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SAS Architecture Plan
Viya 4 Platform

Prepared for
Standard Bank

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Status: Draft for review
Date: 14 October 2022

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Notices

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Revision History

Version	By	Date	Summary of change
0.1	Rajesh Soma	02-09-2021	Draft – for review
0.2	Rajesh Soma	07-09-2021	Updated Draft
0.3	Rajesh Soma	16-09-2021	Updated Draft
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2.1	Jeremia Mtimunye	29-09-2022	Draft – Updated node classes
2.2	Jeremia Mtimunye	10-10-2022	Draft – Updated diagrams and Node Pool Details

Version	By	Date	Summary of change
2.3	Shane Empey	14-10-2022	Cosmetic updates
2.4	Shane Empey	19-10-2022	Update version of Kubernetes

Documentation Acceptance

Recipient	Title / Role	Organisation
Emmanuel Mdhluli	Platform Owner – SAS	SBSA

Meetings and Workshops

The following table lists the various meetings and workshops held to support the preparation of this document.

Venue / Location	Date	Subject
MS Teams	Weekly	SBSA SAS Viya
MS Teams	12-09-2022	Production Kick-Off
MS Teams	13-09-2022	SBSA - Architecture Workshop 1
MS Teams	21-09-2022	SBSA - Architecture Workshop 2
Call between Jeremia & Tumelo	26-09-2022	SBSA – Architecture: HA, CAS & Compute
Discussion Between Jeremia, Shane and Gavin	10-10-2022	SBSA – Architecture: HA, CAS & Compute

1 Introduction

Standard Bank South Africa (SBSA) have engaged SAS Institute ("SAS") to produce a design for the installation of SAS software (SAS Visual Analytics and SAS Visual Machine Learning) in Microsoft Azure cloud services.

To add context, the following provides a high-level description of the scenario:

- SBSA has an on-premises SAS9.4 M7 grid platform.

- SBSA has upgrade the existing version of the SAS Viya software purchased, from SAS Viya3.5 to SAS Viya4.

- This is the first SAS Viya deployment at SBSA, which includes both PreProd and Production environment. Pre-Production has been deployed already as of September 30th, 2022.

- The SAS Viya software will be deployed on the MS Azure cloud infrastructure.

- The corporate network is connected to their Azure subscription using an ExpressRoute connection.

- The environment will use Azure Active Directory for SAS Identities.

- TLS encryption is required.

- The customer TLS certificate will be used for all secure connection.

- Encryption of data at rest is not required.

- An ARM template will be used to build a dedicated AKS Cluster for Viya in the SBSA Azure subscription.

- A separate AKS cluster will be used for each Viya Environment.

- The default workload classes will be used in Pre-Production.

- Production will use a new configuration on workload classes which removes connect class and combines stateless and stateful services classes.

- A Jump host will be provided for administration.

- See more in the requirements and architectural decisions.

1.1 Purpose

The purpose of this document is to specify the solution architecture for the SBSA Viya 4 platform based on workshops and discussions with SAS, SBSA and Microsoft stakeholders. A

solution architecture is a high-level description of how the SAS Viya platform will be deployed to meet SBSA's requirements.

This document is a deliverable in SAS Professional Services' Intelligence Platform Implementation (IPI) Methodology.

The document contains information that can be used to understand:

- SAS and any SAS distributed third-party to be installed.

- The recommended installation design to support the requirements.

- The recommended architecture and hardware/infrastructure for the installation.

- The various environments to be installed.

This design document will form the basis for preparing the required infrastructure to support the SAS software installation and implementation activities.

Terms and definitions used in this document are explained in Appendix B

1.2 Method and Approach

Prior to the delivery of this document, SAS consultants met with relevant representatives at SBSA and Microsoft and worked through a series of workshops and meetings to finalize the requirements and the specific deployment aspects.

The following table lists the participants and stakeholders in this design exercise.

Table 1. Stakeholders

Name	Role	Organisation
Emmanuel Mdhluli	Platform Owner - SAS	SBSA
Tumelo Moiloanyane	SAS Administrator	SBSA
Kim Chetty	SBSA Security	SBSA
Donovan White	Snr. Cloud Solution Architect	Microsoft
Gerhard Coetzee		Microsoft
Andre Mills		Microsoft
Warren du Toit		Microsoft
Gavin Hindman	Solution Architect	SAS
Rajesh Soma	Technical Architect	SAS
Shane Empey	Technical Architect	SAS
Jeremia Mtimunye	Technical Architect	SAS

1.3 Document Scope

This document covers the technical architecture design for the SAS Viya software deployment on Kubernetes, including any infrastructure requirements and dependencies on third party applications and services. It validates suitability for a baseline installation but does not examine whether the resulting SAS environment(s) will have any performance characteristics and has not explored any details of the planned workload.

The key aspects relating to the design are summarized below.

1.3.1 In-scope

The following items are within scope of this document:

- Architecture and installation design for SAS software (listed in Section 3) based on the identified requirements and decisions between SBSA, Microsoft and SAS.

- SAS software component details.

- Detailed specification of the SAS configuration.

- Storage details for the SAS Viya environment.

- Network configuration related to the SAS Viya environment.

- Security details for the SAS platform, the base platform configuration.

- Source data systems and databases to be integrated to the platform.

- Design and implementation of any Disaster Recovery (DR) environment or processes for Production Only.

1.3.2 Out-of-Scope

The following items are out-of-scope for this document and the installation services:

- A detailed requirement gathering process and documentation.

- The business design, process data or model requirements.

- This document does not cover detailed security requirements and design considerations, in particular aspects related to content and process authorizations (definition of permissions).

- This document does not provide any formal sizing recommendation on hardware capacity required to support planned usage. Capacity planning and on-going monitoring is recommended to ensure the system is running optimally given changes to increased users, usage and data volumes over time.

- Hardware, Cloud Provider resources and other manufacturers are referred to for indicative purposes only, and not to be construed as a recommendation or endorsement by SAS.

2 Requirements Summary

The following sections capture the requirements that affect the deployment and installation of the SAS software. This is not intended to be the definitive reference or a complete list of the Viya4 Platform requirements. There may be other requirements captured in SBSA documentation that are beyond the scope the SAS services.

2.1 Environments

The following SAS Viya 4 environment will be built:

- SBSA Pre-Prod Environment
  The SAS Visual Data Science solution plus Risk Modelling Add-on software will be used for the SAS Viya Pre-Prod (environment).

- SBSA Production Environment
  The SAS Visual Data Science solution plus Risk Modelling Add-on software will be used for the SAS Viya Production (environment).

2.2 Availability and Recovery Requirements

Pre-Prod

There is no HA requirement for the SAS Pre-Prod environment.

See decision AD013 for details of the decision relating to the HA requirements.

No disaster recovery (DR) requirements have been specified for the SAS Pre-Prod environment, and no dedicated DR or standby environments will be implemented.

SAS licensing permits a cold recovery environment being maintained, as long as no SAS processing occurs on that environment whilst the environment is active.

SBSA will develop and test backup and recovery procedures for the SAS platform, based on their IT standards and server backup policies.

Production

There is an HA requirement for the SAS Production environment.

See decision AD013 for details of the decision relating to the HA requirements.

Disaster recovery (DR) requirements have been specified for the SAS Production environment only. Cold DR to be designed.

SAS licensing permits a cold recovery environment being maintained, as long as no SAS processing occurs on that environment whilst the environment is active.

SBSA will develop and test backup and recovery procedures for the SAS platform, based on their IT standards and server backup policies.

2.3 Security requirements

The following security requirements have been defined.

2.3.1 User Authentication

The following authentication requirements have been identified:

- All users must authenticate using their SBSA credentials (username & password).
- Open ID connect was used for authentication in Pre-Prod.
- SAML is recommended for authentication in Production.
- Azure Active Directory (AAD) will be used as a service provider for SAML/OpenID Connect.

2.3.2 Users, Groups, and Identities

The existing processes will be used for user and group management. The SBSA Active Directory is the definitive source for identity information. Active Directory is currently synchronized with Azure AD.

- Identities will be pulled from Azure Active Directory (AAD). If this configuration does not meet the requirement, we will move on to alternative configuration of pushing identities from a SCIM client.
- LDAPS will be used to import SBSA users and groups into the SAS environment.

2.3.3 Encryption

Encryption in motion is supported on all network communications and it is configured by default.

The following encryption requirements have been identified:

- TLS (SSL) encryption must be used to secure all end-user environment access.

- The SBSA Certificate Authority (CA) will be used to provide TLS certificates for platform access. The Ingress access will use the SBSA certificate.

- SBSA will provide certificates for all internal network sessions. (Session traffic internal to the Viya platform).

2.4 Batch Processing Requirements

The batch processing requirements and processes will be implemented after the SAS environments have been built. The definition of any batch processes it beyond the scope of this document.

2.5 User Community and Workloads

The SAS environment(s) will be supporting the following users.

Table 2. User community summary

Environment	User Group	User population
SBSA Viya Pre-Prod	SAS Users	685
SBSA Viya Production	SAS Users	685

3 Software Information

This section details the SAS software that will be installed and configured.

In addition to the SAS software, third-party software is required to support the running and operation of the SAS environment(s), both on the servers and client workstations. An example of these products are browsers and database clients.

It is SBSA's responsibility to procure and install these products prior to the commencement of the SAS installation. A list of the required third-party software products is provided below.

3.1 SAS Viya Products

Table 3 lists the SAS software and versions to be installed. The SAS Viya software is provided in two different cadence versions:

- Stable – ships as monthly version releases and has a support window of 4 months. Being the current Stable version and three previous versions

- Long-Term Support (LTS) – ships as 6 monthly version releases and has a support window of 2 years. Being the current LTS version and three previous versions.

- Pre-Prod was deployed using Stable version. It will be changed to LTS in the future.

- Production to be on latest LTS.

Table 3 SAS Software

Products	Cadence / Version
SAS Visual Data Science - Solution (contain SAS Products below)	Stable or LTS
SAS Visual Analytics (on SAS Viya) SAS/ACCESS Products (on SAS Viya) SAS Data Preparation - includes all of SAS Data Quality SAS Studio Analyst SAS Information Governance SAS Job Flow Scheduler (on SAS Viya) SAS/CONNECT SAS Econometrics SAS Optimization SAS IML SAS/QC (on SAS Viya) SAS Visual Forecasting SAS Visual Statistics (on SAS Viya) SAS Visual Data Mining and Machine Learning SAS Model Manager (on SAS Viya)	Stable / 2021.1.5 (Pre-Production) LTS 2022.01 (Production)

Products	Cadence / Version
SAS Visual Text Analytics optional SAS Text Analytics	
Risk Modelling Add-on	

3.2 Third-Party Software Products

This section provides the details of the required third-party software and versions to be installed. This information including version information is correct and up to date at time of writing this report.

Additional 3rd party software may be required such as Adobe Acrobat Reader to view PDF documents or printer driver software to print documents. These are assumed to be installed and provisioned as part of SBSA's standard operating environment.

The term "SAS provided" below denotes SAS sourcing, downloading and installing the relevant software on the server or client workstation. "Customer Provided" denotes software to be sourced and installed on machines prior to SAS software installation by SBSA personnel.

Table 4 details the required software to run the SAS Viya software.

Table 4 Required 3rd-Party Software

Product	Version	SAS Provided or Customer Provided
Kubernetes	Microsoft Azure Kubernetes Service (AKS) 1.22.15	Customer Provided
Kustomize	3.7.0	Customer Provided
Nginx Ingress Controller	3.9.0	Customer Provided
cert-manager	1.1.0 or later	Customer Provided
kubectl	1.18.8	Customer Provided

3.2.1 Viya 4 Deployment Tool Prerequisites

The Viya 4 Deployment tool supports running both from ansible installed on a local machine or via a docker container. The Management Jump Host will be used for administration access and will require the following software to run the tool locally.

Table 5 Viya 4 Deployment tool prerequisite software for Pre-Prod

Product	Version	SAS Provided or Customer Provided
Terraform	0.13.4	Customer Provided
Ansible	2.9	Customer Provided
unzip	-	Customer Provided
tar	-	Customer Provided
Kubectl	1.18	Customer Provided
Kustomize	3.7.0	Customer Provided
python 3		Customer Provided
pip3		Customer Provided
openshift pip module		Customer Provided
dnspython python module		Customer Provided
Helm	3	Customer Provided
Git client		Customer Provided

To confirm the latest prerequisites for the deployment tool, see here.

Table 6 Viya 4 Deployment tool prerequisite software for Production (as of August 26, 2022) See here

Product	Version	SAS Provided or Customer Provided
Terraform	v1.0.0	Customer Provided
Ansible	2.10.7	Customer Provided
unzip	-	Customer Provided
tar	-	Customer Provided
Kubectl	1.22-1.24	Customer Provided
Kustomize	3.7.0	Customer Provided
python 3	3.x	Customer Provided
pip3	3.x	Customer Provided
openshift pip module		Customer Provided
dnspython python module		Customer Provided
Helm	3	Customer Provided
Git client		Customer Provided

4 Solution Overview

The following sections detail the proposed SAS software environment given the SBSA IT standards, identified requirements and architectural decisions.

4.1 System Context

The system context model, sometimes referred to as the business context model, is used to define the scope of the SAS implementation, by depicting the major interactions with external systems and user groups. The model initially represents the entire system as a single object and identifies the interfaces between the system and external entities. This is depicted in the Figure 1 for Pre-Prod, and Figure 2 for Production.
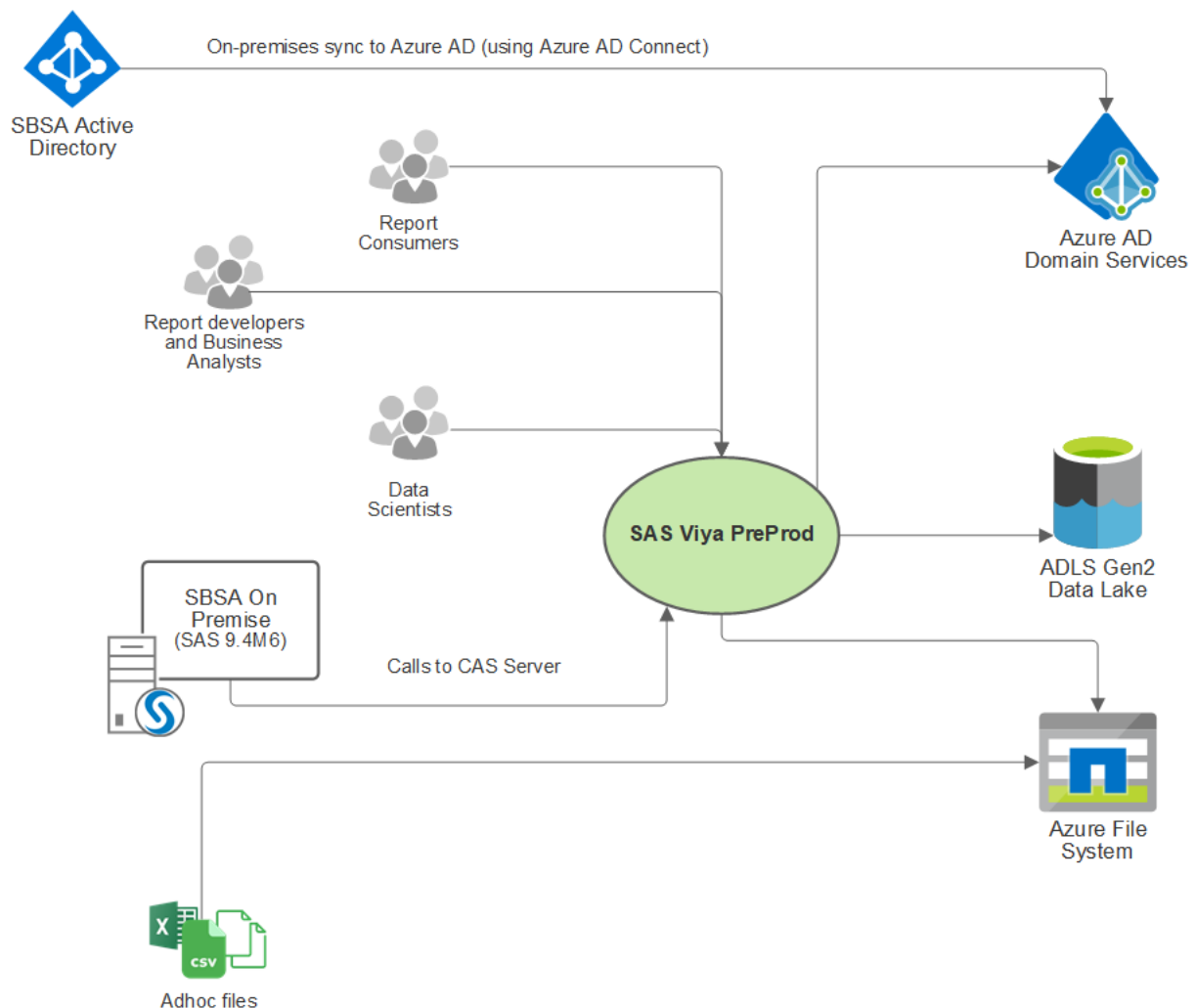
Figure 1. System Context Diagram for Pre-Prod Environment
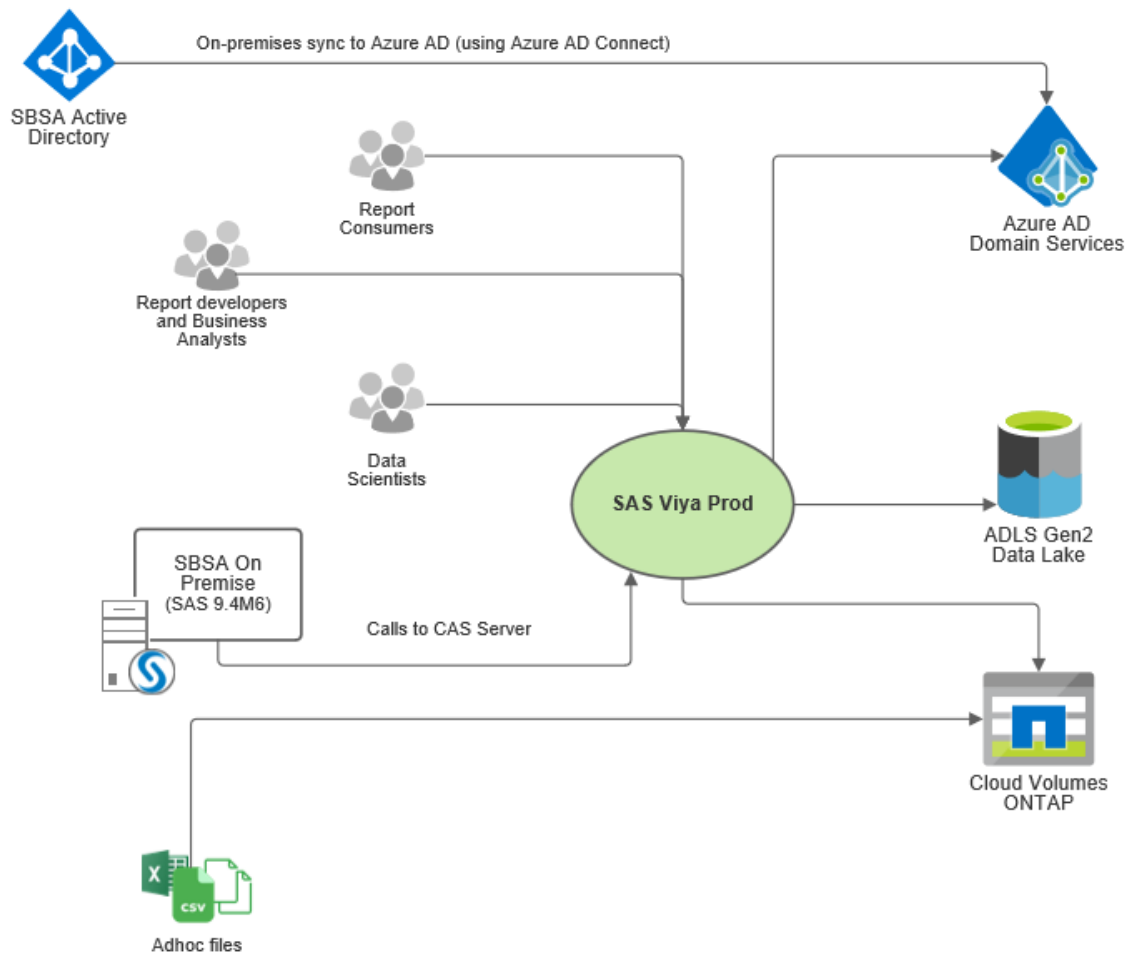
Figure 2: System Context Diagram for Production Environment

4.2 Architectural Decisions

The following table details the key architectural and implementation decisions that have been made.

Table 7. Architectural decisions

ID	Decision	Decision Details / Rationale
AD001	A decision is required on whether the SAS software would use a shared Kubernetes (K8s) cluster or whether a cluster will be dedicated to the SAS environments.	SBSA have made the decision to use a dedicated K8s cluster for the SAS environments. Pre-Prod and Production will have separate K8s clusters

ID	Decision	Decision Details / Rationale
AD002	A decision is required on how to implement the K8s cluster. Will the Terraform scripts (using the [SAS Viya 4 Infrastructure as Code (IaC) for Microsoft Azure](#) GitHub project be used to create the AKS cluster, or will the cluster be manually built?	SBSA have made a decision to manually build the K8s cluster and will make use of ARM template scripts.
AD003	The following namespace will be used for the cluster	sasviya-preprod sasviya-prod
AD004	The following default names will be used for each of the AKS node pods	**Pre-Prod** Default name: cas, compute, connect, stateless, stateful **Production** Default name: cas, compute, services (stateless and stateful), system (for ingress and ops4viya)
AD005	A decision is required to define the node pools availability zone.	Default of single zone will be used. Multi-Zone support in the works for future releases.
AD006	A decision is required on whether the Internal or External PostgreSQL instance will be used.	The decision was made to use the Internal Instance of PostgreSQL.
AD007	A decision is required on whether a local (mirror) registry will be used for the SAS Viya software.	The decision was made to create a mirror registry using the Azure Container Registry (ACR). Implication(s) An implication of using a local registry is that the SAS images need to be kept in sync with the Deployment Assets. This is required for any future SAS Viya version updates (to install future versions of SAS Viya). The Deployment Assets are linked to a specific Viya version. Automation will be required to pull the SAS images and push them to the ACR. The use of the SAS Mirror Manager will be scripted and run on a scheduled basis.

ID	Decision	Decision Details / Rationale
AD008	A decision is required on whether the 'SAS Deployment Operator' will be used. The SAS Viya Deployment Operator is a Kubernetes operator that automates some of the manual tasks that are required to deploy and update the software.	As the Deployment Operator does not automate all aspects of the installation and update of the SAS Viya environment (deployment) the decision was made not to use the Deployment Operator at this point in time. As you still have to manually maintain kustomization.yaml file, the manual method will be used. Production configured to use deployment operator. Pre-prod will be aligned at a later stage.
AD009	A decision is required on the approach to logging and monitoring. Whether the SAS Viya Monitoring for Kubernetes GitHub project will be used or whether another approach (set of tools) will be used.	The decision was made to use the SAS Viya Monitoring for Kubernetes GitHub project. https://github.com/sassoftware/viya4-monitoring-kubernetes
AD010	Secure platform access. The approach to securing platform access needs to be defined.	To support SBSA IT standards all ingress access will be secured using SBSA's TLS (X.509) certificate. SBSA will also provide certificates for internal TLS sessions (session flows between SAS Viya pods).
AD011	A decision is required on the approach for the SAS Identities microservice. Two options are support for the identities provider, using LDAP or using System for Cross-domain Identity Management (SCIM).	Pre-Production: SBSA made use of LDAP (Azure AD) for the Identities provider. Production: LDAP will be used. If it does not meet the requirement, we will fall back to SCIM provided we do not need public IP addresses. To support CASHostAccountRequired, SSSD needs to be enabled for the environment. This will happen inside of the pods and does not require any node-level configuration.
AD012	A decision is required for the authentication method	SBSA have decided on OpenID Connect as the preferred authentication method.

ID	Decision	Decision Details / Rationale
AD013	A decision is required on whether the SAS environments will use a HA (High-Availability) configuration.	**Pre-Prod** The decision was made not to implement an HA configuration for the SAS Viya Pre-Prod environment. By default, the stateful services have multiple replicas (2 or 3), but the stateless services (webapps and microservices) only have 1 replica. **Production** HA must be configured within a single Availability Zone. Availability Zone redundancy is a future requirement and will be looked at when fully supported. Due to costs, SBSA decided to keep components to a minimum as follows: • CAS will be deployed in SMP. No HA. • Only one Node will be used for CAS • Only one Node will be used for Compute.
AD013x	A decision is required on whether the SAS environments will use a DR (Disaster Recovery) configuration.	DR to be cold There will be no failover for production SBSA indicated that they can tolerate up to 4 hours downtime.
AD014	A decision is required on whether the [SAS Viya 4 Deployment](#) GitHub project will be used.	The SAS Viya 4 Deployment project can be used to prepare the Kubernetes cluster and install the required software, such as NGINX and cert-manager, as well as the storage provisioners. This tool supports running both from ansible installed on your local machine or via a docker container. The decision was made to use the deployment tool. The 'Management Jump Host' will be used to run any client software for managing the SAS environments. The bank is using ARM template scripts for this.
AD015	Manual deployment	This cannot be used as here is no NFS server. The initial deployment will be done using a manual approach for Pre-Prod only.

ID	Decision	Decision Details / Rationale
AD016	Deployment using deployment operator	This will be investigated after the initial deployment; this may not add value to the SBSA environment as the cluster setup is automated to reach out to the internet for container images stored in a container repository. Production will be deployed using the Deployment Operator. Pre-prod to be updated at a later stage.
AD017	A decision regarding the SAS Viya software cadence is required.	After consulting with other SAS deployment experts, it was recommended to use the LTS release for this deployment. Since this is a PrePod environment it will be a good learning curve for SBSA staff to also get experience in upgrades. Production will be deployed using the latest LTS version. Pre-Prod will be upgraded later.
AD018	A decision is required on the approach to shared storage for the default storage class.	The NetApp Files storage is currently unavailable in Azure South Africa. The Azure files premium storage is unavailable in Azure South Africa. SAS does not recommend Azure Files for Production workloads. Preliminary decision is to use Azure Files. *A decision was taken to wait for Azure Netapp Files (September 29th, 2022).*
AD019	A decision is required on how to implement temporary storage for SASWORK, SASUTIL and CAS Disk Cache. Will the default (emptyDir) storage be used or will dedicated (fast) storage be provisioned.	The decision was made to configure the platform and SAS environments to use instance ephemeral disk (local temporary SSD) for the SAS temporary storage through the use of a hostPath volume. SSD Fast storage will be provisioned, and we will redirect the SASWORK, SASUTIL and CAS Disk Cache to these disks.
AD020	Will AKS cluster will be deployed as a private cluster or standard AKS deployment.	AKS cluster will be deployed as a private cluster. Using user defined routing pointing to firewall. Load balancer with user defined routing.

4.3 Technical Assumptions

The design specifications and recommendations made in this document are based on the information and assumptions provided during the preceding consultation and discussions.

Changes in requirements or assumptions will necessitate a review to determine impact and/or revision of recommendations (including previous estimates provided).

Table 8. Assumptions

ID	Assumption Description
AS01	The Azure infrastructure provides sufficient availability service levels to meet SBSA availability requirements for the SAS environment.
AS02	Workload: It is assumed that the workload in the Pre-Prod environment will not be high as SBSA want to test this technology. Infrastructure proven itself. Production workload can be defined.
AS03	sasviya-preprod sasviya-prod

4.4 Architecture Overview

Pre-Production:

Figure 3 provides an architecture overview of the SAS environment. The architecture overview diagram illustrates the major structuring and components of the solution. Two key decisions that drive the deployment architecture are AD001 and AD004. That is, a dedicated Kubernetes (AKS) cluster will be implemented for the sasviya-preprod platform and the standard labels, taints and tolerations will be used.
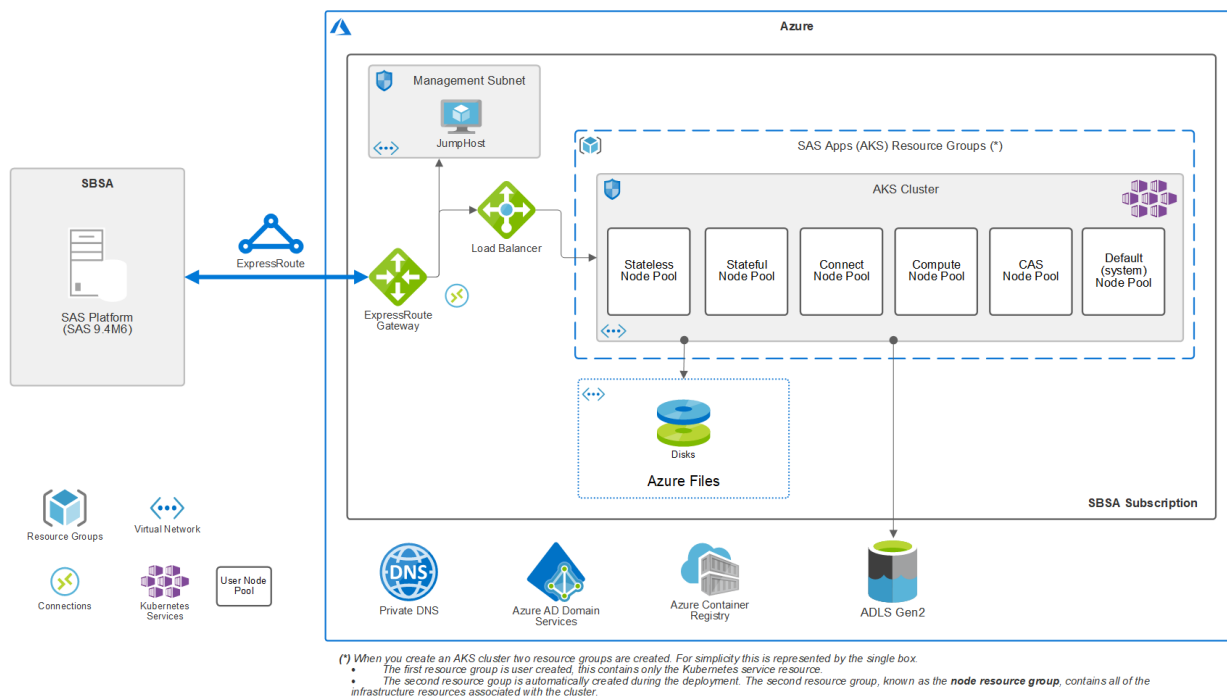
Figure 3: Architecture overview (Pre-Production)

Production:

Two key decisions that drive the deployment architecture are AD001 and AD004. That is, a dedicated Kubernetes (AKS) cluster will be implemented for the sasviya-prod platform and the labels (services [stateless, stateful], cas, compute, system), standard taints and tolerations (stateful and stateless will share nodes, with cas and comp will be used.

(*) *When you create an AKS cluster two resource groups are created. For simplicity this is represented by the single box.*
- *The first resource group is user created, this contains only the Kubernetes service resource.*
- *The second resource group is automatically created during the deployment. The second resource group, known as the* **node resource group**, *contains all of the infrastructure resources associated with the cluster.*

Figure 4: Architecture Overview (Production)

Running the ARM templates scripts will create the required resource groups and other resources to support the AKS cluster for the SAS environments. Note, the default name will be used for the AKS 'node resource group'.

The ARM template scripts we customized to create a Load Balancer with private routing tables to prevent the use of Public IP Address. The ExpressRoute CIDR will be used in the ARM template scripts to create the Network Security Group (NSG) rules to secure access to the SAS environment.

The firewall rules for the existing ExpressRoute connections will have to be updated to allow connectivity and user access to the SAS environments.

As per decision AD007, the Azure Container Registry will be used to create a local mirror repository for the SAS software. This can also be handled by the IaC project.

4.4.1 Kubernetes Cluster Overview

Pre-Production:

Figure 5 provides a more detailed overview of the Kubernetes cluster, illustrating the five 'user' node pools that were implemented and the default (system) node pool in PreProd.
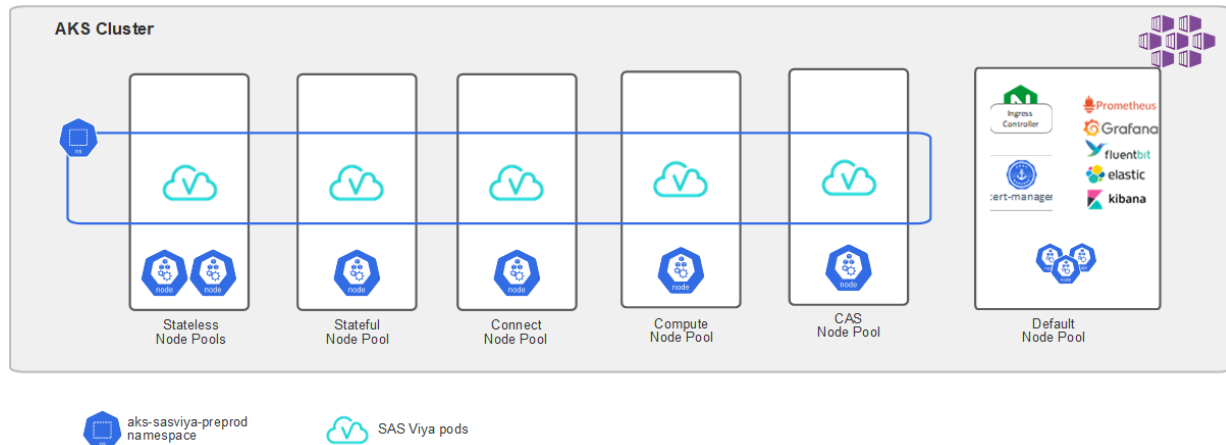
Figure 5. AKS cluster overview for Pre-prod

The default node pools for the SAS Viya software are:

- Stateless

- Stateful

- Connect

- Compute

- CAS.

Additionally, the default, system, node pool will be used for the non-SAS (third-party) applications. These applications are required to support the operation of the SAS Viya software (such as the ingress controller and cert-manager) and to support the logging and monitoring applications.

Production:

Following some changes on the SAS architecture side, we will be dropping the Connect Node Pool, see here for details for Production. The following diagram provides an overview of the Kubernetes Cluster in Production.

aks-sasviya-prod
namespace
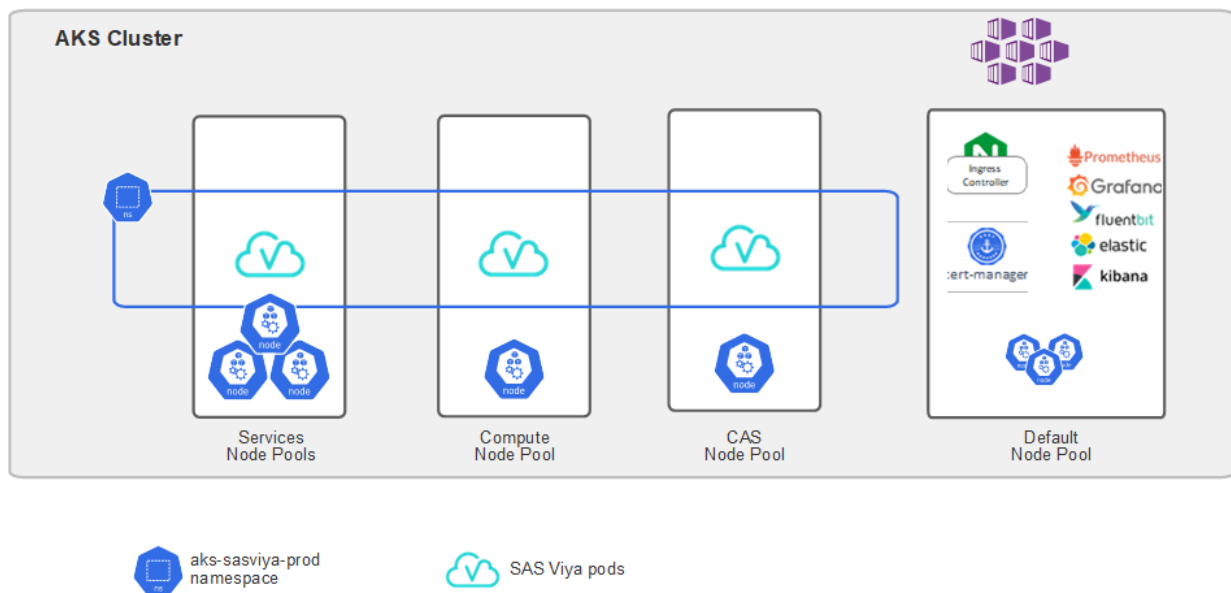
SAS Viya pods

Figure 6: AKS Cluster Overview for Production

4.5 Workload Placement Plan

The following workload placement plan was developed using the default node labels and taints.

4.5.1 SAS Viya PreProd

The SBSA Viya PreProd environment will use the default labels and taints. The following tolerations will be used for the environment:

Table 9. SASViya PreProd workload placement plan

Pod type	Affinity and Tolerations
Stateless	As the aks-sasviya-preprod environment will use HA for the stateless pods, the stateless pods will have a toleration for both the stateless and stateful taints to enable the pods to be scheduled across both the stateless and stateful node pools. The stateless pods will have a preference to be scheduled on nodes that are labeled: workload.sas.com/class=stateless The default tolerations will be used, the stateless pods will tolerate the following taints: • workload.sas.com/class=stateless:NoSchedule • workload.sas.com/class=stateful:NoSchedule
Stateful	The stateful pods will have a toleration for the stateful and stateless taints to enable the pods to be scheduled across both the stateless and stateful node pools The stateful pods will have a preference to be scheduled on nodes that are labeled: workload.sas.com/class=stateful

	The default tolerations will be used, the stateful pods the tolerate the following taints: • workload.sas.com/class=stateful:NoSchedule • workload.sas.com/class=stateless:NoSchedule
CAS	The cas pods will have a preference to be scheduled on nodes that are labeled: workload.sas.com/class=cas The default tolerations will be used, the cas pods will tolerate the following taints: • workload.sas.com/class=cas:NoSchedule The default CAS resource requests (the CAS auto-resources option) will be enabled for the CAS pods.
Compute	The compute pods will have a preference to be scheduled on nodes that are labeled: workload.sas.com/class=compute The default tolerations will be used, the compute pods will tolerate the following taints: • workload.sas.com/class=compute:NoSchedule
Connect	The connect pods will have a preference to be scheduled on nodes that are labeled: workload.sas.com/class=connect The default tolerations will be used, the connect pods will tolerate the following taints: • workload.sas.com/class=connect:NoSchedule

4.5.2 SAS Viya Production:

Pod type	Affinity and Tolerations
Stateless	As the aks-sasviya-prod environment will use HA for the stateless pods, the stateless pods will have a toleration for both the stateless and stateful taints to enable the pods to be scheduled across both the stateless and stateful node pools. The stateless pods will have a preference to be scheduled on nodes that are labeled: workload.sas.com/class=services The default tolerations will be used, the stateless pods will tolerate the following taints: • workload.sas.com/class=services
Stateful	The stateful pods will have a toleration for the stateful and stateless taints to enable the pods to be scheduled across both the stateless and stateful node pools The stateful pods will have a preference to be scheduled on nodes that are labeled: workload.sas.com/class=services The default tolerations will be used, the stateful pods the tolerate the following taints: • workload.sas.com/class=services
CAS	The cas pods will have a preference to be scheduled on nodes that are labeled: workload.sas.com/class=cas The default tolerations will be used, the cas pods will tolerate the following taints:

	• workload.sas.com/class=cas:NoSchedule
	The default CAS resource requests (the CAS auto-resources option) will be enabled for the CAS pods.
Compute	The compute pods will have a preference to be scheduled on nodes that are labeled: workload.sas.com/class=compute
	The default tolerations will be used, the compute pods will tolerate the following taints:
	• workload.sas.com/class=compute:NoSchedule

4.5.3 Workload Placement Summary

Pre-Production

Figure 7 provides a summary of the workload placement plan, showing the result of the node taints and pod tolerations for the SAS environments (as discussed in the previous sections).
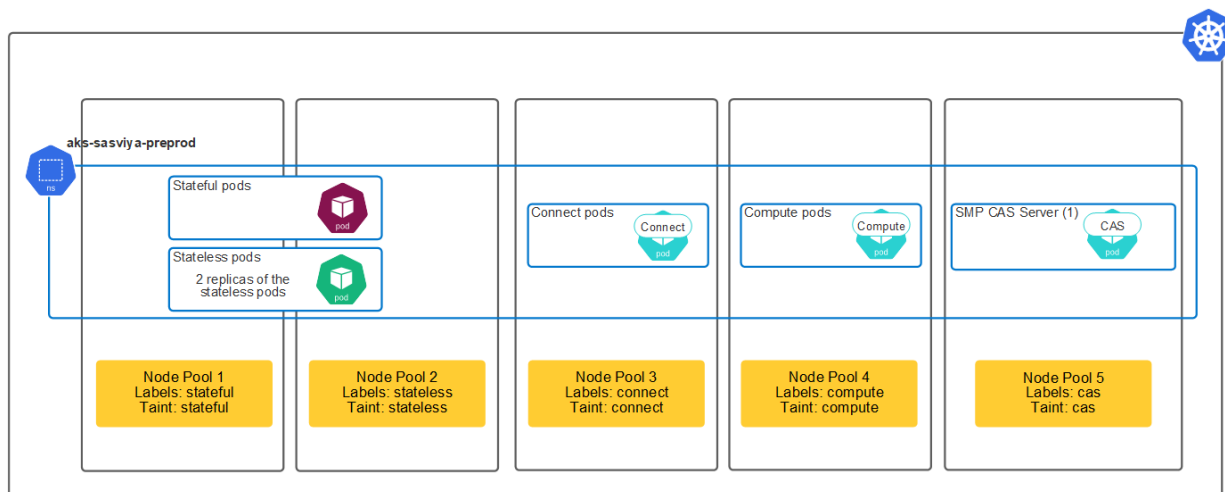
Figure 7. Workload placement summary for PreProd

This configuration means that:

- Only pods that have a toleration for the "stateful" taint will be scheduled onto the stateful node pool (Node Pool 1) nodes.

- Only pods that have a toleration for the "stateless" taint will be scheduled onto the stateless node pool (Node Pool 2) nodes.

- Only pods that have a toleration for the "connect" taint will be scheduled onto the connect node pool (Node Pool 3) nodes.

- Only pods that have a toleration for the "compute" taint will be scheduled onto the compute node pool (Node Pool 4) nodes.

- Only pods that have a toleration for the "cas" taint will be scheduled onto the cas node pool (Node Pool 5) nodes.

The SBSA Viya PreProd environment will use a SMP CAS server.

Production:

Figure 8 provides a summary of the workload placement plan, showing the result of the node taints and pod tolerations for the SAS environments (as discussed in the previous sections).
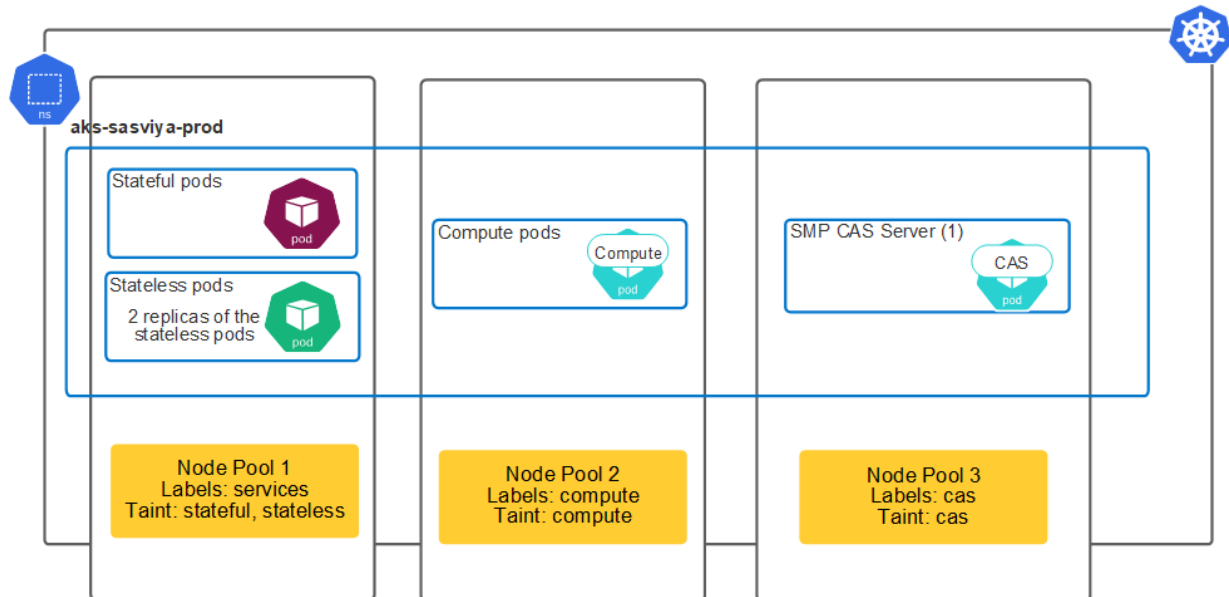
Figure 8: Workload placement summary for production

This configuration means that:

- Only pods that have a toleration for the "stateful" and "stateless" taint will be scheduled onto the Services node pool (Node Pool 1) nodes.

- Only pods that have a toleration for the "compute" taint will be scheduled onto the Compute node pool (Node Pool 2) nodes.

- Only pods that have a toleration for the "cas" taint will be scheduled onto the CAS node pool (Node Pool 3) nodes.

The SBSA Viya Production environment will use a SMP CAS server. The sizing exercise recommended MPP CAS, however the SBSA team has opted to start with SMP CAS to managed costs and grow the environment over time.

5 Environment and Infrastructure Details

This section provides details of the Kubernetes cluster and related infrastructure that will be used to run the SAS Viya environment(s).

5.1 AKS Cluster Details

Pre-Production:

As discussed previously, the AKS cluster will be implemented with five 'user' node pools for the SAS Viya software and the default (system) node pool will be used for the required third-party applications. One namespace will be implemented for the SAS Viya environment.

The following table details the AKS configuration options.

Table 10. AKS cluster details for pre-prod

Attribute	Details
Azure Resource Group name:	SAN-DataServices-PreProd-SAS
Kubernetes cluster name:	aks-sasviya-preprod
Azure Region:	South Africa (North)
Kubernetes version	1.22.15
Node Pool names and node specification:	Figure 11: Node Pool and node specification for pre-production
Container registry:	sasMirrorRegistry
Tags:	Name: Vendor Value: SAS
Infrastructure resource group	MC_SAN-DataServices-PreProd-SAS_aks-sasviya-preprod_southafricanorth
API server address	aks-sasviya-preprod-c765d010.privatelink.southafricanorth.azmk8s.io

Production:

AKS cluster will be implemented with three 'user' node pools for the SAS Viya software on Production and the default (system) node pool will be used for the required third-party applications. One namespace will be implemented for the SAS Viya environment.

Figure 9: AKS Cluster details for production

Attribute	Details
Azure Resource Group name:	SAN-DataServices-Prod-SAS

Kubernetes cluster name:	aks-sasviya-prod
Azure Region:	South Africa (North)
Kubernetes version	1.22.15
Node Pool names and node specification:	Figure 12: Node Pool and node specification for production
Container registry:	sasMirrorRegistry
Tags:	Name: Vendor Value: SAS
Infrastructure resource group	MC_SAN-DataServices-Prod-SAS_aks-sasviya-preprod_southafricanorth
API server address	aks-sasviya-prod-c765d010.privatelink.southafricanorth.azmk8s.io

5.1.1 Nodes and Node Pools

Pre-Production:

The following approach to sizing the node pools will be used.

Table 11. Node pool capacity estimates for pre-prod

Node pools	Capacity estimates
Stateless	As the environment will use HA for the stateless pods there will be 3 replicas of all the stateless pods. A minimum of two nodes will be used.
Stateful	Two nodes will be used for the stateful node pool.
CAS	One node will be used.
Compute	One node will be used.
Connect	One node will be used.
Default (system)	One node will be used.

Production:

Figure 10: Node pool capacity estimates for production

Node pools	Capacity estimates
Services	HA will be implemented for Stateless pods Services node pool will have three nodes. Stateful pods will have 3 replicas of Consul, PostgreSQL and RabbitMQ Services node pool will have three nodes.

CAS	One node will be used.
Compute	One node will be used.
Default (system)	One node will be used.

The following table provides details for the Node Pools and nodes that will be used to support the SAS Viya pre-prod environment.

Figure 11: Node Pool and node specification for pre-production

Node Pool	Stateless	Stateful	Connect	Compute	CAS	Default
Node Pool name	stateless	stateful	connect	compute	cas	default
Description	Used for Stateless pods and for the stateful pods.	Used for Stateful pods and for the stateless pods.	Dedicated to connect pod.	Dedicated to compute pod.	Dedicated to CAS pod.	Used for system pods, 3rd Party applications and other required software.
Node specification	Standard_D8s_v4 (8 vCPU's, 32GB)	Standard_D8s_v4 (8 vCPU's, 32GB)	Standard_D8ds_v4 (8 vCPU's, 32GB)	Standard_E8ds_v4 (8 cores, 64GB)	Standard_E16ds_v4 (16 cores, 128GB)	Standard_D8s_v4 (8 cores, 32GB)
Node Pool size	Static: 2 node	Static: 1 node	Static: 1 node	Static: 1 node	Static: 1 node	Static: 1 node
Availability zones	None	None	None	None	None	None
Node specific storage	OS 128 GB	OS 128 GB	OS 128 GB	OS 128 GB	OS 128 GB	OS 128 GB
Node specific storage	N/A	N/A	300GB of instance temporary SSD to be used for SASWORK.	300GB of instance temporary SSD to be used for SASWORK.	600GB of instance temporary SSD to be used for CAS disk cache.	N/A
Shared Storage	N/A	N/A	Azure Files PVC Breakdown in table 12 below	Azure files PVC Breakdown in table 12 below	Azure files PVC Breakdown in table 12 below	N/A
Node Labels: workload.sas.com/class =	stateless	stateful	connect	compute	cas	N/A

Taints: workload.sas.com/class =	stateless	stateful	connect	compute	cas	N/A

The following table provides details for the Node Pools and nodes that will be used to support the SAS Viya production environment.

See here and [here](#) for more details.

Figure 12: Node Pool and node specification for production

Node Pool	Services	Compute	CAS	Default
Node Pool name	services	compute	cas	default
Description	Used for Stateless and Stateful pods.	Dedicated to compute pod.	Dedicated to CAS pod.	Used for system pods, 3rd Party applications and other required software.
Node specification	Standard_E16dsv4 (16 vCPU, 128GB)	Standard_E64bds_v 5(48 vCPU, 512GB)	Standard_E64bds_v 5(48 vCPU, 512GB)	Standard_D8s_v4 (8 cores, 32GB)
Node Pool size	Static: 3 nodes	Static: 1 node	Static: 1 node	Static: 1 node
Availability zones	Africa North	Africa North	Africa North	Africa North
Node specific storage	OS 128 GB	OS 128 GB	OS 128 GB	OS 128 GB
Node specific storage	N/A	300GB of instance temporary SSD to be used for SASWORK.	900GB of instance temporary SSD to be used for CAS disk cache.	N/A
Shared Storage	N/A	Azure Files (temporary until	Azure Files (temporary)	N/A

		Azure Netapp files is available) Breakdown in table 12 below		
Node Labels: workload.sas.com/class =	services	compute	cas	N/A
Taints: workload.sas.com/class =	stateless, stateful	compute	cas	N/A

5.1.2 Storage

The following table provides details of the storage required for the SAS environment.

Pre-Production

Table 12. Storage specification for pre-prod

Storage volume	Type	Share location	Used by	Pod mount point	Access mode
User data 512 GB	Shared FS	/azure_files PVC/sasdata	CAS, Compute & Connect pods	/sasviya/ /sasviya/data	ReadWriteMany
User home directories 64 GB	Shared FS	/azure_files PVC/homes	CAS, Compute & Connect pods	/home	ReadWriteMany
Open-source companion software 64 GB	Shared FS	/azure_files PVC/opensource	CAS, Compute & Connect pods	/bin /bin/pvcsviyapython /bin/pvcviya_r	ReadWriteMany

CAS_DATA_DIR	Shared FS PVC "cas-default-data"		CAS, Compute & Connect pods	/data	ReadWriteMany
persistent volumes provisioned using the filesystem	Shared FS		Any pods as needed	/pvs	ReadWriteMany
CASPERMSTORE	Shared FS		CAS pods	/permstore	ReadWriteMany
Backup	Shared FS	/ azure_files /backup	CAS and any other pods as needed	/backups /backups/cas /backups/common	ReadWriteMany
QKB	Shared FS	/ azure_files /qkb	CAS, Compute & Connect pods	/quality-knowledge-base	ReadWriteMany
Consul **Default PVC 1GB**			Consul pod(s)		ReadWriteOnce
RabbitMQ **Default PVC 2GB**			RabbitMQ pod(s)		ReadWriteOnce
Geode **Default PVC 2GB**			Geode pod(s)		ReadWriteOnce
Postgres (internal) **Default PVC 128GB**			Postgres pod(s)		ReadWriteOnce

Production

Table 133. Storage specification for Production

Storage volume	Type	Share location	Used by	Pod mount point	Access mode
User data 512 GB	Shared FS	/anf/sasdata	CAS, Compute & Connect pods	/sasviya/ /sasviya/data	ReadWriteMany
User home directories 64 GB	Shared FS	/anf /homes	CAS, Compute & Connect pods	/home	ReadWriteMany
Open-source companion software 64 GB	Shared FS	/anf /opensource	CAS, Compute & Connect pods	/bin /bin/pvcsviyapython /bin/pvcviya_r	ReadWriteMany
CAS_DATA_DIR	Shared FS PVC "cas-default-data"		CAS, Compute & Connect pods	/data	ReadWriteMany
persistent volumes provisioned using the filesystem	Shared FS		Any pods as needed	/pvs	ReadWriteMany
CASPERMSTORE	Shared FS		CAS pods	/permstore	ReadWriteMany
Backup	Shared FS	/anf/backup	CAS and any other pods as needed	/backups /backups/cas /backups/common	ReadWriteMany
QKB	Shared FS	/anf/qkb	CAS, Compute & Connect pods	/quality-knowledge-base	ReadWriteMany

			Consul pod(s)		ReadWriteOnce
Consul **Default PVC 1GB**			Consul pod(s)		ReadWriteOnce
RabbitMQ **Default PVC 2GB**			RabbitMQ pod(s)		ReadWriteOnce
Geode **Default PVC 2GB**			Geode pod(s)		ReadWriteOnce
Postgres (internal) **Default PVC 128GB**			Postgres pod(s)		ReadWriteOnce

5.2 Namespaces

Table 14 details the Kubernetes namespaces to be implemented. Along with the namespace for the SAS Viya environment (**sasviya-preprod**) there are several namespaces for the supporting third-party applications.

Table 14. Kubernetes namespaces for pre-prod

Environment or application	Namespace
Viya 4 PreProd Environment	sasviya-preprod
NGINX Ingress Controller	ingress-nginx (default – set by Deployment Tool)
Cert-manager	cert-manager (default – set by Deployment Tool)
Monitoring applications	monitoring (default – set by Deployment Tool)
Logging applications	logging (default – set by Deployment Tool)
EFS Provisioner	efs-provisioner (default name – set by Deployment Tool)

Table 14 details the Kubernetes namespaces to be implemented. Along with the namespace for the SAS Viya environment (**sasviya-prod**) there are several namespaces for the supporting third-party applications.

Table 1415. Kubernetes namespaces for production

Environment or application	Namespace
Viya 4 Prod Environment	sasviya-prod
NGINX Ingress Controller	ingress-nginx (default – set by Deployment Tool)
Cert-manager	cert-manager (default – set by Deployment Tool)
Monitoring applications	monitoring (default – set by Deployment Tool)
Logging applications	logging (default – set by Deployment Tool)
EFS Provisioner	efs-provisioner (default name – set by Deployment Tool)

5.3 Networking

Figure 13 provides an overview of the network sessions for systems and clients that will access the SAS Viya environments and the monitoring and logging applications. As illustrated, several DNS aliases need to be configured to support the system access.

Pre-Production:

The figure shows the connections for the SAS Viya visual interfaces (**https://sasviya-preprod.standardbank.co.za**) and the connections for the following:

- The SAS Viya CLI (the administration command-line interface)

- Access to the CAS Server (both the RESTful and BINARY APIs)

- SAS/CONNECT sessions, and

- The monitoring (Grafana, Prometheus and AlertManager) and logging (Kibana) services.
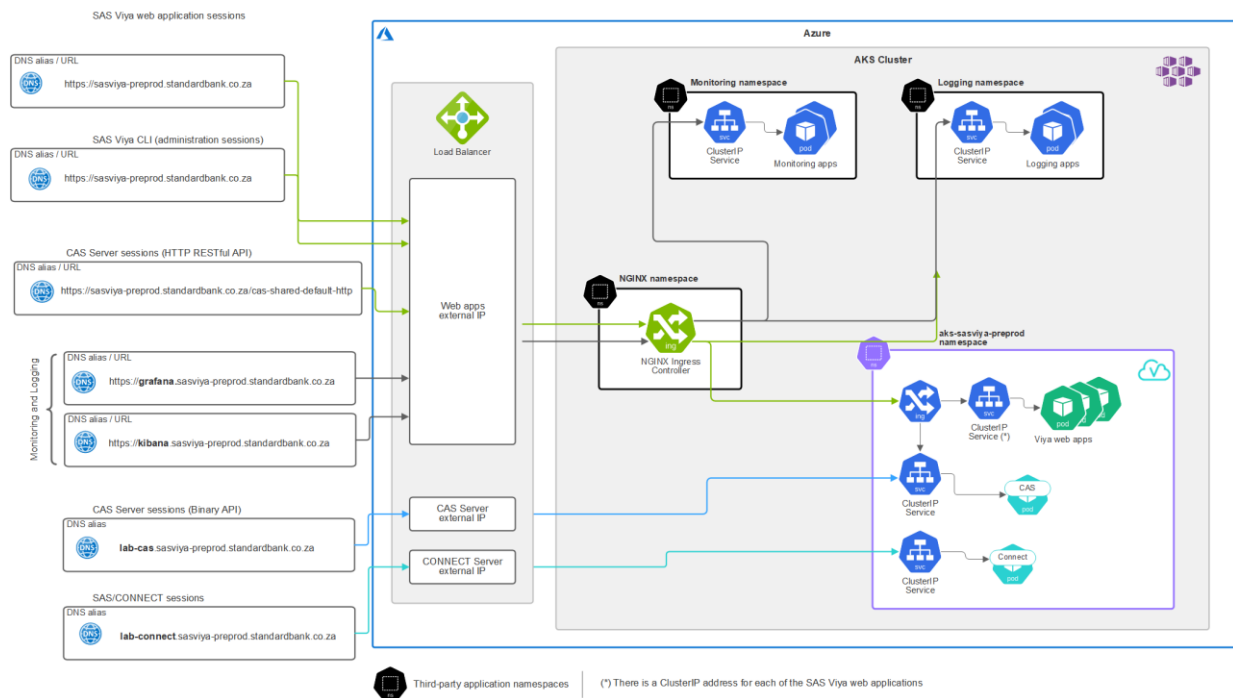
Figure 13. Networking overview for pre-prod

Production:

The figure shows the connections for the SAS Viya visual interfaces (**https://sasviya-prod.standardbank.co.za**) and the connections for the following:

- The SAS Viya CLI (the administration command-line interface)

- Access to the CAS Server (both the RESTful and BINARY APIs)

- SAS/CONNECT sessions, and

- The monitoring (Grafana, Prometheus and AlertManager) and logging (Kibana) services.
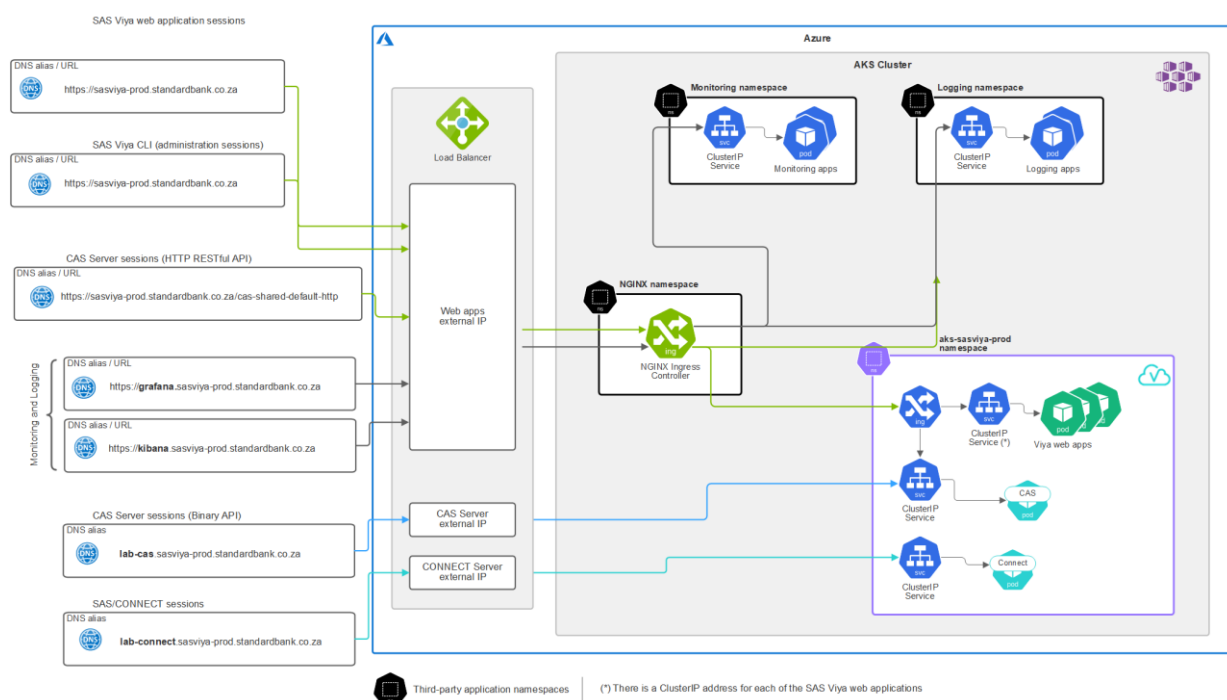
Figure 14: Networking overview for Production

Note, the figure only depicts the namespaces that relate to the session flows and/or clients detailed on the left of the figure. For example, the 'cert-manager' namespace isn't shown.

The ARM template scripts we customized to create a Load Balancer with private routing tables to prevent the use of Public IP Address. The ExpressRoute CIDR will be used in the ARM template scripts to create the Network Security Group (NSG) rules to secure access to the SAS environment.

The ExpressRoute network peering will also have to be updated to allow access to the SAS environment using either Azure Public or Microsoft peering.

SBSA are responsible for the configuration and testing of the connectivity and firewall rules, including the Azure Network Security Groups (NSG).

5.4 Database Drivers and Client Software

The database drivers and client software must be installed on a folder in a persistent volume so that they can be mounted to the Compute Server and CAS pods.

Cloud Volumes ONTAP will be used as NetApp is not yet available in Azure South Africa.

It is a SBSA responsibility to provide and install any required database drivers, driver managers and other client software to support the data access.

5.5 Approach to Kubernetes Administration

SBSA & Microsoft will provide K8s application administration

5.6 Private Registry Information

The SAS Mirror Manager can be used to copy the images from the registry SAS hosts to a local Private Docker Registry. SBSA have made the decision to implement a local registry, see decision AD007. The Azure Container Registry (ACR) will be used.

5.6.1 Registry Update Approach

SBSA will implement an automated batch process to nightly pull the SAS images to ACR. This process will run from the Jump Host in the management VLAN. This will ensure that SBSA have latest, or a daily image update to match any Deployment Assets that will be used in the future.

The definition of the batch process is beyond the scope of this document.

Manual trigger is recommended.

5.7 Deployment Assets

SAS Viya Orders is a command-line interface (CLI) that calls the appropriate SAS Viya Orders API endpoint to obtain the requested deployment assets for a specified SAS Viya software order. This can be used to automate the download of the deployment assets.

SAS Viya Orders CLI GitHub project

6 SAS Viya Configuration Details

This section details the SAS Viya configuration and additional customizations for the SBSA aks-sasviya-preprod environment. The environment will implement the following SAS software.

- SAS Visual Data Science plus Risk Modelling Add-on

6.1 SAS Viya Deployment Approach

The default method is to perform the deployment using Kustomize and kubectl commands. The SAS Deployment Operator can also be used.

SAS Viya Deployment Operator	
Will the SAS Viya Deployment Operator be used?	No for Pre-Prod Yes for Production
Will the [SAS Viya 4 Automated Deployment tool](#) be used?	Yes

6.2 Namespace Information

Each SAS environment is installed into a dedicated namespace. This architecture only depicts the Viya PreProd Environment.

The following namespaces name will be used:

sasviya-preprod

sasviya-prod

6.3 Directory Structure

The following directory structure will be used for the deployment assets. The Deployment Assets can be manually downloaded from the SAS portal (https://my.sas.com).

The deployment assets will be downloaded to the JumpHost and stored under the following directory structure: '**/sas/deploy/<environment>/**'

For the pre-prod environment this will be: `/sas/deploy/preprod/`

For the prod environment this will be: `/sas/deploy/prod/`

6.4 SAS Viya Configuration

The following sections detail the SAS Viya specific configuration.

6.4.1 Ingress Host and SAS Services information (Pre-Prod)

The following details the Ingress host and SAS Services URL information.

Kustomization	Value
INGRESS_HOST=	sasviya-preprod.standardbank.co.za
SAS_SERVICES_URL=	https://sasviya-preprod.standardbank.co.za

Note, The SAS_SERVICES_URL variable is used to provide the value for the SERVICESBASEURL option in compute server sessions. It should point to the host name and port of the cluster's Ingress for this deployment.

6.4.2 Ingress Host and SAS Services information (Prod)

The following details the Ingress host and SAS Services URL information.

Kustomization	Value
INGRESS_HOST=	sasviya-prod.standardbank.co.za
SAS_SERVICES_URL=	https://sasviya.prod.standardbank.co.za

Note, The SAS_SERVICES_URL variable is used to provide the value for the SERVICESBASEURL option in compute server sessions. It should point to the host name and port of the cluster's Ingress for this deployment.

6.4.3 Security Aspects

The following sections provide the details for the authentication and identity provider configuration that will be used for the SAS environment.

6.4.3.1 Authentication: SAS Logon Manager

SBSA will use the following authentication methods for the SAS Logon Manager:

- OpenID Connect with single sign-on enabled.

6.4.3.2 Identity Provider

There is the option to pull identity information from an LDAP provider.

The following information will be used to configure the LDAPS, to configure SAS Viya as an enterprise application.

ldaps://ldapadprd.sbicdirectory.com:3269

ldaps://ldapgcprd.sbicdirectory.com:3269

The SBSA team is testing this option for multiple domains. A final decision will be documented later.

6.4.3.3 TLS configuration

The SAS Security Certificate Framework uses cert-manager, which is an open-source Kubernetes tool, to manage certificate pairs (private key and signed server identity certificate). By default, SAS Viya generates a self-signed Certificate Authority which is used to sign all internal certificate pairs.

A choice must be made for the certificate pair used by the Ingress Controller. The Ingress Controller certificate pair can be signed by the internal cert-manager issuer or provided by the customer. Customers can either provide a PEM format certificate pair or their own configured cert-manager issuer.

The following configuration will be used:

- The SBSA certificate will be used for all external (inbound) access to the SAS environment.

- The SBSA certificate will be used for all internal sessions.

- Cert Manager will be used to connect to Venafi.

6.4.3.4 SSSD Configuration (optional)

The use of SSSD isn't required for the platform to function. If SSSD is enabled for SAS Cloud Analytic Services, the customer has the option to use the default configuration that is generated or to use a custom configuration.

SSSD configuration	
Will SSSD be enabled?	Yes
If yes, will the default SSSD configuration be used or is a custom SSSD configuration required?	Default

6.4.4 SAS Infrastructure Data Server

SAS Infrastructure Data Server stores SAS Viya user content, such as reports, authorization rules, selected source definitions, attachments, audit records, and user preferences. SAS Viya uses PostgreSQL for SAS Infrastructure Data Server.

The default configuration will deploy an instance of PostgreSQL inside Kubernetes namespace, which is described as an internal instance. Alternatively, you can provide your own PostgreSQL (from Azure Postgres), which is described as an external instance.

As per decision AD006, SBSA have decided to an Internal instance of PostgreSQL.

6.4.5 CAS Server mode and configuration

Pre-Production:

The CAS Server will run in SMP mode. The following table details the CAS server configuration.

Autoscaling – manual overnight

CAS configuration	
CAS mode (SMP or MPP):	SMP
The Backup Controller is required? (MPP mode only):	No
Number of CAS Workers (MPP mode only):	N/A
Adjust CPU Resources	Yes – the default settings will be used
Adjust RAM Resources	Yes – the default settings will be used

Production:

The CAS Server will run in SMP mode as a start. As more business units are onboarded it can be increased to MPP. The following table details the CAS server configuration.

Autoscaling – manual overnight

CAS configuration	
CAS mode (SMP or MPP):	SMP
The Backup Controller is required? (MPP mode only):	No
Number of CAS Workers (MPP mode only):	N/A
Adjust CPU Resources	Yes – the default settings will be used
Adjust RAM Resources	Yes – the default settings will be used

6.4.5.1 CAS Disk Cache Configuration

The CAS Disk Cache is to be configured to use the temporary (ephemeral) disk on the Kubernetes nodes, rather than the default emptyDir settings. The **hostPath** configuration will be used for the CAS Disk Cache.

6.4.5.2 Optional Connectivity

Additional configuration is required to support the following connections:

- Connections from SAS 9.4, SAS Viya 3.5, or other binary clients.

- Connections to CAS from SAS Data Connect Accelerators.

Both Viya PreProd and Production environments will NOT have any BINARY client connections and will not use the SAS Data Connect Accelerators.

6.4.5.3 Additional CAS Configuration

No additional CAS configuration is required. Autoscaling to be considered. But manually configured.

6.4.6 SASWORK Configuration

The SASWORK is to be configured to use the temporary (ephemeral) disk on the Kubernetes nodes, rather than the default emptyDir settings. A **hostPath** configuration will be used for SASWORK.

6.4.7 Configure SAS/CONNECT Settings

Both Viya PreProd and Production environments environment will not use SAS/CONNECT.

6.4.8 SITEDEFAULT.YAML Configuration

SITEDEFAULT.YAML will not be used to pre-load any configuration settings.

The SAS Viya CLI can be used for scripting updates to the SAS Viya configuration. This approach (using the SAS Viya CLI) can be used with CI/CD build processes that SBSA might implement in the future.

The SAS Environment Manager can also be used for interactive updates.

6.4.9 High-Availability Configuration

Pre-Production:

The default configuration provides 1 replica of the stateless pods. A Kustomize transformer enables HA for the stateless microservices.

HA configuration	
HA for the SAS Viya stateless microservices is required?	Yes
Is there a need to configure the stateless services availability with additional replicas? **The default HA configuration provides 2 replicas.**	No

Production:

HA configuration	
HA for the SAS Viya stateless microservices is required?	Yes
Is there a need to configure the stateless services availability with additional replicas? **The default HA configuration provides 2 replicas.**	No

6.4.10 Mail Service Configuration

The following details will be used for Mail Service configuration.

Mail Host:

Username:

6.4.11 Workload Placement Implementation

See section 4.5 for details.

7 Systems Management

This section details the system management approach and implementation.

7.1 Logging and Monitoring

As per decision AD009, the decision was made to use the SAS Viya Monitoring for Kubernetes GitHub project. https://github.com/sassoftware/viya4-monitoring-kubernetes

7.2 Backup and Recovery Recommendations

A Cold DR environment will be deployed in a different Availability Zone. The DR will mirror the production configuration.

A recovery period of up to 4 hours is allowable by SBSA.

SBSA will take daily backups of the environment.

- These backups will include SAS Viya deployment/configuration.

- Data will be replicated in the background to DR.

8 Installation and Configuration

Installation and configuration of the software will take place following SAS' standard installation engagement process. A pre-installation workshop or meeting will be held to ensure that all installation prerequisites are finalized, and all parties are aligned as to how each of the components will be installed and configured.

The output of the workshop will be a plan detailing steps and responsibilities of the installation, configuration and testing of SAS software prior to hand-over to SBSA.

At the time of installation, SAS will document and provide an installation report. This document provides a summary of the configuration of SAS software but does not include details on installation steps. SAS strongly recommend that installation only be performed by trained SAS installers, and do not provide detailed screenshot-by-screenshot installation guides.

8.1 SAS Viya Summary

The following table provides a summary of the key aspects of the installation for the SAS installation specialist.

Table 16 Installation summary – SAS Viya PreProd

Item / Task	Description
Customer site number	70292688
Cloud or on-premises deployment (If using a Cloud Provider state the provider being used)	Azure AKS
SAS software cadence	Stable 2020.1.5
SAS Viya product offering(s)	SAS Visual Data Science plus Risk Modelling Add-on
Environments to be installed	SAS Viya PreProd
Will a shared Kubernetes cluster be used?	No
Will the Deployment Operator be used	No
Will the SAS Viya 4 Automated Deployment tool be used?	Yes
Is a High Availability (HA) configuration required for the stateless services?	No
Will the CAS Server run in SMP or MPP mode?	SMP
If using CAS MPP, is a backup Controller required?	N/A for SMP
Internal or External instance of PostgreSQL?	Internal
Will the customer's TLS (X.509) certificate be used for the Ingress?	Yes
What authentication method will be used?	LDAP
What Identity providers will be used?	Azure AD, or SCIM.
Will a custom SSSD configuration be used?	No
Is external access to binary ports required?	No
Will SAS Viya Monitoring for Kubernetes be used?	Yes

Table 15 Installation summary – SAS Viya Prod

Item / Task	Description
Customer site number	70292688
Cloud or on-premises deployment (If using a Cloud Provider state the provider being used)	Azure AKS
SAS software cadence	LTS 2022.01
SAS Viya product offering(s)	SAS Visual Data Science plus Risk Modelling Add-on
Environments to be installed	SAS Viya Prod
Will a shared Kubernetes cluster be used?	No
Will the Deployment Operator be used	Yes
Will the SAS Viya 4 Automated Deployment tool be used?	Yes
Is a High Availability (HA) configuration required for the stateless services?	Yes
Will the CAS Server run in SMP or MPP mode?	SMP
If using CAS MPP, is a backup Controller required?	Will be required later. Initial deployment will be SMP.
Internal or External instance of PostgreSQL?	Internal
Will the customer's TLS (X.509) certificate be used for the Ingress?	Yes
What authentication method will be used?	OpenID Connect
What Identity providers will be used?	SCIM / LDAP using Azure AD.
Will a custom SSSD configuration be used?	No
Is external access to binary ports required?	No
Will SAS Viya Monitoring for Kubernetes be used?	Yes

Appendix A.   Pre-Installation Checklist

The following checklist details the activities that should be completed prior to the SAS installation specialist starting the install and configuration of the SAS software. It also includes the high-level tasks to configure and deploy the SAS Viya software.

ID	Task	SBSA	SAS	Status / Notes
1.	Download the Deployment Assets for the selected SAS Viya cadence version from the my.sas.com portal	✓		
2.	Create service and SAS administrator accounts	✓		
3.	Create any new user groups and required accounts	✓		
4.	Provide any required X509 Certificates	✓		
5.	Download the SAS Viya Administration Resource Kit from GitHub https://github.com/sassoftware/viya4-ark	✓		
	Kubernetes environment setup			
6.	Azure administration & subscription	✓		
7.	Provide functioning AKS (K8s) cluster for SAS Viya 2021.1.5 (For Production: SAS Viya 2022.1)	✓		Will SAS RMS be used?
8.	Provide AKS (K8s) cluster administration for SAS Viya 2021.1.5 (For Production: SAS Viya 2022.1)	✓		Will SAS RMS be used?
9.	Required client software and tools have been installed on a jump host or the workstation to be used for the installation activities			
10.	Create the base directory structure that will be used for the deployment assets	✓		
11.	Create the Kubernetes Cluster for the SAS Viya environment(s)	✓		
12.	Configure the NSG and firewalls rules required to support communication and access to the SAS environment			

ID	Task	SBSA	SAS	Status / Notes
13.	Label and taint nodes to support the Workload Management Plan	✓	✓	SAS to assist as required.
14.	Install the Kubernetes logging and monitoring tools	✓	✓	SAS to assist as required.
15.	Create a Mirror Registry	✓	✓	SAS to assist as required.
16.				
	Data Sources			
17.	Install required database client software and drivers on persistent volume	✓		
18.				
	SAS Viya Deployment			
19.	Configure High Availability (optional)		✓	
20.	Configure TLS		✓	
21.	Configure PostgreSQL (internal instance)		✓	
22.	Configure PostgreSQL (external instance)	✓	✓	
23.	Configure CAS Server type and settings		✓	
24.	Configure Kerberos (if being used)	✓	✓	
25.	Configure SSSD (optional) – customer to advise if SSSD will be enabled and to provide any custom SSSD settings (optional). See here for details.	✓	✓	
26.	Persistent storage is required by multiple SAS Viya components. Verify that a storage class has been defined. See the System Requirements: Persistent Storage Volumes, PersistentVolumeClaims, and Storage Classes Also see Additional PVC Requirement for Microsoft Azure			
27.				

ID	Task	SBSA	SAS	Status / Notes
28.				
	Post Installation Tasks			
29.	Configure authentication / Identity provider		✓	
30.	Perform platform validation tests		✓	
31.	Arrange for a full backup of the persistent storage and the SAS Viya environment configuration, for the purposes of using this as a restore point in the event of a disaster to a known working state	✓	✓	SAS to assist as required.
32.	Assign customer resources for Knowledge Transfer session(s)	✓		

Appendix B. Definitions of Terms and Glossary

Term	Description
AD	Active Directory
AD DS	Active Directory Domain Services
BI	Business Intelligence (reporting related)
BU	Business Unit
Data Aggregation	Data Aggregation is a type of data migration where data may be drawn from several different source databases and consolidated on a single target database.
Data Constraints	Data Constraints describe the constraints for data items. For example, one data item must be numeric while another must be alphanumeric and match the ISBN format.
Data Dictionary	Data Dictionary is a catalogue listing of the entities, their attributes, data types, constraints, and descriptions. Input is provided from an initial analysis of the legacy data sources and the Physical Data Catalogue produced earlier. However, the data dictionary will be aligned to the requirements provided by the Functional team and the business. The data dictionary will also be aligned to the different process areas as identified by the functional team.
Data Mapping Activity	Data Mapping Activity is the activity that defines the mapping or translation of records and fields as used by one system to those as used by another. This activity is necessary for successful data migration and data integration.
DBMS	DBMS is a Database Management System and usually represents an industry standard database such as Oracle or Sybase SQL Server.
Dispatch Window	A dispatch window specifies one or more time periods during which batch jobs are dispatched to run on hosts. Jobs are not dispatched outside of configured windows. Dispatch windows do not affect job submission and running jobs (they are allowed to run until completion).
Domain Model	Domain Model is a data model that represents the overall logical structure of a database, independent from any software or data storage structure considerations. It is based on an understanding of the legacy data sources as well as the new data requirements. The Domain Model will provide a high-level view of the new enterprise data requirements and logical organisation of that data.
DR	Disaster Recovery
EDW	Enterprise Data Warehouse
ELT	Extract, Load, Transform
Entity Relationship Diagram	Entity Relationship Diagram (ERD) is a graphical method for showing the entities and relationships between them. For example, what is the relationship between a 'company' and 'employee'? A company may have many employees, but an employee can only belong to one company.
ETL	Extract, Transform, Load
FTP	File Transfer Protocol
GB	GigaByte

Term	Description
HA	High Availability
Logical Data Model	Logical Data Model models the overall logical structure of a database, independent from any software or data storage structure considerations. This may be an existing SAS pre-defined Data model.
SBSA	Standard Bank South Africa
SCIM	System for Cross-domain Identity Management (SCIM) is a standard for automating the exchange of user identity information between identity domains, or IT systems.
SSO	Single Sign-On
Static/Reference Data	Static/Reference Data is data that does not change often and is used to reference common data items. For example, currencies are used in different places, but the choice of currencies is always the same. It is often used to populate user choices for the front end.
Vocabulary	Vocabulary is used to refer to a collection of data items that have the same meaning but may be called by different names, depending on the system that references the data item. There should be a common agreed vocabulary for the enterprise data model. This will ensure consistency and avoid confusion.