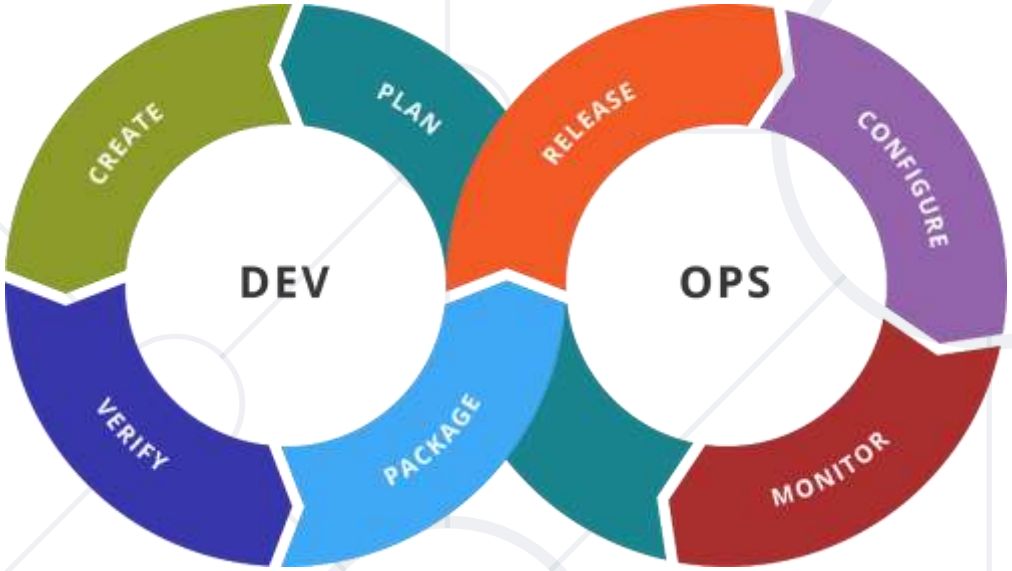
Prometheus and Grafana



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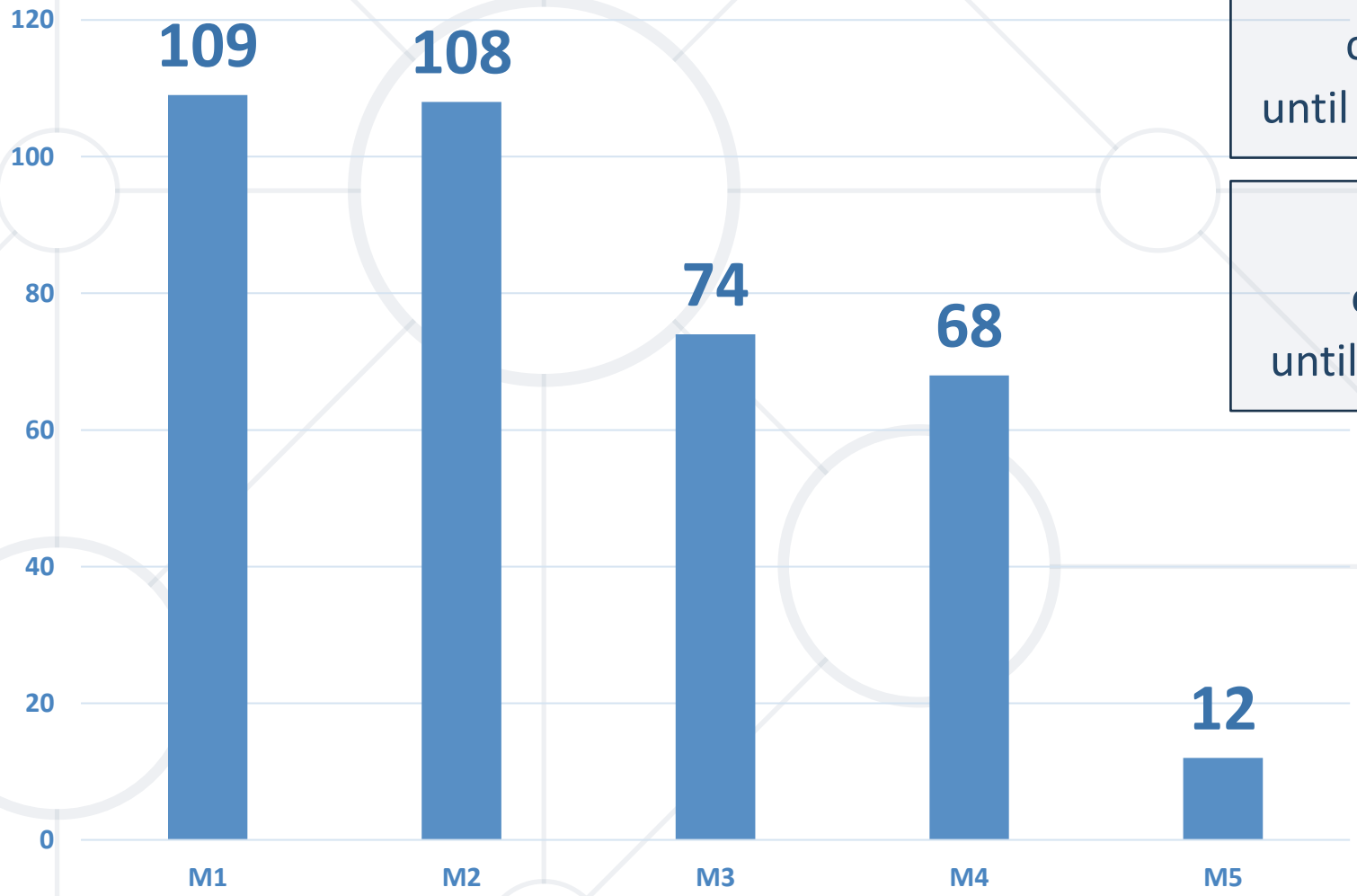
/groups/DevOpsContainerizationCICDMonitoringJanuary2023

Homework Progress



Solutions for M5
can be submitted
until 23:59 on 08.03.2023

Solutions for M6
can be submitted
until 23:59 on 15.03.2023

Previous Module (M5)

Quick Overview

What We Covered

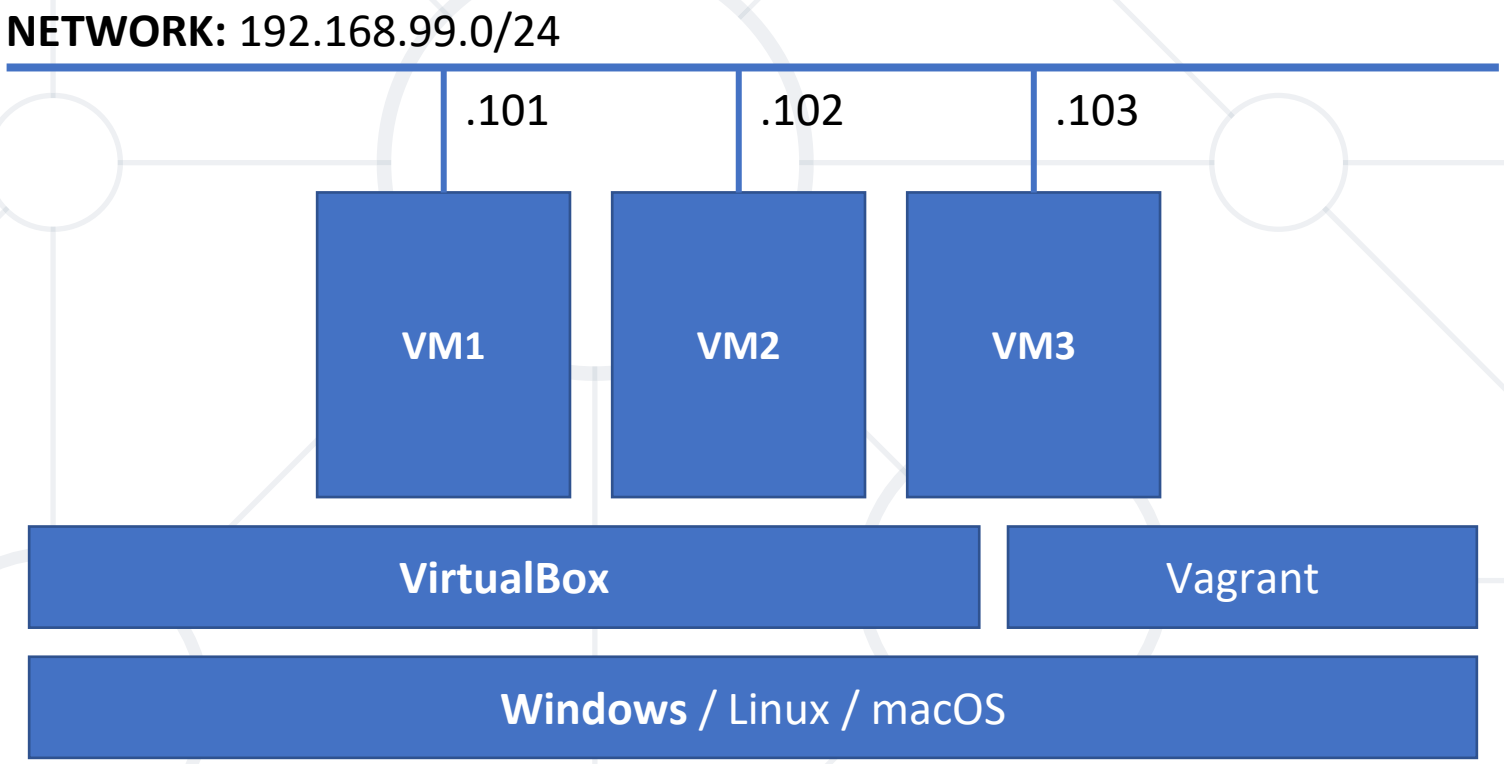
- Remote (slave) hosts
- Working with Jenkins using CLI
- Export and Import jobs
- Blue Ocean
- SCM integration

This Module (M6)

Topics and Lab Infrastructure

Table of Contents

Lab Infrastructure



Prometheus 101

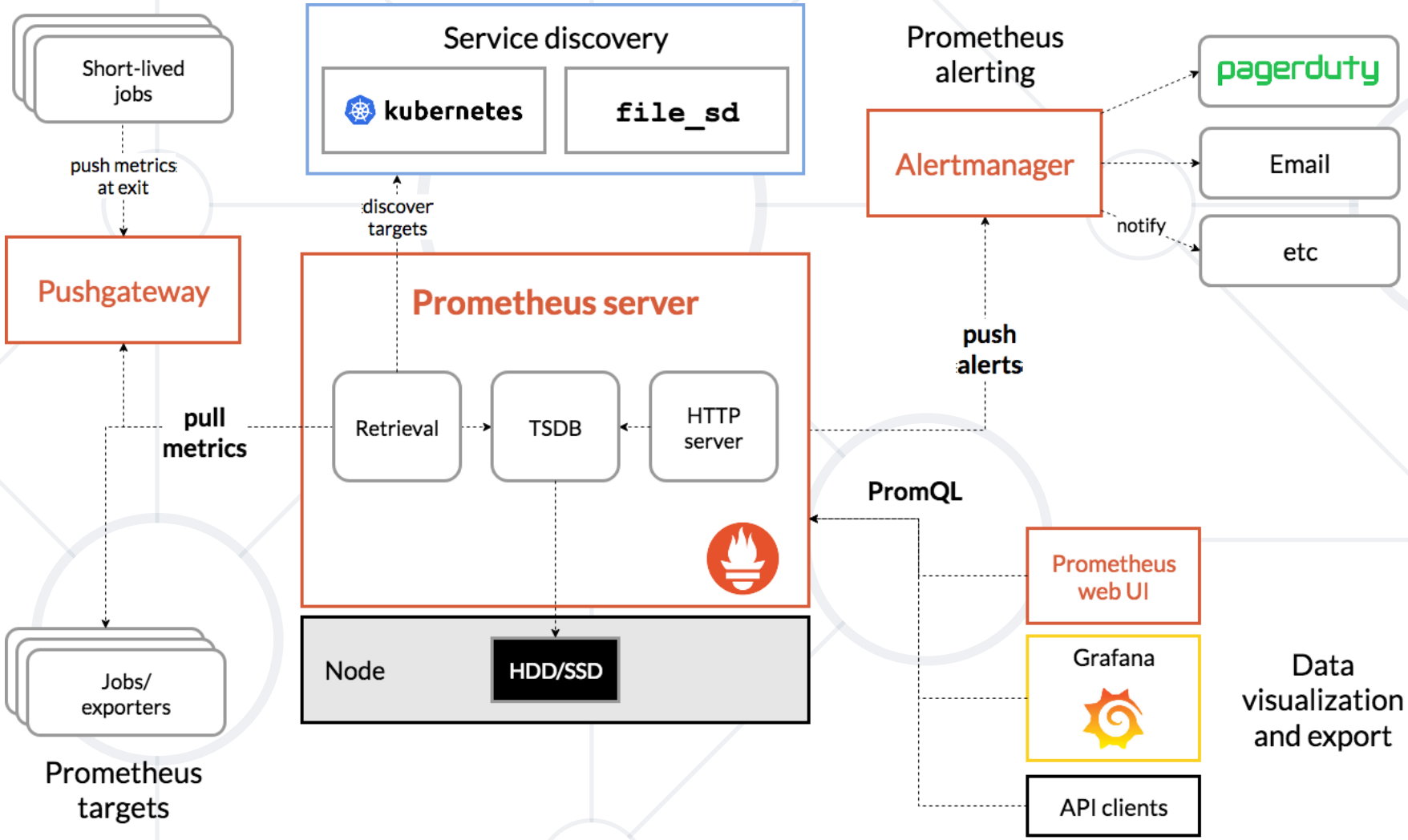
Getting to Know Prometheus

What is Prometheus?

- An open-source toolkit for **monitoring** and **alerting**
- Collects and stores **metrics** as **time series data**
- Additionally, it can store **optional labels** (key-value pairs)
- Offers flexible query language (**PromQL**)
- Data collection happens via **pull model** over HTTP
- Pushing of data is also supported via an **intermediary gateway**
- Suitable for recording pure numeric time series
- Not suitable when we need 100% accuracy (for example, for billing)

https://prometheus.io/docs/introduction/overview/

Architecture



https://prometheus.io/docs/introduction/overview/

Install Options

- Pre-compiled binaries
  - Most popular operating systems are supported
- Build from source
- Using containers
- Using configuration management systems
  - Ansible, Chef, Puppet and Salt
- Different components are available as separate artefacts

https://prometheus.io/docs/prometheus/latest/installation/

Prometheus Configuration

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- Configured via **command-line flags** and a **configuration file**
- Command-line arguments are used to configure **immutable system parameters** like storage location, amount, etc.
- Configuration file is used to control **scraping** and **rules**
- The configuration file is in **YAML** format
- It can be reloaded (including any rules) by sending
  - **SIGHUP** to the Prometheus process
  - **HTTP POST** request to **/-/reload** endpoint (***--web.enable-lifecycle*** flag)

https://prometheus.io/docs/prometheus/latest/configuration/configuration/

Data Model

- Data is sored as **time series**
- Which are **streams of timestamped values** belonging to the same metric and the same set of labeled dimensions
- Every time series is uniquely identified by its **metric name and optional key-value pairs** called labels
- The metric name specifies the general feature of a system that is measured
- Labels enable Prometheus's dimensional data model
- Any given combination of labels for the same metric name identifies a particular dimensional instantiation of that metric

```
api_http_requests_total{method="POST", handler="/messages"}
```

https://prometheus.io/docs/concepts/data_model/

Metric Types

- **Counter** is a cumulative metric that represents a single monotonically increasing counter whose value can only increase or be reset to zero on restart. For example, number of tasks completed, requests served, etc.
- **Gauge** is a metric that represents a single numerical value that can arbitrarily go up and down. For example, temperatures, number of concurrent requests, etc.
- **Histogram** samples observations (like request durations or response sizes) and counts them in configurable buckets. It also provides a sum of all observed values
- **Summary** samples observations (like request durations and response sizes). While it also provides a total count of observations and a sum of all observed values, it calculates configurable quantiles over a sliding time window

https://prometheus.io/docs/concepts/metric_types/

Jobs, Instances, and Samples

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- An endpoint that we can scrape is called an **instance**
- Usually, it corresponds to a single process
- A collection of instances is called a **job**
- When target is scraped, two additional labels are added – **job** and **instance**
- Each instance scrape adds sample to a set of system time series
- A **sample** is a single value at a point in time in a time series
- Each sample consists of a float64 value and a millisecond-precision timestamp

https://prometheus.io/docs/concepts/jobs_instances/

Practice: See It in Action

Live Demonstration in Class

Prometheus 102

Advanced Tasks

Relabeling

- We can utilize two techniques to control the information flow
- **Target relabeling** is a powerful tool to dynamically rewrite the label set of a target before it gets scraped
- **Metric relabeling** is applied to samples as the last step before ingestion
- Both share the same configuration format and actions

https://prometheus.io/docs/prometheus/latest/configuration/configuration/#relabel_config

Recording Rules

- Allow to precompute frequently needed or computationally expensive expressions and save their result as a new set of time series
- Querying the precomputed result will be much faster
- Useful for dashboards, which need to query the same expression repeatedly every time they refresh
- Stored in rule groups
- Rules within a group are run sequentially at a regular interval

https://prometheus.io/docs/prometheus/latest/configuration/recording_rules/

Alerting Rules

- Define alert conditions and send notifications about firing alerts to an external service
- No matter if the alert condition will result in one or more vector elements at a given point in time, the alert counts as active
- They are defined the same way as recording rules

https://prometheus.io/docs/concepts/jobs_instances/

PromQL

Introduction

PromQL

- PromQL = Prometheus Query Language
- It allows to select and aggregate time series data in real time
- The result of an expression can either be
  - shown as a graph
  - viewed as tabular data

  } in Prometheus's expression browser
  - consumed by external systems via the HTTP API

https://prometheus.io/docs/concepts/jobs_instances/

Expression Data Types

- Expressions and sub-expressions evaluate to one of the following
- **Scalar** - a simple numeric floating-point value
- **String** - a simple string value; currently unused
- **Instant vector** - a set of time series containing a single sample for each time series, all sharing the same timestamp
- **Range vector** - a set of time series containing a range of data points over time for each time series

https://prometheus.io/docs/concepts/jobs_instances/

Vector Selectors

- Instant vector selectors allow the selection of a set of time series and a single sample value for each at a given timestamp (instant)

```
http_requests_total                    # all time series with the specified metric name
```

- Range vector selectors work the same way but for a range
- A time range is appended at the end of the selector
- It specifies how far back in time values should be fetched

```
http_requests_total[5m]                # values for the 5 minutes
```

https://prometheus.io/docs/prometheus/latest/querying/basics/#time-series-selectors

Selectors and Label Matchers

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- We can select just some of the time series for a metric with **exact match**

```
http_requests_total{job="web",os="win"}
```

- Other operators include **not equal** (!=)

```
http_requests_total{job="web",method!="POST"}
```

- **regex-match** (=~)

```
http_requests_total{job="web",environment=~"stage|dev|test"}
```

- and **not regex-match** (!~)

```
http_requests_total{job="web",host!~".*dev.*"}
```

https://prometheus.io/docs/prometheus/latest/querying/basics/#time-series-selectors

Time Durations and Modifiers

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- **Time durations** (**ms**, **s**, **m**, **h**, **d**, **w**, **y**) are specified like **[5m]** and can be concatenated

```
http_requests_total{job="prometheus"}[1h5m]   # values for the last hour and 5 minutes
```

- **Offset modifier** can be used to change the **start point in time**

```
http_requests_total offset 5m                 # value as of 5 minutes ago
```

- **@** modifier is used to change the evaluation time for individual instant and range vectors
- **Offset** and **@** can be combined. In addition, we can use the **start()** and **end()** functions

```
http_requests_total offset 5m @ 1646937045    # value as of 5 min before 20:30:45
                                              # on 10.03.2022
```

https://prometheus.io/docs/prometheus/latest/querying/basics/#time-series-selectors

Operators *

- **Arithmetic** binary operators (**+**, **-**, *****, **/**, **%**, **^**) between scalar/scalar, vector/scalar, and vector/vector value pairs
- **Comparison** binary operators (**==**, **!=**, **>**, **<**, **>=**, **<=**) between scalar/scalar, vector/scalar, and vector/vector value pairs
- **Logical/set** binary operators (**and**, **or**, **unless**) between instant vectors
- **Aggregation** operators (**sum**, **min**, **max**, avg, etc.) on a single instant vector

(1) Trigonometric binary operators are omitted from the list above

(2) Operations between vectors attempt to find a matching element in the right-hand side vector for each entry in the left-hand side. Two types of matching behavior - one-to-one and many-to-one/one-to-many.

https://prometheus.io/docs/prometheus/latest/querying/operators/

Alerting

Introduction

Alerting

- Separated into two parts
- **Alerting rules** in Prometheus servers send alerts to an **Alertmanager**
- Then it manages those alerts including **silencing** (mute), **inhibition** (suppress), **aggregation** (group), and **sending out** notifications
- Notification methods include **email**, **on-call notification systems**, and **chat platforms**

Configuration

Software University

- Configured via **command-line flags** and a **configuration file**
- Command-line arguments are used to configure **immutable system parameters**
- Configuration file defines **inhibition rules**, **notification routing** and **notification receivers**
- The **visual editor** can assist in building routing trees
- The configuration file is in **YAML** format
- It can be reloaded (including any rules) by sending
  - **SIGHUP** to the Prometheus process
  - **HTTP POST** request to **/-/reload** endpoint (***--web.enable-lifecycle*** flag)

https://prometheus.io/docs/prometheus/latest/configuration/configuration/

Practice: See It in Action

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Grafana

Getting to Know Grafana

Introduction to Grafana

- Grafana is a complete observability stack
- Monitor and analyze metrics, logs and traces
- Query, visualize, alert on and understand our data
- Create, explore, and share beautiful dashboards
- Offered in three variants – **open source**, **cloud**, and **enterprise**
- Includes additional components like **Loki** and **Tempo**

Installation (on-prem)

- **Native packages** (for various Linux distributions)
- Windows installation either with **installer** or **binary**
- macOS via **Homebrew** or **standalone binaries**
- Docker image – **Alpine** or **Ubuntu** based
- Supported databases are **SQLite**, **MySQL**, and **PostgreSQL**
- Supported browsers are **Chrome**, **Firefox**, **Safari**, and **Edge**

Administration

- Server level settings are spread across three files **defaults.ini**, **grafana.ini**, and **custom.ini**
- We can control the instance and the server
- There is **Grafana CLI** which can be used to automate stuff
- It can be set up for high availability

Data Sources

- Most popular are supported out of the box
- Prometheus, Graphite, OpenTSDB, and InfluxDB
- Loki and Elasticsearch
- MySQL, PostgreSQL, MicrosoftSQL
- Cloud services
- Many enterprise and third-party plugin

Panels. Visualizations. Dashboards

- Panels are the building blocks of dashboards
- They connect via query to a data source
- On them we use different visualizations
- Those can be time series, charts, gauges, tables, etc.
- We then assemble panels as a dashboard

Practice: See It in Action

Live Demonstration in Class

Resources

Prometheus

https://prometheus.io/

Prometheus documentation

https://prometheus.io/docs/introduction/overview/

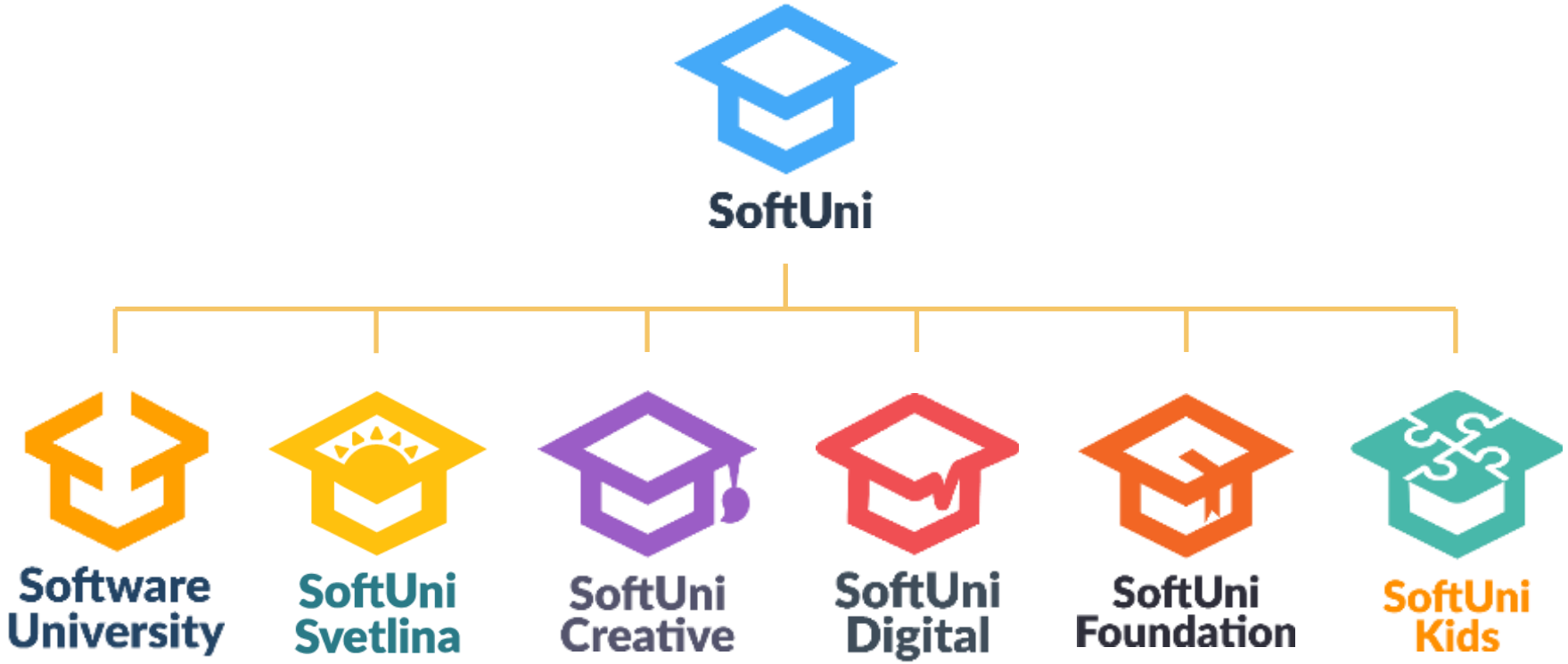
Grafana

https://grafana.com/

Grafana documentation

https://grafana.com/docs/grafana/latest/

Questions?



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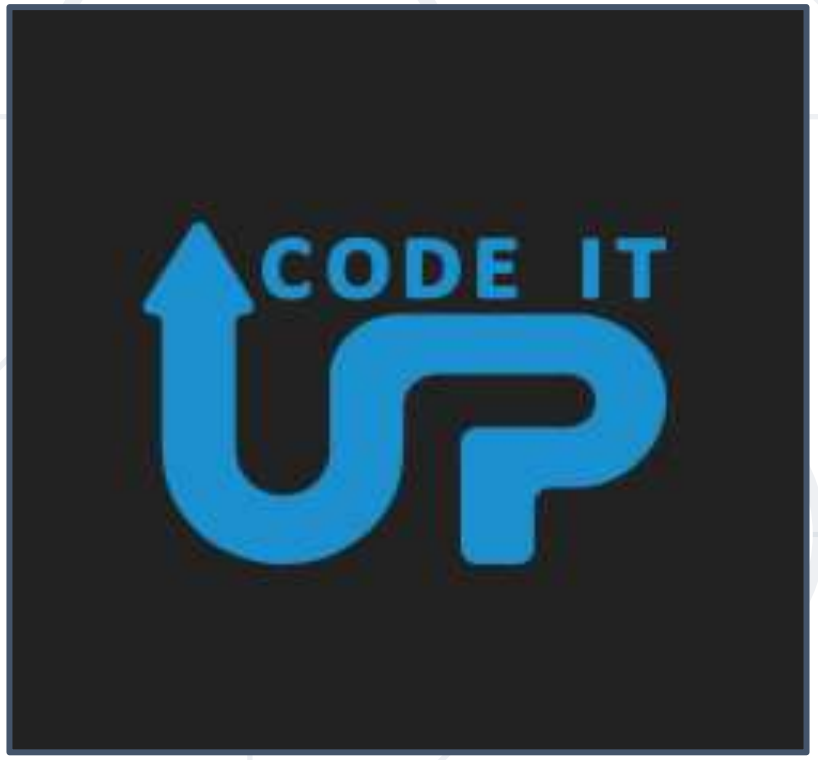

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