Redesigning and Implementing the Bootstrap of Large Scale Kubernetes Enterprise Infrastructure through Automated Self Contained CLI

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by

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> *Redesigning and Implementing the Bootstrap of Large Scale Kubernetes Enterprise Infrastructure through Automated Self Contained CLI*

gemäß § 5 der „Studien- und Prüfungsordnung DHBW Technik“ vom 29. September 2017 selbstständig verfasst und keine anderen als die angegebenen Quellen und Hilfsmittel benutzt habe. Die Arbeit wurde bisher keiner anderen Prüfungsbehörde vorgelegt und auch nicht veröffentlicht.

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Abstract

- Deutsch -

Um unternehmensübergreifende Prozesse auf ein neues Niveau zu heben, arbeitet SAP an der Entwicklung von *Cross-Company Workflow Collaboration*. Die dort anfallenden, geteilten Prozessdaten sollen in *Signavio Process Intelligence* importiert werden, um sie dort mittels Process Mining zu analysieren und in Key Performance Indicators darzustellen. Da bei Cross-Company Workflow die *SAP Blockchain* zur Datenhaltung verwendet wird, stellt die Aufbereitung der Daten für eine Analyse in Signavio jedoch eine Herausforderung dar.

Im Rahmen dieser Projektarbeit werden zunächst diese Schwierigkeiten herausgearbeitet. Anschließend wird sich mit der Konzeptionierung eines Datenintegrationsprozesses befasst. Hierzu wird zum einen erörtert, wo die Transformation der Daten aus Cross-Company Workflow in das angestrebte Format durchgeführt werden sollte. Andererseits werden auch verschiedene Transportwege beleuchtet, über die die aufbereiteten Daten in Signavio Process Intelligence bereitgestellt werden sollen. Auf Basis des erarbeiteten Konzepts wird ein Prototyp der Datenintegration implementiert.

Abstract

- English -

In order to raise cross company processes to a new level SAP is working on the development of Cross-Company Workflow. The shared process data is to be imported into *Signavio Process Intelligence* to be analyzed with process mining and to be presented in Key Performance Indicators. Since Cross-Company Workflow uses the *SAP Blockchain* to store data the preparation of the data for analysis within Signavio is a challenge.

In the context of this report, these difficulties will first be discussed. It then deals with the conceptual design of a data integration process. For this purpose, on the one hand, it is discussed where the conversion of the data from Cross-Company Workflow into the target format should be carried out. On the other hand, different transport routes are discussed, through which the processed data should be made available in Signavio Process Intelligence. Based on the developed concept, a prototype of the data integration is implemented.

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List of Abbreviations

ACL Access Control List

API Application Programming Interface

CLI command-line interface

VCS Version Control System

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1 Introduction

2 Fundamentals

2.1 Go

Go (also known as Golang) is an open source programming language that was started at Google in 2007 and initially launched in 2009. The language was designed to face engineering challenges at Google with the goal to make it "easy to build simple, reliable and efficient software". [1, 2] By now the compiled and statically typed language [3] is widely used and the way it approaches network concurrency and software engineering has influenced other languages to a noticeable extent. [1] Through its structure go supports programming on various levels of abstraction. For instance, one can embed Assembler or C code into a Go program or on the other hand combine groups of components into bigger, more complex components to realize abstract design patterns. [4] Nowadays, Go is a popular choice for everything related to DevOps and therefor also for the development of command line tools. [5]

Go also tries to provide its own, official solutions for common tasks in software development. When installing Go, it comes packed alongside with a formatter (which shall ensure uniform styling across all programs written in Go) and an included suite for unit testing, just to name a few examples. Furthermore, Go supports generating documentation based on comments in the source code; much alike JavaDoc. Go features an extensive standard library which depicts a good starting point for developing your own applications. In case one wants to include a third party library, this can be done via the *go get* command. It fetches the necessary resources (usually directly from a Version Control System (VCS)) and saves the modules as a dependency in the *go.mod* file. (cite go tour and go docs)

2.2 Cobra

Cobra is an open source library for Go. Its aim is to provide developers with an easy way to create modern command-line interface (CLI) applications. The cobra library is

being used by noticeable projects like the CLIs for Kubernetes or for GitHub. The idea behind Cobra's intended command schema is that commands of a well constructed CLI should read like sentences. This way, new users that are familiar with CLIs in general quickly feel native because interacting with the CLI feels more natural. In this approach, a command represents a certain action that the CLI can perform. This action than take arguments and flags to further specify on which objects and in which way the command should take action. With Cobra, one can also easily create nested subcommands. This means that a before mentioned command can also be divided into multiple sub-actions to enable detailed handling of complex actions. Further, benefits of Cobra are, among others, the automated generation of autocomplete for the most common shells as well as the ability to automatically create man pages. [6, 7]

2.3 Terraform

2.4 Hyperscalers

2.4.1 AWS

2.5 Gardener

2.6 Jenkins

2.7 Kubernetes

Kubernetes (often short: k8s) is an open source solution to ease up and automate management of container based services. While doing so, it follows a declarative paradigm. This means that the users just needs to describe the desired state – for example through the use of configuration files or via the Kubernetes CLI – and Kubernetes determines the steps by itself which are necessary to reach and maintain this state. Kubernetes also enables users to dynamically scale their applications and services. This means that the amount of resources, that are dedicated to an application, is adapted during runtime

this sounds ugly

dependent, for example, on the current number of users. Furthermore, Kubernetes can perform load balancing and redundancy between different instances of the same service. [8, 9]

One instance of a Kubernetes system is called a cluster. A Cluster is composed of multiple nodes (which usually are virtual machines or physical servers) which run the actual applications. The interaction with a cluster is managed by the so-called *Kubernetes Master*. It is a central controlling unit. The user actually never interacts with the nodes themselves directly. [10]

2.8 Vault

Vault is a service with the primary task to provide a central control unit to manage and organize enterprise secrets. It encrypts secrets both at rest and in transit. Access to the secrets can be granted granular per user through the use of Access Control Lists (ACLs). Furthermore, vault audits access to the secrets. That means that it keeps a detailed log on whom accessed what secret at which point in time. If there was a security breach, where an unauthorized person got access to vault, this protocol can be used to tell, if a specific secret has been read by the attacker or if it is still safe to use.

Vault is designed to be highly pluggable. An instance is composed of *storage backends*, *audit log instances*, *authentication providers* as well as *secret backends*. Each of these can be impersonated by a variety of different components. This makes it possible to use different trusted authorities for attestation of identity. For example, among others LDAP, JWT, GitHub, and Radius can be used. An automated build service could very well use a different service to authenticate to vault than a human user.

Secrets and encryption are often the weak spot in applications. If a secret gets leaked and the leak stays unnoticed, attackers could gain long term access to a system. As a solution, Vault offers *dynamic secrets*. When a client requests the access credentials for a supported system, Vault creates a short-lived secret just for that specific client. Because the client is only accessing vault, it does not have to bother with key creation nor rotation and an increased layer of security is added by not using secrets for an extended period of time. Also, if a dynamic secret gets leaked, this single secret can be revoked individually.

If all clients accessing the resource used the same credentials, changing or blocking those could potentially cause an outage of the whole system.

When it comes to encryption, it can happen rather quickly that a single mistake compromises the security of the whole application. Because of this, vault offers encryption as a service. The idea is, that vault concentrates on the single task to handle credentials and encryption safely. The broad variety of applications have a different focus and are not developed with the necessary expertise to guarantee safe implementation of security measures. Vault, on the other hand, uses implementations that are audited by the open source community as well as independent experts. Those are then provided as a high level Application Programming Interface (API) to application developers. That way, the encryption process of data gets very easy while, at the same time, vault can handle the used encryption keys directly, and they are never actually sent to the application itself.

2.9 Bootstrap

3 Evaluation and Future Work

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