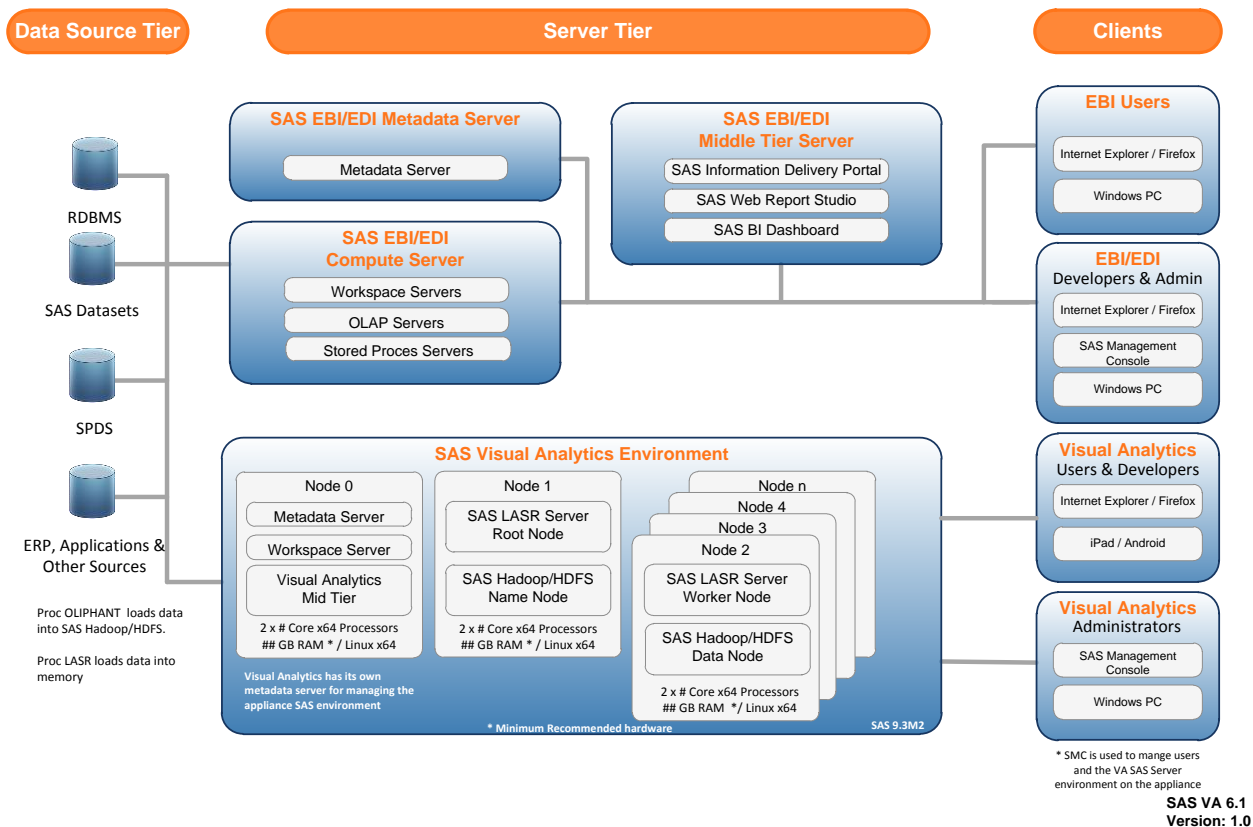


Figure 4. An Example of a Stakeholder View of the SAS Solution Tiers and Components

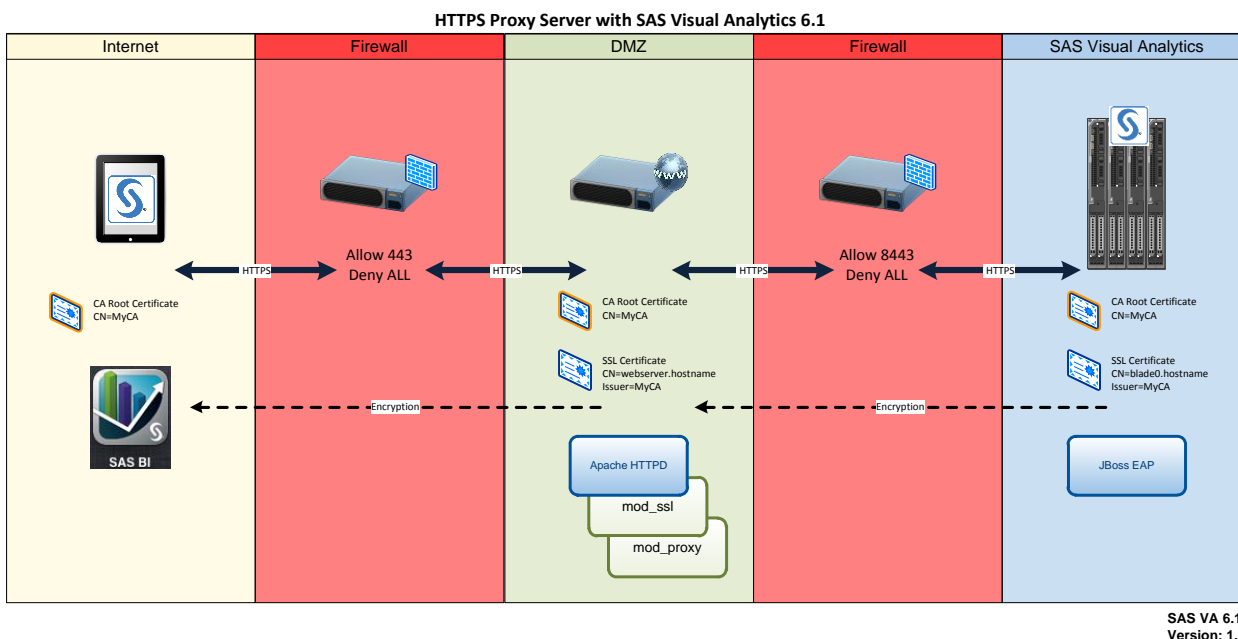


Figure 5. An Example of a Stakeholder View Focusing on Secured Access to SAS Reports

THE INSTALLATION SPECIFICATION DOCUMENT

Once the final detailed architecture designs have been produced and the organization's stakeholders have signed them off as complete and fit for purpose, it will then be possible to produce an installation specification document. The installation specification document provides the following benefits:

- Each step of the installation has been planned so that mistakes can be minimized.
- The organization has the opportunity to identify potential problems prior to the install.
- The installation of additional near-identical environments can be repeated in a straightforward manner.

This document will provide the following:

- a mirroring of a portion of the detailed architecture design decisions
- detailed information for the person tasked with installing the SAS software and potentially third-party software
- an opportunity to deliver a working set of SAS environments in an efficient and repeatable manner

The installation specification document provides details for each of the SAS tiers and related components for each SAS solution environment. The following list highlights a sample of the specifications:

- the location in which the SAS Software Depot is to be stored
- the name and location of the SAS Deployment Plan file (plan.xml)
- the methods and location of documents to perform the validation of the installed environment(s)
- the full path of the location in which to install the SAS binaries for each server host machine
- the full path of the location in which to place the SAS configuration directory for each server host machine
- the user names and passwords for required external and internal accounts for SAS and third-party software (for example, the account to install the SAS solution)
- short names/aliases for server host machines
- fully qualified domain names for each server host machine
- the authentication mechanisms to be integrated with and the configuration information
- multicast settings for web applications
- the port numbers to be used for all of the SAS software and required third-party software
- the decision whether to set up a SAS Unicode Server and UTF-8 encoding, and the level and type of any encryption to be used
- manual changes to settings that can be performed only after the initial installation and configuration (for example, defining the path of SASWORK)

Creating an installation specification document requires in-depth knowledge of the SAS solutions to be implemented. Much of the information can be found by referring to the relevant installation and administration guides, by referring to information in the SAS Deployment Plan packages, and by running the SAS@Deployment Wizard in record mode only.

PRE-INSTALLATION AND INSTALLATION ACTIVITIES

Once the pre-installation and installation activities have been completed, there will be one or more fully functioning SAS environments that will be in a state to receive users from the organization. At this point, the time to value will have arrived.

In this section, we will briefly discuss the following topics:

- identifying required pre-installation activities
- executing the required pre-installation activities
- performing the installation and configuration of the SAS environment(s)
- validating and documenting the SAS environment(s)

IDENTIFY REQUIRED PRE-INSTALLATION ACTIVITIES

Below is a summarized list of activities that will help organizations quickly identify pre-installation activities. The activities in this list will be relevant for SAS 9.4. To become familiar with core concepts, customers who are new to SAS or who have yet to deploy a multi-machine environment are strongly encouraged to read the *SAS Intelligence Platform Installation and Configuration Guide* for SAS 9.3 or 9.4 .

1. Review the latest information in the *SAS Intelligence Platform Installation and Configuration Guide* for SAS 9.3 or 9.4, and contact SAS Technical Support for any additional documentation that might be relevant to your specific SAS solution(s).
2. Share the SAS Software Order E-mail with members of the implementation team so that they can verify that it contains the expected SAS solution technology.
3. The implementation team will need to create directory structures on a shared network storage system to store the following:
 - a. the SAS Software Depot
 - b. third-party software
 - c. a resources directory in which to store the software order e-mail, all supporting documentation, and the SAS Deployment Plan Package(s)
4. Download the SAS Software Depot.
5. In order to determine the required detailed pre-installation activities, the individuals tasked with installing the software will need to access the relevant SAS Deployment Plan package and the latest systems requirement information.
 - a. Use a standard or custom SAS Deployment Plan package to reflect the software topology stakeholder view within the detailed architecture design document.
 - b. Standard Deployment Plan packages can be found at http://support.sas.com/demosdownloads/sysdep_t6.jsp?packageID=000803. For a custom SAS Deployment Plan package, please contact your SAS account manager.
 - c. The SAS Deployment Plan contains the pre-installation checklist.
 - d. System requirements information for the organization's specific SAS solutions can be found here: <http://support.sas.com/resources/sysreq/>.

EXECUTE REQUIRED PRE-INSTALLATION ACTIVITIES

The following list includes pre-installation tasks that are frequently required when installing a SAS solution. The number and types of activities for a given installation depends on the host operating systems, hardware platforms, third-party software, and which SAS solutions are being installed.

- Ensure that the underlying operating system is at the correct version number and that all relevant components or packages are installed.
- Add a small number of SAS administrative users and groups at the OS level.
- Ensure that all ports outlined in the pre-installation checklist documents are available for use by the SAS solution.
- Install third-party software on the compute tier (for example, RDBMS client software and JUnit).
- Install third-party software on the middle tier (for example, Java Development Kit, JUnit, and web application servers such as JBoss).
- Request in advance that anti-virus software be temporarily switched off on the host during the course of the installation.

PERFORM THE INSTALLATION AND CONFIGURATION OF THE SAS ENVIRONMENT(S)

Using the SAS Deployment Wizard interface to install a SAS solution is a straightforward task if the installer is clear about the responses to provide for each prompt. The following list outlines the key factors to consider when installing and configuring the SAS solution:

- Remember to use the installation specification document.
- Perform the installation using a dedicated installation account. (On UNIX or Linux accounts, this should not be the root account.)
- For multi-machine implementations, ensure that the installation and configuration steps are followed in the correct order. For more information, inspect the "deploymentSteps_text.htm" document, which can be found in the SAS Deployment Plan package.
- Use the record facility to capture the prompts and responses. (See the *SAS Intelligence Platform Installation and Configuration Guide* for more details.)
- If time is a limiting factor, consider dividing the installation into separate tasks, as follows:
 - For the first run of the SAS Deployment Wizard, only install the SAS solution software.

- For the second run of the SAS Deployment Wizard, use the record facility to record only the configuration element of the SAS solution configuration.
- For the third run of the SAS Deployment Wizard, use the deploy facility in "quiet mode" to execute the configuration of the SAS solution. (This last step can be run without any prompts to the user.)

VALIDATE THE INSTALLATION AND DOCUMENT THE SAS ENVIRONMENT(S)

Wrapping up the installation phase requires the installed SAS environment to be validated and subsequently documented. The validation of the installation has an important purpose: to ensure that the SAS solution environment's integration points are correctly defined and that the required SAS servers are available for workloads. This provides the relevant stakeholders with confidence that they are now at the "time to value" phase. Further tests to validate NF qualities of the system, such as I/O throughput and availability, can be performed shortly thereafter using the organization's data.

The key attributes of an effective validation of the installation are as follows:

- Leverage the best practice of setting up the SAS First User Account (typically referred to as sademo) to provide a user account for performing the validation activities.
- Thoroughly read the Instructions.html file and perform any server-related testing activities that it specifies.
- Use data that is provided with the SAS solution as the basis of the validation of your SAS client applications. Since the data is already in SAS format, this speeds up the process and mitigates any risks of accessing source data that might not be accessible due to issues outside the SAS environment.
- Ensure that the validation steps are repeatable and documented. This will be helpful if you have multiple SAS environments and if there is a requirement to troubleshoot any issues arising within the SAS solution.
- Test each SAS client application's core functionality in a defined order, and reuse the content between the applications.

Documenting the SAS solution environments is important because it provides the basis for a document that can be used for administration and technical support. The document is likely to reflect many of the installation specification entries and other important details, such as modifications to SAS configuration files.

The key attributes of effective documentation of the installation are as follows:

- As with the detailed architecture design document, the document should include stakeholder views (graphical representations) to assist the reader's understanding of the configured SAS solution environment.
- Properties for server host machines should be explained in terms of the SAS tiers that have been installed and configured on them.
- For each server host machine, several artifacts should be documented including the names of SAS services or daemons running on the host, the port numbers used by SAS processes, the location of software binaries, and identification of configuration files.
- Details of key configured items (such as the authentication mechanisms and the location of the default SASWORK library) should be clearly stated.

CONCLUDING REMARKS

Throughout this paper, the subject areas of requirements gathering and technical architecture design have been discussed at a high level, and a sprinkling of technical detail has been applied when providing examples. These subjects, when leveraged effectively, can contribute significantly to business transformation projects. To close the paper, two summarized items of interest are provided to support readers and their organizations as they embark on implementing a new or extended set of SAS solutions.

The first item is short checklist of items, activities, and due diligence that can speed up the "time to value" and minimize implementation risk.

The second item, Table 5, identifies observable behaviors and actions to support a view of the SAS solution providing long-term value and return on investment (ROI) to the organization.

CHECKLIST OF TECHNICAL ARCHITECTURE DESIGN AND INSTALLATION ACTIVITIES

1. Gather, manage, and document SMART requirements and constraints at the early stages of the project from all stakeholders within the organization.
2. Ensure that the services of subject matter expert(s) with the specified SAS domain knowledge are available to the project team to complete a documented detailed architecture design. There are several knowledge domain areas for SAS solutions, including Base SAS® programming, predictive modeling, administration, and warehousing. In building a new SAS solution or upgrading an existing one, it is highly recommended to leverage a subject matter expert in the area of SAS technical architecture design. Speak with your SAS account manager to discuss how SAS Professional Services and recognized partners can assist.
3. Once enough SMART NF requirements and constraints have been identified, obtain a sizing recommendation for the hardware required to power the SAS solution effectively. The sizing should be performed for all server host machines (and therefore all SAS server tiers) within the SAS solution. For more details about how SAS can provide sizing recommendations, please contact your SAS account manager and ask for more information about the SAS Enterprise Excellence Center.
4. Understand and test the capabilities of the I/O path(s) prior to installing any SAS technology. Subject matter experts in storage and networking technologies within the organization, as well as hardware vendors, will be able to provide input. As of early 2013, an I/O throughput of 100 MB/s per CPU core is recommended for SAS solutions. Regular testing of the I/O throughput independently of the SAS solution technology is encouraged.
5. Leverage the information and references to papers for performance and scalability. See <http://support.sas.com/rnd/scalability/index.html>.
6. Leverage the latest information from the SAS Intelligence Platform documentation area prior to installation of the SAS solution. See <http://support.sas.com/documentation/onlinedoc/intellplatform/index.html>.
7. Leverage the administrator services provided prior to installation of the SAS solution. See <http://support.sas.com/adminservices/>.
8. Ensure that the pre-installation activities are completed using the latest system requirements information from <http://support.sas.com/resources/sysreq/>. The Pre-Installation Checklist aligned to the Deployment Plan package for your SAS solution (Standard Deployment Plan packages) can be found at http://support.sas.com/demosdownloads/sysdep_t6.jsp?packageID=000803.
9. Ensure that a newly installed SAS solution is validated in terms of the integration points and that the SAS client applications are used as part of the testing. Contact SAS Technical Support for more information. See <https://support.sas.com/>.
10. Provide clear documentation of the SAS solution environment(s) so that the documentation can be used to effectively maintain the environment(s) over time.

Table 4 – Identification of Positive Traits That Support Long-Term Business Value

Key Technical Architecture and Operational Considerations	Behaviors and Actions That Support Long-Term value and ROI
Technical architecture design	<ul style="list-style-type: none"> • Functional and non-functional requirements, along with constraints, are in SMART format and are clearly documented. • All stakeholders have been identified, and the necessary stakeholder views provide relevant detail in easily consumable documents. • The final technical architecture design reflects the requirements and constraints and is a direct input to the other work streams that will follow. • The business process activities can be mapped to the tasks undertaken within one or more SAS client applications. • Sizing of the computing machines hosting the SAS platform has been undertaken by the SAS Enterprise Excellence Center. • A lifecycle and/or roadmap for the SAS platform has been defined, to include some or all of the following: increase in the numbers of users and size of data, updates, upgrades, and migration. <p>Bottom line: The SAS platform design for the given business users and IT team will be fit for purpose.</p>
Execution of pre-installation and installation tasks	<ul style="list-style-type: none"> • The installation specifications are consistent with the architecture design decisions. • Pre-installation tasks are completed in a thorough and testable manner by the IT team. • The installation of the SAS platform is completed in a short time frame with the use of repeatable validation techniques. • All components of the SAS platform environment(s) are documented in a manner that enables all stakeholders to obtain assurances and identify future improvements. <p>Bottom line: The time taken for the initial system to be available for business use is optimized.</p>
Administration of the SAS platform	<ul style="list-style-type: none"> • Members of the user community and IT departments are assigned administrator roles and capabilities to ensure the smooth running of the SAS Intelligence Platform. • Considerations for migration to the next version of the SAS solution reflect the needs of the business users and IT functions, and SAS representatives are consulted to provide up-to-date details. • Auditing and performance monitoring provide the necessary information when required to make informed decisions on implementing any possible changes. <p>Bottom line: The SAS platform runs smoothly and it is business as usual for any given day.</p>
Security	<ul style="list-style-type: none"> • Users are authenticated via a single security repository wherever possible. • Integration of all SAS platform integration points via security mechanisms is documented (for example, metadata, data, network communications, OS level, and middle tier). <p>Bottom line: Security is effective, wide ranging, and centrally maintained.</p>

Key Technical Architecture and Operational Considerations	Behaviors and Actions That Support Long-Term value and ROI
Performance	<ul style="list-style-type: none"> • The processing of data is described in terms of the I/O path(s). • Throughput of the I/O path can be demonstrated externally to the SAS applications. • The minimum I/O throughput of 100MB/s per CPU core (recommended as of February 2013) for each of the computing nodes has been demonstrated. • The types of processing and the types of SAS workloads (for example, combining data, predictive modeling) can be understood in terms of the potential use of computing resources. • Baseline performance underpinning the SAS solution is clearly documented. • Requests for resources across the SAS solution are load balanced and can be prioritized to meet the needs of the business. • Performance metrics are monitored over time and bottlenecks are predicted ahead of time. <p>Bottom line: Performance of the SAS platform consistently meets the needs of the business.</p>
Availability of the SAS platform	<ul style="list-style-type: none"> • Software (such as SAS Grid Manager) is used to enable high availability. • Hardware is configured to provide a level of redundancy. • Single points of failure are documented and measures are in place to deal with them. <p>Bottom line: The SAS platform is open for business in a predictable manner.</p>
Recovery from planned or unexpected outages	<ul style="list-style-type: none"> • Outage scenarios and their impact, are aligned to business activities and recovery actions documented. • All content required by the SAS solution are backed up in synchronous and scheduled fashion. • Alternative procedures to deliver regulatory materials on time during an expected outage period should be documented. • Two or more levels (e.g. production, test and development) of the SAS Platform environment exist to enable change management practices. • Updates to the SAS Platform and any third party dependencies are planned ahead of time. • A process exists to both identify and apply business critical hot fixes in an expedited manner is documented. <p>Bottom line: Internal and external factors which impact the system are identified and controlled in a way that minimises impact to the business operations.</p>

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RECOMMENDED READING

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- SAS Intelligence Platform administration guides. Available at <http://support.sas.com/documentation/onlinedoc/intellplatform/index.html>.

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