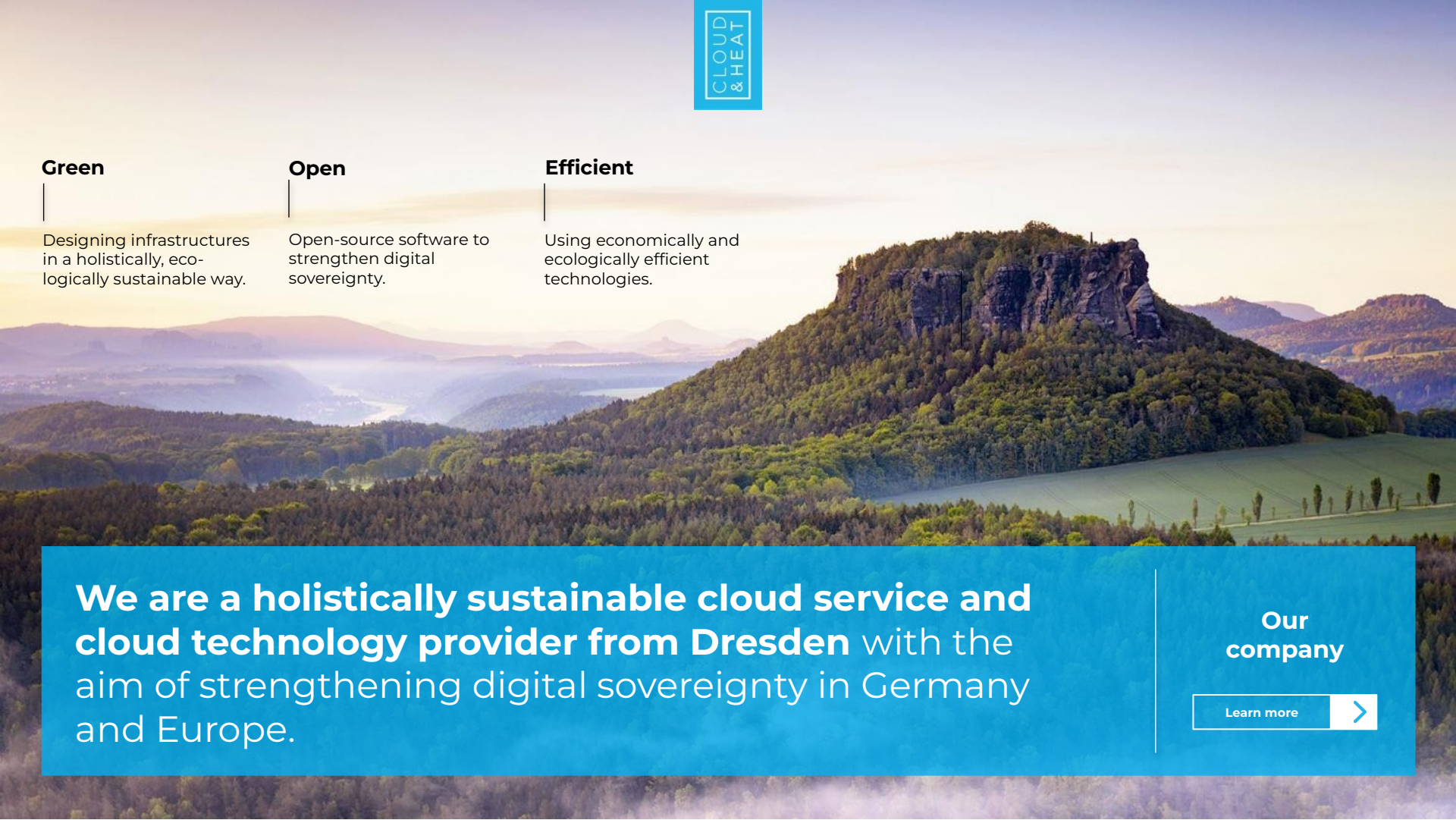
APPROACHES FOR ECOLOGICAL TRANSPARENCY IN OPEN SOURCE CLOUD INFRASTRUCTURES

INTRODUCTION

- 2016-2021: Data Analytics and Natural Language Processing
    - Building scalable microservice-based NLP/AI Pipelines
- 2021 joined Cloud&Heat Technologies
    - Presales Consultant Kubernetes Service
    - Product Owner Cloud Services

Overview Cloud&Heat and Motviation



Green

Designing infrastructures in a holistically, eco-logically sustainable way.

Open

Open-source software to strengthen digital sovereignty.

Efficient

Using economically and ecologically efficient technologies.

We are a holistically sustainable cloud service and cloud technology provider from Dresden with the aim of strengthening digital sovereignty in Germany and Europe.

Our company

Learn more

OVERVIEW PRODUCTS & SERVICES

Cloud services

Services

Infrastructure as a Service (IaaS)

With our IaaS, you benefit from a sustainable, open-source-based cloud infrastructure with a long-term proven operating concept.

Learn more

Managed Kubernetes

Concentrate on your applications, we take over the handling of your Kubernetes clusters.

Learn more

Cloud consulting

As a cloud provider, we pass on our expertise to you in customized consulting and training offers as well as hands-on.

Learn more

Digital infrastructures

On-prem-complement

Cloud&Heat Atlas

We provide you with a sustainable, digitally sovereign on-prem complete solution for your machine learning applications.

Learn more

Cloud&Heat Titan

With Cloud&Heat Titan, we offer a highly secure complete digital package for critical infrastructures (CRITIS)

Learn more

Cloud&Heat Onpremix

With Cloud&Heat Onpremix, we offer a digital sovereign on-prem complement to your existing multi- or hybrid-cloud strategy.

Learn more

Services

Customized Liquid Cooling Solutions

Our Customized Liquid Cooling Solutions improve the energy efficiency of your data centre operations.

Learn more

Infrastructure consulting

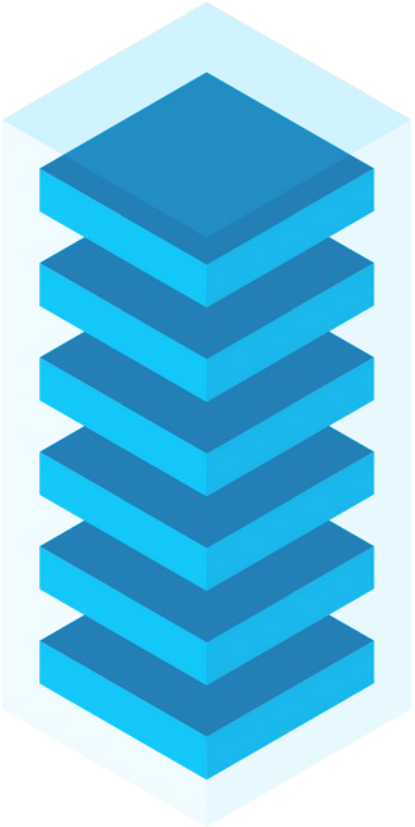
We support you with our consulting and training in planning, setting up and operating your digital infrastructure.

Directly to the training offer

Learn more

CLOUD&HEAT TECHNOLOGY STACK

THE BASIS OF OUR PRODUCTS AND SERVICES



Technology stack

Krake

R&D project for the orchestration of containerized workloads on distributed cloud platforms

Kubernetes

Managed Kubernetes service for the operation of container-based applications

OpenStack

Use of open-source technologies and de-facto standards for cloud infrastructures

Yaook

Fully automated and free OpenStack Lifecycle Management (LCM) tool

Bare Metal

Combination of hardware components (CPU, GPU, RAM, storage), configuration, monitoring and operations

Hot water cooling / waste heat utilisation

Integration and operation of direct hot water cooling systems with waste heat utilisation for heating purposes

Learn more

COMMUNITIES

SHAPING THE DIGITAL FUTURE TOGETHER

ALASCA

The association positions itself as a united cloud and open-source foundation for the joint (further) development of operational open-source projects for cloud infrastructures to strengthen digital sovereignty in Europe.

To the association

Yaook

Yaook (Yet another OpenStack on Kubernetes) is providing a fully automated and free OpenStack Lifecycle Management (LCM) and is being further developed by the open-source community within the ALASCA association.

To the project

OpenInfra Foundation

Since the founding of the Open Infrastructure Foundation, we have been an active member. We have been working with OpenStack since 2012 and have been able to build up extensive OpenStack expertise in recent years.

To the foundation

Gaia-X

Gaia-X aims to develop a secure and trustworthy data infrastructure in Europe. Cloud&Heat is involved in several working groups.

To the project

OSBA

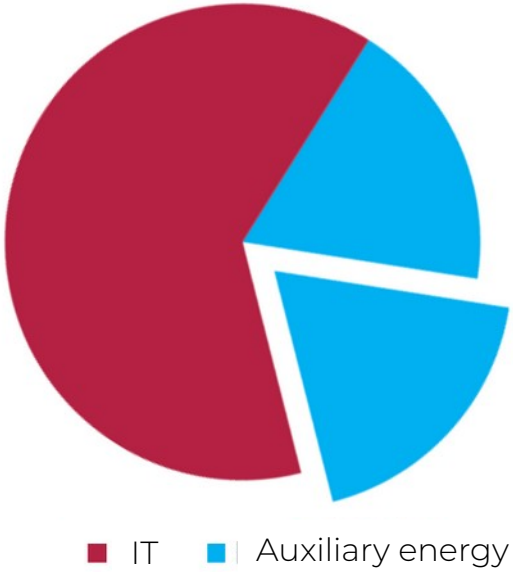
As a member of the OSBA, we work closely with the Sovereign Cloud Stack (SCS). Since June 2023, we have been a member of the working group "Cloud" with the aim of defining open standards for an open-source cloud offering in public administration and politics.

To the association

ENERGY SAVING POTENTIAL

AUXILIARY ENERGY

Electric energy demand for German data centres in 2020:



16 TWh [1]

≙ 3.2 % of electric energy production in Germany, 2020 (503 TWh [2])

5.7 TWh [1] is auxiliary energy (37 %)

50 %
savings

2.9 TWh (0,59 kWh/kWh$_{IT}$ ✉ 0,30 kWh/kWh$_{IT}$)

✉ Electric energy demand of 900,000 households

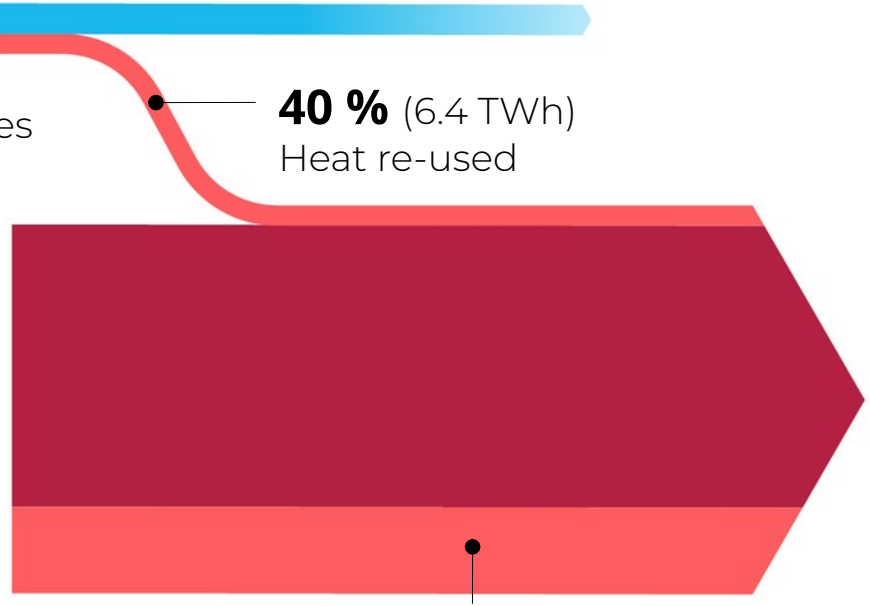
(0.6 % of electric energy production in Germany, 2020)

[1] Borderstep Institut (Hintemann, R., Hinterholzer, S.) - Rechenzentren 2021
[2] Arbeitsgemeinschaft Energiebilanzen (12/2022)

ENERGY SAVING POTENTIAL

WASTE HEAT

16 TWh[1]
Waste heat
from German data centres
in 2020



40 % (6.4 TWh)
Heat re-used

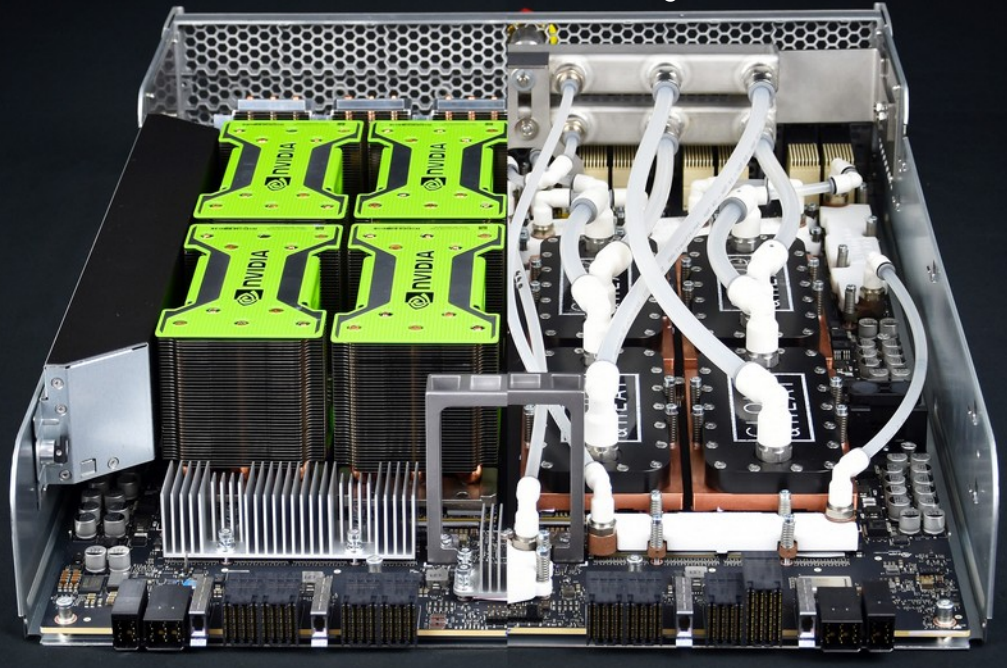
22 % renewable energy

Theoretically
5.3 % of
district heating networks
(121 TWh[2])
can be supplied by data centres

[1] Borderstep Institut (Hintemann, R., Hinterholzer, S.) - Rechenzentren 2021
[2] Anwendungsbilanzen zur Energiebilanz Deutschland für Jahre 2020 und 2021, AGEB 01/2023

COOLING SYSTEM

SERVER COOLING METHODS – AIR COOLING VS. DIRECT LIQUID COOLING



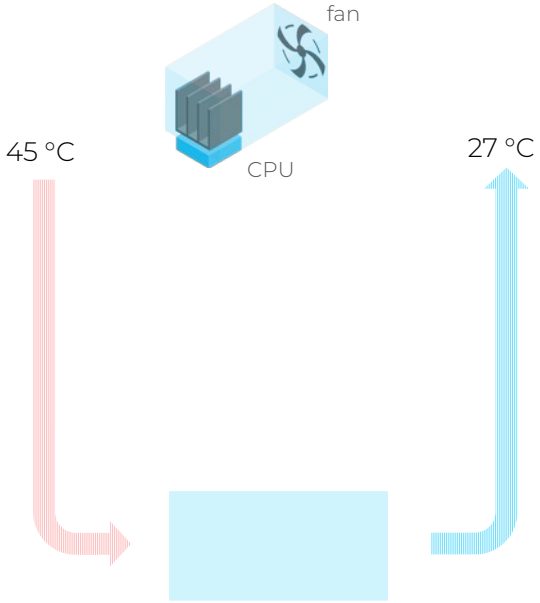
Air cooling

Direct liquid cooling

COOLING CONCEPTS

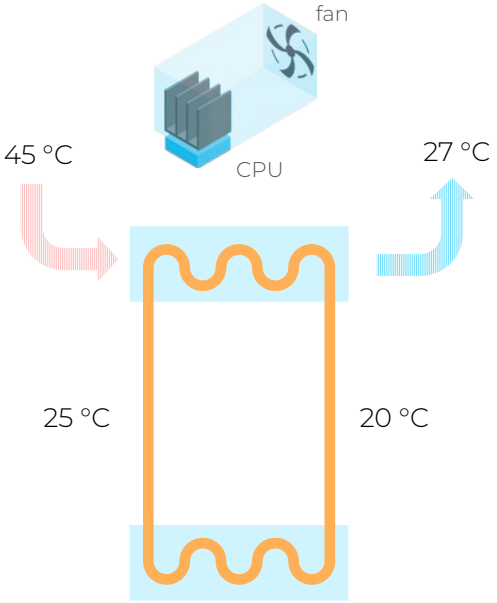
POTENTIAL FOR WASTE HEAT UTILIZATION

Air cooling



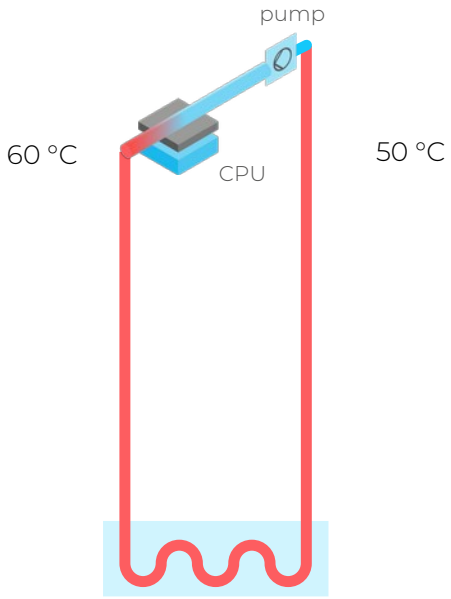
Heat extraction from 45 °C air

Indirect liquid cooling



Heat extraction from 25 °C liquid

Direct liquid cooling

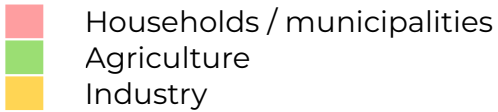


Heat extraction from 60 °C liquid

POTENTIAL FOR WASTE HEAT UTILIZATION

SELECTION OF UTILIZATION SCENARIOS

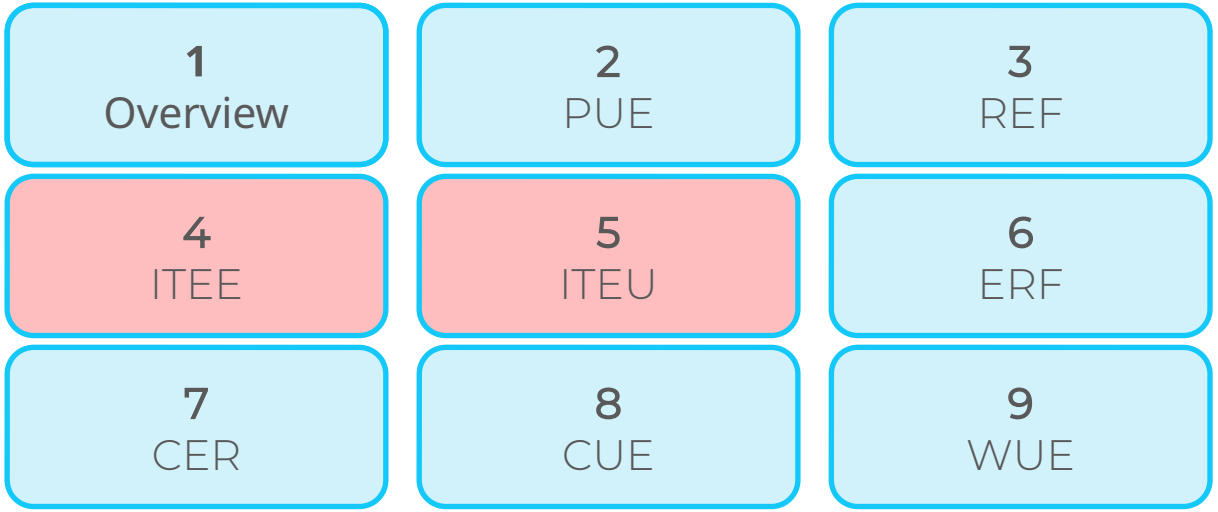
Szenario	Typ. Power in kW	Temperature in °C: 0 10 20 30 40 50 60 70 80 90 100 110
Heating	5 - 100	
Warm water	5 - 100	
District heating	25 - 1000	
Pool heating	8 - 300	
Adsorption cooling	20 - 5000	→
Sea water desalination (MED)	2 - 160	→
Pitch heating (stadium)	10 - 1400	
Indoor-Farming	1 - 300	
Fish farming	5 - 100	
Algae farming	10 - 100	
Fuel/ air preheating gas turbine	10 - 300	→
Industrial drying processes	5 - 3700	→
Water preheating	variable	→



KEY PERFORMANCE INDICATORS

DIN EN 50600-4-X AND ISO/IEC 30134-X, AS OF 2023

KPI Standards



Key:

- DIN EN 50600-4-X
  ISO/IEC 30134-X
- ISO/IEC 30134-X

KEY PERFORMANCE INDICATORS

PUE - POWER USAGE EFFECTIVENESS

How much auxiliary energy do I need **in addition** to the energy my servers need?

KEY PERFORMANCE INDICATORS

PUE - POWER USAGE EFFECTIVENESS

KPI:	KPI function:
PUE	Energy efficiency of the data centre infrastructure

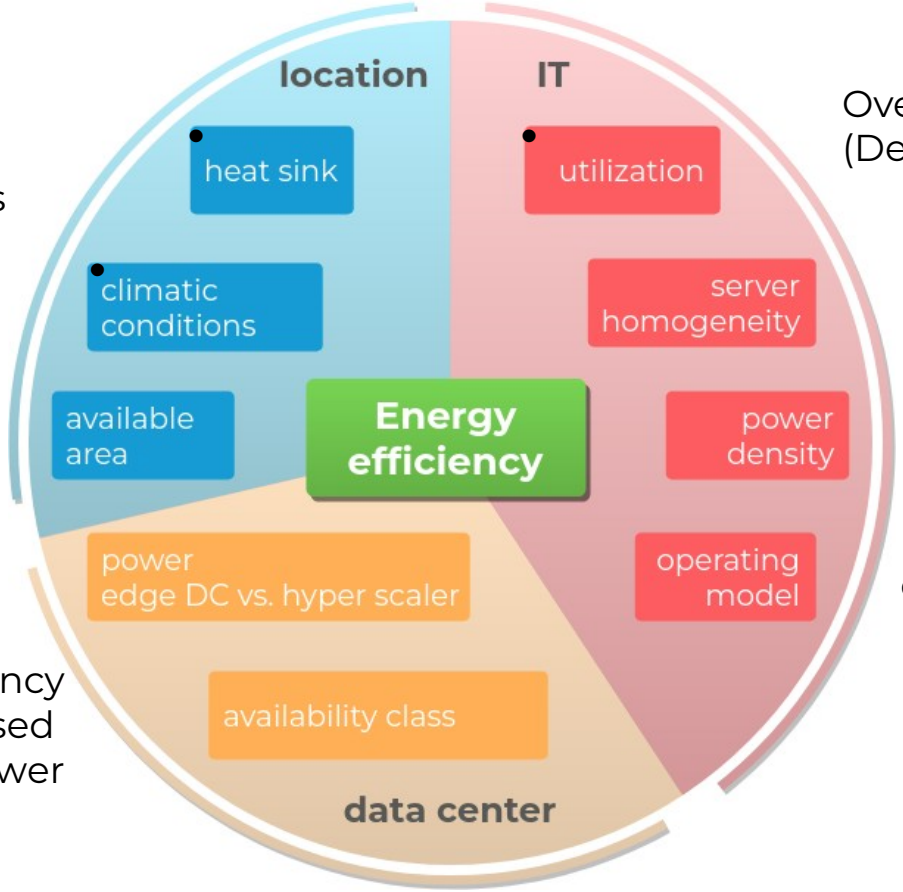
Formula:	Unit:	Value:	Period:	Standard:
$PUE = \frac{DC\ Energy\ demand}{IT\ Energy\ demand}$	–	> 1	1 year	EN 50600-4-2

Definition:	Emergency power supply:
Energy demand of the whole data centre compared to the energy demand of the IT	Back-up power supply must only be accounted for if it exceeds 1% of the total energy demand

Meaning:	Derivates of KPI:	
PUE – 1 is the energy demand of the data centre infrastructure, lower PUE means better efficiency	*iPUE, pPUE, dPUE, idPUE, pdPUE und ipdPUE*	
	DCiE – data centre infrastructure efficiency	$DCiE = \frac{1}{PUE}$

ENERGY EFFICIENCY

EXTERNAL INFLUENCING FACTORS



Proximity and characteristics

Free cooling limit

IT power density cooling method

Cooling method waste heat utilization

Higher redundancy level = increased auxiliary power

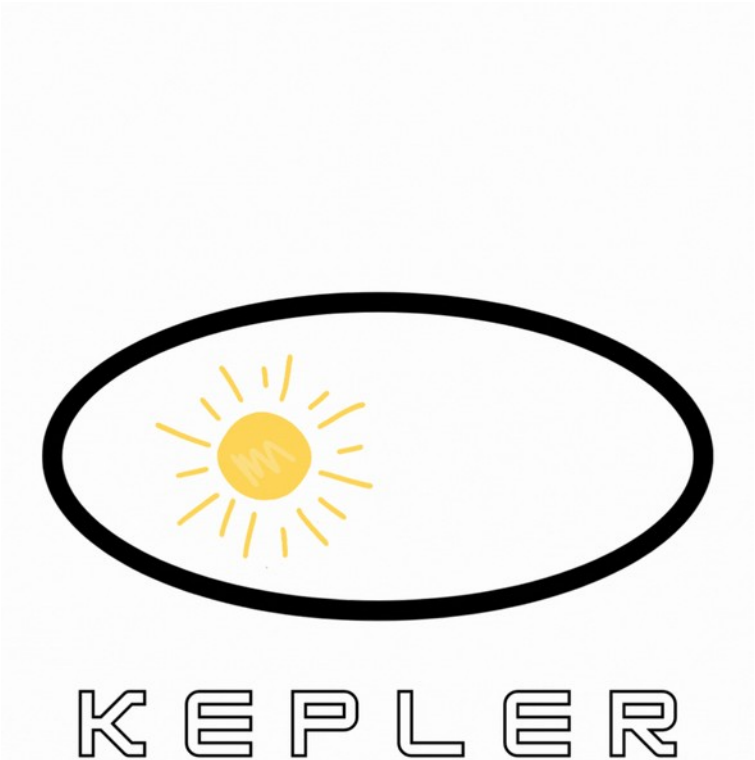
Over- / undersized infrastructure (Design vs. Load)

Cooling method

Cooling method

E.g. co-location DC: decreased influence on IT hardware selection

Tooling

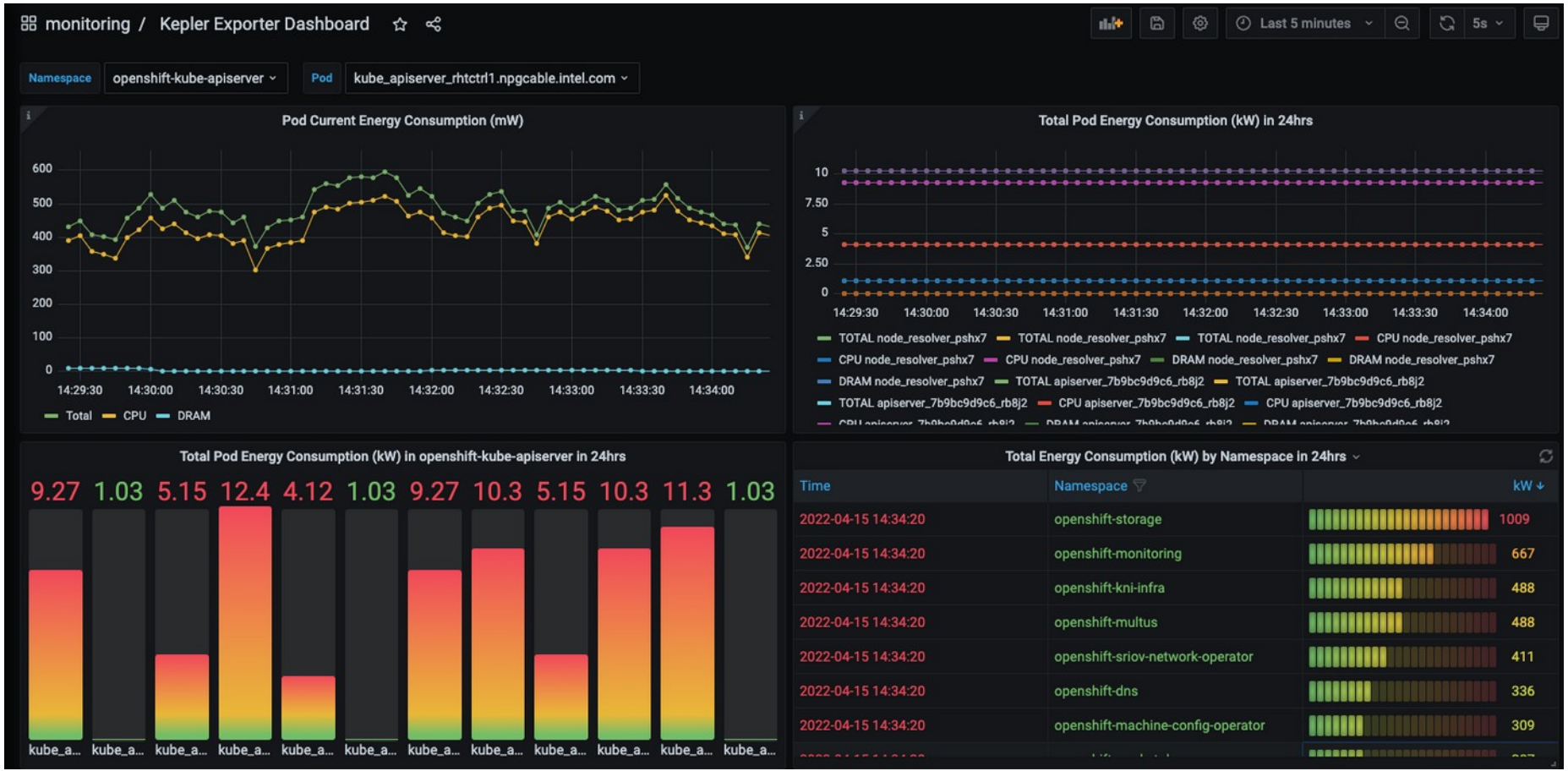


Kepler (Kubernetes-based Efficient Power Level Exporter) uses eBPF to probe performance counters and other system stats, use ML models to estimate workload energy consumption based on these stats, and exports them as **Prometheus** metrics

We are a Cloud Native Computing Foundation sandbox project.

CLOUD NATIVE COMPUTING FOUNDATION

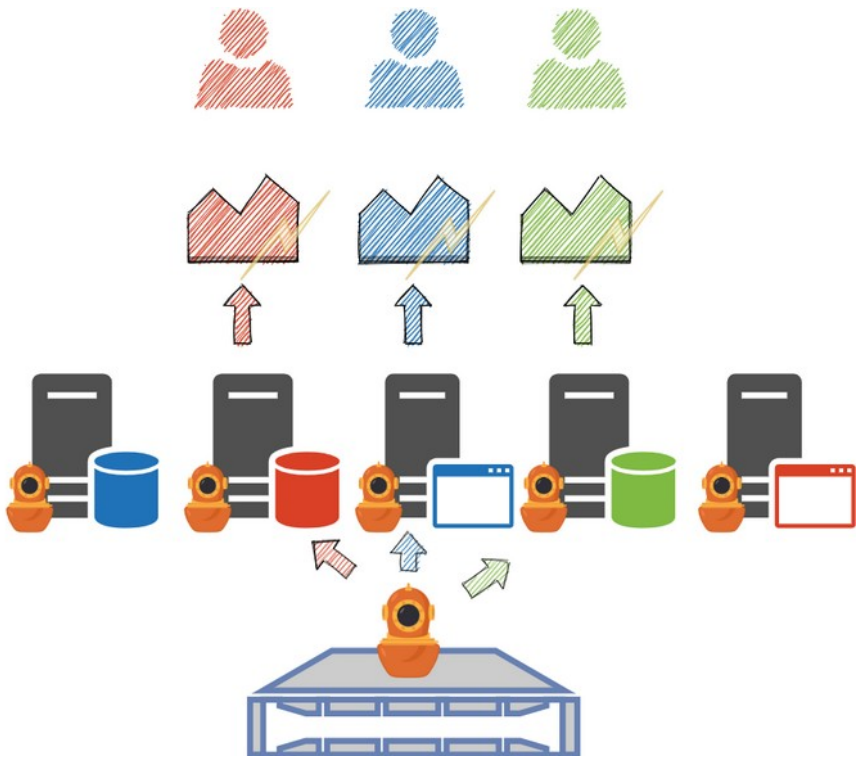
VISUALIZING KEPLER METRICS



SCAPHANDRE

Scaphandre is a monitoring agent, dedicated to energy consumption metrics. Its purpose is to help measuring and thus understanding tech services energy consumption patterns. This could be used, to enable the tech industry to shift towards more sustainability.

SCAPHANDRE



Enabling a communication between a scaphandre instance **on the hypervisor/bare metal** machine and **another one** running **on the virtual machine**. The scaphandre agent on the hypervisor will **compute the metrics meaningful for that virtual machine** and the one **on the VM access those metrics** to allow its user/administrator to use the data as if they had access to power metrics in the first place (as if they were on a bare metal machine).

This allows to break opacity in a virtualization context, if you have access to the hypervisor, or in a public cloud context if the provider uses scaphandre on its hypervisors.

(On Qemu/KVM hypervisors)

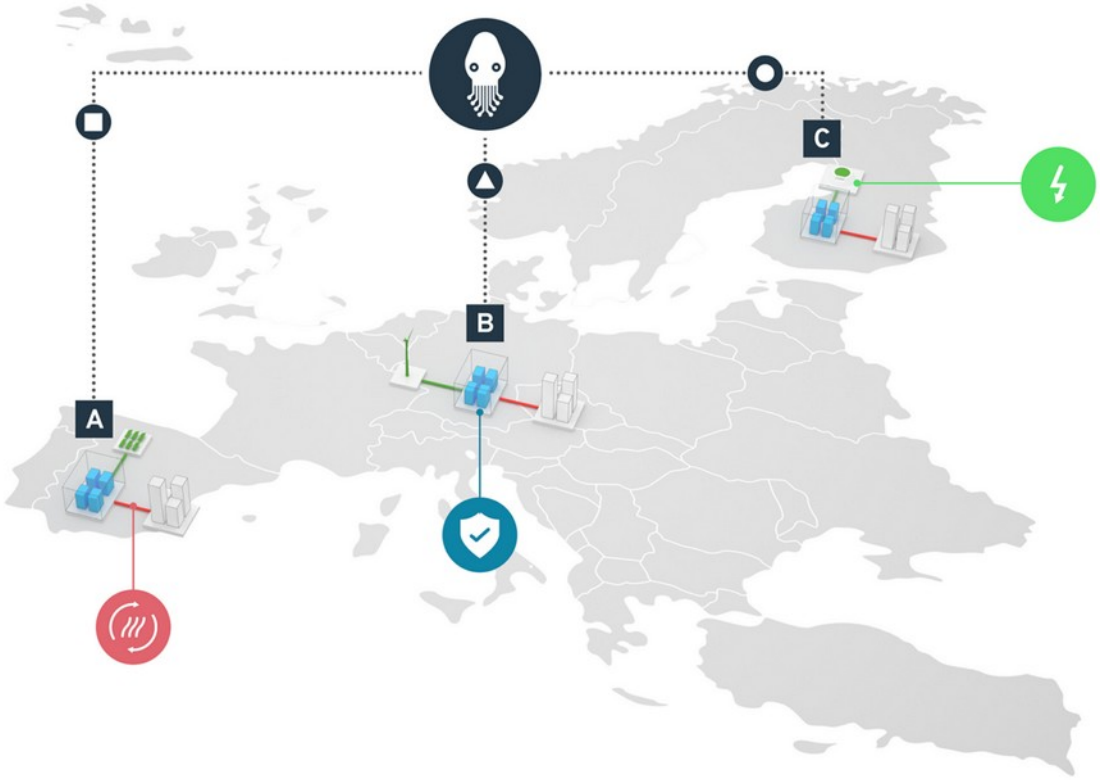
SCAPHANDRE – PROCESS LEVEL POWER CONSUPMTION

KRAKE

MAXIMISING THE ENERGY EFFICIENCY OF COMPUTING JOBS WITH OPEN SOURCE SOFTWARE

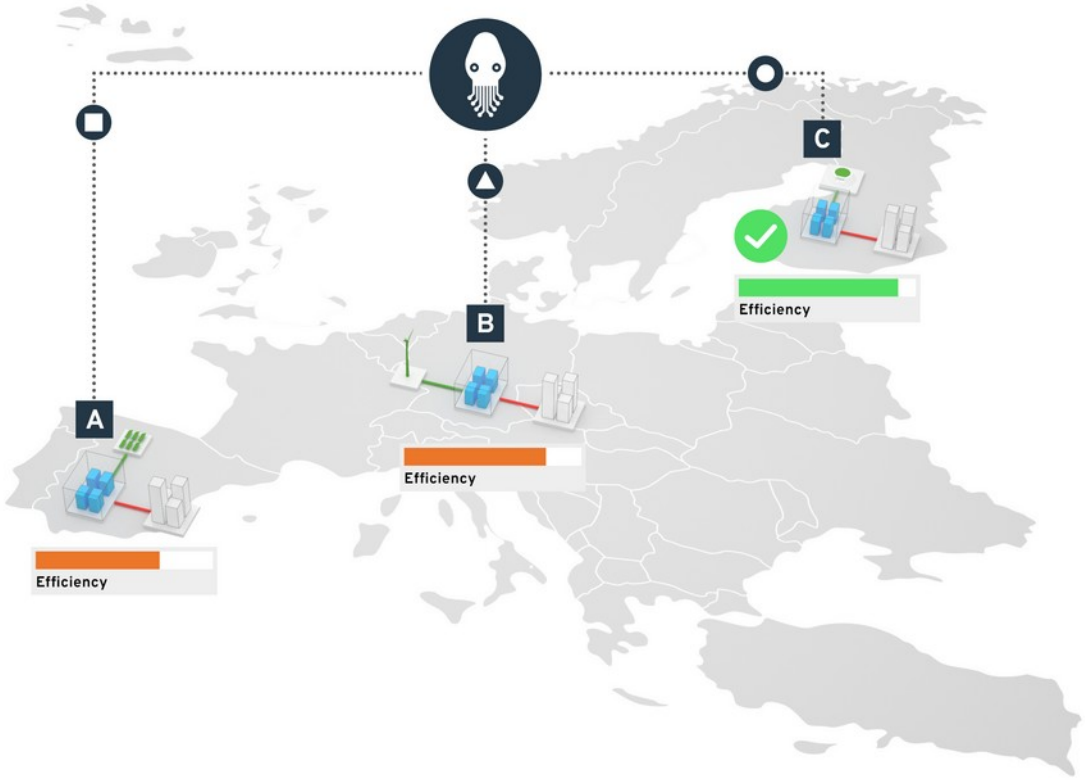
INTRODUCING KRAKE

REQUIREMENT-OPTIMISED WORKLOAD DISTRIBUTION



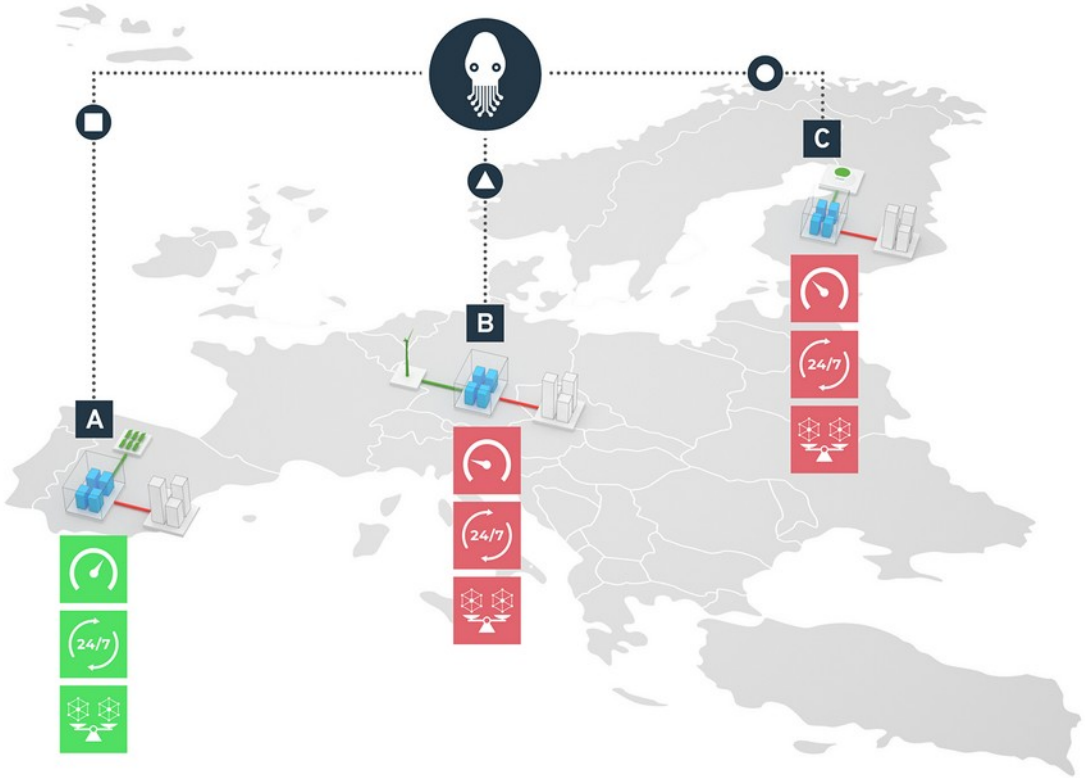
INTRODUCING KRAKE

ENERGY-OPTIMISED PLACEMENT OF WORKLOADS



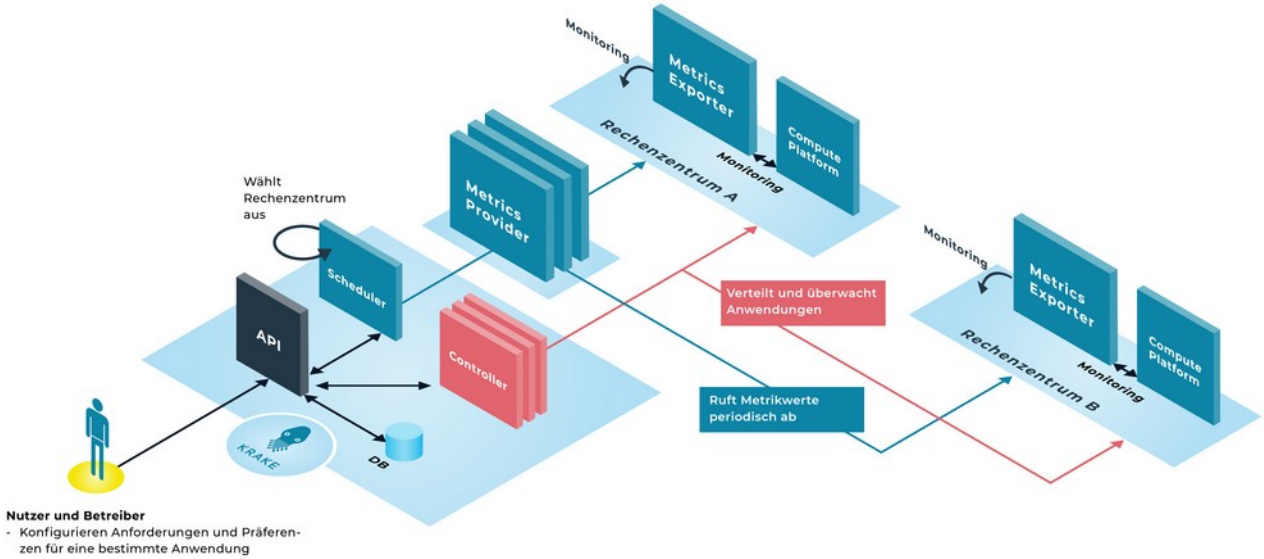
INTRODUCING KRAKE

PLACEMENT OF WORKLOADS BASED ON FURTHER INDIVIDUAL METRICS



INTRODUCING KRAKE

FUNCTIONAL OVERVIEW



KRAKE

NOMINATED FOR SAXON DIGITAL PRIZE 2024

https://buergerbeteiligung.sachsen.de/portal/smwa/beteiligung/themen/1040556

MOTIVATION AND ONGOING PROJECTS

INTEGRATION OF KRAKE INTO TELLUS*

- Tellus is a Gaia-X research project funded by the Bundesnetzagentur
- The goal is to simplify the composition of cloud and network services while ensuring end-to-end service quality
- Krake, an open-source tool for automatic service orchestration in containerized environments, is being integrated into Tellus
- Krake should be used to proactively reschedule the composite service in case the user-defined requirements are at risk of being compromised. This can happen if a service being used fails or its performance declines. In such cases, Krake steps in to transparently and effectively reschedule in order to satisfy the user's needs

** This project is funded by the funding competition "Innovative and practical applications and data spaces in the digital ecosystem GAIA-X" of the BMWK.*

MORE ABOUT KRAKE

RESOURCES / GET IN TOUCH

More Information on Krake and how to get involved:

- https://krake.cloud
- https://gitlab.com/rak-n-rok/krake

- In November 2023, Krake found its new home at ALASCA - a non-profit organisation for the (further) development of operational, open cloud infrastructures
- More about ALASCA: https://alasca.cloud

When and where?

- 29 and 30 October 2024
- German Hygiene Museum Dresden