SAS® Viya® on Kubernetes

Sharing Experiences After 2 Years in Production

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About Myself

Bernhard LAINER

- Born in a small village in Salzburg, Austria
- Started with SAS 9.1.3 about 18 years ago for Raiffeisen Bank and UNIQA Insurance
- Started about 2,5 years ago with container platforms with no prior experience

About Myself

Hans-Joachim EDERT

- I‘m based in Heidelberg, in southern Germany, close to the local SAS office
- Working for SAS since 2002
- Started as a Presales consultant and moved to an international team 2 years ago
- I‘m a cloud architect with a focus on Viya on Kubernetes
- I have specialized in upstream Kubernetes, Azure AKS and Red Hat OpenShift

SAS® Viya® on Kubernetes

Agenda

- Raiffeisen Informatik – Corporate Profile
- Our SAS estate at Raiffeisen Informatik
- Deploying and managing SAS Viya on OpenShift
  - SAS Viya on Kubernetes - architectural changes
  - Managing the software lifecycle
  - Operating SAS Viya on Kubernetes efficiently
  - Migration to SAS Viya on Kubernetes
- Future plans and lessons learned

Raiffeisen Informatik GmbH & Co KG

Corporate Profile

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About Us

Raiffeisen Banking Group (RBG)

- Austria's **largest banking group**
- 327 independent Raiffeisen banks
- 8 regional Raiffeisen banks
- 1,637 banking branches in Austria
- Almost **every second Austrian** is a customer of a Raiffeisen bank
- **400 billion euro** consolidated balance sheet total according to IFRS (as at 31.12.2022)
- around **30 percent market share** (for loans)
- **221 billion euro** in customer deposits (incl. building society deposits)
- Focus on financing: for SMEs, trade and commerce, tourism, industry, agriculture, etc.
- around **33,000 employees**

Raiffeisen Group (Facts & Figures 31.12.2022)

Raiffeisen Informatik GmbH & Co KG

- Professional IT services for more than **50 years**
- **1,100 employees**
- **2.4 million users in MEIN ELBA** online banking
- **41 million logins** to MEIN ELBA app per month

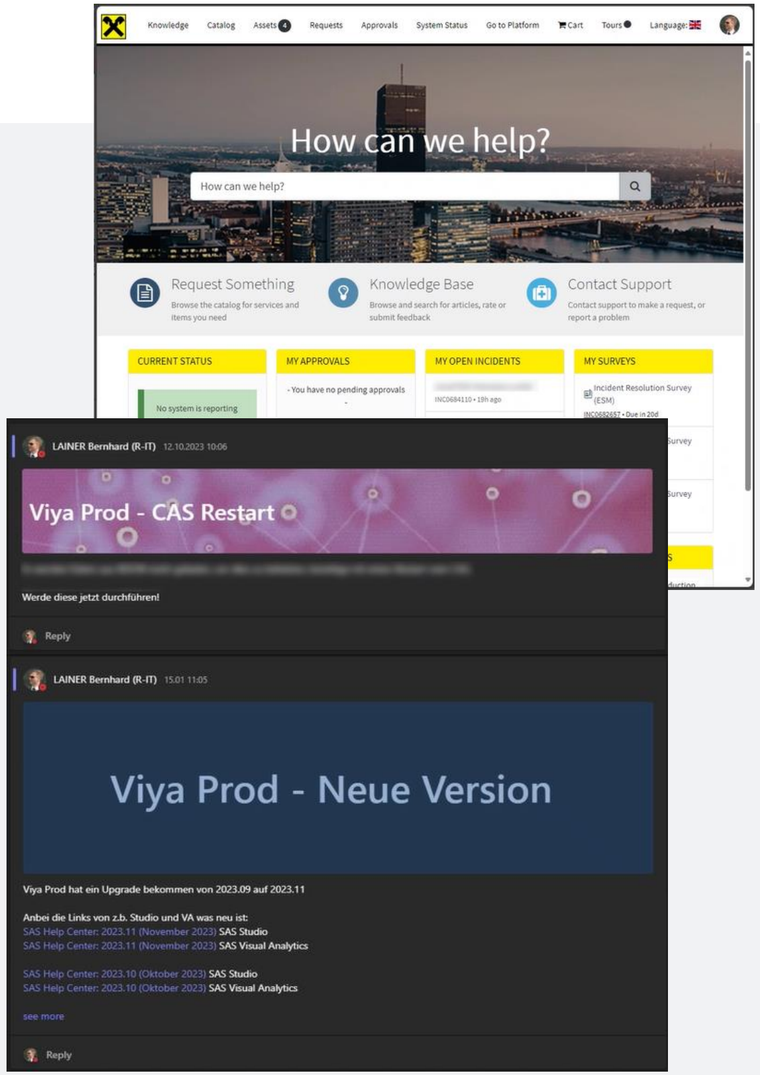
About Us

The SAS administration team at Raiffeisen IT

- **Small team of 2 admins**
  - Taking care for all SAS environments (SAS 9.x, Viya 3.x, Viya 4)

- **Additional Support provided by**
  - SAS SAM services („SAS Application Management“)
    - Team of SAS consultants with on-site access
    - Engaged for ticket handling and regular system maintenance tasks, based on a contractual agreement with SAS
  - Some power users in various business units
    - Channeling news propagation and user feedback

- **Communications**
  - End users are asked to use our internal ticketing system for submitting support incidents, promotion tasks, change requests etc.
  - Microsoft Teams channel allows to us broadcast news to the internal SAS community
    - Often used as a “shortcut“ for sending feedback (especially after updates ☺)



Our SAS estate

How SAS is used at Raiffeisen Informatik

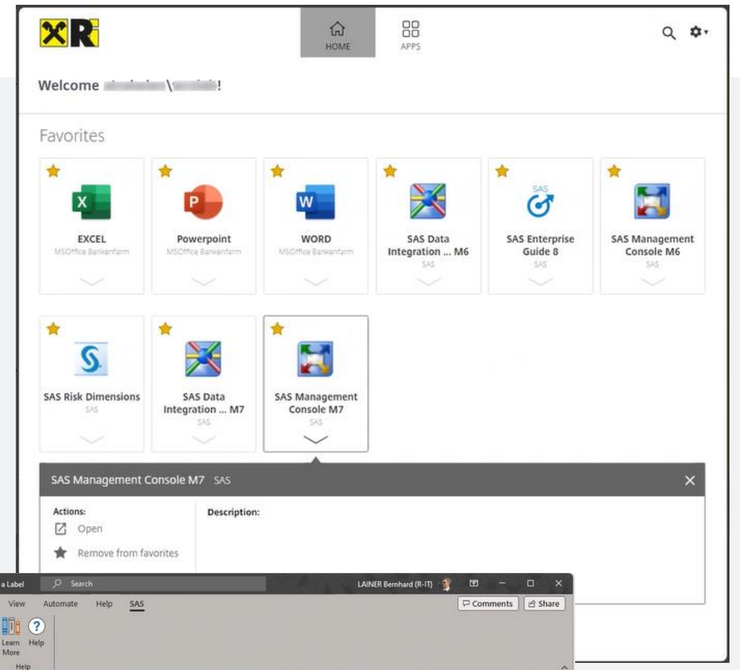
Our SAS Estate

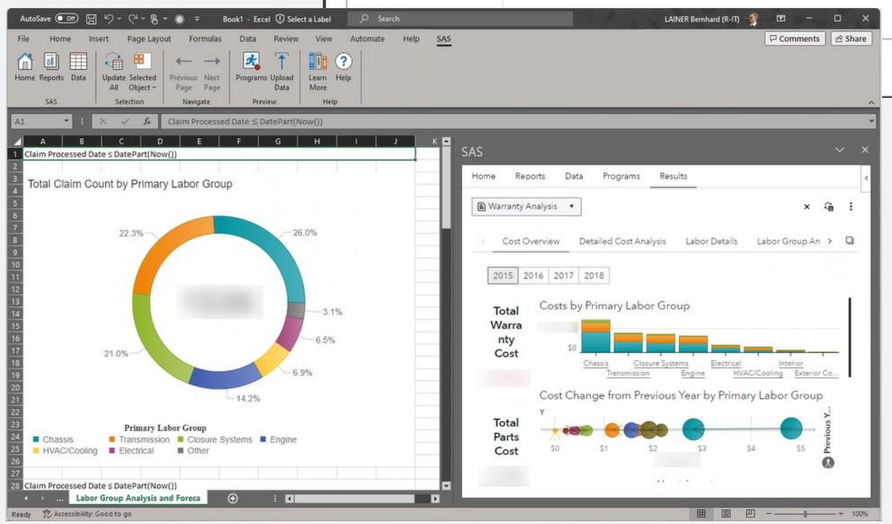
SAS environments hosted by Raiffeisen Informatik

- **SAS 9.4**
  - 25+ separate environments, actively managed, on about 40 machines
  - Linux, AIX, zOS, SAS clients on end-user workstations or provided on Citrix virtual apps
  - Hosting the SAS platform and many SAS Solutions
    - SAS Enterprise Governance and Compliance, SAS Regulatory Capital Management, SAS Credit Risk, SAS Market Risk, SAS Credit Scoring, Risk Stratum
  - Migration to SAS Viya on Kubernetes ongoing / planned

- **Viya 3.5**
  - Both in SMP (“Single-node”) as well as MPP mode (“cluster”)
  - Migration to SAS Viya on Kubernetes ongoing / planned

- **SAS Viya on Kubernetes (“SAS Viya 4”)**
  - Deployed on Red Hat OpenShift Container Platform (OCP)
  - Currently 3 environments on shared infrastructure
  - As of now, 5 additional environments are planned, most likely on dedicated infrastructure





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Our SAS Estate

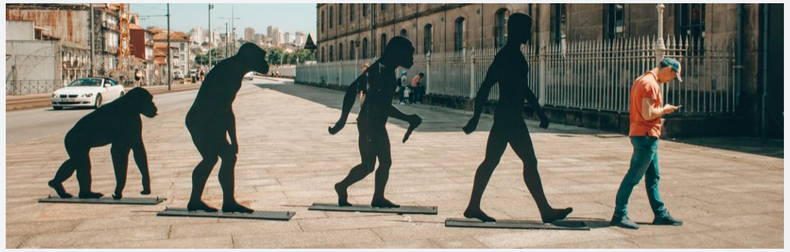
SAS Viya on Red Hat OpenShift

Red Hat OpenShift

- **All SAS Viya 4 environments are deployed on Red Hat OpenShift (OCP)**
  - Running on top of VMWare virtualization
- **OpenShift is a well-established platform at Raiffeisen Informatik**
  - We‘re running large OCP clusters hosting business-critical workloads for years already
  - Skilled operations team, trusted operating procedures …
- **Moving SAS Viya to the OpenShift infrastructure seemed to be a logical step**
  - In total SAS Viya is assigned to around 150 cores and 1.5 TB memory
- **As of now: still sharing the cluster infrastructure with non-SAS apps**
  - Planning to move to dedicated infrastructure in the near future
  - Will make it easier to align the update cycles of both software stacks (OpenShift version and SAS release can‘t be apart too far)

Our SAS Estate

Moving from SAS 9.x to SAS Viya 4: administrative benefits



- **Moving the SAS estate to SAS Viya on Kubernetes is our strategic goal**
  - Migration already underway, but not yet completed
- **Some benefits we‘re expecting for our daily work**
  - Getting rid of maintaining the Linux servers used for SAS 9.x
    - Avoiding time-consuming coordination with our Linux admin team
    - Less low-level work on operating system
  - Less ad-hoc maintenance because of Kubernetes „self-healing“ capabilities
  - Scaling out/scaling up the environments is now much easier
    - … and the OpenShift host machines are much more powerful …
  - All clients are web-based!
    - Avoiding the effort for packaging and distributung local Windows clients and clients deployed as Citrix virtual apps
  - Updating the SAS licenses has become much easier – it‘s part of the regular update process now

SAS Viya on OpenShift

Deploying and managing SAS Viya

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SAS Viya on Kubernetes

Overview: changes in the architecture of SAS Viya on Kubernetes

- **Latest SAS Viya is a fully re-architected SAS software stack**
  - SAS architecture now based on a microservices architecture
  - SAS stack provided as a collection of container images and deployment templates

- **Runs natively on Kubernetes infrastructure**
  - Kubernetes: open-source framework for orchestrating containers, initially created by Google
  - Available as managed service in all public clouds
  - Many SAS customers choose to run SAS on the Kubernetes distribution provided by Red Hat: Red Hat OpenShift Container platform (OCP)
    - Red Hat claims that OCP is “a hybrid cloud, enterprise Kubernetes application platform”
    - Runs on bare-metal, on virtual infrastructure, in private as well as in public clouds
    - Enterprise-grade Kubernetes with a “secure-by-default” approach

Azure Kubernetes Service (AKS)

Google Kubernetes Engine

Viya 4 Deployment

Managing the software lifecycle

- **We‘re updating our Viya environments usually every 2-3 months (= STABLE releases)**
  - Update process is based on GitOps approach, but not yet fully automated
  - We‘re using a combination or OpenShift Templates and the SAS Deployment Operator

- **OpenShift Templates**
  - Using on the sas-orchestration container image and a custom container image with viya4-orders-cli and mirrormgr installed
  - *“A template describes a set of objects that can be parameterized and processed to produce a list of objects for creation by OpenShift Container Platform.”* (*)

- **SAS Deployment Operator**
  - *“(…) provides an automated method for deploying and updating your SAS Viya platform deployment. It runs in the Kubernetes cluster and watches for declarative representations of SAS Viya platform deployments in the form of custom resources (CRs) of the type SASDeployment.”* (**)

(*) https://docs.openshift.com/container-platform/4.14/openshift_images/using-templates.html
(**) https://go.documentation.sas.com/doc/en/itopscdc/v_049/dplyml0phy0dkr/n137b56hwogd7in1onzys95awxqe.htm

Viya 4 Deployment

OpenShift Templates

```
$ oc edit template rit-viya-orders-cli

$ oc process --parameters -n rlb-sas rit-viya-orders-cli

NAME                    DESCRIPTION          GENERATOR           VALUE
orderNum                                                         9XXYYZZ
cadenceName                                                      stable
cadenceVersion                                                   2024.02

$ oc process rit-viya-orders-cli | oc create -f -
$ oc logs job/rit-viya-orders-cli -n rlb-sas -f
```

Set the parameters which should be used by the Job

Check that parameters are o.k.

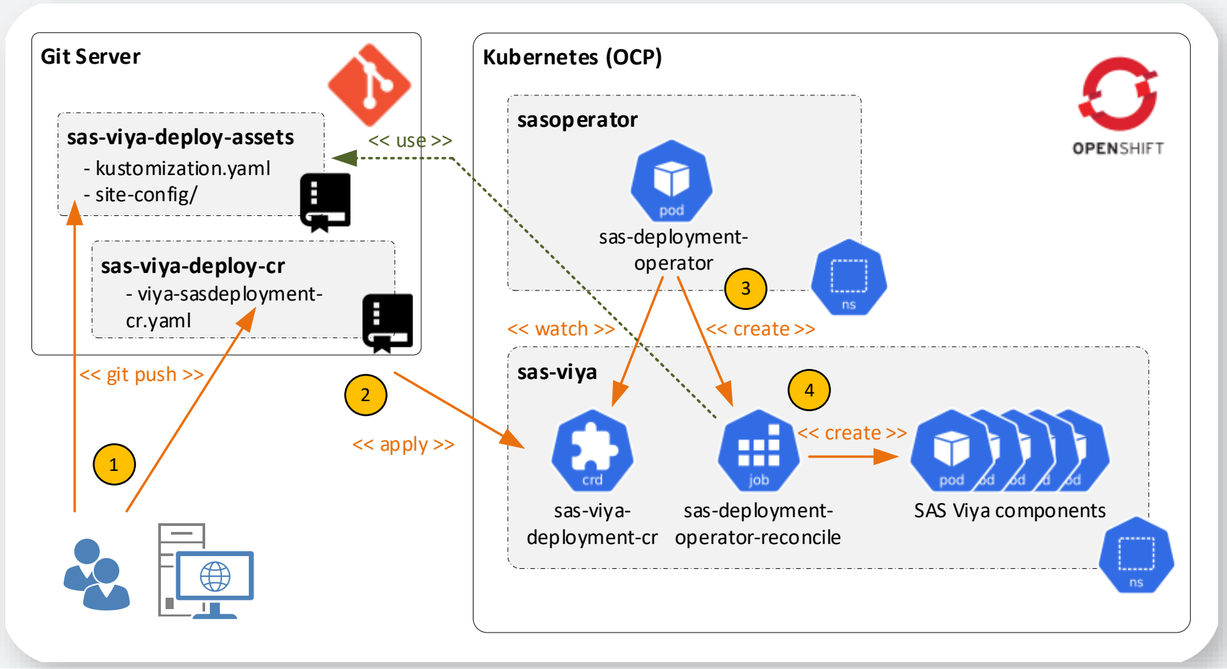
Apply the template (launch the Job)

Check progress

Viya 4 Deployment

SAS Deployment Operator

- **SAS Deployment Operator uses the Kubernetes Operator pattern**
  - *"Operators are software extensions to Kubernetes that make use of custom resources to manage applications (..). The operator pattern aims to capture the key aim of a human operator who is managing a service (with) deep knowledge of how the system ought to behave, how to deploy it, and how to react if there are problems." (*)*
- **Optional service provided by SAS to automate the SAS Viya software lifecycle (deploy/update/delete)**
  - Deployed separately to SAS Viya
  - Runs with elevated privileges
  - Works on information stored in a Custom Resource object ("SASDeployment")
  - Can be integrated into GitOps approach



(*) https://kubernetes.io/docs/concepts/extend-kubernetes/operator/

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Viya 4 Deployment

Step by step

1. Run preparation Job (using OpenShift Templates)

   Download the deployment assets, licenses and certificates (viya4-orders-cli)
   Download SAS Viya images and push them to our Harbor registry (mirrormgr)

2. Update SAS Deployment Operator and sas-orchestration

   This is the only time I need privileged permissions on the OpenShift cluster!
   ("support arrangement" with the OpenShift admin team is in place)

3. Some manual steps (to be automated …)
   1. Adjust mirror.yaml
   2. Work through Deployment Notes
   3. Update manifests as needed
   4. Push to Git

   (1) - not required, but recommended: it will help you to stay organized if you have folders for each release in the container registry

   ```
   harbor.registry.local/viya4/2024.01/sas-arke
   harbor.registry.local/viya4/2024.01/sas-audit
   …
   harbor.registry.local/viya4/2024.02/sas-arke
   …
   ```

   (2) - I recommend to prepare a list what to do BEFORE and AFTER the reconcile run

4. Run sas-orchestration Job (using OpenShift Templates)

   Runs the kustomize command and creates the input resource needed by the Deployment Operator. Output is written to Git.

5. Validate and submit SASDeployment Custom Resource

   This triggers the Deployment Operator's reconcile run

SAS Viya on Kubernetes

Operating SAS Viya (efficiently)

- **Some of my typical “day-2” tasks**
  - Making sure that access to fileshares works (mapping user and group IDs)
  - Keeping an eye on the environment (logging and monitoring)
  - Onboarding of new departments
  - Setting up schedules for automatic loading of CAS tables
  - Connecting to external data sources (SQL databases)
  - “Tweaking” and “tuning” the platform

  - … and of course: handling user questions and technical issues

SAS Viya on Kubernetes

Typical „day-2“ tasks

- **Mapping user and group IDs**
  - Many departments in the bank still store their business data on fileshares
  - Maintaining filesystem security (based on numerical user and group IDs) is essential
  - “No common ground”: user information used by NAS fileshares comes from a domain which is different to the domain used by SAS
    - “Access denied”: UID/GID attributes do not match

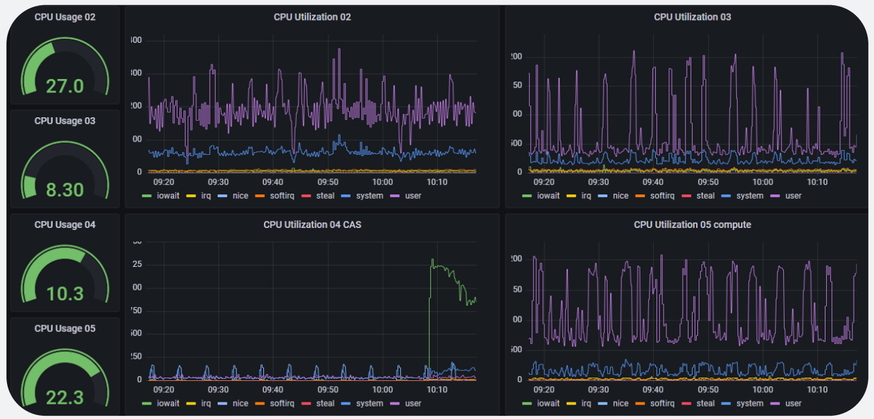
- **Solution:**
  - SAS Viya CLI allows us to map the “right” UID/GID values to SAS users
  - Stored in the SAS identity cache
  - Scheduled to run as a script, looping over all accounts which need to access the NAS shares

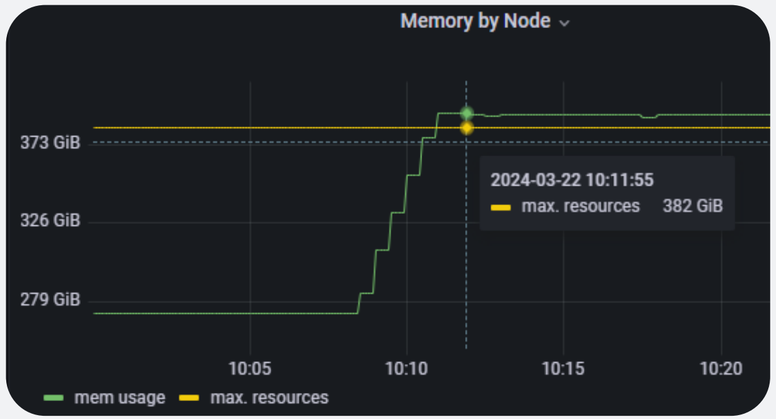
```
$ sas-viya --profile $PROFILE identities update-user --id eric --uid 1000 --gid 6999
```

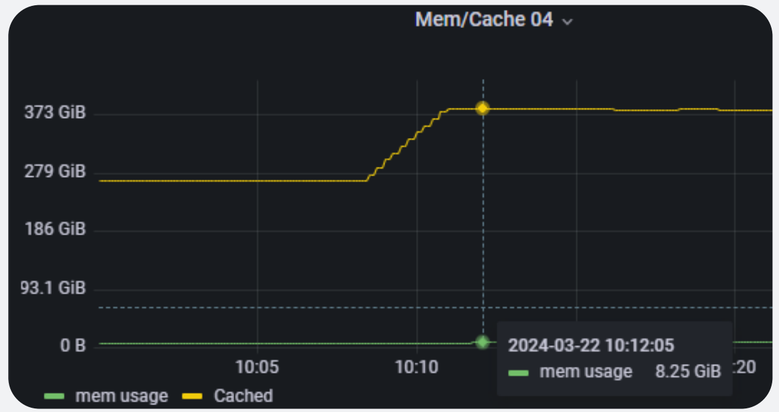
SAS Viya on Kubernetes

Typical “day-2” tasks

- **Logs and Monitoring (Splunk and Grafana)**
  - I created specific Viya dashboards to monitor on resource consumption (CPU / memory / disk)
    - Based on this Git project: https://github.com/sassoftware/viya4-monitoring-kubernetes
  - Sometimes you need to understand how SAS engines work to make sense of the KPIs you see
    - E.g. the difference between CAS “mem usage“ and “mem cached“!







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SAS Viya on Kubernetes

Typical “day 2 tasks”

- Onboarding of new departments
  - Fully automated self-service process for departments
  - Based on AD group memberships and ServiceNow tickets
- Connecting to external data sources
  - Currently we have connected more than 100 different SQL databases to our Viya environments
    - Mostly SQL Server, Exasol, Oracle, PostgreSQL
- Setting up schedules for automatic loading of CAS tables
  - Centrally managed by us (admin team) based on a coordination with the customer as to what is to be done (*what*, *when* and *how often*)
- “Tweaking” and “tuning” the platform
  - Based on metrics collected over time …
    - Upscale the CAS nodes
    - Set CPU and memory limits for SAS compute sessions
    - Increase the default timeout values for background job submits and web apps
  - DVR (“duplicate value reduction”) significantly reduced the CAS memory requirements
    - But you need the “right“ kind of data for it to be effective …

SAS Viya on Kubernetes

Migration plans

- **We started with migrating the BI and Reporting usecases**
  - Moving reports from SAS 9.x (WebReportStudio) and older VisualAnalytics to the new Viya platform

- **Why:**
  - Immediate positive feedback and thanks to new and improved features in VA
  - Users have an “easy way” to make themselves familiar with the new platform
  - Avoiding the “big-bang approach”
    - Helps us (admin team) to set up and gradually optimize our processes as well

- **Based on availability, we now moved on to migrate other use cases as well (SAS solutions)**

Future plans and lessons learned

SAS Viya on Kubernetes

SAS Viya on Red Hat OpenShift – some remarks

- Red Hat OpenShift is a bit different to other Kubernetes distributions
  - Adds additional security-related layers to Kubernetes
  - Encourages on-site administration teams to adopt a specific operating model
- SAS has made great efforts to find an answer to these requirements
  - Still, deploying SAS Viya on OCP requires thorough preparation together with the Kubernetes administration team
- For deploying SAS Viya (“day 1”)
  - Support from Kubernetes administration team required to deploy some components
    - SAS uses Kubernetes operators, which create global metadata (i.e. outside the deployment namespace)
- For running SAS Viya (“day 2” ff.)
  - A few SAS services (most importantly: SAS compute and CAS) require elevated permissions which need to be granted by Kubernetes administratores
    - SAS provides custom Security Context Constraints (SCCs) which need to be applied

SAS Viya on Red Hat OpenShift

„Shaking hands“ - the SAS team and the OpenShift admin team need to cooperate

- Discuss planned topology, sizing and security requirements

- (review security requirements)
- (provide cluster infrastructure)

- Create new project
- Create user account for deployment

- Download deployment assets
- Create site.yaml manifest

- Deploy cluster-wide resources
- Deploy security constraints manifests

- Deploy namespace-local resources

Lessons Learned

SAS® Viya® on Kubernetes

- Don’t assume you will “right-size” your environment upfront
  - Revisit your decisions based on collected metrics (btw: DO collect metrics …) and use built-in Kubernetes elasticity to your benefit
- Fast, local disks (vSAN) are essential for CAS data loads
  - E.g. for loading a 30 GB sashdat file to CAS we started with a NAS share (25 min) and optimized it to 2 min after switching to a vSAN share
- DVR (“duplicate value reduction”) made a big difference for CAS tuning
  - However, it works best on character data with low cardinalities (i.e. city or product names …)
- Keep an eye on the PostgreSQL database disk space usage
  - Especially the audit table can grow enormously

Future Plans

SAS® Viya® on Kubernetes

- We’re all set up, now we need to promote the SAS platform even more!

- Some items on my To-Do list …
  - Investigate how to automate the promotion of reports (Dev – Test - Prod)
  - Investigate if the integrated Container Registry provided with Red Hat OpenShift could be used as a mirror
  - Make (better) use of the SAS Workload Orchestrator to optimize our resource consumption
  - Investigate the “Audit Tables Archive” feature for PostgreSQL to better control the growing demand for disk space
  - *Fully* automate the lifecycle operations by using OpenShift Pipelines (Tekton) and OpenShift GitOps (ArgoCD)

Closing off, the story so far …

SAS® Viya® on Kubernetes

- I started my journey 2,5 years ago with no prior experience of Kubernetes
- Kubernetes requires a different kind of thinking
  - Automation becomes a key principle
- The architecture might have changed, but, at the co
  it‘s still the same SAS
- It has been a steep, but rewarding learning curve
  - Rest assured, you <u>will</u> reach a comfortable „knowledge plateau“

Additional resources

Links to documentation and more …

- Technical overview of SAS Viya on Red Hat OpenShift
  - https://www.redhat.com/en/blog/sas-viya-on-red-hat-openshift-part-1-reference-architecture-and-deployment-considerations
  - https://www.redhat.com/en/blog/sas-viya-on-red-hat-openshift-part-2-security-and-storage-considerations
- SAS Viya Operations Guide (incl. system requirements for OpenShift)
  - https://go.documentation.sas.com/doc/en/itopscdc/v_050/itopswlcm/home.htm
- SAS Viya Monitoring for Kubernetes
  - https://github.com/sassoftware/viya4-monitoring-kubernetes
- OpenShift Templates
  - https://docs.openshift.com/container-platform/4.14/openshift_images/using-templates.html
- OpenShift GitOps
  - https://docs.openshift.com/gitops/1.12/understanding_openshift_gitops/about-redhat-openshift-gitops.html
- The Kubernetes “Operator” pattern
  - https://kubernetes.io/docs/concepts/extend-kubernetes/operator/

Thank you for your time!

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